MODELLING MARINE ACCIDENTS ECONOMIC LOSS AND THE COMPENSATION IN NIGERIA

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CERTIFICATION

This is to certify that this Dissertation **"Modelling Marine Accidents Economic Loss and the Compensation in Nigeria"** was carried out by **NWOKEDI, THEOPHILUS C.** with the Registration Number **(20124771658)** in partial fulfilment of the requirements for the award of Doctor of Philosophy Degree (Ph.D) in Maritime Management Technology, School of Management Technology, Federal University of Technology, Owerri.

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DEDICATION

To my only hope of fulfillment - Our Lord Jesus Christ for always graciously upholding me amidst all of life's challenges.

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ABSTRACT

The aim of the study was to develop models of empirical relationships and elasticity coefficients that will serve as strategic tools for ensuring that, marine underwriters reserve adequate funds to maintain financial solvency for ensuring timely, adequate and sustainable compensation of marine accidents economic loss, for all kinds of insured marine risks, in Nigeria. The study used triangulation design method and obtained time series data on annual marine damage accidents economic costs, compensation funds reserved for insured marine risks, death and injury marine accidents, values of seaborne trade exposed to perils of the sea and per capita output, from the Nigerian Insurers Association (NIA), Central Bank of Nigeria (CBN) Statistical Reports, and Department of Petroleum Resources (DPR) offshore oil and gas incidents Reports. Questionnaire was used as survey instrument to obtain primary data on externalities costs to third party operators affected by marine oil spill accidents impacts on the marine ecosystem. The multiple regression method was used to model the relationships between the dependent and independent variables while the Log-Log constant elasticity model was used to establish the respective coefficients of elasticity. The Gross Output Model (GOM) was used to quantify the output losses occasioned by death cum injury marine accidents, for compensation purposes, while the Willingness to Accept (WTA) method of the Contingent Valuation Method (CVM) was used to evaluate the externalities costs and output losses to third party operators affected by marine accidents ecosystem damages, for purposes of providing adequate levels of compensation funds for indemnification of insured marine risks. It was found that, there exists significant relationships between shipping accidents economic loss and value of seaborne trade. The elasticity of shipping accidents economic loss to growth in value of seaborne trade over the period covered in the study shows that it was inelastic (E<1). The coefficient of elasticity of offshore O&G damage accidents economic loss to growth in maritime trade is 2.376. The mean economic costs of death and injury marine accidents to be compensated by underwriters per annum over the period is 4797662.92USD and 279181.17USD respectively with respective average rates of change of 1399708.27USD and -29587.88USD. The result also shows that, the Mean Willingness to Accept Amount (MWTA) which indicates the externalities cost of marine accidents damages to each third party operator affected by oil spill accidents and which underwriters are to provide adequate compensation is: ₦1,629,610 per annum per capita. The study developed the following models of relationship as contribution to knowledge: $SHAL_t = 2430145.277 + 0.34IMPSTRADE_t + 0.051EXPSTRADE_t + e$; **_and_** $OFFAL_t = 123404.891 + 0.321IMPSTRADE_t + 0.121EXPSTRADE_t + e$.

$InMAPRE_t = 11.021 + 0.364InSHAL_t + e$; **_and_** $InOGRE_t = 16.879 + 0.037InOFFAL_t + e$.

$COMPEN_{percapital} \geq ₦1629610[1+ r]^n$; *and* $COMPEN_{aggegate} \geq ₦1629610[X_n][1 + r]^n$.

Also: $\Delta MAPRE_{death} \geq 1399708.265USD$. *It was recommended that compensation funds reserved by underwriters for indemnification of insured unexpired marine risks must increase proportionately in line with growth in value of seaborne trade exposed to sea perils and maritime accidents economic loss, indicated by the elasticity and rate of change coefficients.*

Keywords: marine, accidents, economic-loss, compensation, Nigeria

CHAPTER ONE

INTRODUCTION

1.1 The Background Information

The history of marine navigation provides evidence that, the sea has always been synonymous with uncertainty, absence of safety, and insecurity for those who venture into it (Volker, 2014). This endemic absence of safety probably explains why early seaborne trade and navigation remained the preserve of adventurers.The sea was associated with the idea of uncertainty, chance or fate, leading to concepts and expressions such as "marine perils" or "perils of the sea", which is still widely used today in expressing the absence of safety in marine adventures (Volker, 2014). Maritime operations and seaborne trade evolved in such a laissez – faire manner that, the many acciden0074s of which navigators and seamen were victims, were soon accepted, as part of the natural course of things. Boisson (1999), noted that, the frailty of the human factor, in the face of the inexhaustible and indefinable sea, confers on the effort of navigation and seafaring, the character of a bold venture, which may succeed and prove quite profitable, but which can also fail and cause irreparable losses. Like the Greek proverb says "He that would sail without danger must never come on the main sea". The danger of sailing into the sea therefore encompasses the risk of injury, death, loss of valuable properties and investments of economic value, among others. The marine ecosystem, particularly the seas, is seen to have inherent potentials of risks of accident, whose occurrence is deemed disastrous to navigation, health of navigators, maritime operations, seaborne trade, and productivity.

Accidents are defined as the occurrences of unexpected events, leading to damages, injury or death. Accidents occur as a result of exposure to risks and/or hazardous conditions in an ecosystem. Marine accidents are the occurrences of events by chance, leading to damages, injuries and/or death in the marine ecosystem/environment. Marine accidents most times are ship-based, following her exposure to marine perils and/or dangers of the sea. The marine ecosystem/environment in this context extend beyond the zones of the ocean environment based on the United Nations Convention on Laws of the Seas (UNCLOS, 1982) into territorial seas, the contiguous zones, the exclusive economic zones and the high seas. It includes the internal waters and inland waters, the continental shelf, the seaports, the dockyards and other land areas, at which ships and seaborne trade are harnessed for marine operations and for purposes of transport by sea, and which can be covered by a policy of marine insurance. Vessel based marine accidents may be caused by grounding, overloading, fire outbreak, human error, weather hazards, siltation, wreckages, faulty machinery, poor channel dredging, explosion, leakages and collision (Ndikom; 2006, Risto and Kim, 2009). Volker (2014) also views the concept of marine accident as the occurrence of an unforseen event, in a ship or involving properties exposed to the marine environment, that, resulting to injuries to persons and/or damages to properties or investments. It encompasses accidents at sea or in port, quayside or anchorage, dockyards or shipyards, inland waterways and territorial waters etc. We thus defined marine accidents in the context of this study as the occurrence of unforeseen events leading to damages to investements, injury and death of crew, damage to the marine ecosystem among other costs, caused by exposure of ships, equipment, properties and seaborne trade to risks and marine perils, provided that, the accidental objects are at sea or being harnessed for sea movement, in port or in dockyards and can be protected by a policy of marine insurance. It is immaterial whether the vessel or object involved in accident is sailing or stationary at the point and time of accident. The Marine Accident Casualty Investigation Board (MAIB, 2008) corroborates the view expressed in the definition above and defines a marine accident as one or more unexpected and undesired marine incident, which result in death or personal injury to crew, damage or loss of marine properties and seaborne trade and harmful to the marine ecosystem. International Maritime

Organization (IMO,1997) supported by Marine Insuranca Act (MIA,1906) explains perils of the sea as hazards of the sea which makes vessels, underwater installations, seaborne trade, oil and gas drilling rigs and platforms, on-board personnel, etc, vulnerable to risks of marine accidents with the attendant economic losses.

The exposure of maritime properties and investments in ships to hazards and perils of the sea, necessitates the application of formal safety assessment (FSA) and other forms of risk assessment methods as well as proper implementation of other IMO convention instruments, to limit the occurrence of marine accidents and consequent economic risks. While marine incidents are near misses with no injury, death nor damage records, accidents cause damages, injuries and even death.

We thus in line with the opinions expressed by Ando (2004) and Demarco, Rob and Thomas (1997) classified marine accidents into classes purely based on the nature of economic consequences and impacts to include: damage accidents (this covers shipping accidents losses, and offshore oil and gas (O&G) drilling accidents economic losses), marine oil spill accidents (marine environmental pollution inducing accidents), marine injury accidents (accidents involving injury to crew) and fatal and/or death accidents (accidents involving death of members of martime labour force/seamen). Based on the categorization above, the social costs of marine accident encompassing the costs to the shipowners and shippers as well the society (external individuals and third parties) can be modeled for purposes of providing adequate compensation. The categorization of the costs aasociated with marine accidents for purposes of compensation is presented in the Figure below:

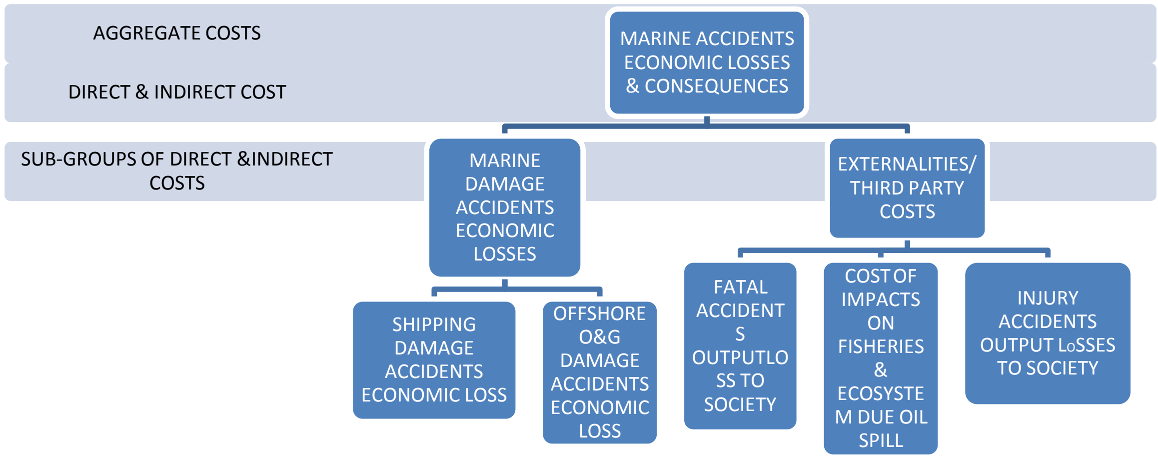


Figure 1.1: Classifications of Marine Accidents based on economic consequences and costs for compensation purposes. (Source: Prepared by author.)

The above classifications indicate the following cost structures: marine damage accidents, injury accidents, fatal/deaths accidents (marine liability cost), ecosystem damage accidents (environmental pollution inducing accidents). While the carriers (shipowners) and shippers are affected by damage accidents causing direct damages and losses to the ship and seaborne trade; injuries and deaths and the associated output losses are are borne by the society and the affected seafarer's families who are external parties to the investment in seaborne trade and ships.

The environmental damages occasioned by ship-based oil spill in the ecosystem are borne by the coastal communities and larger society as external parties whose fishing occupation and dependence on the marine biodiversity for sustenance is adversely affected. Therefore, from the perspective of the shipowners, maritime operators and shippers, marine accidents induce economic losses on their operations equivalent to the value of direct damages done to the accidented maritime investment and/or property (MAIB, 2008). The injured and dead maritime workers following the occurrence of marine accidents suffers and/or causes the economy to suffer output losses equivalent to the economic cost of injury and death. The loss of outputs due to environmental damages and/or pollutions occasioned by marine accidents are equally borne by the society as the equivalent of the economic value of marine biodiversity/wide fishery resources destroyed (Volker, 2009).

Over the years, marine accidents have imposed enormous economic losses on seaborne transnational commercial trade and led to wastages and destruction of global and national productive capital bases in human capital, marine ecosystem and investments in the maritime industry. About 90% of global transnational commercial trade transits by sea transport, these seaborne cargoes, the vessel, the marine environment and resources, the humans that harness them, all constitute productive capital. A right combination of the factors of production produces acceptable and profitable levels of output and gingers economic growth and development with multiplier effects that sustains the developmental needs of the blue economy and future generations.

Thus, productivity, economic growth and development are retarded while sustainable development cannot be guaranteed unless these losses are adequately compensated for in order that operators and shippers can remain in operation while the effects on the fishermen and others who depend on the marine ecosystem for economic sustenance in the coastal communities and general society is equally adequately compensated. Similarly, victims of marine accident death and injury need adequate compensation through maritime employee liability insurance, in order to protect the society from the backlash effects.

Maritime accidents economic loss is thus the financial and/or fiscal value of damages to marine property/investment, environmental danmages, injury, death, cargo etc. It is evident from the above explanation that, marine accidents have serious commercial and financial consequences reffered to as the marine accidents economic losses for which optimal compensation is necessary to ensure sustainability of maritime operations. The concept of marine accidents loss compensation is an economic loss control and risk management approach targeted at mitigating the financial consequences of marine accidents (marine accident economic losses) in order to sustain maritime operations and protect the society against the economic consequences and impacts of marine accidents. In the maritime industry, there exist many loss control measures such as risk aversion, risk reduction, risk retention etc., but the most widely adopted practice is marine insurance (risk transfer) which adopts indemnification principle to provide cover to and compensate maritime operators and other stakeholders at the occurrence of insured risks (IUMU, 2011). This practice has over the years been developed further by Acts of parliament made as compulsory measures for marine accident loss compensation in Nigeria's maritime industry and globally. This is important because, the quest for sustainable development of the blue economy cannot be actualized in the face of random wastages and accidental destruction of the productive capital base occasioned by marine accidents, without a loss control system that provides commensurate compensation for such economic risks via indemnification.

The viability, performance and capacity of such a loss control system to optimally meet the needs of the industry is however dependent on the availability of fairly accurate data of the level and quantum of economic risks being imposed by marine accidents in the economy.

The foregoing is part of the reasons that ignite the coastal nations to establish marine safety administration agencies and policies to limit the effects of unsafe practices leading to accidental wastages. The institution of professional accident investigation boards and the compulsory requirement of a marine insurance policy cover for all vessels, marine-based operations and seaborne trade are also aimed at providing data for indemnifying commercial and financial consequences of marine accident, to ensure sustainable maritime operations.

In Nigeria, United Nations Convention on Trade and Development (UNCTAD, 2014) reports that, seaborne container traffic to Nigerian ports stood at two million, Seven hundred and twenty thousand ,four hundred and twenty two TEUS (2,720, 422 TEU'S), representing an average of nine hundred and nine thousand four hundred and seventy four TEU'S (909,474 TEU'S) per annum, between the 2011 to 2013 period. National statistics indicate that, the total value of export shipping trade and imports shipping trade in the year 2013 were fourteen trillion, seven hundred and thirty five billion, nine hundred and seventy seven million, seven hundred and sixty thousand naira (14,735,977,760,000.00) and nine trillion, eighty four billion, four hundred and fifty four million, seven hundred and thirty thousand naira (9,084,454,730,000.00) respectively, while the cargo throughput of the Nigerian ports excluding crude oil terminals in the same year was 76,886,997 million metric tons (CBN, 2014; NBS,2014; NPA,2014). Further reports from the Nigerian Ports Authority (NPA) reveals that in the year 2013, 5232 ships transited to the ports of Nigeria while an average of 2,200 offshore service boats serviced the logistics needs of the oil and gas industry in the coastal trade, (NPA, 2014). Within the Nigeria coastal regions and internal waters, runs extensive oil pipeline networks of over 7000km extending to the shores and numerous oil exploration and exploitation platforms. The above statistics represent the economic strengths and productive capital base of the blue economy of the Nigeria exposed to the perils of the sea with likelihood of accidental damages with economic consequences. Reports by the Nigeria insurance digest suggests that, the economy lost averages of one-billion six-hundred and thrity-three-million six-hundred and thrity-three-thousand three hundred naira (1,633,633,300 naira) and Nine billion one-hundred and sixty-million four-hundred and fourty-four-thousand seven-hundred and thirty-three naira (9,160,441,733.3naira) due to shipping accidents and accidents in offshore oil and gas drilling operations respectively each year between 1984 and 2013.

As aforementioned, there exist a developed marine underwriting sub-sector in the Nigerian insurance industry with the responsibility to provide cover and structure for compensation of insured marine risks to maritime operators. This sub-sector however seems to lack an optimal structural framework backed with fairly accurate data on the volumes and quantum of economic losses in relation to the volumes and values of seaborne trade cum maritime investment exposed to accidents at sea. As a result, there persist arguments and issues of lack of capacity of the local marine underwriting sector to optimally compensate insured marine accidents economic losses in Nigeria. This has led the multi-national oil companies and the Nigeria National Petrluem Corporation (NNPC) to deny indigenous shipowners involvement in crude oil lifting contracts in Nigeria(onuoha, 2019; Adegbayi, 2017). The fishing sector and the fishermen from the coastal communities involved in wide fishing and aquaculture practices in coastal ponds within the coastal communities are rarely covered by insurance policy. As a result, it takes litigations from the organized fisher's association in coastal communities and the community pressure groups against maritime operators and the oil and gas majors to secure compensation for damages caused by marine accidents involving oil spill in the coastal ecosystem. This is against the provision of known ineternational conventions of the IMO for compensation of marine ship-based oil spill induced damages to third parties. These structural gaps argument against the current framework in use by marine underwriters for marine accidents economic risks compensation in Nigeria, stems from the seeming non-availability and/or inadequacy of marine accidents economic loss data in relation to the value and volume of maritime investments and capital base exposed to accidents in the marine ecosystem over the years.

Accidents are believed to be correlated to safety standards while safety has always been considered a critical feature in almost all marine operations; safety must have equal consideration with environmental and socio-economic impacts. To keep the economic consequences of marine accidents in good control requires proactive loss control measures which marine insurance offers. It also requires the measurement of the economic risks of marine accidents to adequately compensate and properly manage it. The Nigeria Maritime Administration and Safety Agency (NIMASA) Act made provisions for institution of an accident investigation committee, to cause an inquiry into the reported accident cases in the maritime domain of Nigeria and Nigeria flagged vessels. The Act however did not note the importance of extending investigations to finding the economic consequences and impacts of such accidents on the economy as a way of providing data both for compensation of losses by the marine underwriters and as basis for assessing the performance of safety management programmes and authorities. Safety administration should be inclusive of accident analysis and report, establishment of databases, valuation of economic risks cum impacts, environment effects, training, among other things, to which the agency seems to have not shown adequate capacity to handle over the years. It is not possible to control, manage and/or adequately compensate for the economic consequences of marine accidents, if it can't be measured first with precision.

The adequate and sustainable compensation of marine accidents economic risks in Nigeria, and the development, sustenance and growth of the blue economy cannot be actualized until the economic risks and consequences posed by marine accidents in Nigeria in relation to the value of maritime trade and investments exposed to accidents at sea, cum the compensation resources available to indemnify the losses, are measured with precision and made the reflective basis for development of the framework for the optimal compensation of marine accidents economic loss, safety management programmes and policies.

1.2 Problem Statement

The arbitrary provision in the Insurance Act 2007, for the reservation of between 25% and 45% of the aggregate premium revenue from insured marine risks, as technical reserve fund for compensation of insured marine risks (shipping risks, offshore O&G risks, etc), without recourse to the quantum of marine accidents economic loss, value of seaborne trade exposed to sea perils, and their relationships with each other and with the volume of compensation funds available for indemnification of actual losses; led to the problem of seeming financial insolvency of the local marine underwriters, to timely and adequately provide indemnification to shippers and operators, at the occurrence of insured marine risks, while the externalities cost of marine oil spill accidents damages affecting third party operators in Nigeria, are hardly adequately compensated, as they are mostly valuated through court award approaches, to the dissatisfaction of affected third parties (IMF, 2013; Nwokoro, 2015; NIA, 2007, Olukolajo, 2017; Nzeribe, 2019; Babawale, 2013; Chima 2011; Bello & Olukolajo 2016; Adekunbi and Nzeribe 2013).

The current marine accidents economic loss compensation regime in Nigeria therefore faces financial insolvency challenges, induced by the arbitrary provisions in the Insurance Act 2007; posing serious limitations to the timely and adequate compensation both insured shipping risks, offshore O&G risks, externalities cost to third party operators and maritime labour liability risks, due to the non-reservation of adequate volume of funds for this purpose. This situation endangers the local conetent development drive in the insurance sector. For example, Nigerian Government motivation to protect maritime trade and enhance local content development in the local underwriting industry, inserted the cargo insurance policy into Section 14 (3) of the National Shipping Decree 1987 which stipulates that, all public sector contracts for seaborne import and export trade shall be on free on board (F.O.B.) and cost, insurance and freight (C.I.F.) contracts respectively. The clear policy intent being that local marine underwriters will cover such contracts, to enable them develop and to reduce the effect of capital flight. In 1997, the Insurance Decree No. 2, Section 76 provided that all imports (both private and public sector imports) into Nigeria shall be on cost, insurance and freight basis only, thus recommending that both public and private sector import contracts be insured with local insurers. The above provisions were consolidated by the current regime of Insurance Act 2007, which apart from establishing a new capitalization base for all local insurance firms in Nigeria, provided for the maintenance of reserve funds for all types of insured risks of the indigenous underwriting firms, to enable them maintain solvency for timely and adequate compensation of claims and liabilities (NIA, 2007).

However, the problem with the arbitrary reservation of between 25% and 45% of premium revenue as fund for compensation of insured marine risks is that, it limts underwriters capacity to provide timely and adequate compensation to affected parties, as the growth rate of marine accidents economic loss and value of seaborne trade exposed to accidents at sea may push higher than that of funds reserved based on the arbitrary provisions. For example, NIA(2017) and IUMU (2018), reports indicate that while the average rate of growth of marine underwriters premium income is 591782448.5 naira per annum, the average rate of growth of marine accidents economic loss is 761572968.5 naira per annum, and the average rate of growth of compensation funds maintained to ensure underwriters financial solvency for compensation of insured marine risks is 135789339.4 naira per annum. This supports the findings of Nwokoro (2015) and IMF (2013) that, there is no significant difference between compensation funds reserved by underwriters to maintain financial solvency for the compensation of insured marine risks and the quantum of marine accidents economic loss in Nigeria between 1999 and 2010. The result of this is the view expressed by shippers and maritime operators that, marine underwriters in Nigeria lack financial solvency and capacity to indemnify insured marine risks. This perhaps is the cause of the continued refusal of local ship-owners involvement in oil lifting contracts originating in Nigeria, even in the present cabotage regime, by the NNPC and the multinational oil companies (onuoha, 2019; Adegbayi, 2017).

1.3 Aim and Objectives

The aim of the study is to formulate models to ensure timely, adequate and sustainable compensation of marine accidents economic loss in Nigeria based on the elasticities of the relationships between marine accidents economic loss and the value of maritime trade on one hand, and between marine accidents economic loss and compensation funds available for the indemnification of insured marine risks in Nigeria on the other hand.

The specific objectives of the study include:

1. To formulate a model for predicting shipping accidents economic loss based on the relationship with the value of seaborne trade exposed to sea perils in Nigeria.
2. To formulate a model of the relationship between Offshore O&G accidents economic loss and the value of maritime trade exposed to sea perils in Nigeria.
3. To estimate the coefficient of elasticity of compensation funds available for insured shipping risks to changes in shipping accidents economic loss in Nigeria.
4. To determine the coefficient of elasticity of compensation funds maintained for insured offshore O&G accidents risks to growth in offshore O&G accidents economic loss in Nigeria.
5. To evaluate the rate of change of the economic cost of death cum injury marine accidents in Nigeria.
6. To quantify the externalities costs of marine accidents damages to third party operators in the marine ecosystem.

1.4 Research Questions

1) Is there a significant relationship between the shipping accidents economic loss and the value of seaborne trade in Nigeria?
2) Is the relationship between offshore O&G accidents economic loss and the value of seaborne trade exposed marine perils in Nigeria significant?
3) What is the coefficient of elasticity of compensation funds available for insured shipping risks risks to changes in shipping accidents economic loss in Nigeria?
4) What is the elasticity coefficient of offshore O&G accidents economic loss to growth in offshore accidents economic loss in Nigeria over the years?
5) Of what magnitude is the coefficient of the average rate of change of the economic cost of marine accidents death cum injury risks in Nigeria?
6) How much is the externalities costs of marine accidents damages to affected third party operators in the marine ecosystem?

1.5 Research Hypotheses

Ho_1: There is no significant relationship between shipping accidents economic loss and the value of seaborne trade in Nigeria.

H_{02}: The relastionship between offshore O&G accidents economic loss and and the value of seaborne trade exposed to sea perils in Nigeria is not significant.

H_{03}: The coefficient of elasticity of compensation funds for insured shipping risks to changes in shipping accidents economic loss in Nigeria is zero.

H_{04}: The elasticity coefficient of compensation funds maintained for insured offshore O&G risks to growth in offshore accidents economic loss is zero.

H_{05}: The coefficient of the average rate of change of the economic cost of death cum injury marine accidents in Nigeria is zero.

H_{06}: The externalities costs of marine accidents damages to third party operators in Nigeria is undefined.

1.6 Justification of the Study

The study will significantly influence operations and policies of the Nigeria Insurers Association particularly, in the area of marine underwriting practice. It is of importance to the apex marine underwriting regulatory agency in Nigeria- National Insurance Commission (NAICOM), the Nigeria Shippers Council, the Nigeria Shippersand the different associations of shippers and freight forwarders in Nigeria, the Nigeria ship ownes association, as well as the offshore oil and gas industry operators.

Furthermore, the study will be very useful to the government and people of Nigeria in her drive to economic growth, local content development in the marine underwriting sector and sustainable development. This is because, the prediction models raised in the research will be useful in predicting future economic loss patterns, for purposes of compensation and reducing the impacts on the productivity of marine transport sector and growth of seaborne import and export trade. The research will also be of great importance to marine insurers and underwriters, while affording knowledge of the marine claims settlement capacity of the local underwriters, to stakeholders, which includes shippers, ship-owners, offshore oil and gas operators, etc.

Lastly, the study will contribute to the body of existing knowledge in the teaching, learning and research in universities and research institutes, in the area of marine accidents and risk analysis. It will form the basis for further research in areas of marine accidents and economic impacts assessment.

1.7 Scope of the Study

Time Scope: The secondary (time series) data obtained from various sources and used in the study covers a period of 20 years period from 1999 to 2019.

Theoritical scope: The formulated empirical models for predicting the yearly values of shipping accidents economic loss and offshore O&G accidents economic loss based on the values of seaborne trade exposed to sea perils in Nigeria. It also modeled the relationships between each of shipping accidents economic loss and offshore O&G accidents economic loss and the compensation funds reserved for the indemnification of each type of marine damage accident economic loss in Nigeria. It developed the coefficients of elasticity of each of shipping and offshore O&G accidents economic loss to growth in value seaborne import and export trade as well as compensation funds for indemnify each class of loss between 1999 and 2021. The externalities cost of marine accidents to third party operators and marine accidents death cum injury costs were also evaluated for purposes of provisioning compensation funds to improve underwriters solvency for timely and adequate compensation for losses.

Geographical scope: The geographical scope of the study is the Nigeria marine maritime sector. The secondary data cover the entirety of the Nigeria maritime sector while the primary data was sourced solely from the nine (9) coastal Local Government Areas of Rivers State in the South-South region, which are host to the seaports, oil and gas free zone and hub of maritime activities in the Nigeria.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Review

2.1.1 The Concept of Marine Accident

Webster online dictionary explains the word “marine” as an adjective derived from the Latin word “Mare” which means sea. Webster online dictionary further explains that the English word “Marine” is also a derivation of the French word “Marin” which means having to do with or related to, and near the sea. Thus, the word “Marine” is an English adjective which means related to, or near the sea. It is an adjective used to qualify objects, lands or activities in the sea or in close proximity to the oceans, the coastal zones and the seas.

Similarly, the Oxford Online Dictionary explains that the word “Maritime” is an English adjective that originated in the 16^{th} century as a derivative of the Latin word ‘Maritimus’ which in turn has its genesis from ‘Mare’ which means sea. The word ‘maritime’ therefore is English adjective which had its origin in the 16^{th} century English which means pertaining to or of the sea and used to qualify objects, organism activities and lands in or near the sea. Both Oxford Online Dictionary and Webster Online Dictionary agree that both marine and maritime are adjectives and are therefore synonymous.

The advent of motorized transport, offshore technology, and advancement in industrial technology has led to development of sea going vessels of various kinds, oil and gas exploration rigs, floating production storage and offloading systems(FPSO’s) and water crafts of various kinds. Advancement in offshore technology and ocean engineering also offers opportunity for development of underwater exploration and exploitation vehicles, underwater and coastal pipeline transport technology system, cargo handling equipment of various kinds and capacity and onshore port technology systems, all produced through the mastering and use of marine and ocean engineering and offshore technology and put into the sea for purposes of surface sea transportation, (shipping), underwater exploitation, surveillance and hydrographic studies, or stationed permanently at sea or near it, to enhance the purposes of harnessing the marine resources for the socio-economic benefit of the state.

The concept of marine accident is the occurrence of a risk event, in a ship or involving equipment, investments and properties exposed to the marine environment, that resulting to injuries to persons at sea or in port, and damages to the marine property or investment (Volker, 2014). It encompasses accidents in the sea or at port, quayside or anchorage, dockyards or shipyards etc. Marine accidents are caused by exposure to risks, perils and hazards of the marine environment, provided that, the accidental objects are at sea or being harnessed for sea movement, in port or in a dockyard and can be protected by a policy of marine insurance. It is immaterial whether the vessel or object involved in accident is sailing or stationary at the point and time of accident (MAIB, 2008).

Simo (2012) explains marine accident as unexpected, unplanned and unintentional series of events leading to the physical injury of a person at work and/or damage to properties, equipment and the marine environment. In a study on theories of occupational accident, Simo (2012) opines that, marine accidents occur when workers, properties and equipments are exposed to a danger factor (hazards) at sea, such that the worker is injured and the property is damaged while its value is diminished. Presenting a study guide on accident investigation and control, Osha (2016) defines the concept of accident as the final event in an unplanned process that results in injury, illness, property damage and possible environmental damage. It is the final effect of multiple causes and an event, that result in a damage of state of persons and properties involved (Osha, 2016), irrespective of the environment where the occurrence took place. From the foregoing, it is observable that, the occurence of accident in the marine ecosystem diminishes the economic values and structure of properties and health state of persons involved.

Osha (2016) distinguishes between accident and incidents, while accidents are observed to cause injuries and damages, incidents do not cause injuries and damages. Accidents also result from many factors, simultaneously interconnected, cross-linked events that, have interacted in some dynamic way. Osha (2016) identifies that, accidents also result from hazardous conditions and unsafe behaviours which represent risks that have been ignored and tolerated within the safety management system. In the guide for hazard analysis and control in a work environment, Osha (2013) notes that, hazards are dangers, unsafe workplace conditions and practices which threaten physical harms to employees and to property and environment. It posits that, these hazards (dangers) represent risks of damages and injuries that could occur with accidents, once there is exposure to it (Osha, 2013).

Simo (2012) supporting the earlier position of Osha (2013) notes that, the risk of ship-based accident is influenced by the level of exposure to occupational hazards and sea perils. This agrees with the position of Osha (2013) that, exposure to risks (hazards) causes accident. Ohaviro and Paolo (2008), considers accident risk, as the chance of injury, damage or loss. Rosa (2003) further explains risk as a situation or an event where something that is of value to humans (including humans themselves) is at stake and where the outcome is uncertain. Trevisan (2007) in reviewing the International Safety Organization (ISO,2009) definition of risk as the effects of uncertainty on objectives, notes that, risk is the possibility that an event will occur and adversely affect the achievement of objectives. The marine accident casualty investigation boards (MAIB, 2008) further defines a marine accident as one or more unexpected and undesired marine incident, which result in deaths or personal injury to crew, damages or loss of marine properties and seaborne cargoes and injects harmful substances to the marine environment.

It is however important to note that, some school of thought believes that, there exist differences between a marine accident and a maritime accident. This school of thought asserts that, accident involving sea going vessels, sailing crafts in the course of transporting cargoes are maritime accidents while those involving stationary marine installations like oil rigs (Fixed production systems) are classified as marine accidents.

In this study however, we shall adopt the definition of marine accident to include both transport accidents, offshore O&G accidents, accidents in ports and dockyards, etc, provided such an accident is or can be covered by a marine insurance policy or marine energy insurance. This is because, many marine accidents have occurred involving sailing vessels and stationary drilling crafts and pipeline installations, leading to big losses (MAIB, 2008). Also, the O&G industry is serviced by diverse marine crafts and technology types both mobile and/or sailable and stationary, eg the dynamic positioning (DP) vessels, the floating production storage and offloading systems, the drilling rigs, the offshore supply boats, etc. The operations of each class of equipment as mentioned above is covered by a policy of marine insurance and oil and gas energy insurance, which is a new branch of marine insurance, developed to take care of special needs of the offshore energy sector. The difficulty of classifying accidents in the marine environment based on stationarity or mobility of the vessels or drilling platforms at the time of occurrence of the accident, made the study to adopt the definition of marine accidents as encompassing both accident types, provided the accident risk is insurable by a marine insurance policy. Our definition of marine accident in this study thus encompasses both shipping (transport) accidents and offshore O&G accident in the marine environment as explained by the Marine Accident Investigation Branch (MAIB, 2008). Thus, the study adopts the definition given by MAIB (2008) as our definition of marine accident.

The concept of marine accident according the marine accident and casualty investigation boards (MAIB, 2008) is one or more unexpected and undesired marine incident, which result in death or personal injury to crew, damage or loss of marine properties or seaborne cargo, and harmful to the marine environment. Marine incident on the other hand is defined as undesired abnormal events occurring in the course of a marine operation and likely to cause danger to man, ship's architecture work or environment. (MAIB, 2008) supported by Pillay & Wang (2011) opines that, marine accidents may not be limited to accident involving sea-going vessels and inland water boats but includes onshore mishaps such as crane accidents in ports, accident involving oil exploitation platforms and mobile drilling units, accident in dockyards, collision leading to actual or pressumed loss of ship, her abandonment, material damage to her or disablement. Onwuegbuchulam (2013), observes that, while vessel accident is an unintended happening, its severity may vary from no vessel damage to loss of entire cargo, and crew injury to death. MAIB (2008) further notes that, the code for marine accident and casualty investigations distinguishes between "very serious" and "serious" casualties. Very serious means a casualty to a ship which involves the total loss of ship and its cargo, loss of life or severe environmental pollution or damage. Serious casualty means a casualty which does not quality as a very serious casualty and which involves fire explosion, grounding, contact, heavy weather damage, ice damage, hull cracking or suspected hull defect resulting in structural damage rendering the ship unseaworthy such as penetration of the hull underwater, immobilization of main engines, extensive accommodation damage, pollution and breakdown necessitating towage or shore assistance (MAIB,2008; Bird,1974; Demarco & Rob, and Thomas, 1997).

Haris and Solis (2003) opines that, the main legal basis that formed the international background for maritime accident investigation lies in the United Nation convention on the law of the sea (UNCLOS, 1982), which states in article 9A that, it is the responsibility of the flag state to institute an inquiry (investigation) into accidents on the high sea. Accidents occurring elsewhere, such as in coastal and inland waters are not covered by the UNCLOS, though the right of the coastal state to extend investigations to accident on such waters are not in contention and has been viewed as important in determining economic costs of marine accidents and their control measures.

Hariloas (1998) in a study on analysis of marine transportation risk factors grouped marine accident into the following groupings:

- Foundering
- Missing
- Fire explosion
- Grounding
- Collision / contact
- War loss / hostilities
- Mechanical fault
- Hull problem
- Navigational problem
- Other problems not specified above.

The study further observes that, accident in the marine industry are further identified by the data-bases of marine casualty maintained and published by organizations that conduct accident investigation and analysis and regular statistical data updates, such organization include Lloyds maritime information services (LMIS), UK department of transport marine accident investigation branch (MAIB), Institute of London underwriters (ILU), classification societies such as Det Norske Veritas (DNV), American Bureau of shipping (ABS), United States Coast Guard (USCG), The International Association of classification societies (IACS), and the Marine Accident Investigation Board (MAIB) of various maritime states (Harilos,1998).

2.1.2 The Concept of Marine Accident Economic Loss

All damage accidents result to an adverse change in state of the objects, and properties involved. The change in state may take the form of change from healthy to injured/illness (injury accidents), and from normal to damaged of objects and properties involved (Osha, 2016). Trevisani (2007) and Flyvlojerg and Budzier (2011), both agree that, the occurrence of accident risks brings about a consequence, which is a depreciation or loss in the value of the assets involved, following a change in the state of the asset and which equally diminishes the extents of achievement of objective functions. This loss in value represents the impact, cost or consequences of accidents and in most cases is quantifiable in measurable quantities and units. Supporting the opinions of Trevisani (2007) and Flyvlojerg et al. (2011), the International Standard Organization (ISO, 2009), identifies that, accident risk management and control should create value; meaning that, resources expended to mitigate, control and manage accident must be less than the consequence of inaction or the value of the property (Salvaged value) after accident. This suggests that, accidents impose costs, consequences and impact which diminishes the value of the properties and investment involved. This quantitative direct cost or impact of accidents on the subject matter involved can thus be determined by subtracting the salvaged value (value after) from the original/actual value (value before) accident. The above position is supported by Reason (2001). The difference between salvage value (value after accident) and original value (value of asset before accident) is thus termed the accident imposed ‘economic loss’. Accident imposed economic losses affect objective function maximization negatively. Since the basic objective function of the marine transport subsector must be output maximization to the national economy and gross domestic product (GDP), the rate of accident occurrence and related economic loss levels will obviously impinge on the full achievement of this objective.

In the views of Ogwude (1998), both injury and damaged accident can be valued or quantified in financial terms. The financial values representing the impact and consequences of accident on marine properties, investment and seaborne trade on the economy is hereby referred to as marine accident 'economic losses. Demarco, Rob and Thomas (1997), Ando (2004) opines that, since marine risk (accident) are insurable in financial terms, losses imposed by marine accident which can be indemnified or compensated for in financial terms by the practice of marine insurance, represent in strong terms, the economic losses and direct impact of marine damage accident on the economy. Further extension of the above principle of marine accident economic cost holds that, the financial value of the property damaged or lost could be collected, computed or determined using a model of price and quantity relationship or awarded by the courts (court award approach) as the economic losses of marine accident (Ogwude, 1998; Okoroji and Onyemechi., 2014).

Dermaco, Rob and Thomas (1997) in a study on the economic impacts of accident on the marine industry in USA, observes that, marine accident impose the following categories of economic loss; shipping accident economic loss, offshore oil and gas (O&G) drilling accident economic loss, and spill accident economic loss (marine accident involving oil spill), and cost of injury/illness or death of crew personnel. Ogwude (1998) identifies accident involving damages to properties and environment as “Damage accident” while accident that involves injuries and death of persons he notes as injury or death accident. This system of classification by Ogwude (1998) makes it easy for accident valuation, cost/impact assessment purposes, while the human capital models may be used to value injury and death accidents, the court award approach or the insurance award approach may be used to value damage accidents (Ogwude, 1998).

Shipping accident represents marine accident in the course of transportation by water or at shore, and accident in the course of harnessing and facilitating sea transport/seabonre trade, it may involve damage to seaborne cargo of various kinds, the vessel, injury to crew, etc, (Okoroji et al., 2014; Adebiyi, 2008). Offshore O&G drilling accident is accident on oil rigs; floating production storage and offloading systems (FPSO's) and pipeline installations for oil and gas exploitation, drilling and production leading to damages and injuries. It may occur as a result of explosions, blowout, fire, rupture, equipment failure, etc. resulting to severe or minor damages and injuries. Spill accidents are marine accidents involving oil spillage from offshore installations and production systems or from tanker vessels resulting to waste by spill of oil and gas resources which are not covered under shipping accident by the state (Demarco, Rob and Thomas, 1997; Buliaminu, Peter & Ayodele, 2012).

Ando (2004), observes that, while shipping and offshore O&G accidents are covered by marine insurance and offshore oil and gas energy insurance, providing basic method of valuation of the economic risks posed by each through the principle of indemnity paid to the private and public corporate owners of the affected property and/or cargo, spill accident leading to losses of or damages of oil and gas resources at the point of drilling , is best valuated using the natural resources loss and/or damage assessment method, which in this case adopts a price and output (quantity) damaged relationship, to determine the direct economic losses of oil and gas resources lost, as a result of marine oil spill accidents.

These views expressed by Ogwude (1998), Ando (2004), Demarco, Frederick and Thomas (1997); were supported by Hubbard (2009) who asserts that the risk management and loss control strategies also impose a cost. The argument by Hubbard (2009) is that to mitigate, control, avoid, eliminate or transfer / share accidents impacts, organizations and states must vote financial resources. These financial resources represent costs which accident imposes on the economy. This implies that, since the insured in a marine insurance contract for example, must pay consideration in the form of premium in other to transfer accident losses from risks insured against to the underwriters, insurance premium is a direct cost for management of accident risk in the marine industry, but not a direct damage accident cost. Generally speaking, organizations and states also encounter other forms of costs for accident control which can be determined, valued, and categorized as accident risk management and loss control cost. From the foregoing, it is clear that, marine accidents impose financial costs on the economic in various forms. These financial costs imposed by accidents in the marine industry are jointly referred to as marine accidents economic costs. The study however adopted the term marine accident economy loss to describe the direct financial losses imposed by damage accident in the marine industry.

Ando,(2004) is of the view that, the purpose of marine accident investigation is to determine the root and surface causes of marine accidents and the degree of physical, economic and environmental damage and impact, to formulate safety and control measures to eliminate or reduce the influence of root and surface causes. Marine accident economic costs in this case is the financial or economic losses imposed on the economy as a result of devaluation in the economic values or total loss of a marine investment, resources (including human resources) and/or property, following the occurrence of an accident (Okoroji & Onyemechi, 2014; Nwokoro, 2015).

In Nigeria, statistics based on a study carried out by Dogarawa (2012) as reviewed in Onwuegbuchulam (2013), indicates that between year 2000 to 2009, a total number of five hundred and fifty-two (552) persons died as a result of vessel accident in inland waters, indicating an average fatality rate of 55 deaths per year excluding vessel and property damage, cargo losses and oil spill. Okoroji and onyemechi (2014) estimates that, between 2001 to 2010, the economy lost an average of two billion, eight hundred and sixty-six million, four hundred and sixteen thousand naira naira per annum as a result of marine damage accident.

The economic contribution of the marine transport sub-sector to the development of Nigeria cannot be maximized until the economic costs imposed by marine accidents is made a basis for estimation of the level of investment in safety programmes required to minimize accident occurrence. This will happen only if the marine accidents induced damages are optimally indemnified to ensure sustainability of maritime operations (Tatyana, 2004; Raheem, 2015). There is therefore need to ascertain the trend of marine damage accidents economic losses and the relationship with value of Nigerian seaborne trade as basis for determining the optimal framework for marine risks compensation in Nigeria. Since marine accidents impose some degrees of externalities costs, such as impacts on marine environment and output losses to society occasioned by death and injury to maritime workers, there is need to to valuate these third party costs as beginning point for development of optimal loss compensation framework.

2.2 Theoretical Review

Theoretically, the economic losses and impact of marine accidents on the economy can be explained on the basis of the theories of accident causation, accident investigation and accident or risk management and loss control. These include the domino theory, the chain of events theory, the accident incident theory, the theory and principles of marine insurance, human capital theory (Gross Output Model) and the economic theory of natural resource damage assessment model, the economic theory of elasticity, the decision theory, among others.

2.2.1 Accident Loss Causation Theories

There exist many theories which seek to explain the causal factors of accidents and the accident losses. The reason for many of the theories is to lay sound foundation for the understanding of the key accident causal factors, to enable application of control and management measures, to eliminate or reduce accident occurrence (Young, Dong and Wan, 2016). Risto (2014) opines that, accident theories support the valid opinions, that accident are not always Acts of God and misfortunes, to be suffered by people not at peace with gods, as believed until the 19^{th} century when accident theories began to explain the causal factors of accidents. Thus accident theories provide explanation for occurrences of accidental losses and lay basic foundational steps for effective accidental damage and loss control and management. Some of the classical accident causation theories reviewed in this work include; the Domino theory, The Human Factor Theory (HFT), the Accident Incident Theory (AIT), Epidemiological Theory, the systems theory, the Accident Proneness Theory (APT), the combination theory of accident causation, Behaviour Theory (BT), the Energy Release Theory (ERT), energy damage model (Ludwig, 2012, Zobarv and Kazuhiko, 2014)). Each of the accident causation theories attempts to predict accident casual factors and thus prevent its occurrence. Marine accidents is believe by health and safety professional occur due to poor safety decisions by Government, safety regulatory agencies, private firms and employees of organizations.

2.2.1.1 The Domino Theory

Rasmussen (2002) observes that, the domino theory was developed and advanced by Heinrick (1959). In developing the domino theory, Heinrick (1959) as reviewed in Rasmussen (2002) conducted a research on industrial accident and concluded that, 88% of accidents are caused by unsafe acts committed by people, 10% by unsafe condition and 2%

by acts of God. The 2% caused by acts of God, he termed unavoidable accident. Thus the domino theory views that, 98% of accident can be avoided by avoiding the causal factors. (Ludwig, 2012) observes that, the domino theory explained that, injury and loss results from series of events one of which is the accident itself. An accident it explains only result from an unsafe acts committed by someone and a physical hazard. Essentially, removal of the unsafe act or the unsafe condition prevents loss and damage. The theory states that, while most accident result from peoples unsafe behavior and unsafe conditions, unsafe behaviours and conditions do not always immediately result in accident. Therefore, finding the reason why people commit unsafe behavior can guide in adopting corrective measures. According to domino theory, the severity of an accident loss or damage is by chance rather than design and the accident that cause the loss and / or damage is preventable. Heinrick's (1959) opinion of the domino theory is that, management ought to take responsibilities for safety with the supervisor being the key person in the prevention of occupational and industrial accidents seeing as there were indirect losses incurred, besides direct ones. Explaining the Domino theory, Heinrick (1959) as reviewed proposed a sequence consisting five factors that followed sequentially, that is, one factor resulting in the next. The first was ancestry and social environment which explains that negative traits causing people to commit unsafe actions may be inherited or acquired from the environment one was socialized. The second factor is fault of a person which explains that people act in unsafe manner as a result of the negative traits they acquired. The third factor is unsafe act or physical hazard / unsafe condition which directly result to accident. The fourth factor is accident which results in injury, damage and loss. The fifth and last factor is injury, damage and loss which is the consequence of accident. The figure below is an illustration of accident and loss occurrence by the domino theory.

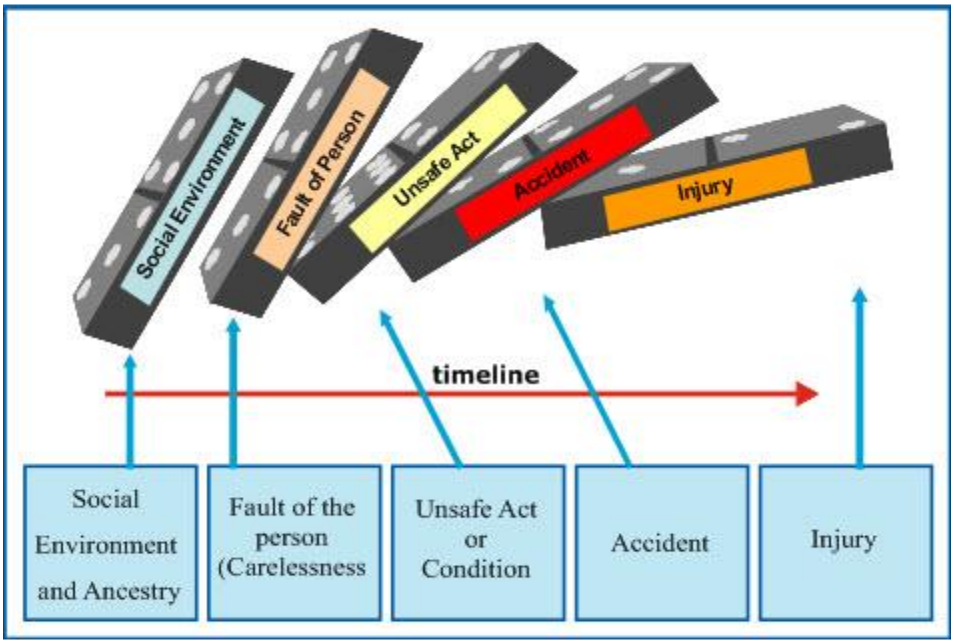


Figure 2.1: Heinrich's Domino Model of Accident Causation

Source: Adopted from Disaster Management Institute, Bhopal; online Explanation of Domino theory.

2.2.1.2 The Human Factor Theory (HFT)

The human factor theory postulates that, three factors lead to human error, and human error causes accident. The three factors that cause human error as identified in HFT are overload, inappropriate response and inappropriate activities. Overload is an indication of imbalance between a person's capacity and the load that, a person is carrying at a particular point in time (Ludwig, 2012). Thorndyke (1951) in Ludwig (2012) observes that, a load consist of burdens resulting from situational factors, internal factors or environmental factors so that workers bears them in addition to their usual task and job responsibilities. The human factor theory notes that, overworking impairs worker's thinking ability to act rationally when faced with a hazardous condition (Ludwig, 2012).

The human factor theory asserts that, the way a worker responds when under an overload situation can prevent or cause an accident when a worker detects a hazardous condition and could or does not correct it, then they have responded to inappropriately and the inappropriate response may cause an accident. It may also be a decision of the worker to err by responding inappropriately, in an attempt to overcome overload (Ludwig, 2012). Typical example of an overload condition is increased demand in production without proportionate increase in manpower, which may strain workers into sloppiness, overworking and irritability which are accident causing conditions. Ludwig (2012) notes that, the adjustment stress theory is as a result of factors in human factor theory and states that, any negative stress or pressure placed on a worker internally (e.g. fatigue), or externally (e.g. noise) will increase the probability of accidents stress, impairs worker judgment and is a source of unsafe behavior as a result of which a worker may deliberately choose to ignore a hazard or fail to detect it, causing accident to occur (Ludwig 2012; Haddon 1958).

It is observed that, an inappropriate activity involves the performance of a task by a worker without appropriate prior training and knowledge of the risk involved. The distraction theory which has correlation to the HFT can be explained to be the consequence of an overload or inappropriate activity. The theory states that, workers suffer once they are distracted by Jobsite (occupational) hazard stress or pressure (Ludwig, 2012; Hadon, 2003). The theory insists that pressure in particular could induce workers to ignore hazardous condition so as to meet employer's expectations such as deadline, stress and mental worries could distract workers from detecting a hazard in time to avoid them. Akhatar (2014) while explaining the human behavior theory of accident causation notes that, inappropriate activities may also be caused by overconfident risk takers who may misjudge the degree of risk involved in a task. The International Maritime Organization (IMO) seems to have observed the role of human in accident causation when it issued the Standards of Training, Certification and Watch-keeping (STCW, 93 as amended) instrument and made it a compulsory requirement to work on-board. Similar instruments like the STCW "95 as amended that recognizes the importance of training to limit the occurrence of human error related marine accidents have over the years been made compulsory for work of ocean going vessels and offshore drilling vessels. Example is theBasic Offshore Safety Induction and Emergency Training (BOSIET) (MAIB,2008)

2.2.1.3 The Accident / Incident Theory of Accident Causation

Rasmusen and Leplat (1983) note that, the accident / incident theory developed by Dan Peterson is an extension of the human factor theory. The theory claims that, unsafe act by workers is a resultant effect of an overload, ergonomic traps or a decision to err. It postulates that pressure such as deadlines and peer pressure could cause a worker to succumb to pressure to work faster than his natural pace and endowment and therefore raise his probability of being involved in an accident. Petersons accident / incident theory sets managements role in accident prevention by establishing that, it is the role of management to take necessary safety procedures and defining responsibility regarding safety, ensuring that employees receive safety training and comply with safety procedures such as inspecting, correction and in the use of personal protective equipment (PPE). OSHA (2013) further notes that, it is the duty of the company to ensure a clean and healthy work environment that eliminates environmental factors that could impair health.

2.2.1.4: Accident Proneness Theory

The accident proneness theory theorized that, some people/workers have inbuilt character traits that raise their probability of their being involved in accidents. It insists that, accident occur to a limited number of individuals who have a stable personality trait (Simo, 2012). The theory suggests that, if accidents were randomly distributed among persons working in similar conditions, some would be more likely than others to cause damage to properties and suffer injury as victims of accident. These groups of people usually are risk takers and on average take more chances than their colleagues. Health and safety decision makers argue positively in support of the theory that behavior can be altered to increase a workers level of risk tolerance (Ludwig, 1975; Johansen, 2002).

2.2.1.5: Combination Theory of Accident Causation

Arben and Ulf (2011), Rasmussen *etal.* (1983) in their studies supports that, accident cannot be adequately explained by one casual model. Most of the accident casual models give important insights but none of them wholly applies to every accident occurrence. As a result, the combination theory insists that, the actual cause of an accident is a combination of different elemental parts of these models. Thus, an accident could result from the combination of a worker's negligence of a potential hazard, indulgence in unsafe behavior or act and succumbing to the pressure of overload.

2.2.1.6: The Multiple Causation Theory (MCT)

The multiple causation theory states that, an accident is caused by a combination of multiple contributory factors. it further states that, the causation factors of accident may be behavioral or environmental (Ludwig, 2012). Behavioral factors are factors related to the workers individuality, like their attitude, skill, physical and mental condition, intellect, etc. Environmental factors are factors affecting the worker's job environment such as machinery, safety and precautionary measures taken in the work place and existence of hazardous conditions. Environmental factors causing occupational accident according to the theory can be more easily predicted and prevented than behavior's and unsafe acts (Young, Dong & Wan (2016); Difford (2011); Pedro (2008)).

2.2.1.7 The Energy Damage Model (EDM)

The energy damage model was developed by Viner (1991) as an engineering approach that essentially requires the workplace to identify all the various types and forms of potentially harmful energy sources and controls such losses by designing away the hazard that in all likelihood, may present danger for the actor. While the energy itself may not be a danger, necessarily, the problem arises when an unwanted and harmful energy source is transferred unexpectedly in type, time, speed or force on to unwilling persons. Viner (1991) opines that, given the fact that Man and machine and/or energy co-exist in work places and do not act separately, engineering solutions should be design to relieve cognitive human weaknesses. The energy damage theory suggests that the identification and control of potentially harmful energy eliminates or reduces the latent conditions of the unsafe person while operating in an unsafe environment (Viner (1991; Difford (2011)).

2.2.1.8 The Danger Factor Theory (DFT)

According the danger factor theory accidents occur when workers, equipments and danger factors come in contact (meet) so that, the workers are injured while the equipment and property gets damaged. The most important danger factors according to the theory are those with the highest energy contents. The ergonomic approach of this theory assumes that, disturbances in flow of information increase the risk of accident occurrence. Thus, the exchange of information between the workers and their work environment is a precondition to accident prevention and avoidance of accident. The most appropriate form of safety information transfer is safety training, by safety training, the worker is informed and trained and given skill on the safe use of the tools and work environment.

1.

2.2.2 Accident Investigation Theories

Sheides, Evelin, Tea, Aljona, Sulev, Mikolaj & Nick (2016) defines accident investigation (AI) as the structural process of uncovering the sequence of events that produced or had the potential to produce injury, death, property damage and/or loss, to determine the causal factors (root and surface causes), impacts and corrective action.

Ludwig (2012) proposes that, the idea of accident investigation is to apply analytical techniques to find the cause and consequences of accident. According to Ludgwig (2012) investigation employs test of engineering experiments to discover the rate of accident root causes and consequences while answering the question of why the accident happened.

The American Bureau of Shipping (ABS, 2014) observes that, the role of the accident investigation process is to provide proper safeguard to prevent and mitigate accident effects. If adequate safeguards are in place, any losses that occur will be acceptable losses. ABS (2014) notes that, individual organizations and states may however have other objectives to achieve with accident investigations (AI) which may include:

- To protect the safety and health if workers particularly the human resources of the maritime industry.
- To preserve the organization's human capital and labour resources.
- To fulfill the legal and statutory obligations of the state with regards to implementation of the IMO instruments particularly the United Nations Conventions on Law of the Seas (UNCLOS 1982) which require coastal states to conduct an inquiry and investigation into accidents in their maritime jurisdiction and involving their flag ships.
- Improve quality reliability, output and productivity of the sub-sector
- Ensure continual and sustenance of service to clients and customer
- Comply with national regulatory and insurance requirements

- Educate management staff and employees
- Control losses imposed by accident.
- Demonstrate management concern and employee involvement
- Advice others of unrecognized risk and or more effective risk management strategies
- Comply with organizational and industry policy
- Classify accidents and generate data.

ABS (2014) supported by Kin, Hagen and Utue (2016) opines that, accident investigation theories (AIT) aims to aid accident investigation (AI) to fulfill investigation roles and therefore cannot serve to merely explain proximate causal factors, as accident cause theories do.

Accident investigators employ analytical, structural and scientific processes, dealing with different levels of analysis to ascertain the root causes and consequences of an accident, thus, while the cause theories are good at explaining the accident phenomena, they do not possess the dept of structural analysis needed to guide investigation processes (ABS, 2014).

Kin, et al (2016) and ABS (2014) notes that, while the accident causation theories (ACT) may explain the proximate causes of accident and the nearest intermediate cause, there may exist serial (connected more than one) intermediate cause and root causes, also connection often times exist between and/or among the root, intermediate and proximate causal factors which only thorough accident investigation can reveal. These forms the basic reason for specific accident investigation theories (AIT), to structurally, analytically, and scientifically guide accident investigators (AI's) and investigation processes.

Ludwig (2012) notes that, among the accident investigation theories are; the single event theory, the chain-of-events theory, the branched event chain theory, and the multi-linear sequences (process) theory.

2.2.2.1 The Single Event Theory

The single event accident investigation theory precepts that, every accident consist of a single event that has a cause. According to the theory, the investigative task is therefore geared towards finding the single cause and correcting it. The theory often relieves the victim of blame and is notorious for blaming it on the factor beyond the victims control such as fate, acts of God or ill luck. Thus, it discourages further examination/investigation into the accident phenomenon in an attempt to forestall a reoccurrence of the same (Ludwig, 1979). The theory assumes reliability of accident phenomenon, opining that, someone or something failed, was at fault or to blame. Otherwise accident is an act of God (Ludwig, 1979).

2.2.2.2 The Chain of Event Theory

The chain-of-event theory is closely tied to the domino theory proposed by Henrich (1936) as reviewed in Ludwig (2012). The theory states that, unsafe conditions create vulnerable relationship in which unsafe acts can trigger "chain-of-events" called accident. This implies that the cause of an accident is a result of various factors that need to be detected as hazards before they all materialized. The task of investigation is to identify unsafe conditions and acts that caused events sequence. Losses can equally be valued for future decisions on optimal loss control measures.

2.2.2.3 The Determinant variable and Factorial Theory

Thorndyke (1951) as reviewed in Ludwig (2012) describe the determinant variable and factorial theory as the search for the experimental idea of the single independent variable (determinant variable), which set the goal. The idea of an accident investigation using the factorial theory is the gathering of data in such a way that, statistical comparisons will permit fair estimates of the influences of the variables in a particular factor on the probability of an accident. The theory proposes that, there are common factors present in accident and that they can be discerned with statistical analysis of the right data generated from accident investigations. It further states that, hypotheses about determinant variables can only be generated or identified after secondary examination of the facts and that criteria for scope, data and outputs should be dictated by hypothesis, rather than direct observation from accidents. The theory therefore requires extensive exercise of investigators judgment and occurrence of sufficient accident to build data base (Randa, Giselda and Laura, 2013); (Ludwig, 2012).

2.2.2.4 The Branched Event Chain Theory

The theory provides a system of using fault tree to predict and prevent accident. It was developed by Watson (1971) for the U.S. military and applied in prediction and prevention of missile launching accidents. Fault tree analysis is today being widely used in the maritime industry and other sectors. The theory proposes that accidental events are predictable. It therefore presents structures for predictive search for alternative events pathway leading to selected undesired events through speculations by knowledgeable system analysts. It provides that, rules and procedures be followed for structuring speculations and assigning probabilities in a branched events chains display, also demands ordering of events into accident sequences. Its significance according to Ludgwig (1979) supported by Jan, Eirik and Ivonne (2012) is that, while it is an adaptation of the chain-of-events theory, it establishes data requirement that facilitate prediction of the accident possibility in a given system, it provides guidance during investigation.

2.2.2.5 Multi Linear Event Sequence (Process) Theory (P-Theory)

The multi linear event sequence or process theory suggests that, accident is transient segment of continuum of activities and a transformation process by which a homeostatic activity is interrupted with accompanying unintended harm (Qingi and Vinh, 2016). The process is described in terms of specific interacting actors, acting in a sequential order with a discrete temporal and spatial logic. The procedures for analyses are defined in terms of changes of state and event (events = actor + action) that produce the change of state, and procedures for generated hypotheses are linked. Thus, the investigative tasks call for identification of the actors, their actions and interactions and the resultant changes of state from the initiating partition through the last sequential harm to the actors (Ludwig, 2012). Both the investigative and analytical procedure are based on the premises that, "everyone and everything always have to be some place doing something (Ludwig, 1979).

2.2.3 Accident/Risk Management Principles and Loss Control Theories.

The International Standard Organization (ISO, 2009) defines risk as the effect of uncertainty on objectives. Cortanda (2007) opines that, risk is the likelihood or probability that an event (incident) will occur and adversely affect the achievement of an objective function. Cortanda (2007) posits that, risk itself has uncertainty. Huber and Douglas (2009) explain that risk management is the identification, assessment priotization and response, followed by coordinated and economical application of resources to minimize, monitor, and control the probability and impact of unfortunate events (accidents/risk) and to maximize the realization of goals, objective function and opportunities. The objective of risk management is to assure that, uncertainty does not deflect the endeavor from the business goals (Hubert and Douglas, 2009). The Committee for the Sponsoring Organizations of the treadway commission (COSO 2004) views risk management as the process that attempts to manage the uncertainty that influences the achievement of objectives, with the goals of reaching the objectives and thus creating value for the organization in which it is applied.

Cortanda (2007) observes that, the theory and principles of risk management processes, methods and control are safety tools and devises that organization and safety managers must adopt to have good control over risk of losses. Trevisani (2007) however observed that risk control and management methods enunciated in the risk management theory, have certain key components in common which includes: Internal environment objective setting, risk identification, risk assessment, risk response, information and monitoring. Tresivani (2007) opines that, risk management follows six (6) basic process as depicted in figure (2.2) below.

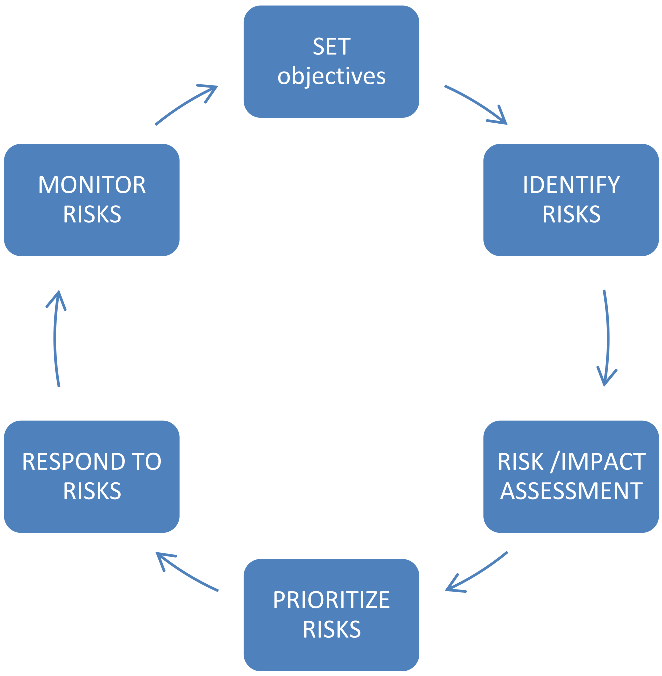


Figure 2.2: Process of risk management

Source: Risk Management process prepared by the Author.

The first step is to clearly state the objective (goal) to be achieved which also helps to derive exactly what is exposed to risk. This is followed by risk identification which identifies the events (risks) that, form the hazardous threats to the objectives. The result of the risk identification process is a register (list), containing internal and external risks that form threat to the maritime property, persons or investment. This is followed by the third (3) step which is assessment of the likelihood of occurrence and impact of each identified risk. Risk assessment can be done with either qualitative or quantitative way. It is expected that, the impact be expressed in monetary quantities or magnitude of economic loss (damages) and injuries. Both risk identification objective setting and risk assessment are done using tools and methods which were later discuss under formal safety assessment (FSA).

The fourth process of risk prioritisation is done by comparing individual risk, frequently used methods here include the expected value method, which ranks risks according to the product of a risk probability and impact (consequence) and plotting risks on a risk matrix which offers a visual aid to compare risks. See figure 2.3 below in risk matrix.

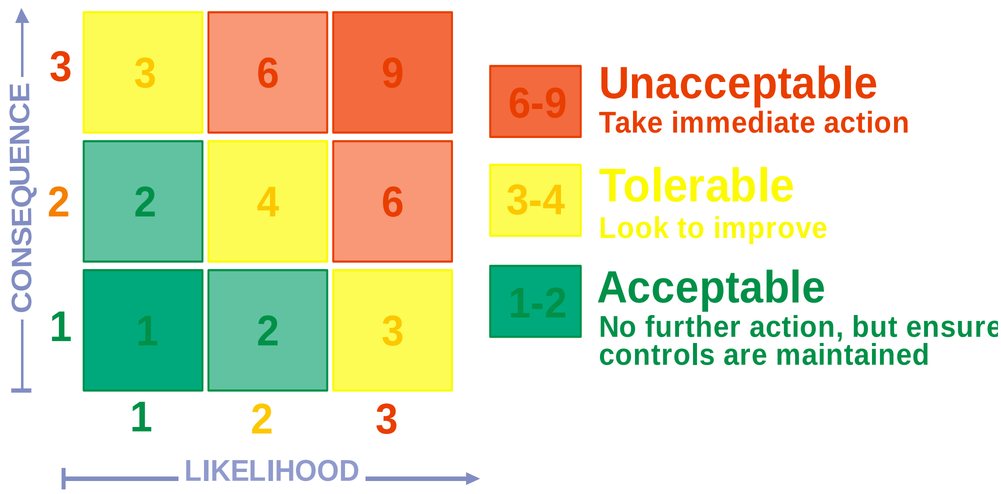


Figure 2.3: Ranking and comparing of Hazards/risk

Source: Safety Check Matrix Prepared by Author

When risks have been prioritized an appropriate risk response or management method is applied to mitigate, manage or deal with risk. This include risk avoidance, risk reduction, risk retention and risk transfer (ISO, (2009); Trevisani, (2007)). The last process in the risk management process is 'monitoring', to ensure that, the risk does not constitute threat anymore. Re-assessment can often or periodically be carried-out depending on residual risk severity. This monitory step is the final step in the risk assessment process and serve as a feedback Mechanisms that ends as well as continuously sustain the risk management process. Trevasani (2007) and COSO (2004) agrees that, the risk management theory identifies four strategic principles of risk management for industrial risk management to include risk avoidance/risk prevention, risk reduction, risk retention and risk transfer (insurance). COSO (2004), and ISO (2009) also upheld the above views expressed by Trevisani (2007).

The adoption of either of the above risk management and loss control strategies or a combination of strategies by organizations will however depend on the expected utility to be derived from such. Decision theory is required for choice making so that, the risk management and control principle that maximizes utility is preferred.

2.2.3.1 Risk Avoidance/Termination or Prevention

COSO (2004); Quingi, Vinh and Thai (2016) agrees that, risk avoidance as a risk management option involves the termination, elimination, and prevention of risk by shutting off of all activities that causes the risk to exist. Risk avoidance may seem the answer to all accident risks, but avoiding risks because of the likelihood of accident also imposes a new risk of losing out on the potential gain that acceptance of the risk prone activity or operation may have offered. Declining to invest in a seaborne trade and marine related business venture to avoid the risk of accident related loss will certainly also avoid the possibility of earning profits , (Vinh and Thai, 2016)

2.2.3.2 Risk Reduction

Since it is impossible to avoid an activity involving risk of accident and still gain the potential benefitsand opportunities offered by the avoided risk prone activity, and since marine business enterprises themselves are exposed naturally to a pool of marine perils/risk, which an entrepreneur must have to contend with (reasonably accept) in other to gain profit and/or achieve objectives. It follows that, risk reduction strategies as a principle of risk management offers a better option for industrial risk management than avoidance as it seeks to mitigate risk, while still retaining/offering the opportunity to gain from the potential benefits offered by such risk prone operation. Risk reduction can be explained as risk optimization, which involves reducing the severity of the loss or the likelihood of the loss from occurring. For example, the practice of using sprinklers to put out fire reduces the risk of losses by fire onboard. Risk reduction programmes sometimes impose cost and in some cases, the mitigation strategy itself may create room for more losses by imposing or creating a new risk dimension (COSCO, 2004).

Acknowledging that risk can be positive or negative, optimizing risks of economic losses means finding a balance between negative risk and the benefit of the operation or activity; and between risk reduction effort applied. Thus reduction or optimization of risk of economic losses will achieve levels of residual risks mitigated from non-tolerable regions to tolerable or acceptable regions (Pemmings and Smiths, 2000).

This implies that, practice of risk reduction is evidence that such organization is risk tolerant, as it predisposes itself to bear the economic impacts and consequences of failure of risk reduction measures.

2.2.3.3 Risk Retention

Jan, et al (2016) opines that, risk retention involves accepting the loss, or benefit from a risk when it occurs. True self-insurance falls in this category.R risk retention is risk tolerance, which involves leaving the risk as it were without taking any action of working to transfer or insure the risk of loss . This is possibly obtainable where a risk of economic loss is of negligible size and is considered an acceptable risk level either before or after the implementation of other risk responses and cannot be further responded to. Furthermore, a risk of substantial impact can be tolerated if the presence of the risk is vital for the existence and continuity of an organization. Such risks retained or tolerated must be subjected to monitoring to deter it evolving from tolerably acceptable risk regions to unacceptable risk regions. Risk retention serves as a viable strategy for small risks, where the cost of insuring against the risk would be greater over time than the total losses sustained (Osiris and Valdez, 2015).

Osiris and Valdez (2015) further reveal that, all risk that are avoided or transferred is retained by default. This includes risks that are so large or catastrophic that they cannot be insured against or the premium would be impossible to be met. Risk retention may also be acceptable option if the chance of a very large loss is small or if the cost to insure for greater coverage amount is so great it would hinder the goals of the organization too much.

2.2.3.4 Risk Transfer (Insurance)

ISO (2009) and COSO (2004) views risk transfer as sharing with another party (third party) the burden of loss or the benefit of gain, from a risk, and the measure to reduce the risk. Risk transfer is the practice of fully or partially reducing the impact or severity of loss or damage imposed by risk of accident occurrence using risk sharing, made possible by purchase of insurance policy to cover the property from risk of loss. Thus purchase of an insurance contract is often described as risk transfer. However, technically speaking, the buyer of the insurance contract generally retains legal responsibility for losses transferred. This means that, insurance may be defined more accurately as post-event compensatory mechanisms. The risk still lies with the policy holder, the insurance policy simply provides that, if an accident (the event) occurs, involving the policy holder, then some compensation (indemnity) may be payable to the policy holder that is commensurate with the loss or damage. In the marine industry, the practice of marine insurance serve as a risk transfer mechanisms for marine risks/saccident management and control.

2.2.4 Risk Management and Loss Control Explanations Based on Decision Theory

Decision theory is the part of probability theory that is concerned with calculating the consequences of uncertain decisions. Since the decision to take risk or adopt any particular risk management strategy over others, must be based on expected value of the outcome and to what extent utility will be maximized. The decision theory can thus be used to explain the choice of marine insurance as risk transfer strategy by policy holders and choices of investment in marine trade by underwriters (Ert, and Erev, 2003) Some aspects of the utility theory such a risk appetite, risk attitude, expected value and expected utility and prospect theory can be applied to state the objectivity of a choice by marine underwriters and policy holders and to optimize the decision to get compensation at the occurrence of the risk insured. In Nigeria however, public policy requires the compulsory insurance of all seaborne import and export trade as the marine insurance policy must be tendered as part of the required documents for cargo clearing in ports and serves as evidence of proactive accidental loss control and management process. Thus, the case for decision theory application for determination of whether utility can be maximally satisfied may be most necessary for inland waterways operations where public policy has not mandated compulsory production and use of marine insurance policy as loss control and management mechanism (Ert, and Erev, 2003).

2.2.4.1 Risk Appetite and Risk Attitude

A clear definition of risk appetite allows for consistent approach to handling risks within an organization. Risk appetite is the amount of risk on a broad level; an entity is willing to accept in pursuit of value (Cosco, 2004). Another term that is associated with this is risk attitude; which describes the tendency to risk averse, risk seeking or risk neutral behavior. Certainty that, the level of marine insurance technical reserve maintained from premium income over a period of time can consistently settle genuine damage accident claims/indemnity may elicit a risk seeking behavior, otherwise, risk averse and risk neutral behaviours (Reason, 2001).

In other words, risk appetite relates to taking risks in a broad sense and risk attitude relates to making a risky decision. Risk attitude can be elicited from the upper echelon of an organization and thus expressed in a quantitative manner by use of risk appetite, which reflects risk taking behavior (Penings and Smidts, 2000). A public or private organization's risk management attitude can be elicited in a relatively straight forward way. When an organization is offered a choice among the strategies for risk management, the organization chooses their preference depending on the expected value and the expected utility to be derived. A choice of marine insurance for both policy purchase and investment can thus be influenced by the expected value and expected utility derivable, which are explained in decision theory (Keeney and Raiffa, 1976; Penings and Smidts, 2000).

2.2.4.2 Expected Utility

In economics, utility is used as a measurement of satisfaction. This can also be used in decision theory, as a means of expressing the satisfaction of a particular choice. In risk management, loss control and management strategies must be evaluated to understand the level of satisfaction derivable from its use, then a choice can be made of the strategies that offers maximal utility. In principle, the cost of adopting a control and management measure must be less than the value of the protected property or investment after loss. When indifference is reached as to whether to buy marine insurance or not, the satisfaction that both options carry is the same. Since the expected utility of an outcome of either decision above, with consequence x and probability p, is calculated by multiplying the probability and the utility of the consequence, so that;

$$\in U(p, x) = p * U(x).$$

This definition of expected utility can be used to evaluate indifferences between a decision to buy and invest in marine insurance being affected by the certain and/or riskiness of getting indemnity by the buyer and earning profit by the underwriters respectively (Penings and Smidts, 2000). A choice of one option over another depends on the level of expected utility derivable from the choice.

2.2.4.3 Theory of Demand Elasticity/Elasticity Theory

The theory of demand elasticity is an expansion of the laws of demand and supply by Alfred Marshal in which the influence of changes in the prices of given market commodity on quantity demanded by consumer's of such commodity is measured. It was an importation of the theory of elasticity developed by the English scientist Robert Hooke in 1660, but published only in 1678, into economics. Hooke theory of elasticity examines the influence of applied forces in the deformation of a spring or any metallic objects. According hookes law of linear elasticity, under elastic condition, extension is directly proportional to load(applied force.). By implication, deformation occurs when the force applied is so greater than the tensile strength of the materials such that, the spring breaks or undergoes plastic deformation.

Alfred Marshal deployed the elasticity theory in economic in estimating the responsiveness of demand to changes in prices of market commodities. Thus the theory of Price Elasticity of demand as a concept, is used to describe the level of changes in quantity demanded of goods and services as a result of changes in the price of such goods and services. In other words, price elasticity of demand seeks to establish how consumers of given products and services responds to changes in the prices of such product and functions as a measure of the impacts of changes in price on the consumers patronage for specific goods and services. In the postulation of the elasticity theory in alignment with the laws of demand, consumers demand for given products and services should be sensitive to the changes in the prices of the products and services. Price elasticity therefore gives the percentage change in quantity demanded when there is a one percent change (increase) in price.

In implication, the demand for financial compensation by maritime operators affected by the impacts of maritime accidents rises with rise in the quantum of maritime accidents economic loss. Consequently, the quantum of compensation funds to be reserved by marine underwriters whose responsibility it is to pay indemnification should be influenced by the quantum of economic loss suffered by operators. Failure of any compensation regime to maintain adequate volume of compensation funds in line with the rise in maritime accidents economic will lead to problem situation where the marine underwriters and deformed to suffere financial insolvency and incapacity to timely and adequately indemnify insured marine risks. Thus, the theory of demand elasticity offers a veritable background for examining the responsiveness of marine underwriters in reservation of compensation funds for insured marine risks, following increasing demand for compensation of attached losses by maritime operators and shippers in Nigeria.

Table 2.1: Summary of Major Theories Reviewed

s/n	Theory	Proponent(s)	Major Postulate(s)
1	The Domino Theory	Heinrich, H.W.(1936)	88% of accidents are caused by unsafe acts committed by people, 10% by unsafe condition and 2% by Acts of God. Thus, 98% of accidents can be avoided by avoiding the casual factors. Management should therefore take responsibility for safety. Accidents that cause losses follow a sequential process.
2	The Human Factor Theory		Postulates that three factors led to human error and human error causes accident. The three factors are overload, inappropriate response and inappropriate activity.
3	The accident/Incident Theory	Dan, Peterson(1982)	Is an extension of the human factor theory and postulates that unsafe act by workers is a resultant effect of an overload, ergonomic traps or a decision to err. Thus, pressure (e.g. deadlines, peer pressure etc.) raises the probability or proneness of workers involvement in accident.
4	The Chain of Events Theory	Hienrick, H.W.(1959)	The theory states that unsafe conditions create vulnerable relationship in which unsafe acts can trigger chain-of-events called accidents. There the task of investigation is to identify unsafe conditions and unsafe acts that caused the sequence.
5	The Branched Event Chain Theory	Watson (1971)	The theory states that accidental events are predictable. The task of investigation should there include predictive search for alternative event pathways by use of fault tree analysis.
6	Single Event Theory		The theory postulates that every accident consist of a single event that has a cause. The investigative task is therefore geared towards finding the single cause and correcting it.
7	Accident/Risk Management Principles and Loss Control Theory	International Standard Organization (ISO,33000:2009)	It recommended seven step processes for risk management in Industries to include: setting objective, risk identification, risk assessment/impact assessment, prioritizing risks, responding to risk and monitoring risk. It also recommended four methods/principles of loss control and management in industries to include: risk avoidance/termination or prevention, risk reduction, risk retention and risk transfer.
8	Expected Utility Theory(Decision Theory)		For decisions/choice between alternative strategies, a choice is made of the alternative that offers maximal utility or that maximizes utility
9	Elasticity Theory	Robert Hookes, 1660	Under elastic limits, extension is directly proportional to applied force/load. Thus, for underwriters to timely and adequately satisfy the demand for compensation by the insured, funds reserved for the indemnification of insured risks must be greater than or proportional to the quantum of maritime accidents economic loss suffered by the insued

Source: Authors preparation based on major theories used.

The study adopted the risk assessment (impact assessment) and risk (loss) transfer principles recommended in the accident and risk management principles and loss control theory ISO 33000: 2009 as well as the expected utility theory.

2.2.5 Some Selected Marine Accidents Economic Loss Valuation Methods

EfficienSea (2012) posits that, in the assessment of economic costs, there are always some uncertainties associated to the complexity of the environment and the ecosystem affected by the accident. Usually only short- term economic costs are valuated, because for medium- to long-term assessment, the biology and recovery of species, and the adaptation of the market to new circumstances are complex factors that require modeling (EfficienSea, (2012).

2.2.5.1 The Human Capital Model and Gross Output Model

The gross output model (GOM) is an offshoot of the human capital theory used by Ogwude (1998) and Adebiyi (2008). The human capital theory, observes EMSA (2008), represent one of the approaches to the problem of valuing human life. The theory asserts that the cost of death is not less than the loss of output which the fatal accident victim would have produced. Similarly, the cost of injury is not less than the loss of output which the injured would have produced over the period of hospitalization / injury induced idle time (Adebiyi, 2008).

According to Ogwude (1998), valuing the economic cost of death of fatal accident victims by the human capital approach involves taking the discounted value of people killed in accident, since the loss of output is thus related to the nation. Ogwude (1998) supported by Adebiyi (2008) opined that, the human capital approach is of two forms.

i. The Net Output Model (NOM) which requires that, the expected consumption of the dead or injured victims be deducted from the expected output over the period. The criticism against this model is that, if the gains from the preventive aspect of maritime transport safety measures are the primary consideration, consumption should not be deducted from the value of expected output ogwude, (1998).

ii. The $Gross\ Output\ Model\ (GOM).The\ gross$ output model is used to overcome the shortcomings of the NOM in valuing human life. By this method, life is valued as the total discounted value of expected output. This is based on the assumption that the proper value of life is what a man would pay to avoid a total accident (Ogwude 1998; WHO, 2009). Thus the value of the gross output represent expected economic benefit to the economy from saving a life in a fatal accident or preventing an injury using marine safety measures.

For total accident involving death, the economic cost of output lost per death is given as;

$$P_N = Y\left[\frac{1}{i}\right]\left[1 - \frac{1}{(1+i)^t} - - - - (i)\right.$$

Total output lost = $P_T = Y\left(\frac{1}{i}\right)\left(1 - \frac{1}{(1+i)^t}\right)N$---------------- (ii)

P_N = National output forgone per death due to total accident.

P_T = Total output forgone due to fatal accident.

Y = Average (national) output or per output.

I = is the social rate of discount (interest) which for developing countries tends towards 10 to 11percent.

t = is the number of working years lost per fatality, defined as retirement age in public sector less national average age of fatality for developing countries, tends towards 25.2 to 29 years.

N = total number of death in fatal accident over a period of time.

2.2.5.2 The Insurance/Court Award Approach.

The marine insurance Act of 1906 defined marine insurance as a contract of indemnity whereby the insurer undertakes to indemnify the assured in manner and to the extent thereby agreed, against economic losses suffered by him in the cause of a marine adventure (MIA, 1906).

Nwokoro (2015) asserts that, marine insurance serves as the most effective risk management mechanism in the marine industry for limiting the financial liability imposed by maritime accidents. The theory and practice of marine insurance denotes that, the underwriter (insurer) in acceptance of consideration (premium) from the insured party agrees to indemnify the insured financially, against economic losses suffered, on the occurrence of marine accident or marine peril insured against.

MIA (1906) section 16 on measure of insurable value established the insurable of value of the subject matter of insurance which in the case of a ship is the value of the ship at the commencement of the risk, including her outfit, provisions and stores for the officers and crew, money advanced for seamen wages and other disbursement including charges of insurance upon the whole. For, freight, the insurable value is the gross amount of the freight at the risks of the assured plus the charges of insurance. For cargo or merchandise, the insurable value is of the prime cost of the property insured plus the expenses incidental to shipping and charges of insurance upon the whole (MIA,1906). The practice of marine insurance requires that, on the occurrence of the risk (accident) insured against, the assured is indemnified by the insurer in manner and to the extent insured. Subrogation principle however limits the assured from making profit from the insurance as only the insured value of the subject matter can be recovered (MIA, 1906).

Ogwude (1998), observed Okoroji, & Onyemechi (2014), states that, among the various approaches to accident costing is the insurance award approach, which is similar in practice to the court award approach. While the court award approach accepts the value awarded by the court to accident victims for their damaged properties as the economic value of the properties damaged, the insurance award approach accepts the values awarded by the insurance firm (insured value) paid as claim or indemnity, as the economic value or cost of the damaged properties.

2.2.5.3 The Natural Resources Damage Assessment Method

The economic loss of maritime accident involving oil spill in which crude oil resources are lost as a result can be estimated based on the natural resources damage assessment methods used by Ando (2004) in estimating the direct economic cost of oil spill in the United States of America. Excluding indirect economic costs associated with oil spill such as cost of environmental cleaning operations, impact on agriculture and aquatic life, etc. The economic cost of oil spill is based on the output lost due to the total quantity/barrels of oil lost (Ando, 2004). The output lost can be measured in terms of revenue loss by the government, and since revenue is a function of price (per barrel price) and quantity lost, variation in economic cost (revenue lost) is caused by degrees of changes in per barrel price and spill quantity. Thus for a given maritime accident involving oil spill (loss of oil resources), the economic cost of oil spill (output lost) is the product of the quantity of oil involved/spilled and the per barrel/per quantity price. The compound amount factor – $(1+r)^n$ can be used for computing to determine the future value and/or present value (PV) of such losses in output over a period of time (Ando, 2004).

Based on the above theory, statistical reports from the Organization of Petroleum exporting Countries (OPEC, 2014) and the Central Bank of Nigeria Statistical Bulletin (CBN, 2014) indicate that the mean econominic cost of marine accidents involving oil spill in Nigerian marine environment between 1984 and 2013 is 138561582.80 naira per annum with a standard deviation of 161752904.39. The economic cost imposed by marine oil spill accident damages over the period is summarized as shown in figure 2.3 below.

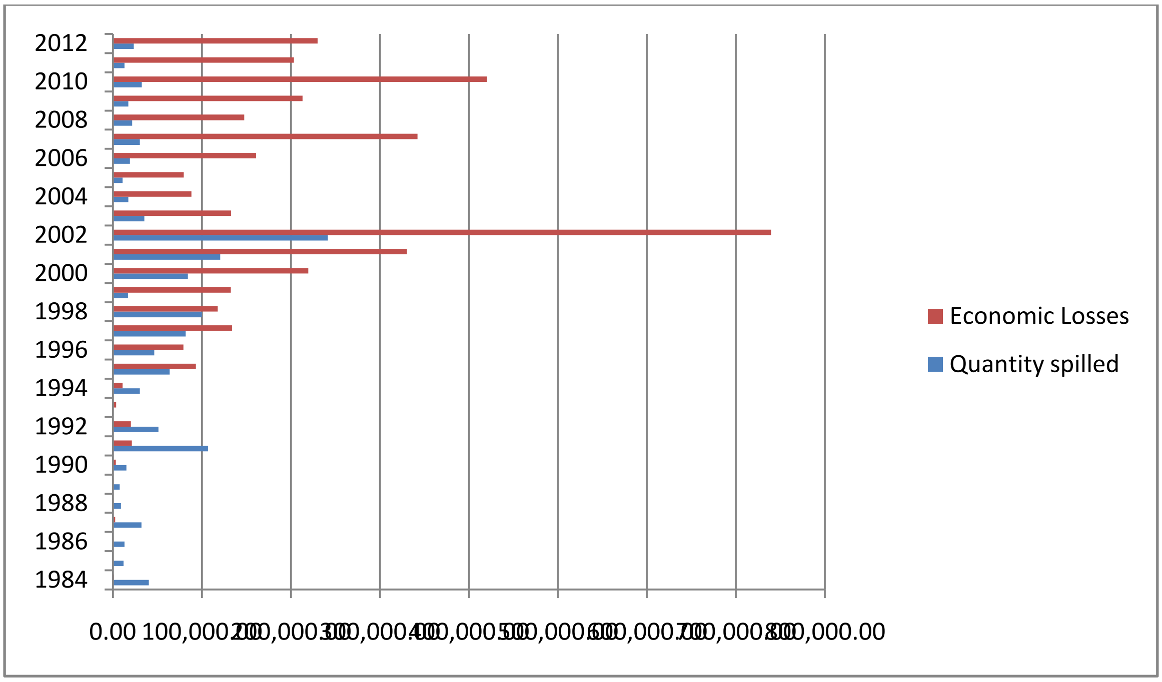


Figure 2.4 : Bar chart representation of marine accident induced oil spill economic risks.

Source: Authors preparation.

2.2.5.4 Summary of other Methods of Accident Valuation

There exist other methods for valueing the economic effects of accidents in the marine environment. Table 2.2 below is a summary of other methods reviewed.

Table 2.2: Methods for evaluation of economic cost of an offshore O&G accidents in a marine environment.

Method	Description	References
Social cost	Assessment of the loss of benefits or revenue from fishing activities; it is frequently evaluated as economic value of the difference in landings before and after the accident.	Garza-Gil, Pada-Blanco, Vazquez-Rodriguez (2006b)
Compensation	The monetary value accepted to be rewarded by compensation mechanisms (insurance) is assumed to be the cost on properties, fisheries and environment.	Moorl (1998)
Evaluation of affected productive sectors	Economic losses of all sectors associated with marine industry operations and activities are assessed with existing base data.	Loureiro, Ribas, Loperz and Ojea (2006)
Habitat Equivalency Analysis	Compares resources lost as a result of an incident with benefits that can be gained from a habitat or wildlife restoration project. Requires modeling.	Zafonte and Hampton (2007)
Resource Equivalence Analysis	Monetary cost of funding the reestablishment of a comparable amount of resources lost or injured. Requires modeling.	McCay et al., (2004)
Restoration Based Analysis	Estimation of costs needed to restore resources equivalent to those existing prior to the accident. Requires modeling.	Mazotta (1994)

Source: Author's preparation based on reviewed literature.

The United Nations Environmental Programme (UNEP, 2011) notes that, some of these methods evaluate the monetary cost of services and properties and can be applied to evaluate the impact an offshore O&G accident makes on local environment. The social cost analysis is by far the method most frequently applied for assessment of costs and impacts on fisheries after major accidents, and has been used in estimation of damages by the Prestige oil spill (GarzaGil, Swris – Regueiro, Varela-lafuente, 2006a), the Amoco Cadia (Grigalunas, Anderson, Brown, Congar, Sorensen and Made 1986), the Sea Empress (Mgoore, Frotitt, Reynolds, Postle, Floyd, Feeu and Viradi 1998) and the Exxon Valdez (Preston, Shildher, and Gates 1990) accidents. The social cost analysis has been preferred over any other method for evaluation of impacts on fisheries for two reasons. First, its application for estimation of damage to fisheries is feasible, as market values are normally available: data of fisheries revenues before and after the accident are recorded in public statistics, The second reason is linked to the conditions of the damage compensation mechanisms: claims based on non-market valuation methods are not accepted in the current international liability framework (Garza-Gil et al., 2006b).

In application of the social cost method, there is no conceptual difficulty in defining commercial losses due to the effects of accidents involving pollution after an offshore O&G accident. However, difficulties may arise from the lack or reduced quality of baseline data and from the need to develop a reasonable scenario of what would have happened had the pollution not occurred (Lipton and Strand, (1997; Tround, Peter, Torgeir, Stein, Jan and Morten, 2015).

In the assessment of the economic cost and impacts of minor offshore O&G incidents, the compensation mechanism is preferred for its simplicity (Jan and Morten 2015). This is because claims made by affected parties to O&G operators are normally accepted and compensated if the cause of the incident is clear. When the incident's responsibility cannot be stated, affected parties claim to a compensation fund (OGUK, 2009).

An examination of the database of Oil and Gas United kingdom reveals that, since year 2000 there have been almost 500 claims to the Fishermen s Compensation Fund (UK) for damages to fishing vessels in relation with incidents of O&G activities in the North Sea (OGUK, 2014). These claims are made for three concepts: loss of gear, loss of fishing time, and damage to vessel. OGUK (2014) notes that the amount claimed and settled in individual cases ranged between £100 and £50,000 with a mean value of £3900 on average, the most costly component of the total amount claimed and settled according to the report is the damage produced to fishing gear which represent about 63%, followed by the loss of fishing time 31% and damages to the fishing vessel make up, on average, 6% of the amount claimed and settled in individual cases (OGUK, 2014). The total amount claimed and settled between year 2000 and May 2013 was €l.8 million.

Michael and Wang (2015) observes that, major deep water accidents causing serious spill exerts serious destructive impact on the economy and the fishing sector most times is more seriously affected. Maria, Alfonso, Edelmiro and Elena (2006) in a study on the effect of the Prestige accident and oil spill in Galacia, Spain observes that, almost five thousand fishing vessels are registered in Galicia, representing 6% in number and power of the entire European fleet and were affected by the Prestige accident. This proportion was confirmed in Garza-Gil et al., (2006a) who note that Coastal communities in Galicia are strongly dedicated to fishing and related industries like canning and freezing and were seriously affected in the Galician coast after the Prestige accident in 2002. Garza-Gil-et al. (2006b) evaluated the short-term cost of the accident impact analyzing fish landings and aquaculture production and income. Reference data were averaged for five years prior to the accident. The economic loss suffered in 2003 (the year after the accident) was estimated to be 56 million Euros in relation with fishing and 9 million Euros for the aquaculture activities. The reduction of production was calculated to be10% while income decreased more than 17%. This difference was -attributed to the loss of consumer confidence on the quality of the produce.

Loureiro et al., (2006) quantified short-term economic losses on the most productive sector affected in Galicia and other regions affected by the Prestige spill. The sectors accounted are commercial fisheries and shellfish-mussel production and canning and processing industries. The difference in landings of 36 species in the periods prior to the accident and after the accident showed a loss of 50% in quantity and 60% in revenue value**.** The accumulated economic loss associated with loss of landings in the two years following the accident was

124 million Euros**.** Loureiro etal (2006) observes that although mussel production was not directly affected by the spill since farming occurs in rivers and estuaries, this sector's economic loss was estimated as 12.8million Euros, affected by market fluctuations and loss of perceived quality and reputation Losses by the canning industry were 26.8 million Euros in two years following the accident.

Garcia, Villasante, Carballo, Rodriguez (2009) performed an exhaustive analysis of landing losses with data broken down for the individual markets and species during period 1998-2005. They found that total landings decreased by 17% after the prestige accident.

Mouhamadou, Mac-Andre, Jean-Micheal, and Valerie (2016) opines that, an apparent variability of results in the estimation of costs and impacts of marine accident like the case after the Prestige accident reflects significant difficulties encountered to produce accurate and reliable estimation of the economic effects and costs. The consistency of the base data, the period of reference, the affected area considered and the species accounted in the analysis are some of the factors that may influence the appraisal results. As posed by the study of Baud and Goodlad(2004), establishing a single global estimate of the social cost of a marine accident induced oil spill is extremely difficult, since three types of figures may be considered: estimates by experts, compensation claims, and compensation eventually paid to claimants.

As an additional limitation, calculation of the economic cost based on fish landings does not reflect the real impact on the fishing industry, as fishing effort is redistributed to other areas (Abad, Bellido and Punzon 2010) implying derived costs, and few species become marketable and exploited with unpredictable consequences.

2.2.6 Protection and Indemnity (P&I) Insurance

Protection and indemnity (P&I) insurance is a form of marine insurance provided to ship-owners for the protection of their ships against losses by the protection and indemnity clubs. This becomes necessary following the fear expressed by most ship-owners on the incapacity, inability and insolvency of most regulation public and private sector marine insurance companies and underwriters to provide adequate cover and indemnify marine claims as they occur,(2001). Consequently, ship-owners now form associations referred to as protection and indemnity (P&I) clubs with the objective of mutually protecting members against the occurrence of mutually agreed marine risks and to indemnify those among them who suffer losses enshrined in the common code and practice of the given P&I club (Susan, 2001). It is important to note that while marine insurance companies provide "hull and machinery" cover for ship-owners, and cargo cover for shippers P&I clubs provide cover for open-ended risks that traditional insurance companies are reluctant to insure. For example, protection and indemnity clubs provide cover for:

(i) a carrier's third-party risks for damage caused to cargo during carriage;

(ii) War risks; and

(iii) risks of environmental damage such as oil spills and pollution.

Tyne (2012) notes that most regular marine insurance companies are reluctant about providing cover for the above identified risk types. One major area of difference between a marine insurance company and the P&I club is that while a P&I club pools the risks of its members consisting mostly of ship-owners, ship-operators, demise charterers, freight forwarders and warehouse operators, and provides information and representation to each member and also reports to the members; the marine insurance and underwriting company reports to its shareholders who may not be ship-owners and charterers (Tyne, 2012).

Similarly, in practice, the insured in a marine insurance contract purchased from an insurance company pays premium as consideration to the marine underwriter from a cover/protection against loss which remains valid fro an agreed given time period (e.g a year or a voyage); but P&I clubs do not charge members premiums for the purchase of cover. Members of P&I clubs instead pay a "call" annually; which is a sum of money that is put into the club's financial pool and maintained for purposes of compensating members who suffered losses as a result of the occurrence of the type of risks the P&I club covers. Each member is expected to pay call annually except in a situation where, at the end of the year or period, there are still funds in the pool. In this situation, each member will pay a reduced call in that year. In the situation that the P&I club made a major payout (huge oil spillage compensation), club members will immediately have to pay a further call to replenish the financial pool (Tyne, 2012; Susan, 2001).

Though in Nigeria, there is currently no locally developed protection & Indemnity club. However, since the operational of the internationally established P&I clubs does not bar willing foreign ship-owners and operators from memberships; it is obvious to state that Nigerian ship-owners with strong affinity to secure sure and adequate protection for their vessels should opt to join foreign P&I clubs to complement the efforts of the local marine insurance companies. One major obstacle that the fulfillment of the desire for membership of foreign P&I clubs by indigenous ship-owners and operators in Nigeria is the huge financial resources in foreign currency required to actualize it. Thus local ship-owners have continued to face the risk of making due for the seeming inadequate cover being provided by the local marine underwriters in Nigeria. In the UK, both traditional underwriters and P&I clubs are subject to the Marine Insurance Act 1906 while in Nigeria, their current marine policy does not explicitly indicate the interest and direction of the state in developing providing a framework for the development of local protection and indemnity (P&I) clubs (Susan, 2001).

At present, there exist an association of global P& clubs referred to as ‘International Group of P&I Clubs’ (IGPIC); based at Peek House, London. The purpose of the IGPIC is to provide a common ground and platform for member P&I clubs to cooperate to provide funds in the event of huge claims using a complex system to determine liability (Susan, 2001).

2.2.7 Historical development of the P&I Insurance

Tyne (2012) note that the ancient Greeks created the practice of general average in Rhodes Island, and ancient Romans could be said to have had a rudimentary form of marine insurance. Consequently, a novel type of insurance more modern than what was practiced by the Greeks and Romans emerged in the London "coffee shops" in the 19th century. Ship-owners and charterers needed underwriters to insure their ships while shippers, importers or consignees needed to also insure their cargoes. Thus ship-owners and operators (Carriers) observed that often, they might themselves be at fault should cargo be lost or damaged at sea, and they sought to take out third-party indemnity insurance in respect of cargo liability. According to Tyne (2012), underwriters showed an unwillingness to take on such open-ended risks, thus motivating ship-owners to form their own mutual P&I clubs, acting as a ship-owner's co-operative. The benefit of this decision to the ship-owners was that a club worked for the ship-owners, thereby eliminating the underwriters' profit margins and making P&I Insurance significantly cheaper (Tyne, 2012).

Further developing in the practice of P&I insurance was the formation of the first protection and indemnity association- the Ship-owners' Mutual Protection Society (SMPS), formed in 1855. It was intended to compensate for loss of life, injuries and collisions that were excluded from marine insurance policies beyond the monetary limit of these policies. Similar associations were later formed within the United Kingdom, in Scandinavia, Japan and the

United States. After the Torrey Canyon grounding in 1967, covering the liabilities, costs and expenses of oil spills became an increasingly important aspect of P&I insurance.

The European Union (EU, 2009) Directive 2009/20/EC was implemented in all 27 member states by January 1, 2012. The directive requires compulsory P&I to cover for EU and foreign ships in EU waters and ports. Foreign vessels that do not comply to the directive may be expelled or refused entry into any EU port, although ships may be allowed time to comply before expulsion. As EU competence does not generally extend to penology, the directive requires the member states themselves to set penalties for any breach (EU, 2009).

Table 2.3: List of available P&I clubs in major countries of the world:

Serial number	Name of P&I club	Country
1	Steamship Mutual Management Limited	Bermuda
2	Gard P.& I. Ltd	Bermuda
3	China Ship-owners Mutual Assurance Association	China
4	Japan Ship-owners P&I Association	Japan
5	Assurance foreningen Gard	Norway
6	Assurance foreningen Skuld	Norway
7	Standard Steamship Owners Protection & Indemnity Association (Asia)	Singapore
8	Sveriges Angfartygs Assurance Forening	Sweden
9	Islamic P&I Club	UAE
10	London P&I Club aka London Steam-Ship Owners Mutual Insurance	UK
11	The Britannia P&I Club, founded in 1855	UK
12	Michael Else & Co	UK
13	North of England P&I Association	England
14	West of England Ship-owners Insurance Service	England
15	North of England P&I Association	England
16	Steamship Mutual Underwriting Association	UK
17	The UK P&I Club, founded in 1869	UK
18	American Steamship Owners Mutual Protection & Indemnity Association, Inc.	USA
19	The Korea Ship-owners' Mutual Protection and Indemnity Association	South Korea

Sources: Susan (2001), Tyne (2012)

Onuoha (2019) notes that the moves by the Ship Owners Association of Nigeria (SOAN), to establish a specialist insurance outfit in Nigeria to cover all maritime related risks, has drawn the ire of the insurance industry. SOAN has said it was moving to establish a maritime insurance outfit in the mode of the Protection & Indemnity, P&I, Club of London to curb the loss of billions of dollars annually in insurance premium paid to foreign insurance companies. But insurance industry chieftains said it was a mission impossible, claiming that marine insurance is an international business where risks are spread locally and internationally. Also, insurance operators argue that the move is not going to fly because most of the vessels in Nigeria are old and uninsurable even as many of them are not registered (Onuoha, 2019). SOAN continues to accuse the local insurance firms of failure to pay claims in cases of accident, an action that have slowed down operations of some maritime businesses. This support the need to develop a mechanisms that will ensure that local underwriters remain financially solvent to provide adequate, timely and sustainable compensation of insured marine risk when such risks attached since the absence of a local P&I club for indigenous ship-owners in Nigeria means that the local insurance industry must at all time be adequately capitalized and financially solvent to indemnify claims as they arise.

2.2.8 Selected Insurance Companies in Nigeria and the marine insurance business performances

In Nigeria, there exist a plethora on marine insurance companies and underwriting working to provide insurance cover and protection for seaborne trade and offshore operations in Nigeria. The activities of these companies are regulated by the Nigerian Insurance Commission (NIA) within the legal framework provided by the Nigeria Insurance Act, 2007 as amended. Notwithstanding the existence of numerous marine underwriting providing insurance protections for seaborne trade in Nigeria, the seeming incapacity and insolvency of the underwriters in the adequate indemnification of marine claims remain persistent (IMF, 2013).

For example, analysis of financial performance of eight major insurers in the industry for the 2018 financial year show that Gross Premium (GP) for marine insurance stood at N8.8 billion while gross claims paid was N4.5 billion. When viewed peripherally, this suggests a good business outing for the insurance firms in that business year as premium revenue far exceeded marine claims. It equally suggests the possession of adequate capacity to settle claims for insured marine risks. However, the provision of the insurance act 2007 for the reservation of between 25% and 45% of the premium revenue as technical reserve for unexpired marine risks gives latitude to the underwriters to employ the premium revenue for other forms of investment and part as operating cost thus rendering most marine underwriting companies insolvent and incapable of providing adequate, timely and sustainable indemnification of insured risks (IMF, 2013).

According to Nigerian Insurance Digest (NID, 2018), Lead way Assurance led the pack of marine insurance companies with GP of N1.7 billion. Nem Insurance followed with GP revenue of N1.5 billion while claims paid was N569.1 million. AIICO Insurance was next with GP revenue of N1.4 billion while gross claims stood at N512.5 million. Zenith General Insurance recorded GP of N1.1 billion while gross claims stood at N675.9 million. Axa Mansard posted GP of N974.3 million while gross claims were N163.9 million. Mutual Benefits recorded GP of N895.4 million while gross claims stood at N242.3 million. Custodian and Allied posted GP of N793.7 million even as claims paid was not recorded in its annual report. Consolidated Hallmark posted GP of N478.3 million while gross claims stood at N2.3 billion (NID, 2018).

The table below summarizes the written premium revenue and gross claims expenditure from marine business of insurance companies involved in practice of marine insurance and the gross claims to gross premium ratio. The gross claims to premium ratio indicate the gross performance of the given companies in the marine insurance sector.

Table 2.4: Claims to Gross Premium Ration of Marine Insurance Companies in Nigeria

s/no	name of company	gross premium written 000	gross claims paid 000	ratio
1	AIICO General Insurance Co. Ltd.	1,353,970	486,866	0.36
3	Allianz Nigeria Insurance Plc	1,903,682	367,770	0.19
4	Anchor Insurance Company Ltd.	463,523	34,097	0.07
5	AXA Mansard Insurance Plc	1,502,252	314,092	0.21
6	Consolidated Hallmark Insurance Plc	783,746	2,680,547	3.42
7	Cornerstone Insurance Plc	1,034,333	173,926	0.17
8	Custodian & Allied Insurance Ltd.	1,194,228	218,451	0.18
9	FBN General Insurance Limited	251,602	38,107	0.15
10	Fin Insurance Company Ltd.	122,168	37,752	0.31
11	Goldlink Insurance Plc	66,126	40,102	0.61
13	Guinea Insurance Plc	72,460	27,040	0.37
14	Industrial & General Insurance Plc	111,607	35,825	0.32
15	International Energy ins. Plc	61,461	19,226	0.31
17	KBL Insurance Ltd.	161,699	19,117	0.12
18	LASACO Assurance Plc	154,751	35,874	0.23
19	Law Union & Rock Ins. Plc	385,160	225,849	0.59
20	Leadway Assurance co. Ltd.	1,650,028	612,887	0.37
21	Linkage Assurance Plc	516,691	313,853	0.61
22	Mutual Benefits Assurance Plc	1,268,017	545,215	0.43
23	NEM Insurance Plc	1,545,763	590,010	0.38
25	Niger insurance Plc	269,027	2,394	0.01
26	Nigerian Agricultural ins. Corporation	10,617	27,733	2.61
27	NSIA Insurance Limited	465,606	276,422	0.59
28	Old Mutual Gen. Ins. Co. Nig. Ltd.	754,268	182,589	0.24
29	Prestige Assurance Plc	724,806	316,855	0.44
30	Regency Alliance Insurance Plc	564,701	67,298	0.12
31	Royal Exchange Gen. Ins. Co. Ltd.	570,936	166,810	0.29
32	Saham Unitrust Insurance Nig. Ltd.	177,880	33,285	0.19
33	Sovereign Trust Insurance Plc	574,468	477,507	0.83
36	Sterling Assurance Nigeria Ltd.	228,905	194,303	0.85
37	Sunu Assurance Plc	496,844	193,730	0.39
38	Universal Insurance Plc	117,560	28,359	0.24
39	VeriatsKapital Assurance Plc	209,858	33,299	0.16
40	Wapic Insurance Plc	531,778	457,745	0.86
41	Zenith General Insurance Co.Ltd.	1,141,626	570,106	0.50
	TOTAL	21,442,147	9,845,041	0.46
	TAKAFUL COMPANY			
42	Jaiz Takaful Insurance Plc	27,784	0	0.00
43	Noor Takaful Insurance Ltd	9,806	0	0.00
	TOTAL	37,590	0	0.00
	REINSURANCE COMPANY			
44	Continental Reinsurance Plc	1,609,949	1,067,100	0.66
45	Nigeria Reinsurance Corporation	100,834	44,486	0.44
	Total	1,710,783	1,111,586	0.65

Source: NID (2018)

2.2.9 International Maritime Organization Resolutions on Practice of Marine Insurance liability and compensation

The International Maritime Organization (IMO) is primarily concerned with the safety of shipping and the prevention of marine pollution, but the Organization has also introduced regulations and resolution covering marine claims, liability and compensation for damage, such as pollution, injury, property damages, etc, caused by ships. IMO (1999) notes that the Torrey Canyon disaster of 1967, which led to an intensification of IMO's technical work in preventing pollution, was also the catalyst for work on liability and compensation.

An ad hoc Legal Committee was established to deal with the legal issues raised by the world's first major tanker disaster and the Committee soon became a permanent subsidiary organ of the IMO Council, meeting twice a year to deal with any legal issues raised at IMO (IMO, 1999).

Acording to the IMO (1999), the main issues raised by the Torrey Canyon for resolution were:

(i) Who is to be held responsible for damage caused by oil pollution?

(ii) What is the basis for determining liability?; and

(iii) What is the level of compensation to be paid to affected parties for oil spill damages?

It is important to note that there were already well-established procedures for settling claims resulting from, for example, a collision between two ships. Generally speaking, only they are to blame, and only the ships, cargo, and those on board are likely to suffer damage or injury. But a major pollution disaster, like the Torrey Canyon, involves third parties and the damage caused can be enormous. It is important to establish a system which enables liability to be determined and ensures that any compensation due is paid.

In 1969, a conference convened by IMO adopted a convention dealing with the civil liability of the ship or cargo owner for damage suffered as a result of a pollution casualty. The purpose of the International Convention on Civil Liability for Oil Pollution Damage was to ensure that adequate compensation was paid to victims and the liability was placed on the ship-owner (IMO, 1999). Some delegates to the 1969 Conference felt that the liability limits established were too low, and that the compensation made available in some cases, therefore, might prove to be inadequate. As a result, another conference was convened by IMO in 1971 which resulted in the adoption of a convention establishing the International Fund for Compensation for Oil Pollution Damage. The Convention came into force in 1978 and the Fund has its headquarters in London. Unlike the Civil Liability Convention, which puts the onus on the ship-owner, the Fund is made up of contributions from oil importers. The idea is that if an accident at sea results in pollution damage which exceeds the compensation available under the Civil Liability Convention, the Fund will be available to pay an additional amount, while the burden of compensation will be spread more evenly between ship-owner and cargo interest.

The limits of liability in the two conventions were greatly increased through amendments adopted by a conference held in 1992, and again during the Legal Committee's 82nd session held from 16-20 October 2000. In May 2003, a Diplomatic Conference adopted the 2003 Protocol on the Establishment of a Supplementary Fund for Oil Pollution Damage. The Protocol establishes an International Oil Pollution Compensation Supplementary Fund, the object of which is to provide an additional, third tier of compensation for oil pollution damage. Participation in the Supplementary Fund is optional and is open to all Contracting

States to the 1992 Fund Convention. However, those States that do not join will continue to enjoy their present cover under the current CLC/Fund regime. Note that the IMO's success in dealing with pollution compensation has encouraged Member States to refer a number of other legal matters to the Organization.

In 1974, IMO turned its attention to the question of passengers and their luggage and adopted a convention which establishes a regime of liability for damage suffered by passengers carried on seagoing vessels. The Athens Convention relating to the Carriage of Passengers and their Luggage by Sea declares the carrier liable for damage or loss suffered by passengers if the incident is due to the fault or the neglect of the carrier. The limit of liability was set at 46,666 Special drawing Right (SDR) per carriage. In 1990 a Protocol was adapted to the Athens Convention raising the amount of compensation payable. For death or personal injury, for example, the limit was raised to 175,000 SDR. In October 2002 a Diplomatic Conference adopted a 2002 Protocol which totally revised the 1974 Convention, adopting much increased levels of liability, revising the basis of liability and introducing compulsory insurance.

The general question of limitation of liability for maritime claims was dealt with in a convention adopted in 1957, before IMO first met. As time went by, however, it became clear that the limits of liability established were too low and, in 1976, IMO adopted a new convention which raised the limits, in some cases by 300%. The Convention on Limitation of Liability for Maritime Claims specifies limits for two types of claim - those for loss of life or personal injury and property claims, such as damage to ships, property or harbour works. The compensation limits of this Convention were raised by means of a Protocol adopted in 1996.

In March 2001, IMO adopted a new International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001, which established a liability and compensation regime for spills of oil, when carried as fuel in ships' bunkers. Previous regimes covering oil spills did not include bunker oil spills from vessels other than tankers. The convention is modelled on the International Convention on Civil Liability for Oil Pollution Damage, 1969. Thus, the IMO in Resolution A.898(21) established the guidelines and basis on ship-owners responsibilities in respect of marine claims. These guidelines aim to ensure adequate, timely and sustainable indemnification of insured risks when losses attached.

2.2.10 Legal Framework for the Practice of Marine Insurance In Nigeria

In the processing of seaborne shipping trade, the Hamburg Rules govern both inward and outward shipment of cargo while the Carriage of Goods by Sea Act, 2004 applies only to outward shipment of cargo. The Hague rules may however apply to inward shipment of cargo by reason of a clause paramount in the bill of lading contract between the carrier and the consignee. By Article 3 rule 6 of the Hague Rules, a written notice of loss or damage to cargo must be given to the carrier at the port of discharge prior to or at the time the person entitled to delivery of the goods takes custody of same. Where the loss is not apparent, the notice must be given within three days. Where the cargo is removed without such notice, its removal constitutes prima facie evidence of the delivery of the goods in good condition by the carrier. Note also that claims for cargo losses as a result of the negligence of the ship-owners abates following failure to institute action against the ship-owners or operators in court within one year from the date of delivery of the goods. Hamburg Rules article 20 rule 14 prescribes a one year limitation period. Different from the Hamburg rules, the Hague Rules, provided that that notice form claims arising from cargo damages be tendered the carrier within one day from the date of delivery.

In Nigeria however, the legal and legislative framework for the practice of marine insurance rest on the insurance Act, 2004, and the marine insurance policy 2007.

According to Akinyeye (2018), the Insurance Act (IA) Cap I18 LFN 2004 is the principal legislation governing insurance business in Nigeria. The Act applies to two main classes of insurance that are life insurance business and general insurance business which include the practice of marine insurance. By virtue of section 2(3) (d) of the Act, marine insurance is expressly classified as one of the categories of general insurance business to which the Act applies (Akinyeye, 2018). Section 67(1) of the Insurance Act directly impacts on marine insurance by providing that 'insurance in respect of goods to be imported into Nigeria shall be made with an insurer registered under this Act'. Thus, section 67(1) of the IA represents a protectionist law that seeks to ensure the promotion of the Nigerian marine insurance industry. By this provision, contracts for seaborne import of goods by shippers must be executed on free on board (FOB) international trade terms (INCOTERMS). This dictates that while the seller will be responsible for ensuring loading of the goods on board the vessel, the Nigerian buyer or importer would be required to pay the freight, cost of transportation and deal with an insurance provider from any of the local marine insurance companies registered in Nigeria for the purpose of insuring the imported goods. However, section 67(3) of the IA appears to contradict section 67(1) when it provided that the letters of credit issued by any bank or financial institution in respect of goods imported into Nigeria shall be on a carriage and freight basis only. According to Akinyeye (2018), in the premise that the general intention of section 67 is to ensure that the insurance of goods imported into Nigeria is undertaken by a local marine insurance provider, it is argued that section 67(3) ought to provide that letters of credit for goods imported into Nigeria are to be issued on Free on Board basis only. Understood this way, it is crucial for section 67(3) to be amended in order to reflect the true spirit of the section (Akinyey, 2018).

To ensure compliance, section 67(4) of the IA lays down sanctions for the failure to comply with section 67(1) by providing that any importer, broker or agent who secures insurance for imported goods other than as provided by section 67 is guilty of an offence and liable to a fine of N500, 000 upon conviction. Thus, the provisions of the insurance act 2004 section 67 provided legal basis to ensure that Nigerian marine insurance companies are patronized and engaged in respect of providing insurance for the importation of cargo to Nigeria.

Similarly, the Marine Insurance Act (MIA) Cap M2 2004 is the primary legislation exclusively dedicated to the subject matter of marine insurance in Nigeria (Akinyeye, 2018). The MIA mirrors the English Marine Insurance Act 1906 which codified the common law principles underpinning marine insurance. Understandably, the English principles of marine insurance are therefore applicable in governing marine insurance related activities and matters in Nigeria.

According to Akinyeye (2018), there is an absence of provisions in the MIA that ought to reflect a shipping or cargo insurance policy that would promote the Nigerian marine insurance industry. This is in sharp contrast to the position in section 67 of the IA which constrains provisions seeking to promote the industry as earlier identified (Akinyeye, 2018). Thus, there are legal and legislative frameworks for the practice of marine insurance in Nigeria and the drive to ensure adequate, timely and sustainable compensation of insured marine risks, when they occur.

2.2.11 Marine Accidents and the History of Safety at Sea

The sea from the earliest times has always been synonymous with danger, uncertainty and insecurity for those who venture on to it. The history of navigation since ages indicates that, safety gradually came to the fore, in the wake of accidents and disasters, which alters the collective and individual behavior of mariners, who long before now clung to ancient practices and habits (Boisson, 1999). It might be though that few risks existed at sea in olden times when water crafts of modest size, and few in number, propelled by sails or oars, never ventured far from the coast. In reality, ancient navigation was a period of persistent uncertainty, insecurity, and safety challenges, that make sea voyages extremely hazardous (Boisson, 1998). The reasons were that ships were hard to handle and easily tossed about by winds, currents and tidal waves, given their modest sizes. Shipwrecks, caused by storms remained a frequent occurrence.

Andre and Baslez (1994) asserts that, until the end of the Roman Empire, mariners were ill equiped to confront bad weathers, bulky cargoes and passengers were packed together on the deck, vessels were loaded beyond safety limits as there were not technically precise ways of determining safe loading limits and freeboards; navigators know little or nothing about winds, ships strengths and stability issues, for most crafts in the period, as the ship was usually bound round with ropes fore and aft, to prevent splitting apart, and an anchor was dragged behind to slow down its progress. Thus accidents at sea were a frequent occurrence following the numerous safety challenges that marine transportation faced. Andre et al (1994) asserts that, jettisoning or casting overboard of cargo became a method of dealing with imminent danger to lighten the vessel in the early ages of navigation. By jettisoning, the captain, the ship-owners or the most prominent person on board takes a decision to throw cargoes overboard to save the ship from danger. Andre and Baslez (1994) notes that, the practice of jettisoning was adopted by Roman navigators from the Island of Rhodes, who have the practice domesticated in the domestic rule Lex Rhodia de Jactu that; if part of the cargo had to be jettisoned, in order to save the ship, the loss was to be borne by the owner of the ship and the owner of the cargo. In modern maritime law and practice, this provision survives as the “general average clause; the general average sacrifice or the “general average loss”.

In the ancient Roman times, it was ultimately certain that safety of every single ship voyage rested on the shoulder of the pilot, the equivalent of a captain who bore all the technical responsibilities for the choice of the safety routes and port of call. But the masters/captains’ decisions were always interfered with and overridden by ship-owners desirous to earn high profits by sailing even in bad weather and poor ship conditions. This explains the frequency with which shipwrecks occurred. To prevent and reduce ship accidents, the Romans placed a band on sailing in the winter, putting the seas out of bounds during the worst weather. The ban on sailing in winter was accompanied in Roman law by an administrative penalty: no ship could leave the port unless it held a dimissorium; a kind of sailing permit by the appropriate official (Werner, 1964).

2.2.11.1 The Beginning of Accident Prevention in the Middle Ages

Dollinger (1988) note that, conditions of navigation underwent very little significant change throughout the middle ages. Ships stayed in port in winter. It was until the end of the 18th century that the Levantines sailed from 5th May to 28th October. In the Baltic, maritime traffic was banned from sailing in winter, particularly between Martinmas and St. Peters day (22, February), on pain of confiscation of cargo. In the mid 13th century, the maritime authorities in the large Mediterranean ports led by Lex Rhodia introduced very strict legislation on freeboard, in order to regulate (combat) the abusive activities of unscrupulous ship-owners and captains who overload their ships at the risk of accident, so as to earn more from the freight. The first accident prevention regulation appeared in Venice (Italy) in 1255. The Venice authorities made it illegal to exceed the draught, marked on each ship by a cross. Cagliari and Pisa made similar provision around the same period while Barcelona (Spain) in the decree issued by Lagode Aragon in 1258, and Marseilles (France) in maritime status of Marseilles 1284, adopted similar accident prevention regulations (Boisson, 1999).

In 1330, the maritime authorities in Genoa laid down very precise rules for calculating the maximum draught of different sizes of ships, and also provided inspection procedure and a whole range of penalties for anyone contravening the rules, while officials were appointed to measure ships in accordance with the safety rules in force, and attend to the fixing of irons to the hull, the precursors of modern day use of load lines. It is important to mention that despite these measures, shipwrecks remained a common occurrence in the Mediterranean, particularly during winter season, notes Biosson (1999). Biosson (1999) asserts that, a single storm such as occurred in 1546 in the Adriatic sea sank fifty vessels. The Hanseatic League introduced very severe criminal legislation which applies mainly to the pilot who has responsibilities for directing the ship. The sea laws of Oleron, empowers the captain, who exercises absolute authority on board, to cut off the luckless pilots head if by ignorance, he had endangered the cargo and the crew. However, Werner (1964) notes that, these punishments were so barbarous that they were practically never applied, rather, they remain sure indicators of how seriously early marine adventurers took safety issues.

In the 18th century, seaborne trade witnessed growth, subsequently as expected, there was increase in the number of ship traffic, with greater speed and carriage capacity; also the increase in value of the property transported in them, provided backing for the introduction of policing methods among the major maritime nations. Prevention rules which become more seriously implemented, for example, a Spanish ordinance in 1563 required shipbuilders and owners to see to the perfect sea worthiness of their vessel, check the low water level and lash the cargo securely (Marie & Dilly, 1931).

Also in France, an edict on the Admiralty issued by French King Henri III in March, 1584 required maritime cities to oversee the abilities of ship captains. The most innovative measure became the institution of ship survey authorities to carry out survey in order to prevent accidents caused by poor ship conditions and inadequate equipment. For example, the Genoese law of 1607 provided for double survey, before and after loading of the cargo and entrusted surveys to the “magnificent curators of the sea”. In France, a Royal declaration of 17 August, 1779 provided for dual survey of the ships, on the outward voyage and on the return trip. Strict obligation was laid on the captains of ships to solicit for a survey before equipment and before loading of the vessel and also the office of the huissier-visituer or ship surveyor was created. The ship surveyors consisted of certain class of navigations, shipbuilders, and carpenters appointed by the commercial courts or by the local mayor (Werner, 1964; Philippe, 1999).

Biosson, (1998) opines that, despite the system of policing of navigation in the 18th century, risk prevention remained a rudimentary matter. To protect maritime trade, legislation was introduced to provide compensation and protection for the financial interests of ship-owners. The original system was based on the principle that the various parties with an interest in marine transport had to bear their share of liability, since only they were concerned with such problems. Following this, techniques such as joint ownership of ships aimed at reducing hazards by sharing risk, and bottomry, which allowed their transfer become legal system of managing risks of losses. Boisson (1999) notes that the third technique, which consist of involving a third party – the insurer, who took the place of the person normally bearing the risk, met with prompt general acceptance and success. Since the events that led to accident remain largely unknown and in most cases, multidimensional, legislation to define the formula for sharing of liabilities and damage, finally appeared as the cogent solution and appropriate answer to the problem of insecurity of seaborne trade (Boisson, 1999).

2.2.11.2 The Intervention of States in Maritime Safety in the 19th Century

The industrial revolution brought about technological innovations that revolutionalized marine transport operations in the 19th century. The most pronounced of these innovations were the introduction of steam engine powered vessels and the use of iron and steel in the construction of ship hulls. Surprisingly, with these innovations, there was an increase in the risk of accident at sea following greater number of traffic, size and speed of vessels engaged in trade. Marine accident figures points to the acuteness of the problem as it was indicated that during the winter of 1820 alone, more than two thousand (2000) ships wrecked in the North sea with death figures of twenty thousand people and unquantified cargo values (Boisson, 1999).

Attoma (1976) asserts that, the principal attempt to achieve greater safety at sea took place within private framework, as state supervision of shipping was viewed as hindrance to the trade. It was viewed that the proper interest of the ship-owners, who had committed all his wealth to the acquisition of ships, ultimately represents the best guarantee of safety for all concerned. Following this view, accidents continued to occur and state intervention was unavailable until the mid 19th century after the birth of the earliest classification societies. The classification societies were purely private organizations who conduct survey on merchant ships and provide accurate and regular information on the quality of shipping and ship equipment. The mid of the 19th century saw the intervention of states and marked the turning point on the issue of safety at sea, with the proliferation of prevention rules, increasingly introduced within the official framework (Attoma, 1976). Boisson (1999) opines that, two factors led to this growing state intervention, these include:

(i) The speed with which marine transportation was becoming a real industry, necessitating state policing powers, to monitor safety conditions in the interest of the seamen and the increasing number of other people going onboard ships.

(ii) The need to harmonize national rules, habits and customs, since ship sail across ports belonging to differing states, and states are the only entities under international law, to sign agreements, treaties and other regulatory instruments. State interventionism came with increases in the number of public laws relating to the safety of ships and navigation. For example, the promulgation of the Commercial Code of 1808 in France repeated the provision of survey of ships. France public laws of 1846, 1853, 1870 and 1896 and Decree 26 of June

1903 made provision for safety of steam ships, fishing vessels and vessels engaged in home (domestic) navigation and carriage of dangerous goods.

Furthermore, the French Act of 17 April, 1987 and the Decrees of 20th and 21st September, 1908 introduced public health and safety rules and measures on navigation (Attoma, 1976).

Similarly, Britain in response to public pressure following the recurrence of accidents involving British vessels at sea adopted state intervention in 1836 with the appointment of a parliamentary select committee to examine the causes of reoccurring shipwrecks and recommend solutions. In 1867, alone, there were 1,313 shipwrecks, causing the death of 2,340 British sailors and 137 passengers (Bull, 1966). The investigation identified ten (10) casual factors; including defective construction, inadequate equipment, imperfect state of repair, improper and excessive loading, incompetence of masters, drunkenness among officers and crews, and marine insurance which inclined ship-owners to disregard safety. Thus in 1839, restriction was placed on the transport of timber deck cargoes in the North Atlantic. In 1840, and 1846, rules for lights and traffic at sea, and approved British surveyors were made (Bull, 1966). The most important advance in British intervention came in the form of the Merchant Shipping Act of 1850 under the auspices of the Board Trade, which had the task of monitoring, regulating and controlling merchant shipping affairs, safety of ships and the working condition of seamen. Following more accidents after the Merchant Shipping Act of 1850, a Royal commission was setup to investigate the claimed unseaworthiness of British vessels, particularly the conditions of loading. The British parliament adopted the Merchant Shipping Act of 1876 known as the “Plimsoll Act” in honour of Samuel Plimsol, a British parliamentarian who published a number of observations and a manifesto denouncing the scandal of “Coffin ships”. The 1876 plimsoll Act laid down new requirements, with criminal penalties for ship-owners found guilty of operating ships that presented a risk for human life. It equally provided for the arrest and detention of substandard ships coming to take cargoes in

British ports (Bull, 1966). It also instituted load-line marks to put an end to dangerous practice of leaving the captain complete discretion as to loading. Subsequent British interventionist regulations came with 1890 merchant shipping load line Act, 1894 merchant shipping Act as amended by the Act of 21st December, 1906. All made provisions for seaworthiness and safety of ships, health and arrangement on board. Load-line requirements were applied to all vessels, including foreign ships visiting British ports.

With France and British showing the first display of considerable transformations in preventive regulation and interventionism in shipping, interventionism finally triumphed in the major maritime nations, for example, Denmark with her interventionist, Shipping Acts of 13th February, 1980, 14th May, 1909 and 3rd January, 1911. Sweden with the ordinance of 1st July 1989, Norway with the Acts of 13th February, 1890, 14th May, 1909, 3rd January, 1911, 1st July, 1898, June 9, 1903, 3rd October, 1908, and 24th April, 1906.

Germany with the seafarers Acts of 7th June, 1902, Netherlands with the shipping Act of 1st July, 1909. In the United States of America, the regulations on safety at sea were set out in the seamen's Act of March, 1915. Spain has regulations similar to British legislations in its two Decrees of 18th January 1924 concerning safety onboard ships and lifesaving appliances (Boisson, 1999). Shipping interventionism has continued to spread across the globe over the years.

2.2.11.3 The Globalization of Maritime Safety Regulations in the 20th Century

The quest to achieve some degree of uniformity in national accident prevention measures and safety rules led to the internationalization of safety regulations in the 20th century (Srivastava, 1983). The key factors that, influenced major maritime nations to set up joint rules include:

(i) Challenges of policing the High Seas: According to Biosson(1999), the challenges posed by the freedom of operations in the high seas led maritime nations to seek common conditions for exercising the freedom of the high seas in the interest of the whole international community, and to deal with anarchy leading to dangerous conditions for navigation. This was because the policing of sea traffic posed no problems in the in territorial waters of coastal countries, but the high seas where the freedom of navigation prevails posed a serious threat, if rules were not unified. Thus navigation, rescue, collision avoidance and signaling needs to be unified and respected in the interest of the international community.

(ii) The Presence of Foreign Ships in Ports. Bull (1966) notes that, in the early years, maritime nations had national conditions for control of ships in ports. Most of these national rules were used to regulate both local and foreign ships in ports. The range of provisions resulted in uncertainty for navigational permits and seaworthiness certificates such that such permits had no international validility. The confusions that followed was such that ships visiting ports in several States were sometimes required to meet contradictory safety conditions (Boisson, 1999).

(iii) Regulation of Competition: Seaborne trade has always been subject to fierce international competition. Frequent accidents at sea as a result of the competition in use of the sea finally gave conviction to national legislators that economic rivalries, particularly as regards fleet operation, could endanger safety. Only agreement among States, laying down minimum standards to be met by a particular ship in service, could offer a satisfactory long-term solution.

2.2.11.4 Steps in Internationalisation of Maritime Safety Regulations

The first steps to internationalization of safety regulatory rules came with the adoption of bilateral treaties and agreements among leading maritime nations, particularly between Britain and France. Next was the holding of international conferences, in order to set up genuinely universal rules. Finally the organizations intergovernmental were to take over and encourage the adoption of international instruments to regulate safety at sea and protect the marine environment. The first such international conference on the safety of marine transport was held 28th July 1879, in London; following which 19 states adopted joint rules for an international signal code. In first September 1880, an international convention set the first unified rules for prevention of collision at sea. In November 1889, a congress met in Washington DC, to draw up a proper code for the sea covering rules on steering and sailing, lights and signals, and distress signals. The Berlin convention of 3rd November 1906 saw the emergence of the first rules on wireless telegraphy while two conventions were signed in 1910 covering collision and life saving appliances.

Boissson (1999) asserts that, the sinking of the transatlantic liner “Titanic” on 14th April 1912 off Newfoundland, after colliding with an iceberg, led to spectacular acceleration in the standard-setting process, and encouraged the realization of the for collective safety. Thus by July 1912, a wireless telegraphy conference held in London, made intercommunication systems and radio equipment on board ships compulsory. The most important result of the loss of the Titanic was the first international conference on the safety of life at sea (SOLAS), held in London in January 1914 at the invitation of the British Government. Two other conferences in Washington DC in 1927 and Madrid in 1931, finalized the international regulations on radio communications. In 1948, the British Government invited all the states that had previously signed the SOLAS to attend an international conference, in order to revise the provisions of SOLAS. A new version of SOLAS was adopted in June by twenty-seven states, and came into force on 19th November 1952.

2.2.11.5 Marine Oil Tanker Accidents in Nigeria

There seems to be an increase in oil tanker accidents in Nigeria in recent times. The associated environmental implication has called for a concern. The problems created by oil tanker accidents are threats to both aquatic and terrestrial life and can lead to their extinction. The major environmental problems caused by oil tanker accidents range from pollution of air, water and land to biological losses of aquatics and atmospheric contamination. However, while some blame these tanker accidents on the operational system occurring through the poor level of safety practices in the carriage of oil by sea in Nigeria. The willingness to accept model of the contigent valuation method offers a popular environmental economist approach to valuing the impact of marine accidents on the marine biodiversity for purposes of providing adequate compensation to members of the coastal communities whose economic survival is dependent on the marine biodiversity (UNTAD, 2012). This table reveals some selected cases of tanker accident in the Nigerian territorial waters and the causes.

Table 2.5a: Tanker Accidents

S/N	Names of Tanker	Time of occurrence	Nature of accident	Environment section affected
1	M.T. Al-Zainah location: **Lagos**	June, 1997	Explosion: The last cargo of the ship was PMS (Premium Motor Spirit)., later, hot work was carried in one of the cargo tanks not properly washed and gas freed and then, an explosion occurred.	Air
2.	M.T. Aribi **Location**: Bonny anchorage	March, 1999	Flooding and sinkage: The tanker was fully loaded with about 2000 tons of AGO (Automotive Gas Oil and so she had a small free board, she took in water into the engine room though the propeller shaft and later sank due ton uncontrollable flooding. The entire cargo (AGO) was lost with the ship.	Air, sea and coastline in the area.
3.	M.T. Walvis-14 **Location:** Eket Offshore	October, 1999	Explosion: The small fresh water tanker was loading fresh water from an offshore production platform when some dangerous gases entered the cargo tank through the water hose, one of the crew members lit a cigarette on the main deck and there was an explosion.	Air
4.	M.T. Real Progress **Location:** Lagos	January, 2000	**Explosion:** The ship was load with 700 tons of PMS (Premium Motor Spirit), the PMS leaked from the pump room to the pump-motor room and the Bosun's store through the pump/pump-motor shaft hole due to malfunctioning packing. There were some chemical reactions in the pump-motor room and the Bosun's store, which generated static electricity, and then there was an explosion in the pump-motor room and the Bosun's store.	Air
5	M.T. Crown O. **Location:** Warri	January, 2000	**Explosion**: The ships compressor was bad, the chief engineer attempted to start the main engine with compressed oxygen bottle, there was an explosion and then fire.	Air
6.	M.T. Stella D **Location: Bonny**	August, 2000	**Fire Outbreak**: A barge tied alongside was transferring crude oil onboard the ship with a petrol pump. Soon, the petrol pump caught fire and the entire barge became engulfed in fire, the forward rope of the barge was cut while the aft rope was still intact, the barge cast off from forward and the tidal streams swung it from amidship area towards the aft where the superstructure was located. The high flame from the barge connected with the superstructure/accommodation and the ship was completely razed down.	AIR, SEA and adjourning coastline.
7.	M.T. Christo **Location:** Lagos	Sept, 2000	**Flooding and Sinkage:** The engine room was taking in through the propeller shaft and due to the very low freeboard because of the loaded AGO onboard, the ship lost her buoyancy and sank together with the cargo onboard quicker than expected.	Sea and adjourning coastline.
8.	M.T. Taboti **Location:** Lagos	Nov, 2000	**Explosion and Sinkage:** Welding work was going on around the main deck while the ship was about half loaded with crude oil, there was an explosion, the tanker capsized and sank immediately.	Air, sea and adjourning coastline.

Source: Akinforo (2013).

Table 2.5b: Tanker Accidents (contd)

S/N	Names of Tanker	Time of occurrence	Nature of accident	Environment section affected
9.	M.T. Ife **Location:** Port-Harcourt	Dec, 2000	**Explosion, fire and sinkage:** while the tanker was loading PMS at the Okrika NNPC refinery jetty, some of the engine room staff' fetched some PMS for their personal use and kept it in the engine room, soon, there was an accumulation of dangerous gas in the engine room and coupled with the high heat/temperature generated by the machineries in the engine room, there was an explosion and then fire, the tanker was disconnected from the jetty and then toward to Dawns Island anchorage, the explosion opened up part of the hull around the engine room and the engine room started flooding. The ship eventually sank with about 7000 tons of PMS.	Air, Sea and adjourning coastline.
10.	M.T. Juwon **Location:** Lagos	March, 2000	**Fire outbreak:** During a transfer operation of AGO from the cargo tanks to the engine room bunker tank, the weak pipeline got burst and the fuel started spraying on a working alternator and its environs in the engine room, the alternator generated fire and fire started spreading round the engine room due to the fuel spray. The fire was later put out.	Coastline and Air
11.	M.T. Jupiter **Location:** Bonny Offshore	August, 2001	**Fire:** There was two barges loaded with crude oil alongside tanker Jupiter. The barges wanted to start discharging into tanker Jupiter, an attempt was made to start the petrol pump on the barge, the pump generated spark and there was an explosion, the wind unfortunately pushed the big fire ball from the exploding barge to the ship's accommodation, the ship immediately caught fire and was razed down. The ship was eventually beached close to Bonny river Mouth.	Air, Sea and adjourning coastline.
17.	M.T. Bridget **Location:** Lagos	Nov, 2001	**Flooding and Sinkage:** The tanker was staying idle at the Lagos outer anchorage for over a year when she suddenly started taking in water through the propeller shaft, the engine room became flooded and the ship sank, thereby constituting an obstruction to fishing and visual nuisance to the Lagos outer anchorage.	Sea
18.	M.T. Marine Trade **Location:** Bonny anchorage	March, 2002	**Flooding and Sinkage:** The tanker started taking in water from engine room while loading with more than 2000 tons of oil and anchored to Bonny anchorage. The master of the ship picked up anchor and proceeds towards the fairway boy. The ship sank with all the cargo before she on her way to the fairway bouy.	Sea and adjourning coastline.
19.	M.T. Pace Setter **Location:** Escravos anchorage	July, 2002	**Flooding and Sinkage:** There was a leakage in the bow section of the small tanker, a pump was supplied to the ship to keep pumping out the water as it comes in, the tanker was loaded and the leakage increased and the vessel sank	Sea and adjourning coastline.

Source: Akinforo (2013).

2.3. Empirical Review

2.3.1 Overview of Global Trend and Nature of Marine Accidents and the Associated Losses.

The sea has always been a potentially hazardous and dangerous working environment. Yet ships and marine transport operators have new factors and new pressures to contend with as the structure of global market place requires that goods and materials be delivered not only to the geographical location where they are required but also within a very precise time frame. As a consequence¸ safety and efficiency have now, more than ever before, become two side of the same coin; accidents are not only undesirable outcomes in themselves; they have negative impact on the supply chain that is the heart of the global economy (Andrea, Lara, Sergi and Joaquim2009). Negative impact of accidents in the maritime industry was recognize early enough, thus compensation for damages caused by accidents and commitment to safety has long pervaded virtually all deep sea marine operations and shipping was amongst the very first industries to adopt widely implemented international safety standards and risk transfer measures (IMO, 2011).

The international maritime organization (2011) observes that, from the mid-19th century onwards, a number of international maritime agreements were adopted. For example, the Titanic disaster of 1912 spawned the first safety of life at sea (SOLAS) convention, which albeit completely modified and updated, and nowadays within the responsibility of the IMO, is still the most important international instrument addressing maritime safety and accident prevention today, covering among others, such areas as ship design, construction and equipment, subdivision and stability, fire protection, radio-communications, safety of navigation, carriage of cargoes (including dangerous cargoes), safety management and marine insurance and risk transfer ((Pedro, 2008); Ebehard and Ulrich, (1999)).

The IMO (2011) posits that, SOLAS aims to curb and/ or minimize the direct and indirect impacts of accident in the marine industry, including economic impact, which as a result of multiplicity of factors influencing it, is not so easy to measure. Global loss rate of all ship types according to the IMO (2011) reports covering the period from 2006 to 2010 shows a ship loss rate of 1.3 per 1000 vessels at risk in 2006. It rose to 1.4 in the year 2007 and remained constant for 2008 and 2009, rising to 1.7 in the year 2010.

Bijwaard and Knapp (2008) notes that, a number of factors influences accidental loss of ships, these they identifies to include, the changes in general ship particulars such as flag, classification Society, ship type, age, ship safety inspection and ship economic cycles.

The pie chart below indicates the Global number of ship loss due to safety issues as reports the IMO (2011) from 2006-2010.

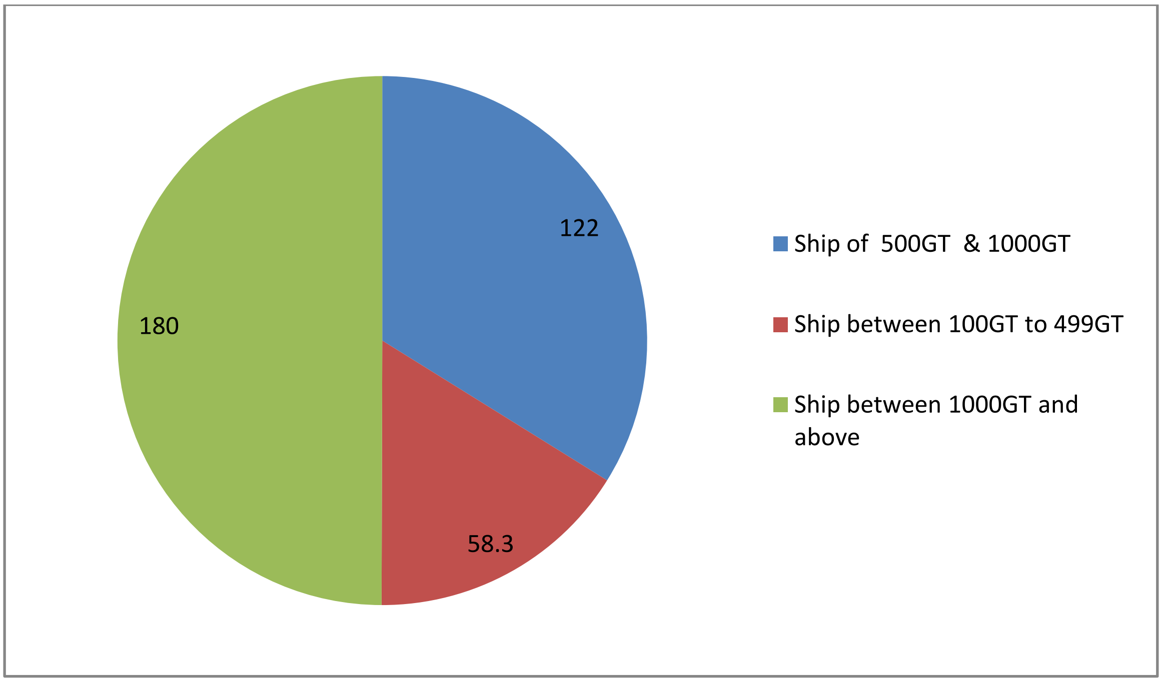


Figure 2.5: Pie chart of number of ship losses due safety related issues from 2000 – 2010

Source: Authors preparation.

Fair play world casualty statistics (2010) report that 172 ships of 0.81million gross tonnage were reported as total losses. The number of total losses of cargo carrying ships was 119 of 0.78million gross tonnage.

2.3.1.1 Global loss of life due to Safety Related Marine Accident

As in all transport modes, lives are sadly lost following the occurrence of accidents in maritime industry. However, loss of life following the occurrence of marine accident is in fact relatively modest. The IMO (2011) reports that the global trend in loss of life at life due to marine accident is one of reduction in the number of Fatalities, which is all the more impressive in view of the growth in the number of ships in the world fleet. The international union of marine insurance (IUMI) (2011) statistics supports this as total losses of ships over 500GT for the 30years since 1980 demonstrate a continuing downward trend, whether viewed by number of vessels, by tonnage, or a percentage of the world fleet. Inter cargo (2011) in a study on bench marking bulk carries 2010-2011, observe that trend of safety related losses suffered by bulk carriers is consistently downward, with average of 26 lives and 5.9 ships per year lost in the period 2001-2010 compared to 74 lives and 135 ships a decade previously. The above statistics did not reflect (include) casualties suffered in incidents involving ships on domestic voyages within the archipelagic waters of states or ferries trading on rivers and lakes (Isabel, Gonzalez and Diana 2015). IHS fair play (2010) world casualty statistics publication shows that, the number of lives lost at sea fell sharply in 2010 compared with the previous 13months. The publication noted that, in the year 2010, 250 seafarers (excluding passengers) lost their lives, the lowest figures for loss of seafarers' life at sea since 2003.

The table below summaries the global trend in lives lost at sea according to IMO (2011) study covering the period 2006-2010.

Table 2.6: Number of lives lost at sea due to safety related accident (2006-2010)

Year	HIS Fair play Data	Imo Data
2000	1825	n-a
2007	525	n-a
2008	1160	1921
2009	699	2395
2010	250	1622
Total	**4459**	**5938**

Source: Authors preparation based on reports from:

(i) HIS fair play merchant vessels over 100GT

(ii) IMO secretariat, IMO Document CWGSP 12/3

Table 2.7: Ratio of life lost due to safety related marine accident to total number of lives at risk.

	2006	2007	2008	2009	2010
Lives lost all ships	1825	525	1160	699	250
N0. of seafarers at sea	1,232,000	1,277,000	1,246,200	1,266,000	1,371,000
Estimated N0. of ferry passenger Estimated total N0. of	1,629,572,538	1681,931,684	n-a	n-a	2,056,062,948
Cruise passenger	16,927,718	17857,711	n-a	n-a	20,775,922
Total number of passenger	1,646,501,276	1,699789,395	1,913,962859	2,155,122	2,076,838,700
Total of lives at sea	1,646,624,479	1,701,066395	1,915,209,059	3,421,122	2,078,209,870
Ratio best estimated	1.11E-06	3.09	6.06E-07	3.24E-07	1.20E-07

Source: Authors preparation based on IMO Document CWGSP 12/3 for loss of lives.

The international union of marine insurers (IUMI, 2011) publication apparently shows that between 1994 and 2010 global safety related marine accident total losses trend downwards¸ from 175 vessel to 75 vessels per annum and from 2million gross tonnage to 700,000 gross tonnage. Ship accident has also contributed to global trend in marine pollution caused by oil spill and accidental discharge of hazardous seaborne shipment of crude oil amounted to 1.72 billion tons and world shipping of petroleum products amounted to 924.6 million tons, reports UNCTAD (2014). Measures introduced by the IMO have helped to ensure that the majority of oil tankers are safety built and operated and are constructed to reduce the amount of oil cargo losses into the environment in the event of an accident. The IMO (2011) reports that despite the rare major tanker accident which can cause a spike in the annual statistics, the overall trend in marine accident involving oil cargo spill demonstrates a containing improvement both in the number of oil spills and quantity of oil spilled each year. The IMO (2011) report notes that the biggest single "decade-to-decade" reduction in oil spills was from the 1970s to 1980s, (including with the adoption and entry into force of the international convention for the prevention of pollution from ships, 1973 as modified by the protocol of 1978 relating thereto (MARPOL73/78) which is rightly credited with having had a substantial positive impact in decreasing the amount of oil that enters the sea from maritime transportations operations. Statistics provided by international tanker owners federation (ITOF, 2011) covering the period between 2000 to 2010 indicates that, the number of large spills (700tons) has decreased significantly. The average number of major spills per year for the previous decade (200-2009) is just over three(3), approximately eight times less than less than for the 1970's (ITOF, 2011). Only about 7% total quantity spilled occurred in the 2000s, about 55% occurred in the 1970s. The tables below summaries the trend of oil cargo spill in the marine environment as reviewed by ITOF (2011) covering the period 2006-2010.

Table 2.8: Number of Oil cargo spills from ship due to safety related accident (2006-**2010)**

	2006	2007	2008	2009	2010
Number of spill over					
Over 7 tones but loss than 7oot	13	13	9	7	4
N0. Of spill over 700 tones	5	4	1	1	4
Total	**18**	**17**	**10**	**8**	**8**

Source: Author's preperetion based on ITOPF annual report (2011)

Table 2.9: Ratio of oil spill into the sea to total quantity carried

	2006	2007	2008	2009	2010
Annual quantity of oil spill tones	13, 000	18,000	2000	100	10,000
Annual seaborne trade-crude					
Oil (million tons)	2,646	2,719	2,798	2805	2,998
Ratio	**6.0E-06**	**6.6E-06**	**7.1E-07**	**3.6E-08**	**3.3E-06**

Source: Authors preparation based on ITOPF Annual Statistics (2011)

2.3.2 Economic Cost and Impacts of Marine Accidents in the U.S.A

In a study on the economic impacts of accidents on the marine industry in the United States of America, Demarco, Fredrick and Thomas (1997) asserts that, accident in the marine industry impose four (4) basic categories of cost on the economy of the U.S.A. These they identified as oil spill costs, property damage costs, injury and death costs, and other indirect costs. The study further notes the oil spill costs in the U.S.A environment to include emergency response and clean up damage costs, natural resources damage cost, fisheries damage costs, third party cost or cost of externalities, the values of oil cargo lost, fines and penalties for oil spills and litigation expenses for oil spills (Demarco, Fredrick and Thomas, 1997). Property damage cost or loss of property and marine equipment is a direct consequence of marine accident following collisions, groundings, fires and explosions, etc, causing varying degrees of damages to vessels, facilities and cargo, ranging from minor losses to total losses. The study by Demarco *et al* (1997) notes that, economic loss imposed by such accidents may be ascertained through accident investigation in relation to the actual market values of the damaged properties or through insurance award method. A summary of damage accident cost implications in the United States of America as revealed in the study is discussed below.

2.3.2.1 Property Damage Costs

Marine accidents often result in damages or loss of property or equipment. Collisions and groundings, fires and explosions, and other events can cause varying levels of damage to vessels or facilities, ranging from minor losses to total constructive losses. According to the U.S Department of interior (DOI, 2002), Property damage is usually estimated during accident investigations. A summary of the cost of marine property damage accidents as findings of the accident investigation carried-out between 1993 and 1994 (two years period) is between 510,800,000 to 5715,000,000 United States dollars (Demarco and Fredrick, 1997). See table8 as shown below for marine damage accident economic cost in the USA.:

Table2.10: Estimated Property Damage Costs for Marine Damage Incidents

	Number of Damage Incidents	Total Damage	Average cost of Damage ($)	Median Damage ($)
	Barge/Tow/Tug	55	69	15,250
	Fishing	45	90	15,000
	Passenger	14	55	9 00
	Tanker	22	292	49,000
	Others	90	246	30,000
	Vessels (total)	226	114	18,000
	Onshore	22	212	55,000
	Offshore	340	170	60,000
	(total)	588		

Source: Demarco, Grey and Fredrick (1997).

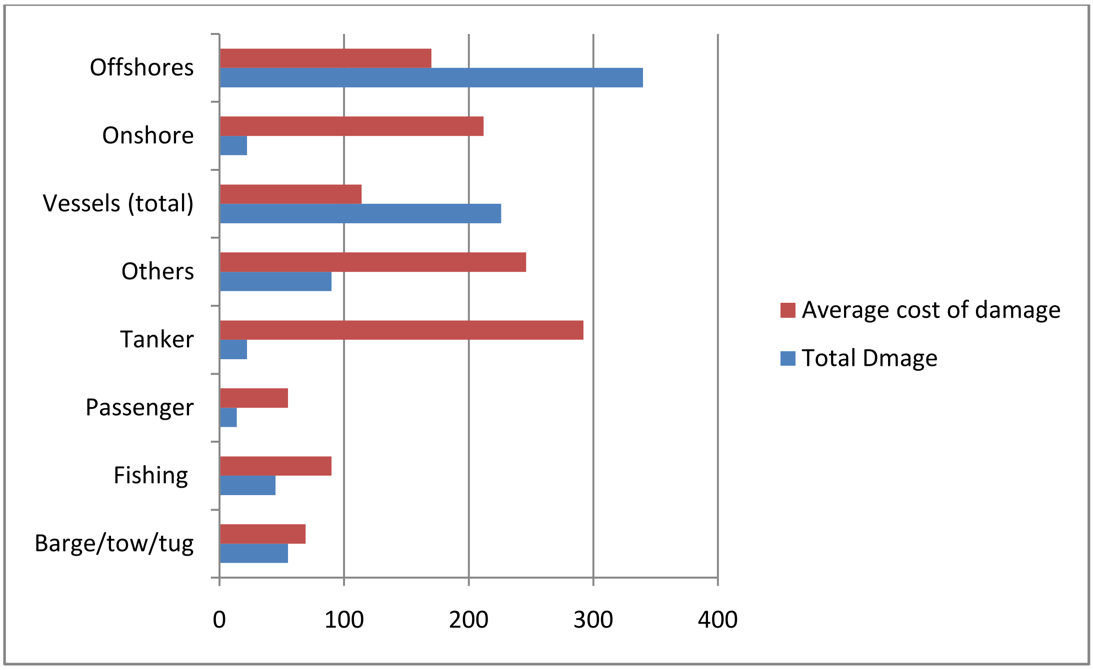


Figure 2.6: Barchart showing number of various types of vessels damaged and the average cost per damage accident.

Source: Authors preparation.

2.3.2.2 Economic Costs of injury and death accidents in the U.S.A.

According to Arsham, Jakub, Jari and Pentti (2015), a variety of information sources, database and incident reporting systems are necessary to obtain data and information on injury to and death of crew and/or passenger and the economic cost and impacts of injuries or deaths resulting from accidents in the marine industry. The major components of costs associated with injury and death according to Arsham *etal* (2015) are medical expenses and compensation for lost time (wage loss). Obviously insurance plays a major role in compensation and determination of who incurs these costs and at what level Eric and James (2014). An overview of the structure of insurance coverage for injuries and deaths pro vides a reliable source on economic costs and impacts in this area (Eric and James, 2014, Desai, 2017).

Demarco et al (1997) notes that, each of the 50 states of America have worker's compensation laws, which enable injury and death accident victims to draw compensations in manner and to the extent provided for in the laws . These laws hold that, industrial employers should assume costs of occupational disabilities without regard to any fault involved. Resulting economic losses are considered costs of production; chargeable, to the extent possible, as a price factor (Demarco et al (1997); Floris and jakub, (2015); (Desai, 2017). Virtually all industrial employment is covered by workers compensation, including many activities related to the maritime sector. There are, however, several separate authorities that address maritime workers. The Long-shore and Harbor Workers' Compensation Act provides for private and public employees in nationwide maritime work (Jeffery and James, 2008). The actual values of these compensation reflect the true accepted economic impacts and costs imposed by marine injury and death accident. Demarco, Grey and Fredrick (1997) observes that, crew members aboard U.S. flag vessels are not governed by either state workers' compensation laws or by the Long-shore and Harbor Workers' Compensation Act, but may seek economic damages under the Federal Employers Liability Act or Jones Act.

The study further noted that, most jurisdictions require employers to obtain insurance and prove financial ability to carry their own risks of economic losses occasioned by death and injury such that, the state may determine the level of economic wastages occasioned by injury and death accidents, by aggregating the total compensation claims over a period of time. Insurance for Jones Act crewmen is usually covered as part of Protection and Indemnity (P&I) Club policies (Jeffery and James, 2008).

The encouragement of safety is for minimization of injury and death, minimization of material damages, minimization of environmental effects as well as socio-economic impacts; these remain also the basic objectives of workers' compensation as practiced in the United States of America. The U.S chamber of commerce (2005) reveals that, the premium rates for maritime workers' compensation are compiled scientifically to fairly determine how occupational accident actually impact the victims economically, given the very strategic position and safety sensitive nature of maritime operation. For example, inaccurate and/or undervaluation and subsequent payments of a maritime employee's injury compensation might at the long-run, influence the work attitude of other employees in the industry and this might lower the productivity of the sub-sector(Jeffery and James, 2008).. The effect of such a low productivity might have a serious multiplier effect on the economy; given the very importance of the sub-sector on the U.S transportation system, oil and gas, and economy. The U.S. chamber of shipping (2005) notes that; first, overall rates based on accident experience data throughout American businesses are established. Once these overall rates are established, they are applied under a uniform classification system that groups of employers by hazard of employment; the hazard of employment in the marine industry is critically important in the determination of actual economic values for injury and death compensation. In addition, the uniform experience rating plan provides a price adjustments for each employer, based on the actuarially predicted value of its own claims history. All but the smallest employers are subject to this experience rating, which furnishes direct monetary incentives for safety programs (USCS, 2005; Demarco *et al* 1997).

Benefits provided through such policies include cash benefits for impairment and wage loss, medical benefits; and rehabilitation benefits. Most cases involve temporary, not total, disability; all of these add to the economic effects. That is, the employee although totally disabled during the period when benefits are payable is expected to recover and return to employment (Demarco et al., 1997). In some cases, only medical benefits are provided as economic loss since substantial impairment or wage loss is not involved.

The U.S. National Safety Council (1995) estimated that, the economic loss per death for marine accidents involving death is $790,000 for a death. With this, it is possible to estimate the direct costs for an average fatality incident. Using the total number of incidents in which deaths occurred and the total number of deaths for these incidents over a two-year period (1993-1994), Demarco et al (1997) estimated the average number of deaths per incident for each marine industry sub-sector. A summary of the findings by sub-sector for vessels and facilities is presented in the figure below.

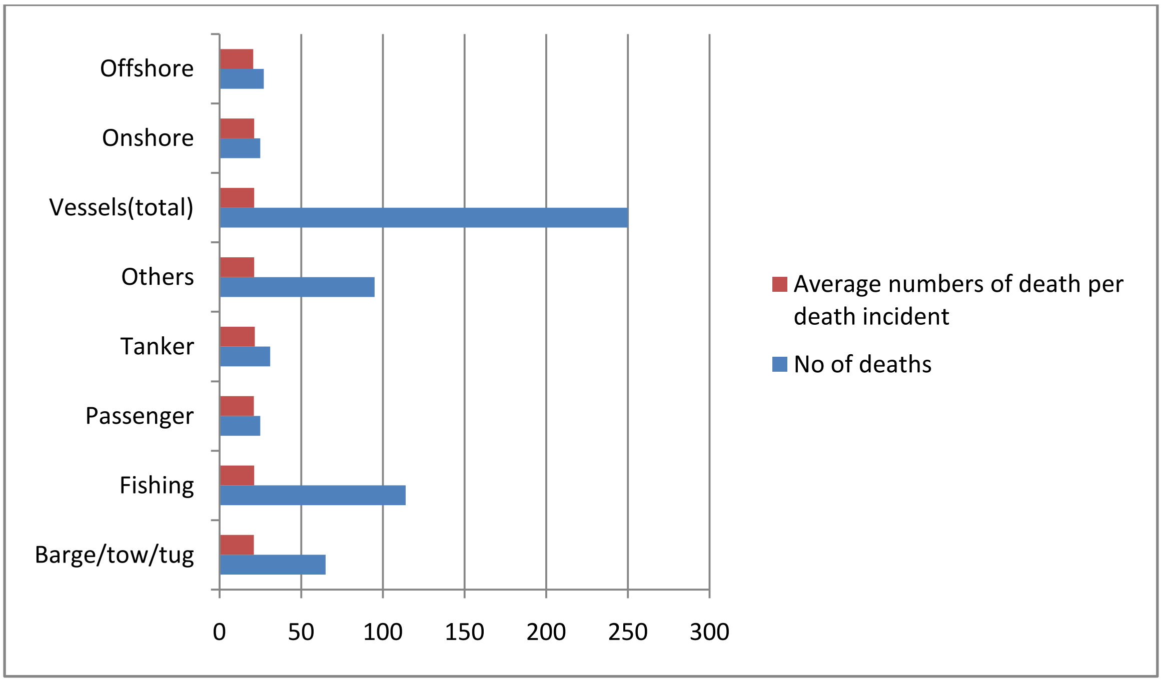


Figure 2.7: barchart comparing the no of deaths accidents and average number deaths per death accident.

Source: Author's preparation with statistics from Demarco et al (1997).

Based on the table above, the number of deaths associated with vessels categorized as 'fishing vessels recorded the highest fatality rates over the period. The injuries sustained by crew and passengers which kept them hospitalized and unproductive over the period of hospitalization also imposed economic cost on the economy. Demarco, *et al, (*1997) observes that, major components of cost associated with injury and death are medical expenses and compensation for lost time (wages loss) which may equally be appropriately determined by the Human Capital Models (HCM).

Table 2.11: Average Number of Injuries for Injury lncidents and Average Cost per incident

	Number of Injury Incidents	**Number of Injuries**	**Average Number of Injuries per Incident**	**Average Cost per Injury Incident ($)**
Barge/Tow/Tug	86	107	1.24	34,720
Fishing	769	808	1.05	29,400
Passenaer	23	552	1.35	37,800
Others	210	224	1.07	29,960
Vessels (tota1	1,088	1,691	1.55	30,240
Onshore	2,897	3,179	1.10	30,800
Offshore	18	35	1.94	54,320
Tanker (total)	68	72	1.06	29,680
	4,071	4,977		

Source: Demarco etal (1997).

The United States Oil spill intelligence Report (1995) asserts that, the offshore O&g facilities typically employ vigorous accident-induced oil spill reporting standards, resulting in a proportionately larger number of small spills reported, and therefore, a much lower average spill quantity. The studies of Erick, Pedro, Nan and Francisco (2007) show these estimates to be reasonable indicators of typical spill sizes and reliable data for estimation of financial impacts of oil resources/cargo loss. An analysis of spill accident data maintained by the United States Coast Guard (USCG, 1997) shows that over 90 percent of all crude oil spills from tankers vessels in U.S. waters from 1985 to 1995 were between 1 and 500 gallons

The Oil Spill Intelligence report (OSIR, 1995) asserts that Spill unit values for emergency response and cleanup are used in the derivation of a cost estimate and economic loss for the average spill quantities. Demarco et al (1997) used a unit spill value of approximately $50 per gallon of oil spilled to estimate company cleanup expenditures which are considered as a component of the cost imposed on the economy by spill accidents. Although Bird and Franks (1984) in an earlier study asserts that the use of such approach is likely to vary somewhat depending upon the size and location of the spill (smaller spills generally have higher per gallon cleanup costs); the estimate provides a reasonable approximation of cleanup costs that can be expected to result from a typical spill incident. Economic expenditure estimates for oil spill clean-up is as well obtainable through an annual survey of some 800 oil companies; approximately 200 companies annually return responses each year (Demarco et al, 1997). Demarco et al (1997) asserts that, a unit value of $5 1.48 was used in the estimate for cleanup of per gallon of spilled oil which is then used to monetize the average spill sizes to determine economic expenditures for spill clean-up as shown in table 2.12 below.

Table 2.12: Estimated Emergency Response and Cleanup Costs for Typical vessel Spill Incidents

	Average Quantity (gallons)	**Spill Unit Value ($ per gallon)**	**Average Cleanup. Cost ($)**
Barge/Tow/Tug	438	51.48	22,548
Fishing	197	51.48	10,142
Passenger	77	51.48	3,964
Tanker	433	51.48	22,291
Others	131	51.48	6,744
Onshore	235	51.48	12,098
Offshore	16	51.48	824
Facilities (total)	120 1,647	51.48 -	6,178 84,789

Source: Demarco et al (1997)

The United States Coast Guard (USCG, 1997) asserts that, this method over-simplifies the calculation of overall cleanup costs as spill unit values can vary widely depending on numerous factors namely; spill size, oil type, impacted environment, etc. It however agrees that the estimates above provide a reasonable indicator of the range of costs (3,964USD – 84,789USD) that can be expected for emergency response and cleanup of a typical or average incident. Obviously, the actual cost to clean up larger spills can often be much higher.

2.3.2.3 Framework for Compensation in the United States

The United States department of interior (DOI, 2002) asserts that, in the United States, spillers are liable for NRDs (Natural Resources damages) resulting from oil spills into navigable waters and hazardous substance spills to coastal and marine environments. BY the Federal Regulations (FR) for 1995, the cost to clean up for a 37,000 gallon spill was approximately 500,000 USD. For example, DOI (2002) asserts that the February 7, 1990 grounding of British Petroleum's American Trader tanker, took the company almost $35,000,000 in cost, to clean up a 400,000 gallon spill. Also the November 17, 1995 collision involving the Honam Sapphire tanker off the coast of South Korea, 294,000 gallons spilled resulted in cleanup claims totaling 58,300,000 USD. In the July 22, 1991 collision of the Tenyo Man with a Chinese freighter, a 173.000 gallon spill cost approximately $9,000,000 clean up expenditure (DOI, 2002).

2.3.2.4 Natural Resource Damage (NRDs) Costs

Historically, the financial liability of responsible parties in an oil spill to water has been based on direct liability costs, such as costs for spill response, mitigation, and cleanup. The growing trend has been to expand spiller liability to include consequential costs of a spill (Nima and Gina, (2014), Seokho and Sangwon, (2013)). A broad category of consequential spill costs is associated with NRDs resulting from an oil spill. Approaches for monetizing economic effects of such NRD costs remain a developing science and, therefore, are highly contentious (Bird, 1974).

Demarco et al (19997) asserts the U.S. National Oceanic and Atmospheric Administration (NOAA) developed a new natural resource damage assessment regulations for assessing NRD resulting from discharges, or threats of discharges of oil into navigable waters in 1996, while the DOI acknowledged that NOAA's final rule supersedes the formal procedure for assessing NRD in the U.S. the method determines the economic value lost by the public pending recovery of the resources (compensable value); and reasonable costs of assessing NRD. The procedures further allows trustees to arrive at a number representing spiller liability for the value of lost or damaged natural resources, capturing: Fisheries consumptive use values, Wildlife consumptive use values (e.g., hunting), Recreational use values (e.g., beach use and boating), Restocking cost, and Direct restoration costs of affected habitats (Demarco et al, 1997).

.Demarco et al (1997) used the NRD spill unit values for the appropriate spill tier and then applied it the estimates of average spill sizes by sector in the U.S. to provide an indicator of the NRD economic costs of a typical spill, as shown in Table 2.13 below.

Table 2.13: Estimated NRD Costs for Typical Spill Incidents

	Average Quantity (gallons)	**Spill Unit Value ($ per gallon)**	**Average NRD Cost ($)**
Barge/Tow/Tug	438	0.25	109.50
Fishing	197	0.25	49,25
Passenger	77	0.25	19,25
Tanker	433	0.25	108.25
Others	131	0.25	32.75
Container Vessels	249	0.25	62.25
Onshore	235	0.25	58.75
Offshore	16	0.25	4.00

Source: Demarco et al (1997).

Although the generalization of data can limit the ability of the model to accurately estimate the damages associated with a specific incident, such an approach was appropriate and necessary for estimating the damages associated with a large number of spills on a national scale.

2.3.2.5 Third Party Costs

USCG (1997) notes that, Oil spills not only impact the environment, but often also have serious adverse economic effects on local recreation and tourism, industry, fisheries, and other third parties. Section 1002(b)(2)(E) of Oil Pollution Act (OPA 1990) makes each responsible party liable for “damages equal to the loss of profits or impairment of earning capacity due to the injury, destruction, or loss of real property, personal property, or natural resources, which shall be recoverable by any claimant.” Prior to OPA 90, the legal trend in judgments against spillers for third party claims was against compensation for economic losses unless the plaintiff suffered direct physical harm. Thus, the majority of third party claims against a spiller for economic losses resulting from a release were dismissed since they do not involve direct physical harm to the third party (Ted, Charles and Brain, 1989). Claims for economic losses suffered by commercial fishing, however, were often exempt from this interpretation. Demarco and Fredrick (1997) asserts that, in the case of Exxon Valdez, for example, the Ninth Circuit Court of Appeals dismissed claims against Exxon from third parties (e.g., seafood wholesalers, processors, and cannery workers) other than commercial fisherman. However, the following two incidents provide examples of the potential magnitude of third party claims for a medium and major discharge.

(1) The collision incident on August 3, 1995 off the coast of South Korea, a 12,000 gallon spill resulted in fishery-related claims of $25,400,000 and other loss of income claims of $3,950,000.17

(2) The grounding involving the Sea Prince off the coast of South Korea on July 25, 1995, a 220,000 gallon spill resulted in fishery related claims of $280,000,000, canning-related claims of $400,000, and tourism-related claims of $5,400,000.18 (USCG, 1997). In addition, such claims are generally covered under insurance policies that shippers and cargo owners maintain. Direct costs to companies responsible for causing such spills thus usually take the form of premiums, deductible payments, and other insurance-related expenses. (See the discussion of marine insurance in the earlier chapter under theoretical review).

2.3.2.6 Litigation Expenses for Oil Spills

The legal cost element refers to costs a spiller incurs for spill-related legal transactions beyond any monetary or other compensation the spiller pays in settlements. Spill-related legal costs may include:

• Attorney’s fees,

• Expert witness testimony,

• Professional consultant time, and

• Other overhead expenses (e.g., technical and administrative support).

Kaiser (1995) state that, the availability of data concerning specific legal costs associated with litigating a spill-related lawsuit is limited. Many key spill- related cases are ongoing, with undetermined legal costs. Information concerning cases and fees are confidential and proprietary in nature (Kaiser, 1995). Information that is available publicly for spill-related law suits does not provide information on fees and costs for transacting the case.

Demarco and Fredrick (1997) determined the legal costs related to spills based on an analysis by the U.S. Minerals Management Service (MMS) for spill-related litigation for Offshore

Continental Shelf (OCS) installations. The MMS analysis estimated leg costs for spill-related transactions in terms of barrels of oil spilled. MMS projected costs for private legal transactions using data on government attorney hours.

In the analysis; MMS estimated the private legal costs associated with a spill incident using data from four oil spill litigation cases (Ashland Oil, Shell Martinez, World Prodigy, and Total Petroleum). Demarco, Fredrick and Thomas (1997) notes that legal fees are typically incurred only for major spills, the number and quantity of spills greater than l0,000 gallons in U.S. waters were used to determine the average quantity spilled per major spill incident. From these average quantities for major spills, the estimated legal costs financial estimates were determined for various sectors as shown in Table 2.14 below.

Table2.14: Estimated Legal Costs for Spill Incidents

	Spill Incidents> 10,000 gallons	**Total Quantity (gallons)**	**Average Quantity per Spill Incident (gallons)**	**Average Legal Cost per Spill Incident ($)**
Barge/Tow/tug	33	2,367,000	71,727	99,701
Tanker	12	481,500	40,125	55,774
Other Vessels	69	3.437,700	49,822	69,253
Onshore	33	30,988,000	93,903	130,525
offshore	17	2239°	47,100	65,469

Source: Demarco and Fredrick (1997).

2.3.2.7 Insurance Costs

Insurance arrangements play a key role in limiting costs to a company as a result of an accident. Though insurance or protection itself is purchased at a cost, so accident induced insurance places cost (premium) burden on the company. The amount of premium is related to the anticipated accident frequency, severity and magnitude of damages to be caused by the accident and probability of occurrence, among other factors. Policies can be obtained to address nearly all of the cost categories described earlier, including cargo loss, injuries, property damage (including third party and company property), and pollution (Jeffery and James, 2008; Loureiro et al 2006). The costs associated with insuring risks in the marine industry can be extremely high. However, while a poor safety and accident record has the inherent potential to cause premium rate to increase, better and improved accident records can result in fewer premium and deductible payments and savings on premiums on a company-specific and industry-wide basis. Protection and indemnity (P&I) clubs are also dominant institutions in the marine insurance and protection market. They are nor-profit groups of ship owners and charterers who mutually indemnify one another.

The analysis of major marine accidents claims in the U.S.A in 1992 indicates that far more claims were paid for cargo damages than any other factor, as cargo claims accounts for almost 50% of all marine industry claims over the period(DOI, 2002; Demarco et al, 1997). A similar study by Det Norsk Veritas (DNV, 1998), the Norwegian classification society, sheds additional light on shipping industry clams. The study reports that across five types of incidents (cargo, pollution, personal injuries, collision/grounding, and property damage), company managers reported that their companies saw on average no more than 17 incidents per year which resulted in $10 million of claims. Again, these are not $10 million worth of costs to the companies but $10 million worth of costs per company shared across the industry. DNV (1998) correctly points out that. insurance has played an important role in blinding managers to the extent and expense of accidents, adding that rising payouts will always be matched by higher premiums.

2.3.2.8 Financing Rates

The risk associated with an increase in the number or severity of marine accidents may restrict the availability of capital to a company or make capital very expensive (i.e., higher financing rates). Companies with weak environmental, health, and safety records may experience increases in the time and money-consuming process of conducting environmental and risk assessments and also may turn away potential investors(Haijing, Wang and Zhou, 2015).

2.3.2.9 Costs of Public Notoriety

Dealing with the consequences of marine accidents diverts the company’s focus from innovation and growth to crisis-type activities such as defending company actions, engaging in lawsuits, responding to the public and media attention, and combating lost market share(Haijing, Wang and Zhou (2015)).

2.3.2.10 Port Fees

Port fees can be a substantial component of operating expenses for a shipping company. In some cases, demonstration of an improved safety record by a shipping company can lead to a reduction in such fees. For example, the Rotterdam Municipal Port Management has developed the Green Award Certification scheme to improve the safety and environmental standards on board seagoing ships. The Green Award promotes safe and environmentally friendly ship and vehicle management, with the ultimate goal of ports accepting, recognizing, and providing reduced port fees to ships with Green Award Certificates. Although, this recognition has yet to reach the other countries in the international community, the Rotterdam

Port rewards ships with a Green Award Certificate a reduction in port fees of 6 percent. Other ports including the Dirkzwager Coastal and Deepsea Pilotage BV., Portnet South Africa, and State Ports of Spain, offer similar reductions on published tariffs for vessels with a Green Award Certificate(Haijing, Wang and Zhou (2015)).

2.3.2.11 Stock Price

Studies have shown that, large-scale accidents and/or indications of a poor safety or environmental records can affect (at least temporarily) the stock value of publicly traded corporations. This impact can be measured by charting changes in the overall value of them before and immediately after an incident. Other things being equal, if the stock price of a company owning and operating a tanker fleet or marine facility decreases immediately after an accident, and there are no other nearly simultaneous confounding events, then the decrease in aggregate share value is the imputed costs to the company (Haijing, Wang and Zhou (2015)).

2.3.3 Impacts of and Compensation Framework for Marine Accidents on European Union (EU) Marine Environment and Fisheries.

Cristina, David and Virginija (2013) opine that, the offshore oil and gas drilling industry and the fishing industry coexist in the marine environment of coastal states, utilizing the same physical space and natural resources. Both the offshore O&G and fishing industries are important human economic activities which impacts importantly on the environment as a result, both industries are regulated with focus and dedication to ensure efficient and safe utilization of the marine environment. Cristina, David and Virginija (2013) in their study on the impact of offshore oil and gas drilling accidents on the European Union (EU) fisheries found that despite the seriousness and dedication to regulation and guidelines, offshore O&G accident occur in EU waters. The study however, notes a decreasing trend in the number of accidents in EU O&G industry since the beginning of the offshore O&G industry in Europe while the impact of the accidents on the environment is equally decreasing. The study attributed the decline in the trend and impact of O&G accident in EU waters to the continuous improvement of technology used in offshore installations and implementation of international liability and compensation mechanisms (Cristina, David and Virginija, 2013). Currently, while fixed production units suffer the highest numbers of accidents, floating installations that, are dedicated to drilling have the highest risk factor while accidents involving transportation of products are the most environmentally damaging (Wayne, 1999). Explosion and structural collapse of offshore structures are the most dangerous, contributing highest to figures of human casualties (Cristina, David and Virginia 2013; Ahmed and Abuelenin, 2017). Cristina et al (2013) observe that it is the duty of maritime accident investigation branch to investigate accident on all UK registered ship and accident on other ship within the UK waters. The findings of the study indicates that;

- Despite intense regulations and guidelines, incidents related with offshore O&G activities exist in EU waters and such accidents are recorded in characterized databases for investigation and assessment of risks. It also shows that, the most environmentally destructive accidents in EU waters have occurred during transportation of oil and gas products by ships.

- In the present, fixed production units suffer the highest number of accidents, while for floating installations; those dedicated to drilling have the highest risk. Explosion and/or structural collapse of structures are also the most dangerous type of accident, frequently involving human casualties (Cristina, David and Virginija, 2013).

It is important to note that, every phase of the offshore O&G industry is in close interaction with the marine environment. Exploration activities, drilling activities, production activities, maintenance activities, transport activities, and decommissioning of installations are following detailed guidelines and strict legislation for normal functioning and all takes place in the marine environment. Thus accident occurrence in the process of execution of any of such marine-based activities imposes direct and indirect economic effects. There also exist always risks of human error, exceptional weather conditions, and malfunction or failure of equipment. Any deviation from normal functioning is considered an incident or accident whose effect is felt in form of loss by the economy. Each accident occurs in a particular combination of natural and technical conditions and its effect on the environment is variable as well.

2.3.3.1 Classifiction of O&G Accidents in EU Accident Databases for Ease of Compensation Administration

The root factor that causes most O&G accidental episodes frequently triggers further events(chain of events) that could be considered individual accidents in themselves. For example, an unexpected oil blowout in a production well might lead to an explosion, which may equally trigger out-brake of fire, oil spillage, and/or structural failure and collapse of the entire installation, if the response is not fast and adequate. The effects and consequences of individual accidents depend on a combination of circumstances and environmental factors and may include economic effects, environmental effects, social effects and systems effects, among others (MAIB, 2008). The chain of effects and events of typical offshore accidents on the installation systems and operations may include:

(A) Blowout

EfficienSea (2012) and Garza-Gil, et al (2006a) explains that, Blowout is an unexpected flow of oil and gas that occurs during drilling wells, when there is a zone of abnormally high pressure. Both studies agree that, Blowouts -are more frequent during the initial stages of construction, when preventative measures are not in place, but may also occur during production. Low-intensity blowout episodes are controllable by blowout preventers (BOP) such as safety valves, or by changing the density of the drilling fluid, but intense and prolonged gushing may lead into catastrophic situations. According to Efficiensea (2012), Uncontrollable blowouts can cause large oil or gas spills. Blowouts occur as consequence of equipment failure, human error or extreme natural impacts, such as seismic activity or hurricanes.

(B) Explosion

Oil and gas well explosions are rated the most dangerous O&G accident, imposing risks of catastrophe with human casualties (Efficiensea, 2012) . Accident investigators note that explosion may be linked to a blowout, spillage of oil, or may occur directly (Sovacool, 2008). According to Sovacool(2008) supported by Cristina et al (2013), where there is a partial or complete destruction of the offshore installation, an additional risk of a high volume of hydrocarbon spill is imposed. In such a situation, the volume of leakage is difficult to quantify, and the well could be spilling for a long period until depletion or until it is brought under control.

(C) Structural Failure or Platform Collapse

Cristina et al (2013), notes that, in the construction of a platform, or during production, there exists risk of structural failure associated with difficult working conditions. Most accidents are due to error in the design or fabrication because the undulating sea-beds where the structures are located make them susceptible series of uncertainties. El-Ladan and Turan (2012) posits that, failures can also result from material fatigue and human error in the course of operating equipment. If the failure is enough to make the entire structure collapse and sink, there is an obvious and economic loss since the damaged equipment represents investment in financial terms. The loss of oil and gas resources following such accident represents another loss to the economy. The classes of losses examined above are actually direct losses arises from direct accidental wastages of resources. A system of indirect losses may also be caused and this may come in various components as impacts from the single accident phenomena (Yun-fei Ai, (2015); Loius, Leblanc and Conway, 1990). Transport pipelines may malfunction and even break during transport, as a consequence of corrosion or global buckling or collision with transiting watercratfs. When the rupture is localized, the pipeline can be repaired or replaced. If the rupture is small or occurs in a remote area it might go unnoticed for some time, leaking oil or gas resources (Emre, 2008).

(D) Transportation

Cristina et al (2013) identifies oil tanker accidents as transportation accident in the cause of O&G drilling and lifting operations. They are of the opinion that, tanker accidents are among the most harmful in the marine industry due to the nature of the materials being transported and the effects on the environment. The most frequent causes of tanker accidents are running aground and into shore reefs, collision with other vessels or installations, hull failure, and fires or explosion of the cargo (Musk, 2012). According to Musk (2012), accidents frequently occur in proximity to the coast and may lead to shores being affected by large amounts of spilled oil. The spillage might be slow or fast, sometimes lasting for months.

(E) Spillage of oil products and chemicals

Floris, and Jakub (2015); Axel (2014) observe that, as stipulated in the International Convention for the prevention of Pollution from Ships (MARPOL 73/78), the discharge of oil or chemicals into the marine environment from offshore O&G installations or from transporting vessels is regulated by law, and can only take place under certain circumstances, normally in small quantities. Only substances of minor polluting power can be discharged legally. However, accidental discharges from offshore installations may occur, caused by human error or equipment failure, during operations of diesel transfer from supply vessels, overfilling of tanks, or during well operations. Cristina et l (2013) in agreement to the opinion of Axel (2014) adds that, in most cases, spills associated with drilling operations are rarely as large as oil-tanker (transport) spill and as a result have minimal economic consequences and impact on the environment. The IMO Civil Liability Convention (CVC) and The Fund convention provide that the spiller and/or shipowner should provide adequate compensation for the impacts of such marine oil spill accidents. Operators are required by the International maritime Organization to have an oil spill contingency plan to respond effectively in such case (IMO, 2011).

IMO (2011) notes that, the effect of an oil discharge or spillage on the environment depends on many factors, including the size and nature of the spill, the season of year, weather conditions, the nearby physical environment and biological communities, and the effectiveness of the response. Light oil is easily dispersible and has a less harmful effect than dense products. Hydrocarbon spills leave dispersed and dissolved residues in the water column that may taint fish populations. Denser residues are deposited on the seabed, sometimes smothering habitats and affecting the spawning, nursing and feeding of some species (Floris and Montekwa, 2016). The indication is that, there seems to be a correlation between spill accident and transport accident in one hand, and between spill accident and offshore O&G drilling accident with each group having varied effects on the performance of the marine industry. See table 2.15 below.

Table 2.15: Factors determining the effects of oil spillage

Factor	Lower impact	Higher impact
Size of spill. Nature of spill	Small Light oil	Large
Season of year	Non critical	Dense crude
Weather conditions	Storminess	Reproductive pence Leisure time
Physical	Open ocean	Calm atmosphere Enclosed water
Environment	Rocky cliff	Sand and beach Sensitive ecosystem (coral, mangrove)
Response	Fast and adequate	Inadequate

Source: Authors preparation based on IMO, 2011 reports.

According to the Cohen (1995), Oil slicks have a selective influence on animal groups. Short-term effects, which are visible and sometimes quantifiable, depend on the mobility of fish and the possibility of escaping toxicity. As a result, sedentary populations unable to escape the area directly affected by the oil slick might get tainted and possibly die rapidly by intoxication. Long-term effects on fish communities are more difficult to estimate, and depend on feeding habits, adaptation, and reproductive capacity (Cohen, 1995). Long-term effects also rely on the capacity of the physical environment to return to normal levels of toxicity. Jézéquel and Poncet (2011) observed the long persistence of oil in some shore habitats ten years after the Erika spillage of 20,000 tons of heavy oil on the coast of Brittany. The implication is that, heavy oil persist in the environment a far longer time than light oil and as a result imposes a persistent economic and environmental effects. Similarly, Payne, Driskel, Short and Larsen (2008) has documented the persistent effect on the coast caused by the spillage of the Prestige in 2002 in Spain. On the contrary, Payne, Driskel, Short and

Larsen (2008) reported a stable and extremely low contaminated environment in Prince William Sound and the Northern Gulf of Alaska, strongly affected by the Exxon Valdez spillage twenty years before, Xavier, Amel, Aldo, Franck, Thibaut, and Benjamin (2012) observes that, the consequences of offshore accidents involving spillages are especially severe when they happen near the shore, in shallow waters or in areas with slow water circulation.

(F) Other circumstances:

There are harmful effects occurring in association with offshore O&G accidents but not limited to those events that impact i.e. fauna and marine environment. Some of the events as reported in various studies include:

(i) Noise. Marine accidents release various decibels of noise into the marine environment which are harmful to the marine ecosystem habitats. Though the extent impact of damage done by these noise levels is not within the scope of this work, Gordon, Gillespie, Potter, Transtzis, Simmounds, Swift and Thompson (2004) notes that, a remarkable level of harmful effects and damages are done to aquatic life by excessive noise levels in the marine environment. Other underwater sources of noise related with offshore O&G include seismic surveys, drilling operations, and supporting vessels. Seismic surveys during exploration use high frequency noise that sometimes results in the temporary redistribution and distortion of fisheries particularly during breeding periods. The works ofEllis, Blood and Sampson, (2010); Gordon et al., (2004) have studied the impact of noise on fisheries and aquatic mammals with both agreeing that noise generated in the process of O&G operation have some level of harmful impact on fisheries and aquatic life. The significance and level of such impacts is still not clear. Seismic activity could have an adverse impact on the spawning success of fish, but there is a lack of supporting evidence. Strong noise produced with explosions and blowout during decommissioning of installations is of relatively short duration and charges are shaped to direct noise and energy into a narrow band, minimizing the effect on the environment. The level of noise produced by platforms depends on the type of installation: fixed platforms make less noise when drilling than semi-submersible platforms, which emit noise with thrusters to maintain position (Garza-Gil etal, 2005).

(ii) Cuttings piles. When drilling the substrate to access the oil or gas reservoir, small pieces of rocks known as cuttings are originated. Cuttings need to be removed to avoid clogging the well, and are carried to the surface combined with the fluids used for extraction and lubrication. The cuttings are discharged to the seabed by re-injected into a well or taken ashore for treatment and disposal. According to Cristina et al (2013), oil based drilling fluids are considered harmful for the environment, as they do not disperse easily. Water-based drilling fluids are considered more environmentally friendly. The constituents of mud must be identified in the Offshore Chemical Notification Scheme(CNS) which categorizes chemicals according to their toxicity, persistence and bioaccumulation potential. Oil-based mud is transported ashore for treatment and recycling and only water based mud can remain to disperse in these.

Larsson and Purser,(2011) and Pabortsova, Purser, Wanger and Thonner, 2011) notes that in deep waters the oil might disperse and dissolve before depositing on the seabed, but in shallow waters sediments deposit faster and may harm living species.

(iii) Atmospheric emissions. In the view of OGUK (2009), activities producing gaseous emissions due to flaring at the well site and marine environment are assumed to have harmful impact on but no impact on fish and aquatic populations.

• Radioactive materials. “Produced water” (the compound of water and waste materials that result from drilling) contains soluble components, including Barium and radioactive intermediates of Uranium and Thorium that can precipitate forming an insoluble naturally occurring radioactive material scale. Extreme measures are taken to clean equipment and dispose these materials in authorized locations. The studies of Olsgard and Gray, (1995) have corroborated the existence of radioactive contamination sourced from production platforms (on the Norwegian shelf) after a period of 6-9 years and evidence of contamination was found 2-6 km away from the platforms. However, the radioactivity discharged from offshore oil and gas operations is not considered to have a significant environmental impact (OGUK, 2009).

2.3.3.2 Offshore Accident and Incidents Records and Databases in the EU.

The EU maintains various offshore accident data bases and for reporting of major accidents in EU O&G industry. The data bases helps to keep trend of O&G accident and incidence. They include:

i. **BLOWOUT** is-a database compiled by Stiftelsen for Industrial Ogteknisk Forskning (SINTEF) for assessment of offshore blowout risk. The -database -includes information of blowouts and well releases occurred worldwide since - 1955, categorized by location, well type, operation in course, blowout cause and characteristics. This database is sponsored by oil companies.

ii. **WOAD:** Worldwide-Offshore-Accident Databank, This database is operated by Det Norske-Veritas and is one of the main sources -of offshore accident information for public use; and compiles data from public domain sources.

iii. **ITOPF** -International-Tanker Owners Pollution Federation limited maintains a database of oil spills -from tankers, carriers - and barges. This database -contains information on - more than 10000 accidental spillages occurred worldwide since

1970, (excluding those resulting from acts of war) that are categorized according to the amount of spilt substance.

iv. **REMPEC:** Regional Marine Pollution Emergency Response Centre-for Mediterranean Sea. The REMPEC maintains an online database and GIS of alerts and accidents since 1977 in Mediterranean Sea, related with oil and other hazardous-substances spillage. The database records accidents-to any type of ship and accidents on land that result in spillage to the Sea.

v. **ACOPS:** Advisory Committee on Protection-of the Sea. It provides annual reports of the oil and chemical spills that are reported from vessels and offshore O&G installations operating -in UK waters in the- UK Pollution Control Zone (UKPZ).

vi. **HSE** (Health and Safety Executive) bodies in Norway and UK implement a system for compilation of incidents' data collected directly by companies. Operators -fill -in a standard questionnaire to inform of incidents occurred offshore,

vii. **MAIB:** Marine Accident Investigation Branch. This is of the UK Department for Transport. It examines and investigates all types of marine accidents to or on board UK ships and on other ships within UK territorial waters.

2.3.3.3 Trends in offshore accidents in the EU

Eliopoulou, Papanikolaou and Voulgaleris (2016) states that historically, almost about 31% of major accidents recorded by the international Tanker owners pollution Federation (ITOPF) database have occurred in the European coasts, with many incidents in the Atlantic sea area, one of the main routes of oil tankers. But despite the offshore O&G industry intensification and increased seaborne trade during the last decades, there has been a reduction in the number of accidents, with a clear and drastic trend captured in databases. According- to ITOPF, the amount of oil spilt between 2000 and 2012 in relation with tanker (transport) accidents is about 19% the quantity spilt in decades 1990 and 1980 and about 7% of the quantity spilt in the 1970s (ITOPF ,2011).

According to SINTEF records, the number of offshore blowouts was highest in the 1980's and it has reduced ever since. Accidents occurrence in the Mediterranean Sea that resulted in the spillage of more than 5000 tons of oil in the past has had a decreasing trend too.

Oil and Gas UK (OGUK, 2009) analyzed the statistics of accidents occurring in all types of offshore units, on the UK continental shelf during the period 1990-2007, with data compiled from relevant UK and Norwegian databases. This analysis enabled identification of the type of installation with higher risk of accidents. A total of 6269 accidents occurred in fixed units and 3436 in floating units during period1990-2007.

During the recent period 2000-2007, more than half (53%) of the accidents occurred in floating installations were suffered by Mobile Offshore Drilling Units (MODU), while Monohull and Mobile Offshore Production Units (MOPU) suffered 31% and l6% of a total of 1465 incidents (OGUK, 2009). In floating units the most frequent type of accident is "falling object", with "spillage" and "crane" related accidents in second and third places.

OGUK (2009) notes that, most accidents that occurred in fixed installations during the period 2000-2007 happened in production units (92%), while 6% were in wellheads and less than 1% in drilling, compression, injection or accommodation units. Injection units did not register any accidents. Comparing the accident data with the previous period (1990-1999) a reduction in all types of fixed units is observed, particularly relevant in accommodation and compression installations. The most frequent type of incident in fixed units is by far "spillage", followed by "falling object" and "crane" related accidents.

In the Mediterranean Sea, the number of recorded incidents resulting in spillage of oil increased from 1977 to 2010 (REMPEC, 2011), but no major spillage has occurred offshore during this period. An increasing activity and better detection mechanisms are thought to be the reasons for the increased number of spill records. See figure 2.8 below:

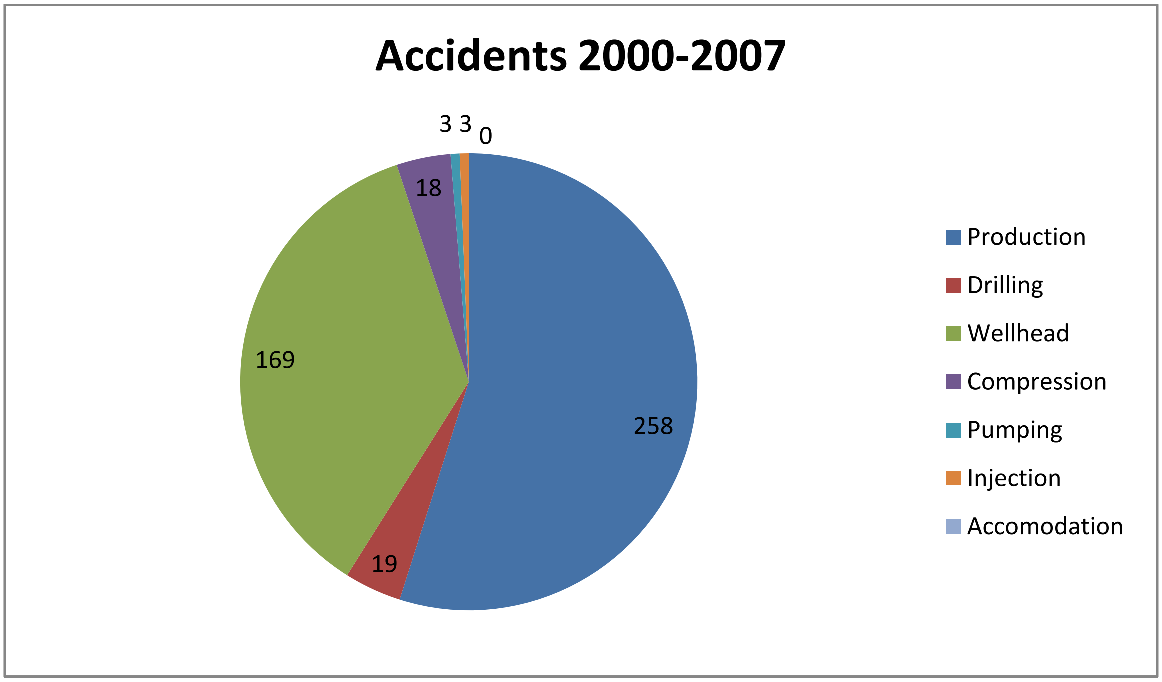


Figure2.8: Pie chart presentation of O&G in the EU between 2000 and 2007.

Source: Prepared by author with statistics from OGUK (2009).

2.3.3.4: Transport/Shipping accidents in the EU

Pachai, Elangovan and Rangana (2008) observes that, although historically, a big proportion of the worldwide transport accidents occurring in European waters causes major environmental damage, the majority of recent accidents have had only moderate or minor environmental effects, except for the case of Prestige in 2002. See table 2.16

Table2.16: Tanker accidents occurrence in European waters between 1967 and 2012.

	Name	Country	Spillage	Spill (t)
1967	Torrey Canyon	Scilly Islands, UK	Crude spillage	119,000
1975	Jakob Maersk	Portugal	Crude spillage	88,000
1976	Urquiola	Spain	Crude spillage	100,000
1978	Arnocco Cadiz:	France	Crude spillage	223,000
1980	Irene Serenade	Portugal	Crude spillage	100000
1991	Haven	Italy	Crude spillage	144,000
1992	Aegean	Spain	Light crude oil	74,000
1993	Braer	United Kingdom	Light crude oil	85,000
1996	Sea Empress	United Kingdom	Light crude oil	72,000
1999	Erika	France	Heavy fuel oil	20,000
2000	Eurobulker	Greece	Bunker fuel oil	700
2000	Alhambra	Estonia	Light crude oil	250
2001	Battic Carrier	Denmark	Heavy fuel oil	2,700
2002	Prestige	Spain (Garcia)	Heavy fuel oil	77,000
2003	Fu Shan Hal	Baltic-3 countries	Heavy fuel oil	1,200
2012	Alfa I	Greece	Heavy fuel oil and other pollutants oil	330

Source: OGUK (2014)

Cristina, Davids and Virginija (2013) found that, accidents in the EU waters have direct and indirect impacts on the economy, environment, fisheries and 'aquaculture, etc which can be reliably quantified in the short-term, and other long-term impacts more difficult to quantify. EfficienSea (2012) states that for estimation of' the economic' cost of the impact on fisheries of an offshore O&G major accident, the Social Cost is the method most, frequently applied. The economic cost of minor incidents is evaluated by the Compensation 'method, by assessment of settled claims. Valuation methods requiring assumptions and modelling are not acceptable by compensation mechanisms, and they are therefore' seldom used EfficienSea, 2012).

Figures of landing losses after an accident are used as market value for appraisal of costs, although these data are recognized to reflect only part of the impact on fisheries. Loius, Leblanc & Rucks (1990) notes that, the estimation of costs may vary conditioned by the consistency of data, the period of reference, the area considered affected, and the fishing species accounted. Different figures of the global cost arise from expert estimations, estimation by claimants, and compensation paid to claimants (Isabel, et al, 2015). Garza-Gil et al (2006b) further opines that Offshore O&G accidents may have serious impacts on fisheries and on the entire seafood industry but that due to uncertainties related with the resilience of the environment, the adaptation of species, and the reaction of the market, only short term impacts can be reliably assessed. Garza-Gil etal (2006b) identifies some of the direct impacts to include:

• **Closure of fisheries.** Garza-Gil etal (2006b) note that, following any kind of accident offshore, exclusion -safety areas is established to limit and control potential effects. If there is a spill of oil or other substances, local authorities usually close fisheries immediately, as precautionary measure to preserve public health. The ban to fishing in the usual areas constitutes an of indirect impact of O&G accident on the fishing industry, which sometimes has no alternative for fishing elsewhere (Garza-Gil etal, 2005). The duration of the closure is variable, dependent on the species 'affected and on the impact of the accident. Reopening occurs when waters are free from oil, and might be considered .on a species by species basis, after passing sensory and chemical analysis to ensure there are no harmful oil residues (Isabel, et al 2015).

• Change in demand due to public perception. Public perception may change the demand for products if the consumer feels there might be a health risk or an increased environmental impact. For example, Isabel et al (2015) reports that, after the Braer accident in 1993, enormous worldwide publicity surrounding the oil spill resulted in serious damage to the reputation of Shetland's seafood and a temporary reduction in consumption. Through shifts in market demand due to broader consumer concerns, the spatial effects of pollution can extend beyond the area of physical impact (Upton and strand, 1997). The adjustment of markets and fishers to a new situation is usually fast. Cristina, David and Virginija (2013) notes tha the indirect impact of O&G accidents on fisheries may include among other things:

• Reduction in harvesting rates. Even if the fishing exclusion zone is not very extensive, the mortality of some fish and the running out of others, leads to reduction of stock availability. The fishing effort has to intensify to obtain a similar return (Virginija, 2013).

• **Mortality of organisms.** In addition to fish unable to escape the accident, which die by direct impact, a number of fish might be affected by intoxication in the following days or months. Immobile organisms such as corals are likely to be affected by smothering when toxic substances are deposited over them (Virginija, 2013).

• Behaviour and reproductive capacity. If the seabed is affected by deposition of oil or other substances, sensitive species might be prevented from spawning in their usual areas, affecting present and future spawning levels. A report in Shetland after the Braer spill concluded that the effects on shellfish reproduction and behaviour change could last for eight years (Virginija, 2013)

2.3.3.5 Other economic impacts

A number of factors influence the economic cost and the impact of offshore accident. The intensity of effects, associated with the type of accident and environmental characteristics is crucial, the resilience and response of the affected environment and materials to pollutants, and also the responsiveness of consumers to price changes following a decline in supply of affected commodities and services(Benjamin, (2008); Xavier et al, (2012)). Furthermore, the mechanism of valuation is critical in determination of costs, with diverse mechanisms yielding very different results. Various classification of losses and costs associated with impacts of marine accidents include:

2.3.3.6: Direct Economic Cost

Immediate economic losses and costs are linked to the loss or damage of ship and equipment, the cargo, the immediate damage of third party properties, direct injury to crew and/or death of crew. The times lost over the period of the accident also constitute an important element of cost. Garza-Gil et al (2006b) however argues that, time lost is not a direct component of the impact of accident but rather and indirect impact of accident. This is because, the duration of the business closure (maritime operations and shipping) goes from few days to several months, being tradeoffs between ensuring safety and providing business services opportunities to merchants and the commercial world. For example, Thebaud, Bailly, Hay, Perez (2004) observes that, the grounding of the 'BRAER' in the southern coast of Shetland in 1993 led the total loss of the tanker and the equipments onboard, valued at some millions United States dollars, and the direct loss of 85, 000 tons of oil , and 25% of total production of farmed salmon was severely tainted. Also 40% of all-shellfish grounds were excluded-for two years. The directed affected third parties and damaged properties are always in close proximity to the accident zone and are normally eligible for economic compensation. For instance, claims to the IOPC Compensation Fund for economic loss may be accepted only if there is a ‘reasonable proximity’ between the contamination or damaged property and the prejudice for which compensation is being claimed. After the ‘SeaEmpress’ spill in 1996, claims for shellfish dealers that were based hundreds of kilometers from the area were rejected through application of this principle of non proximity to the affected zone, as such the dealers could not claim compensation because there was no direct impact of the accident on their businesses (Thebaud *et al*., 2004; Brainislav, 2013)).

2.3.3.6: Indirect economic cost

The indirect economic impact of marine accident may include the cost of loss of confidence in the services of the firm involved, this may force prices to go down which subsequently will cause revenue to plummet. The magnitude of the perceived change in quality of the services and products depends to a great extent on how the media treat the case. The publicity surrounding a marine accident, for example a spill, can result in serious damage to the reputation of the firm (Thebaud et al, 2004; Emrah and Shigeru, 2015). A media counter-campaign might be necessary to recover public confidence and increase patronage. Some schools of thought remain with the opinion that time lost as a result of accident is an indirect effect of the accident which equally has destructive and negative effects on the economy (Nima and Faisal, 2014; Thebaud et al, 2004).

Markets generally adapt to what is available. When the supply of services from an area affected by a marine accident is reduced or inexistent, merchants go somewhere else to get the necessary products and services. Sometimes search of other selling markets, which might be less convenient or profitable (Thebaud et al., 2004). While direct economic cost is appreciated on the short term, indirect impacts mostly run in the medium to long-term, and consequences and implications are more difficult to estimate (Thebaud *et al.,* 2004).

2.3.3.7 Current Efforts to Mitigate Marine Accident Impacts

Among historical efforts to reduce the frequency and impacts of accidents offshore, are various instruments and international framework of liability, including the Civil Liability Convention (CLV), the International Regulation for the prevention of ship Collision at sea (COLREGS), the International Convention for the Prevention of marine Pollution from Ships (MARPOL 73/78), the Safety of Life at Sea Convention (SOLAS), the Load Lines convention (LL) the standards of Training certification and Watch-keeping (STCW ‘’93) convention as amended , etc; have had important positive effects (Jeffery and James, (2008); Leung, Tally and Jin, (2011), (UNCTAD, 2012)).

Eric and James (2014) observes that, in recent times, European legislations dealing with all the industry activities aim to minimize the risks associated with offshore Q&G activities exists while international mechanisms for compensation of damages caused by offshore activities exist. Some of these mechanisms are specific to O&G industry accidents while other covers the wide areas of shipping and fishing operations. Also intense research classification societies, equipment and technology companies and academies supported by O&G operators and promoted by governments and international organizations searches technological improvements and risk analysis tools to assure a safe development of the maritime and offshore industry (Antao, Almeida, Jacinto and Guedes, 2008).

Cristina, David and Virginija (2013) observes that, the 2010 Deep Horizon environmental disaster in the Gulf of Mexico raised awareness of the risks involved in O&G offshore activities and evidenced the Lack of adequate regulations for a case of accident, triggering the development of new legislation that ensured maximum safety. The study notes that currently the O&G industry in European waters operates under the most safety conditions worldwide. It was noted that, national legislation is diverse between EU states and the marine and offshore industry operates to different environmental, health and safety standards in different EU state members. A study by EMSA (2008) notes that, recently ratified European legislations aims to ensure that offshore O&G production respects the world's highest safety, health and environmental standards everywhere in the European Union; it also aims to promote the same standards across the world.

2.3.4 Current State of Loss Compensation Regime and the Challenges of Insolvency of Underwriters Affecting Timely Adequate and Sustainable Compensation of Maritime Accident Economic Loss In Nigeria.

As earlier identified, the current loss compensation regime in Nigeria is based on the Nigeria Inurance Act (NIA) of 2007 which allows marine undwriters litatude to maintain between 25% to 45% of aggregate premium income earned from each class of marine risk insured, as technical reserve and/or fund aimed at mainaining the solvency of the underwriters and ensure that they have capacity for timely and adequate compensation of losses when such losses occur (Nwokoro, 2015, NIA, 2007, IMF, 2013). This arbitrary choice of between 25% to 45% of earned premium income as reserve for compensation fund to maintain solvency aimed at timely and adequate indemnification of loss has however being faulted as wrong and identified as the major reason why marine underwriters in Nigeria at the point of occurrence of insured marine risks show gross insolvency and incapacity to timely and adequately pay claims arising from such losses. For example, Studies by the International Monetary Fund (IMF, 2013) also faulted the solvency regime of the Nigeria underwriting sector in general, noting that the basis for the maintenance of technical reserve and/or reserve funds for the compensation of unexpired risks does not guarantee that underwriters remain financially solvent to ensure timely and adequate compensation of insured risks, when such risks attached. Similar studies by Nwokoro (2015) also notes that there is no significance difference between compensation funds maintained for marine risks and the value of maritime accidents economic loss recorded between 2007 and 2016, asserting that local underwriters lack capacity and financial solvency to indemnify losses when they occur.

Studies by Olukolajo (2017), Nzeribe, (2019) indicates that third party/externalities cost and human capital costs occasioned by marine accident damages to third parties and marine oil spill accident damages to the marine ecosystem in Nigeria are rarely adequately compensated, as operators deny liability and/or seek avenues to limit their liability for such losses. This has led to a situation of continued conflict between the affected third parties, ship-owners and oil and gas companies operating in the marine ecosystem such that it takes litigation and court awards for affected victims to secure compensation for losses suffered due to marine oil spill accident damages. Similar but different studies by Babawale (2013), Chima (2011) and Bello & Olukolajo (2016), show that the affected third parties in cases of marine oil spill accident damages to marine ecosystem and biodiversity show dissatisfaction with such compensations secured through litigation and valuated through court awards approaches as awards are viewed as grossly inadequate as compensation for damages suffered, after many years of litigation and arbitration following oil spill damages in the coastal communities. It is therefore evident that the current marine accident loss compensation regime, strategy and practices is marred with challenges of late and/or inadequate compensation of insured risk of as a result of insolvency of marine underwriters at the time of the loss and this is occasioned by the arbitrary choice of between 25% to 45% of earned premium revenue as reserve fund for the compensation of unexpired marine risks (IMF 2013, Nwokoro, 2015,) The compensation of externalities costs is alos dependent on court award and compensations valuated through court waward approaches are viewed as inadequate, time wasting and unacceptable as adequate compensation by the affected third party operators (Bello and Olukolajo 2016; Babawale 2013; Olukolajo 2017 and Chima 2011).

Statistical evidence from the Central Bank of Nigeria (CBN, 2018) Statistical report indicate that the average annual value of seaborne export and import trade in Nigeria between 2007 and 2016 representing value of trade by exposed to the risks of accidental loss at sea, for which maritime operators seek protection by means of marine insurance cover is about 11.5trillion naira and 8.7trillion naira respectively per annum. According to the CBN (2018), while the rate of growth of the value of seaborne export trade is an average of 2.2billion naira per annum, the average rate of growth of seaborne import trade is 5.7billion naira per annum between 2007 and 2016. However, statistical evidence from the International Union of marine underwriters (IUMU, 2018) and the Nigerian Insurers Association (NIA, 2017) reveal that while the average value of premium revenue of underwriters in Nigeria between 2007 and 2016 is 18.9billion per annum, marine damage accidents economic loss over the period is an average of 3.4billion naira per annum while the average amount of compensation funds maintained as reserve by marine underwriters to ensure solvency fortimely and adequate compensation of insured risks, in the event of accidental damages is 3.9billion naira per annum.

The reports by the NIA(2017) and IUMU (2018), indicate that while the average rate of growth of marine underwriters premium income is 591782448.5 naira per annum, the average rate of change (growth) of shipping damage accidents economic loss is 761572968.5 naira per annum, and the average rate of growth of compensation funds maintained as technical reserve to ensure solvency for timely and adequate compensation of insured marine risks is 135789339.4 naira per annum. The above statistical evidences suggests that the maritime accidents economic loss grows at a far higher rate than compensation funds reserved by underwriters to maintain financial solvency for timely and adequate compensation of insured risks. This suggest a danagerous situation as underwriters may face serious insolvency challenges, gigen such situation. Studies by Nwokoro (2015) also found the existence of a non significant difference between the compensation funds reserved to ensure solvency, timely and adequate compensation of insured marine risks and the quantum of marine damage accidents economic loss in Nigeria between 1996 and 2010. From the afore mentioned, it is equally evident that the annual rate of change/growth of marine accidents economic loss between 2007 and 2016 is higher than the rate of growth of compensation funds reserved by underwriters to maintain financial solvency with regards to timely and adequate compensation of insured risk. The implication is the existence of a problematic situation where marine underwriters in Nigeria are viewed by shippers and maritime operators as lacking financial solvency and adequate capacity for timely and sustainable indemnification of insured marine risks. Maritime operators (shippers and ship-owners) in view of the high value of maritime trade and investments exposed to marine perils and the higher increasing trend of such investment when compared to the lesser value of compensation resources reserved for insured risks, and lower annual growth rate of such reserve funds, envisage that the underwriters lack capacity and financial solvency to timely and adequately provide compensation for insured risks. Similar studies by the International Monetary Fund (IMF, 2013) also faulted the solvency regime of the Nigeria underwriting sector in general, noting that the basis for the maintenance of technical reserve or reserve funds for the compensation of unexpired risks does not guarantee that underwriters remain financially solvent to ensure timely and adequate compensation of insured risks, when such risks attached. This is perhaps the cause of the continued refusal of local ship-owners involvement in oil lifting contracts originating in Nigeria, even in the present cabotage regime, by the NNPC and the multinational oil companies (onuoha, 2019; Adegbayi, 2017). These oil companies assert that, the Nigeria ship-owners who obtain marine insurance policy and cover from the local underwriters as required by law, are not adequately covered; as a result, lack capacity to adequately and sustainably compensate insured marine risks.

The indigenous ship-owners are required to compulsorily make lump sum payments in hard foreign currencies and secure membership of foreign protection and indemnity (P&I) clubs as condition for qualification to participate in crude oil afreightment in Nigeria. By implication, the local marine underwriting sub-sector probably lack financial solvency to timely and adequately compensate indigenous ship-owners, shippers, and third parties for insured marine risks, when such risks attached. The friction caused by this situation has led to clamor by the indigenous ship-owners to establish a local version of protection and Indemnity (P&I) clubs to ensure adequate compensation of losses and improve their opportunities for growth.

It is important to point out that, the motivation of the Nigerian Government to protect maritime trade and enhance local content development of the local underwriting industry to compete favourably with the foreign firms, in the underwriting of seaborne import and export trade, saw the insertion of the cargo insurance policy into Section 14 (3) of the National Shipping Decree 1987 which stipulates that all public sector contracts for seaborne import and export trade shall be on free on board (F.O.B.) and cost, insurance and freight (C.I.F.) contracts respectively. The clear policy intent being that local marine underwriting firms will cover such contracts to enable them develop and to reduce the effect of capital flight. it was until 1997, that the Insurance Decree No. 2, Section 76 provided that all imports (both private and public sector imports) into Nigeria shall be on cost, insurance and freight basis only, thus recommending that both public and private sector import contracts be insured with local insurers. The above provisions of the Shipping Decree 1987 and Insurance Decree 1997 were consolidated by the current regime of Insurance Act 2007, which apart from establishing a new capitalization base for all local insurance firms in Nigeria, provided for the maintenance of technical reserve fund for all types of insured risks of the indigenous underwriting firms to enable them maintain solvency for timely and adequate compensation of claims and liabilities (NIA, 2007). In the marine underwriting sector, the Act made arbitrary provision and reservation of between 25% and 45% of the total marine premium revenue collected to be maintained as technical reserve fund for compensation of insured marine risks (NIA, 2007). The seeming insolvency of the local underwriters with regards to availability of compensation funds for timely and adequate compensation of liabilities as earlier identified is thus traceable to the arbitrary provision of between 25% and 45% of earned premium income as technical reserve by the insurance Act of 2007, which has given the underwriters the latitude and freedom to determine what amounts to be maintained as reserves for unexpired marine risks without recourse to the value of seaborne trade at risks, the history cum quantum of marine accidents economic loss in the economy and their relationships to each other and the volume of compensation funds available for marine risks over the given period of time.

The current structure of the marine underwriting sub-sector equally seems to rarely provide cover to third parties against environmental damage risks in the marine ecosystem. For example, fishermen and aquaculture farmers in coastal communities and others who depend on the marine biodiversity for economic sustenance hardly get compensation for damages caused by ship accidents involving oil spill without having to litigate to secure court awards. Studies by Olukolajo (2017), Nzeribe, (2019) indicates that third party/externalities cost and human capital costs occasioned by marine accident damages to third parties and marine oil spill accident damages to the marine ecosystem in Nigeria are rarely adequately compensated, as operators deny liability and seek avenues to limit their liability for such losses. This has led to a situation of continued conflict between the affected third parties, ship-owners and oil and gas companies operating in the marine ecosystem such that it takes litigation and court awards for affected victims to secure compensation for losses suffered due to marine oil spill accident damages. Available evidences show that the affected third parties show dissatisfaction with such compensations secured through litigation and valuated through court awards approaches as it has been proven in many studies to be grossly inadequate as compensation for damages suffered, after many years of litigation and arbitration following oil spill damages in the coastal communities (Olukolajo 2017; Babawale 2013; Chima 2011; Bello & Olukolajo 2016; Adekunbi and Nzeribe 2013). With particular reference to human capital output losses occasioned by crew injury and death which seem to be rarely adequately compensated over the years, the offshore industry safety report by the Department of petroleum resources (DPR, 2017) indicates that between 2015 and 2016, an average of 47 maritime/offshore workers died due to work related accidents while an average of 88 maritime workers had serious injury following the occurrence of occupational accidents. The current practice by marine underwriters in Nigeria have not however been able to prioritize the need to protect the seafarers from output losses occasioned by occupational injury and death through the provision adequate compensation as provided in the International Labour Organization's (ILO's 2006) Maritime Labour Convention. Local seafarers are abandoned to seek personal life insurance protection for occupational injuries and death, a liability placed on the ship-owners and operators by the ILO and which the local marine underwriting sector can be galvanized to prioritize through the development of marine accidents human capital cost database upon which future projections of the quantum of economic resources needed to ensure adequate protection and compensation of maritime labour liability risks can be based.

It is at this point important to note that, notwithstanding the seeming loopholes and problems identified in the current practice of marine underwriting and the provision of compensation funds for insured marine risks in Nigeria, such as the seeming insolvency of underwriters with regards to maintaining adequate compensation funds for timely and adequate compensation of marine damage accidents economic loss, the limitation and denial of compensation to affected third parties costs and inadequacy of compensation secured by third parties through litigation and valuated through court award approaches, and the seeming lack of basis to ensure adequate protection and compensation of maritime labour liability risks in line with the provisions of the ILO's Maritime Labour Convention; available empirical literatures have dwelt more on identifying these inadequacies of the present compensation regime without any attempt at providing empirical evidences on best approaches to overcome the identified inadequacies in the current strategies and approaches of providing compensation funds for insured marine risks. The current study therefore in a bid to provide solution to the identified problems, aims to bridge the literature gaps identified.

It is obvious that these problems, gaps and seeming insolvency and incapacity of the current compensation regime to ensure timely and adequate compensation of insured marine risks in Nigeria stem from arbitrary reservation of compensation funds without recourse to an understanding of the nature of relationships between the level of economic risks posed by marine accidents, the volume of compensation resources available, and value of maritime trade exposed to accidents. The empirical relationships between these variables once developed will form clear basis for decisions aimed at ensuring the solvency of marine underwriters in providing timely, adequate and sustainable compensation of marine accidents economic loss. The current study therefore aims to bridge this literature gap by building models of empirical relationships and conditions between maritime trade, marine accidents economic loss, and compensation resources for insured marine risks that will ensure timely, adequate and sustainable provision of compensation funds for insured marine risks.

2.3.5 The Economic Effects of Marine Accidents on Nigerian Economy

There are several dimensions to the socio-economic impacts of marine-based accidents. A holistic analysis of the impact of marine accidents reveals a severe imposition on the economy of wastes of valuable productive capital base occasioned by the characteristic destructive effects, inherent to accidents and which puts a wedge of economic stagnancy and backlash draw-back effects on the quest for improved productivity, economic growth, development and sustainability (Thebaud et al, 2004)..

Marine accidents are catastrophic, and as such, poses risk of destruction of valuable economic goods; limiting the performance and productivity of the subsector. This limits as well, the achievements of the socio-economic objectives of the affected firms in particular, and the nation at large. The sustainable development objectives in the use of marine-based economic resources become hampered. The economic impact of marine based accidents is considered to have multiplier effects. This is because, a single major ship accident will directly and indirectly affect negatively all the allied sectors: example, shipping, fishing, O&G operations, market value of imported goods and services etc. Ukoji and Ukoji (2015) notes that, further that the death and injury related to ship accidents constitute another major source of accidents induced economic losses. This is because, the losses of output of the injured victims over the period of impairment and hospitalization limits the productivity maximization objective of Firms and States (Zaloshuja Ted and Waehrer (2006). The Gross domestic product(GDP) seems to have a direct relationship with output per factor(labour) employed. Thus output losses to society due to injury to labour (factor of production) and death will cause the GDP to plumet with the resultant backlash effect; except necessary levels of compensation is provided to cushion the effects of such output losses. The theory of gap analysis enables one to measure how marine accidents economic losses have impacted on the economy over time. By the theory of gap analysis, its clearer to understand that marine accidents causes output losses which represent in clear terms the gap between achieved performance (actual output) and expected performance or target output. The gap represents the deviation from performance target (output objectives) caused by marine accidents induced losses. It is this gap that accident loss compensation mechanism should be engaged to bridge in order to ensure optimal performance of the system(Zaloshuja Ted and Waehrer (2006). (see figure 2.9 below).

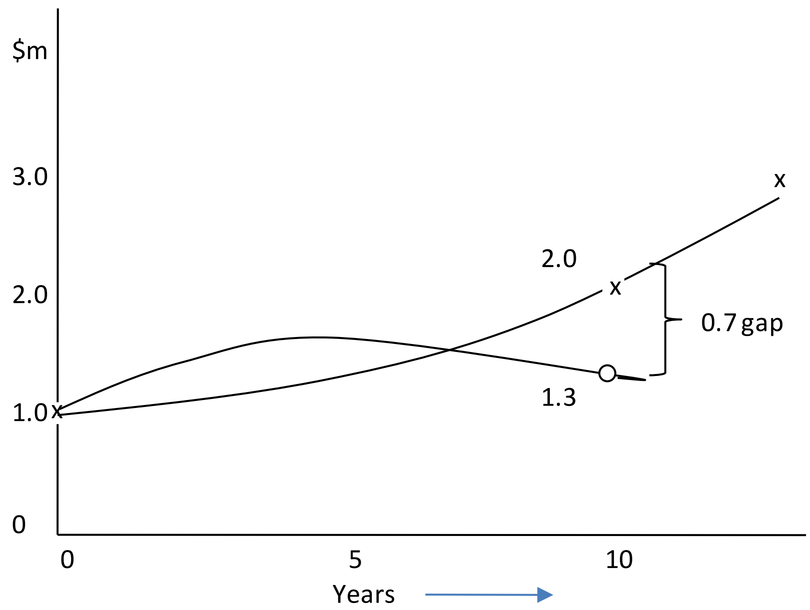


Figure 2.9: A simple gap analysis chart

Gap analysis reveals decline in performance caused by accidents by 0.7units. The expected output was 2 units while the actual/achieved output was 1.3 units. The existence of gap in the drive to achieve target performance and productivity objectives in the event of accident indicates that, marine accidents decline performance, productivity, economic growth and development.

Osayemi (2013) and Aderemo (2012) observes a similar situation in the road transport subsector where there exist a relationship between productivity and injury accident rates. They linked decline in productivity in the economy to high rates of accident induced injuries.

Zaloshuja, Ted and Waehrer (2006) found increases in productivity, income and employment following reductions in occupational injury costs in the United States of America. Using the accident hazard index, studies have found that the higher the accident index, the greater the risk of loss and decline in performance and productivity (Odeleke, Salami & Oyewo 2013; Sajid, Khurrun, Umer 2013; and Agbonkhese, Yissa, Akannbi, Aka & Mondiga, 2013). Since marine accidents cause pollution, damages to cargo and equipment, injury and death to crew and passengers, among others economic costs, it is necessary that, the impacts on the economy be adequately compensated in order to ensure sustainability of maritime operations in Nigeria.

2.3.5.1 Effects of Shipping Accidents on the Nigeria Economy

Unctad (2014) asserts that, shipping plays dominant role in global economy particularly in the distribution of trade across continents. One may be led thus infer that factors that cause breach to the smooth flow of trade resources such as accident, will certainly create ripple effects on trade levels, economic growth and development. This is worse when such factors impose destructive and injurious effects and with no serious management mechanism put in place to force it to take a continuous reducing trend (Zaloshuja, Ted & Waehrer, 2006). Allianz (2014) reports that, between 2001 to 2011, global losses of ships due to maritime accident stood at 1,437 ship accidental losses, with the West African region having a sum total loss of 84 vessels, which represents about 5.0% of global ship accidental losses. Though Nigeria dominates marine safety issues in the West African Coast; given the size of her coastline, and the volume of seaborne trade and maritime operations in Nigeria, including the level of exploration and drilling activities in her EEZ (Lame, 2008). CBN (2014) statistics reveals an increasing trend in volumes and values of Nigeria seaborne oil and non oil trade from 2006 to 2013. Similar trend was noted in the performance and output of the marine transport sub-sector as the contribution of marine transport ($GDP_{marine\ transport}$) to the gross domestic product (national output) maintained a steady rise from 2006 to 2013 (CBN, 2014). Financial losses occasioned by marine accidents are found to have relationship with the productivity of the sector, as well as values and volumes of seaborne import and export trade

(Aderemo 2012; Robert and Williams, 2007). For example, statistical reports from the CBN (2014) indicate that value of seaborne import and export trade in Nigeria between 2006 and 2010 was an aggregate of about 50Trillion and 45Trillion naira respectively while the GDP contribution of the marine transport sub-sector was within the same period was about 6Billion naira. However, the economic cost imposed by shipping accidents compensated by marine underwriters over the same period is an aggregate of 23Billion naira (NIA, 2012). The directions of this relationship is however uncertain as some schools of thought assert that the existence of a relationship does not imply causality, inferring that marine accidents induced economic losses may not be causal factors of output decline or improvement in the marine transport subsector (Yan, Min, Kwaai-Sang &Xiu, 2013; Rodrigue and Brown, 2007). Allianz however recommended compulsory insurance of marine risks and adequate indemnification and compensation of insured marine risks, as best approaches to ensuring sustainable maritime operations.

Allianz (2014) reviews of global insurance claim for shipping and O&G accidents losses puts global shipping accidents loss claims at 45% of total global loss in all sectors and O&G losses at 12% between 2009 and 2013. Statistics by the Nigerian Insurers Association (NIA, 2012) reveals that, between 2006 and 2010, the average shipping accidents induced financial losses amounts to four billion, six hundred and twenty million, four hundred and eighty two thousand naira (4,620,482,000) per annum. This is exclusive of the cost of safety administration and loss control, environmental impact, legal and police cost, third party cost and cost of insurance premium. Report by the International Union of Marine Insurers (IUMI, 2014) puts the total financial cost of premium for purchase of insurance (policy) cover for marine risks between 2006 and 2010 at an average of fourteen billion, six hundred and thirty million, five hundred and twelve thousand eight hundred (14,630,512,800) naira.

The pie hart below shows the summary of economic values of seaborne imports and exports trade, output of the maritime subsector and the economic losses of output due to shipping accidents to the economy.

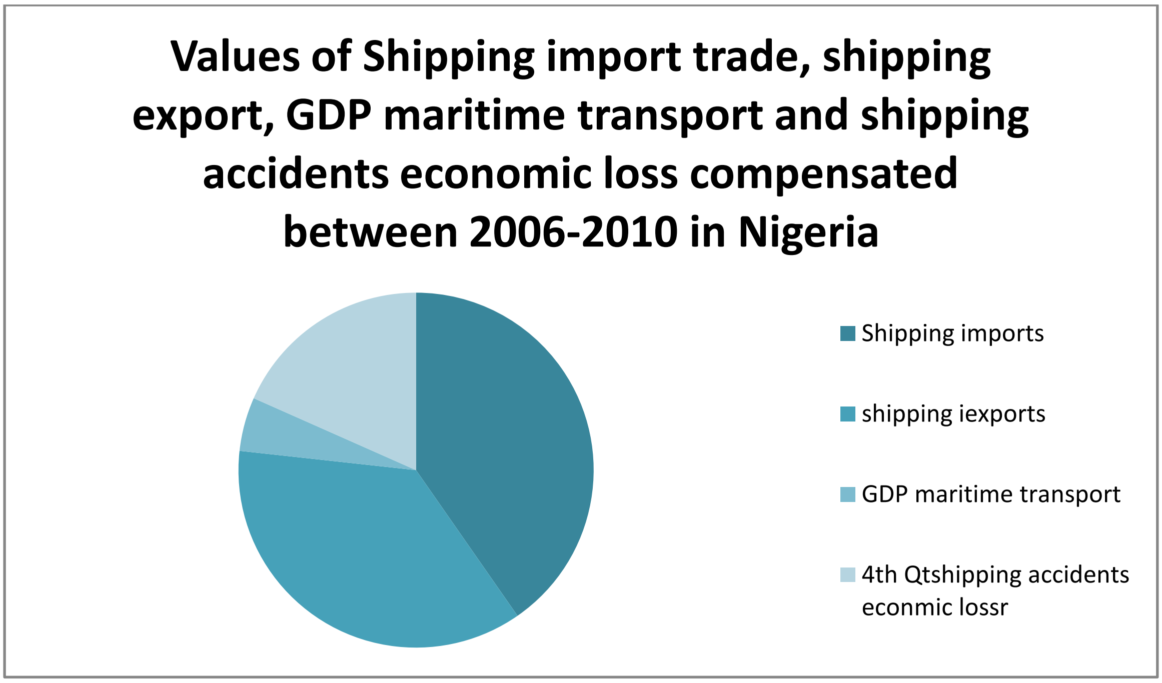


Figure2.10: Pie-chart showing the values of seaborne import and export trade, GDP maritime transport and shipping accident losses.

Sources: Prepared by author with statistics from IUMI data and Central Bank statistical bulletin.

The Nigeria Insurers Association (NIA, 2012) also notes the trend of shipping accidents and the associated quantum of economic loss has implications on the performance of the marine underwriting sector particularly on the mpremium for purchase of protection for marine risks, the claims for compensation in the marine sector and the output of the marine underwriting sector in terms of the Gross Domestic Product (GDP marine insurance). Statistics by the NIA (2012) and the International Union of Marine Underwriters (IUMU, 2018) indicate that between 2006 and 2010, an aggregate of 58Billion naira was recorded as the output (GDP) of the marine insurarnce sub-sector while about 73Billion naira aggregate was recorded as premium income from insured marine risks by underwriters. The aggregate claims compensated over the same period for shipping accidents risks is about 23Billion. The pie chart below summarises the relationship between the shipping accidents claims compensated over the period, the output of the sector in term of the GDP and the premium income of underwriters from insured shipping risks.

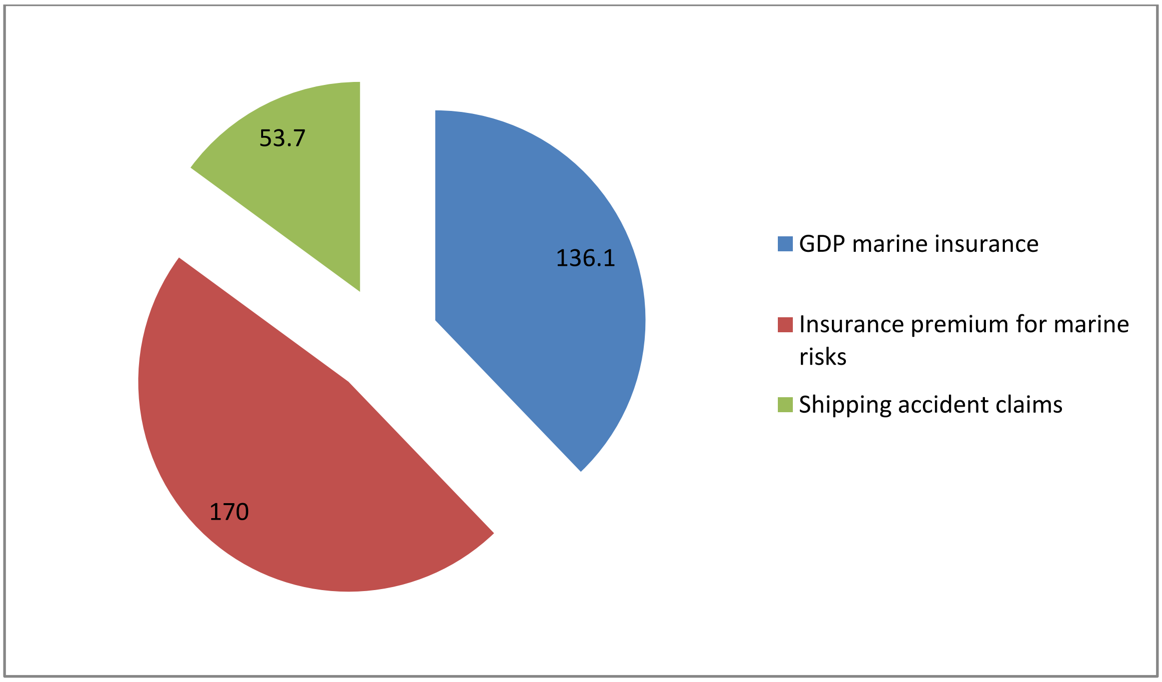


Figure2.11: Pie chart showing the nature of marine insurance premium, GDP marine insurance and marine claims

Source: prepared by the author.

2.3.5.2 Effects of Offshore O&G Accidents Losses on Nigerian Economy and need for Adequate Compensation

The importance of the need for the economic sustenance of operations in the offshore O&G energy subsector of the marine industry in Nigeria cannot be overemphasized. This is because, the offshore oil and gas sector remains the dominant foreign exchange earner, one of the cash cows, and economic life wire of the Nigerian nation. Available statistics by the Nigeria Maritime Administration and Safety Agency (NIMASA) suggests that, over 2000 offshore service vessels satisfy the logistics needs of the offshore O&G energy sector in Nigeria. Okoroji, & Onyemechi (2015) notes that, over 272 mobile offshore drilling units (vessels) and floating production storage and offloading systems (FPSO's) are involved in O&G operations offshore Nigeria; while port statistics indicate a daily increasing trend in the number of marine oil tanker vessel that call to Nigerian ports and crude oil terminals for cargo lifting and discharge.

The Nigerian O&G sector over the years, have had its fair share of accidents ranging from fire, explosion, collision, contact, grounding to blowouts; leading most times to catastrophic losses of life, material investment and oil resource (cargo) losses (Akinforo, 2013). Although, shipping accidents involve oil spill, the majority of oil spill losses in the offshore environment are traceable to O&G drilling accidents, coastal oil pipeline rupture and marine tanker vessels (Afshar, Ahmad and Parviz, 2015). A typical example is January 16th 2012 explosion and fire of a drilling rig run by Chevron Nigeria Limited offshore Nigeria. This led to the death of two workers. Marine accidents impact the environment negatively, causing degradation of otherwise arable land, destruction of fisheries and pollution of streams. The economic impact of spill incident usually put a long term economic loss on the economy. Oil and Gas accidents poses risk of loss or destruction to the drilling unit, risk of life and injury to oil/rig workers, as well as loss of the oil cargo spilt. The economic values of the lost oil and gas resources also present further sources of revenue losses to Government.

Umeorizu (2015) in a study on the cost estimation of the economic impact of oil and gas spill in Nigeria estimated the total value of oil and gas resources spilt following O&G accidents in the marine environment between 2005 and 2010 at three billion, two hundred and seventy-three million, three hundred and forty-eight thousand, two hundred and twelve naira. (₦3, 273, 348, 212). The study puts the average O&G accidents value of oil resources lost at six hundred and fifty-four million six hundred and sixty-nine thousand six hundred and fourty-two naira (654,669,642 naira) per year over the period. Apart from the financial losses to the economy occasioned by the losses of oil and gas resources, the loss of the ship and drilling equipment also constitute a major component of the economic losses from offshore O&G accidents. Cost of safety (e.g accident administration and management, risk analysis and loss control measures, and insurance policy purchase) constitutes economic cost variables necessitated by the occurrence of offshore O&G drilling accidents (Rodriguez and Brown, 2007). The International Union of Marine Insurers (IUMI, 2015) report that, between 2007 and 2014, a total of 1, 217, 200, 000USD was spent as insurance premium for the purchase of marine/energy policies to cover offshore O&G accident risks. The IUMI (2015) report reveals that an average of one hundred and fifty million, one hundred and fifty thousand (152, 150, 00 USD) was spent as premium cost for insurance cover of offshore O&G accident risks in Nigeria. The Nigeria Insurers Association (NIA, 2014) however report that, offshore O&G accidents economic loss levels between 2006 and 2013 was three billion two hundred and thirty-four million two hundred and fourty-eight thousand naira (3,234,248,000 naira) per annum.

The figure below summarizes the economic losses of offshore O&G accidents, insurance cost (premium) for offshore O&G accidents risk factors, value of seaborne oil export trade in Nigeria between 2006 and 2010.

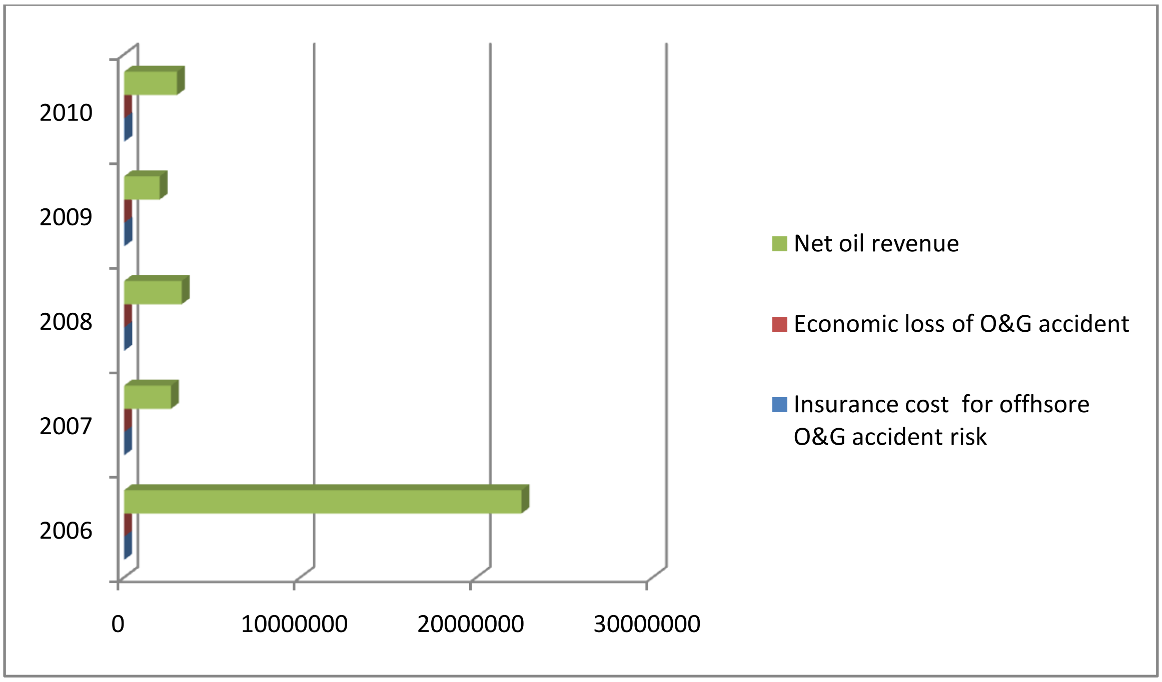


Figure 2.12: Barchart showing O&G accidents economic losses, insurance cost for offshore O&G risks, and GDP oil and gas between 2006 and 2010**.**

Source: **Prepared by** author with data from CBN (2014), IUMU (2011).

It also important to understand the nature of the aggregate effects of marine accidents economic loss on National output and investment in marine transport subsector in Nigeria. Statistics from the CBN(2014) and the NIA (2014) indicate that the aggregate of national output between 2010 and 2014 is about 4.2Trillion naira. The market capitalization of quoted maritime companies in Nigeria over the same period is an aggregate of fourty-nine billion five and and six million naira (₦49,506,790,000) while aggregate cost of maritime damage accidents on the economy compensated by marine underwriters is about fourty-two billion five-hundred and sixty-two million naira (₦42,562,732,290). The implication is that an average of about Eight billion, one-hundred and twelve million naira (₦8,112,546,460) was lost per annum over the period due marine accidents while the market capitalization of quoted maritime companies over the same period is an average of about Nine billion, nine-hundred and one million naria (₦9901358300) per annum. This quantum of loss is expected to be adequately compensated by the marine underwriters, since inability of the underwriters to indemnify these loses will not guarantee sustainable maritime operations and this will inturn lead to the extinction of many maritime companies operating in Nigeria. However, to ensure that these losses are adequately indemnified, marine underwriters must maintain adequate level of funds to be able to remain financially solvent at the point of occurrence of loss for insured marine risks. The figure 2.13 below is a summary of the trend of market capitalization of quoted maritime companies in Nigeria and the quantum of marine eccidents economic loss between 2006 and 2010.

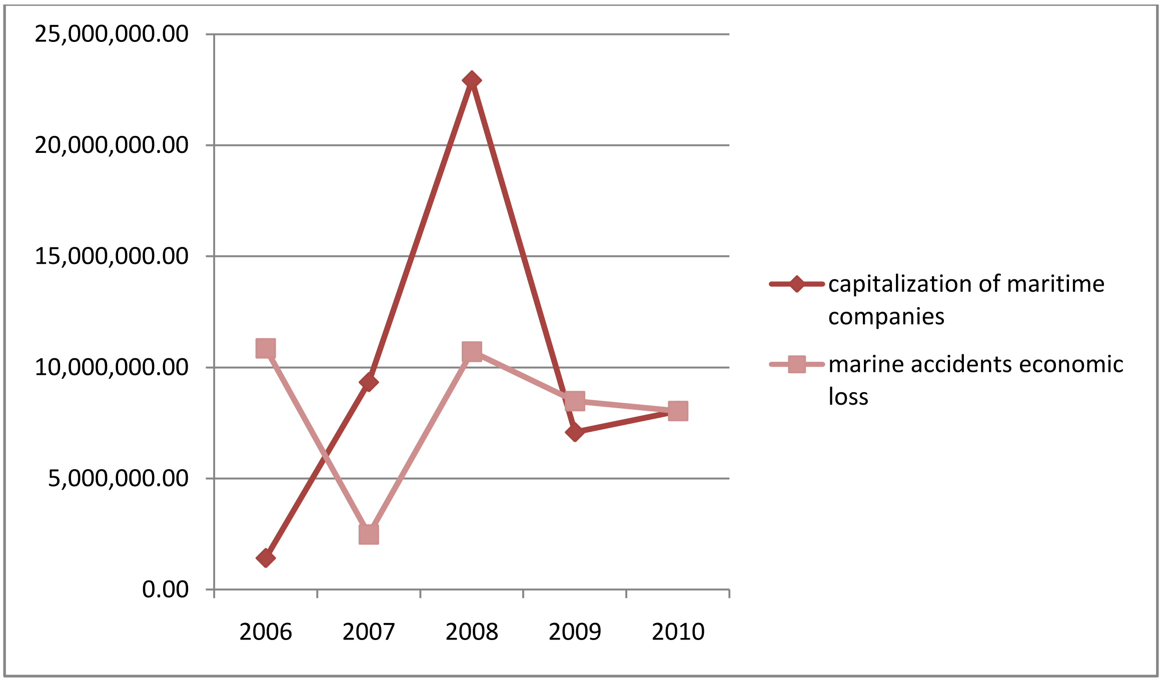


Figure2.13: Comparison of Trends of capitalization of quoted maritime companies and maritime accidents economic loss between 2006-2010.

Source: Prepared by the author (2020).

2.3.5.3 Human Cost of Marine accident in Nigeria

The dangers associated with ship-based accident are complex and multifaceted. Apart from the risk of wastages of human resources by death accidents and incapacitation by injury accidents, many seafarers who have experienced major ship-based marine accident suffer considerable mental alteration as a result of trauma; such that, they never want to go to sea again (Chalk, 2009). In many cases, death, injury and traumatic experiences associated with marine accident, has led to symbols closely related to post-traumatic stress disorder (PTSD) among affected seafarers. It is important to note that, marine accident induced occupational injuries and deaths, apart from constituting wastages of crucial manpower capacity and human resources of the marine industry, impacts negatively on output performance and productivity of the industrial subsector (Zaloshuya *et al.,* 2006; ShanShan, 2019).

Ogwude (1998), in estimating the economic cost of traffic accidents in Nigeria using the Human Capital Model – Gross output model to determine the wastages and loss in output and productivity of the road transport sub-sector due to injury and death of personnel. Extending the model to the marine subsection, one may model/estimate the economic losses induced by injury and death of marine industry manpower resources due to accidents, given the necessary statistical data and information. The implication is that, human resources constitute a major component of the marine industry capital. The productivity and output of the industry is a dependent on capital resources; wastages, decline, and incapacitation of capital resources therefore cannot produce optimal contribution to performance, as such, productivity and output may dwindle (Zaloshuja *et al.*, 2006; Ogwude, 1998). Figure**2.15** below is a comparison of Nigeria maritime workers affected by death accidents to Global figures.

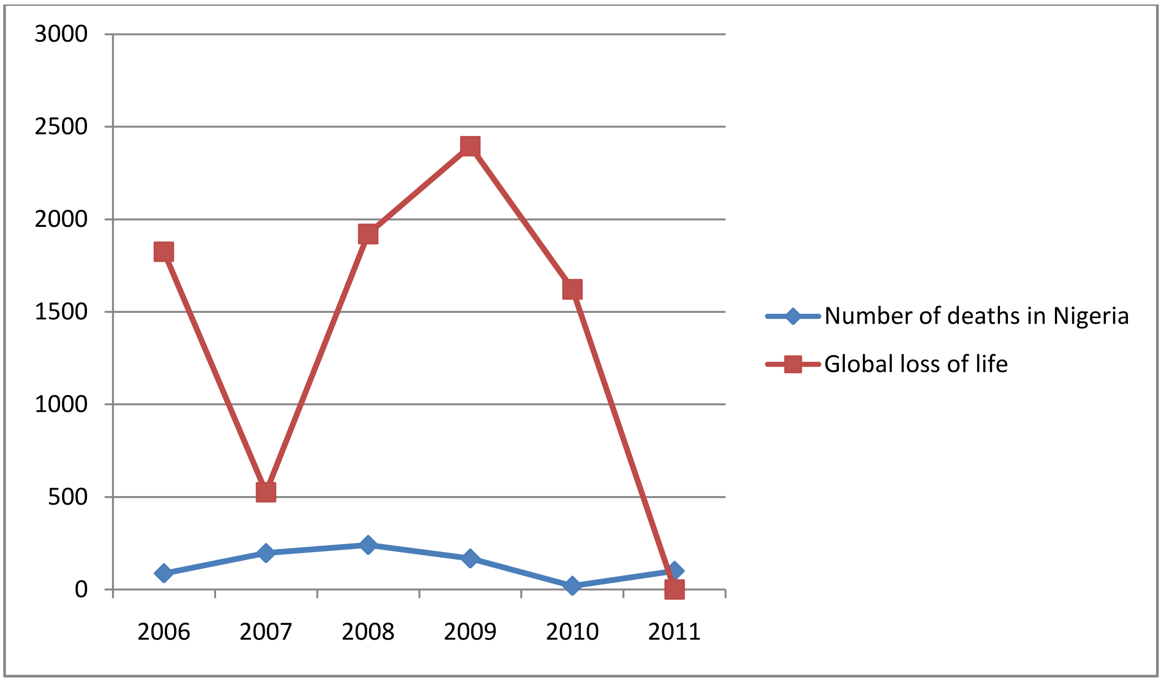


Figure 2.14: Trend of marine accidents from 2006 t0 2011.

Source: Prepared by Author (2020) **with data from:** (a) IMO report (2011). (b) Ukoji and Ukoji (2015

While the table above indicates the global and Nigerian losses of life due to marine related accidents culminating into marine manpower capacity wastages and decline in performance of the subsector. There is a general economic loss suffered by the nation, the marine industry, individual seafarers, the transoceanic fishing and domestic fishing industry (Chalk, 2009). For example, the marine accident induced oil spill in the Nigerian marine environment has over the years, constituted a major source of marine pollution, which has led to depletion of fisheries and aquatic life. In some cases, it has led to the extinguishing of some fish species and caused poor fish breeding and productivity (Tepp, 2012). This is evident in the report by the Nigerian Trawler Owners Association (NITOA, 2014) which reveals a decline in fish production and revenue loss by the Nigerian industrial fishing sector from 2007 – 2013. Between 2007 and 2013, NITOA (2014) reports that fish output by the industrial trawler fishing sector in Nigeria declined by an aggregate of 120016.98 metric tons;

representing an average of 17145.14 metric tons per annum over the period, Consequently, revenue from the industrial fishing sector declined by an aggregate of about 23,200,000 naira between 2007 and 2013. This gives an average of about 3,314,285.7 naira decline in revenue from that sector per annum over the period. The bar chart below captures the degree decline in fish production and revenue loss from the industrial fishing sector affected by accident induced oil spill in the marine environment.

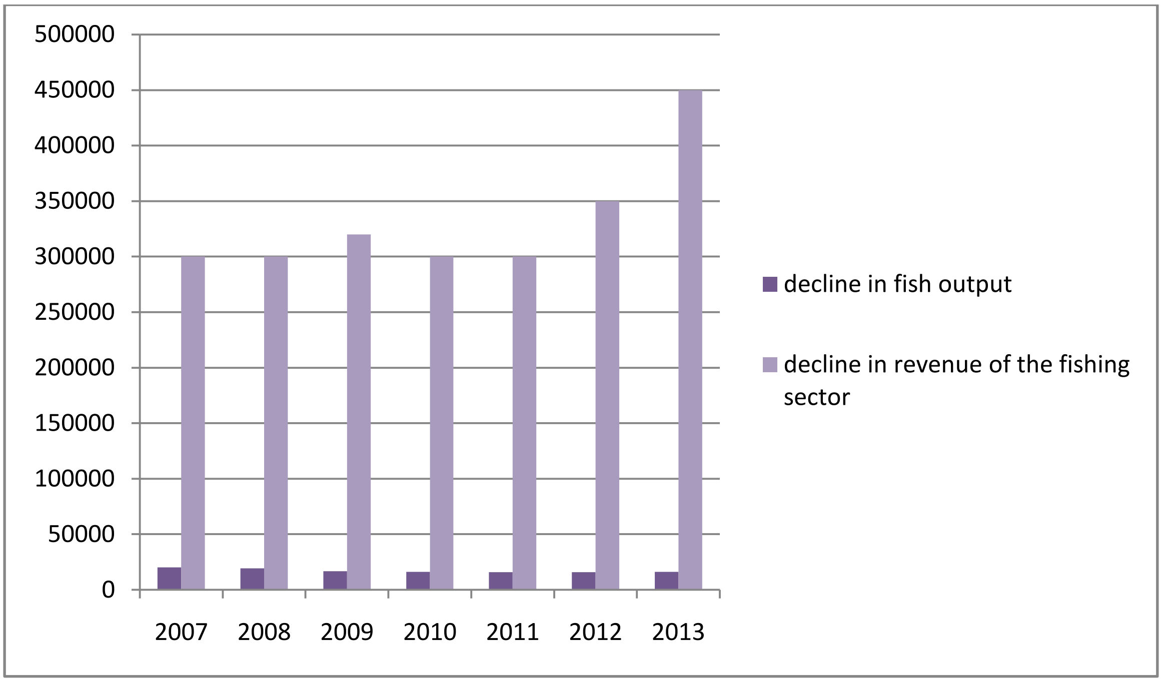


Fig 2.15. Degree decline in fish production and revenue loss from 2007-2013

Source: Prepared by author (2020) with data from NITOA (2014

2.3.6 Summary of Empiricalworks Reviewed

Table 2.17a Summary of Empirical works Reviewed

S/n	Author(s)	Title	Method, findings/conclusion
1	International Monetary Fund (IMF 2013)	Publication of Financial Sector Assessment Program Documentation—Detailed Assessment of Observance of Insurance Core Principles.	Used secondary data. The Nigeria non-life insurance sector suffer from challenges of insolvency at the occruence of insured risks, affecting the capacity of the sector to timely and adequately settle claims. This is caused by the basis for the maintenance of reserve funds for the compensation of unexpired risks which does not guarantee that underwriters remain financially solvent when such risks attached.
2	Olukolajo, M.A. (2017)	Monetary Compensation For Oil Spill Damage In Niger Delta Region, Nigeria: A Question of Adequacy.	Employed survey research designs to estimate the adequacy of comensation paid to third party operators in the coastal communities affected by marine oil spill damages. The study found that a significant difference exist between the amount expected as compensation by tthird party operators affected by marine ecosystem damages and the actual compensation they received. In conclusion, it noted that far less amounts were paid to the respondents than they expected, given the quantum of damages they suffered.
3	Babawale G. K. (2013)	Emerging Issues in Compensation Valuation for Oil Spillage in the Niger Delta Area of Nigeria.	Data was sourced from both secondary and primary sources. The study found that in almost all cases, it took third party operators affected by marine accidents oil spill damages court litigations to be able to secure compensations for losses suffered. Such compensations valuated and secured through court awards are viewed as inadequate for the amounts of damages suffered by the third party operators.
4	Ogwude, I.C. (1998)	Valuation of Reduction in Traffic Accident.	Used the gross output model of the human capital method and the 1% of the GDP method. Findings: An average of 44,310,870,000 naira was lost in the economy between 1980 and 1995 as a result of death, injury and damage accidents while an average of 1,852,138,777.40 naira was lost per annum as a result of death accident between 1991 and 1995. The conclusion is that road safety programmes and must have economic targets such that benefits of investment in safety can be appraised relative to fund committed into it
5	Aderemo, J.A., (2012)	Road Accident Injuries and Productivity in Nigeria	Used z-score and multiple regressions to estimate relationship between injury accident and productivity in Nigeria. Findings: There is a significant relationship between road accidents injury and productivity in Nigeria
6	Zaloshuya,E., Ted, M., Waehrer, G.,(2006)	Impact of Occupational Injury Reduction on the U.S A Economy	They used the compensation method (workmen compensation) for occupational accidents and the input-output model and found that reduction in occupational injury accidents has impacts on national income, GDP and employment. Conlusion: Declining injury cost between 1993 and 2002 increased employment by 550,000.00 jobs and increase GDP by 25.5 dollars.

Source: prepared by author.

Table 2.17b. Summary of Empiricalworks Reviewed (contd)

S/n	Author(s)	Title	Method, findings/conclusion
7	Prsichal, M., Lisa, S., James, H., Jennifer, B., Wen, W.,(2006)	Evaluation of the Burden of Logging Injuries Using West Virginia Workers' Compensation Claims Data from 1996 - 2001	Estimated the injury cost using west virgin workers' compensation data to be over 14million dollars between 1996 and 2001. Conclusion: the magnitude of the economic cost emphasizes the need for active research for injury prevention among loggers and for greater attention to occupational safety and health programmes.
8	Akinforo, H.B.(2013)	An Assessment of Marine Tanker Accident in Nigeria Coastal Environment	Using primary data draw from sample respondents; Akinforo (2013) concluded that human error constitutes the major factor causing marine tanker accidents in Nigeria.
9	Nze, I.C. (2013)	Analysis Of the Fatality Rates of Boat And Ferry Accidents on Inland Waterways in Nigeria	Nze used secondary data from NIWA and employed simple averages and percentiles in analyzing fatality rates of boat and ferry accidents. Conclusion: boat accidents increased by 63% between 2004 base year and 2009 with higher fatality rate while ferry accidents showed irregular trend and lower fatality rate of 6%.
10	Onwuegbuchulam, D.E.(2013)	An Analysis of Determinants of Accidents Involving Marine Vessels in Nigeria's Waterways	Used multinomial logit regression model to analyze primary data gathered from a sample of respondents. Findings: human related factors accounted for over 50% of accidents investigated followed by environmental factors which accounted for 30% while machinery factors accounted for 20% of accident risk factors. Conclusion: human error and environmental factors significantly affect probability of accidents involving marine vessels.
11	Ukoji, V.N., Ukoji, V., U.(2015)	Boat Accidents in Nigeria: General Trends and Risk Factors(2006 – 2015)	Used trend analysis to analyze secondary data from police sources. Conclusion: there is increasing trend in boat accidents between 2006 and 2015. Human error, preponderance of wrecks, turbulent weather conditions and poor safety standard are significant risk factors causing boat accidents in Nigeria.

Source: prepared by author.

2.3.7 Literature Gap/Research Gap

From the various empirical literatures reviewed, the following literature gaps are identified:

(i) The problem of financial insolvency of marine underwriters for timely and adequate compensation of insured shipping risks as a result of inadequacy of reserved compensation funds was identified in IMF (2013), Onuoha (2019) and Nwokoro (2015). However, no empirical study was able to establish how undwerwriters can overcome this financial insolvency problem, by reserving adequate volume of compensation funds for insured shipping risks, based on the relationship between actual shipping accidents economic losses and value of seaborne trade exposed to sea perils over a given period rather than arbitrary choice of what amounts to reserve for compensation of unexpired shipping risks..

(ii) Studies by IMF (2013), Nwokoro (2015) and Adegbayi (2017) also identified the problem of financial insolvency of marine underwriters for timely and adequate provision of indemnification for insured offshore O&G risks. The studies did not however provide any models based on empirical evidence to enable underwriters reserve adequate volume of funds to overcome the problem of financial insolvency for timely and adequate compensation of insured offshore O&G accidents economic loss relative to value of seaborne trade exposed to sea perils; induced by the arbitrary reservation of between 25% and 45% of revenue from premium income as compensation funds for insured offshore O&G risks.

(iii) There is seeming inadequacy of empirical evidence in available literature on what constitute the coefficient of elasticity of compensation funds reserved by underwriters for insured shipping risks to growth in shipping accidents economic loss in Nigeria. Such a knowledge is important for predicting the percentage of changes in funds reserved for insured shipping risks, following increasing trend of shipping accidents economic loss; in order that underwriters will maintain adequate financial capacity for timely, adequate and sustainable indemnification of shipping accidents economic risks.

(iv) Similarly, there is a current lack of knowledge of what constitute the coefficient of elasticity of compensation funds reserved by underwriters for insured offshore O&G risks to growth in offshore O&G accidents economic loss in Nigeria. A knowledge of it is important for predicting the percentage of changes in funds reserved for insured offshore O&G risks following increasing trend of O&G accidents economic losses, in order that, underwriters maintain adequate capacity for timely, adequate and sustainable indemnification of offshore O&G accidents economic risks.

(v) Available empirical lieterature has not established any knowledge and understanding on the quantum of economic costs occasioned by marine accidents deaths and injuries affecting maritime workers, and of what constitute the coefficients of average rate of change of these costs, to guide marine underwriters in the provision of adequate volume of financial resources to maintain financial solvency for the timely, adequate and sustainable indemnification of insured maritime labour liability risks.

(vi) Studies by Olukolajo (2017), Nzeribe (2019), Babawale (2013) and Bello & Olukolajo (2016) identified the problem of the inadequacy of court award approach, in valuating compensation for externalities costs of marine accidents oil spill damages affecting third party operators in Nigeria. These studies however left a gap as each failed to establish from the pesrpsective of the affected third party operators, what would constitute the acceptable compensation for externalities costs, to ensure that affected third party operators are adequately compensated by marine underwriters without recourse to litigation and court awards.

CHAPTER THREE

METHODOLOGY

This chapter explains the methodology that will be used in this study. Mark *et al* (2009). This chapter therefore, describes the research methodology showing the research design, sources and procedure for data collection, method and procedure for data analysis, methods and procedures for test of hypotheses. The target here is to identify and select for use in this work methods and techniques that can appropriately yield logical answers to the research questions, thus helping to convincingly achieve the objectives of the research following a systematic approach.

3.1 The Study Area

The study area of the research is the Nigeria maritime industry with particular emphasis on the economic cost associated with marine damage accidents and the compensation funds reserved by underwrieters in the compensation of such losses. It also covered the externalities cost of marine accidents to affected third party operators and injury cum death accidents induced output losses to the economy.

However the the major coastal and fishing communities in the Rivers-State selected from coastal Local Government Areas (LGA's) of Akuku-Toru, Bonny, Degema, Andoni, Gokana, Opobo-Nkoro, Ogu-bollo, Eleme and Okrika for the study area from primary data was obtained using suvey instruments. It is important to note that, while Akuku-Toru hosts the Abonema-wharf (port-Harcourt seaport), Ogu-bollo, Eleme and Okrika are co-host to the oil and gas free zone where Onne seaport is located.

3.3 Research Design

The study employed triangulation research design. Triangulation research design is a mixed research design in which both secondary data and primary data obtained from survey or other primary sources are both used to accry out the study.

In adopting the mixed research (triangulation) method, data was sourced from both secondary and primary sources. While time series/historical data on damage accidents economic loss, value of seaborne trade exposed to marine accidents, compensation resources maintained by marine underwriters for marine risks, injury and death of seafarares occasioned by marine accidents were sourced from secondary sources, the costs of marine accidents to externalities/third parties and impact on marine ecosystem was obtained from primary sources using survey (Mark, Philip and Adrain, 2009).

The investigation also revealed the elasticity and nature of changes in marine accidents economic loss as a result of changes and growth in value of seaborne investment exposed to accidents, and volume of available compensation resources maintained for marine risks; this provides basis for determining quantum of increments in compensation resources to be maintained by underwriters in response to growth of maritime trade and operations.

3.3 Sources of Data

Data needed for the study was collected from both secondary and primary sources. The data on marine damage accidents economic loss, compensation funds/resources for marine risks, and value of maritime trade exposed to sea perils were obtained from secondary as they were sourced from various editions of the Central Bank of Nigeria (CBN) statistical bulletin, the Nigeria Insurers Association (NIA) annual insurance digest various editions, and the International Union of Marine Insurers (IUMI) annual reports. Also the data on per capital output to be used for determining the output losses due to fatal marine accidents was sourced from various editions of World Bank reports on Nigeria’s per capital output.

Lastly primary data on the economic cost and impact of marine oil spill accident on the marine ecosystem and fisheries was sourced through primary sources using survey instruments. The survey instruments of interview and questionnaire methods were used to obtain data from the coastal communities based on the Willingness to Accept (WTA) method of the Contingent Valuation Method (CVM) while appropriate validity and reliability tests was conducted on the survey instrument. See the figure above for the map area covered by the study.

3.3.1 Population of the Study and Sampling Technique

The population of interest of the research from which primary data was sourced mainly the third party operators in the Nigerian maritime industry who suffer externalities costs arising from marine accident oil spill damages in the marine ecosystem. They comprise mostly of fishermen, farmers and other interest groups in the coastal communities depending on the marine ecosystem for economic survival and sustenance.

The Food and Agricultural Organization (FAO, 2017) put the total number of fishermen depending on the wide fishery resources for economic sustenance in Nigeria at 1,190,497. However, given the projections by the Nigerian Population Commission (NPC, 2017; Ndubueze-Ogaraku, Udensi, and Olutayo, 2017) based on the 2006 Census figures, the total population of the fishing coastal communities in the eight LGA's of Rivers State that constitute the area of the study is 2,146,300 people. However, the researcher was unable to determine the exact population of the coastal communities that depend wholly or entirely on the marine biodiversity and fishery resources for livelihood. Thus we used the Z score formula for unknow population to determine the sample size while adopting a purposive random sampling method in which the members of fishermen associations of the various coastal communities randonmely sampled in the survey, interviewed and questionnaires administered.

The determination of sample of unknown population using Z score is given as: N = Z2(P) (1-P) /C2 -- (3.1)

Where Z = standard normal deviation set at 95% confidence interval =1.96

P = percentage picking a choice or response =50%

C = confidence interval =0.05

Therefore N = (1.96)2(0.5)(1-0.5)/(0.05)2

N= 0.9604/0.0025

N= 384.16

=384

3.3.2 Validity Test

Validity test is a measure and explanation of how well the collected data accurately covers the real purpose of the survey and/or investigation (Ghauri and Gronhaug, 2005). Validity test ensures that, the survey instrument (questionnaire) measure basically what is intended to be measured and is of various types (Field, 2005). The study will test the face and content validity of the survey instrument defined by Straub, Boudreau and Grefen (2004) as the degree to which the questions in a survey instrument reflect the content universe to which the instrument will be generalized. Thus, content validity test evaluates content of questionnaires (survey instruments) to ensure that only questions (items) that are essential are allowed while undesirable questions and items are struck out. The study will adopt a quantitative approach to test the validity of the survey instrument in which content validity questionnaires will be sent out to professionals in same field of research for responses (Hamed, 2016). Each item in the questionnaire will be assessed based on a three point scale: not necessary, useful but not essential, and essential.

The content validity ratio (CVR) will thus be determined by using Lawshe's (1975) method: $CVR = \frac{ne-(N/2)}{N/2} ----------- (3.2)$

Where CVR =content validity ratio, n_e = number of experts or panel members indicating essential, N is the total number of experts or panel members. Note items in the survey instrument that are non significant at critical level will be eliminated.

However, to retain an item in the survey instrument based on the CVR is dependent on the population and/or size of the panel of experts sampled. Lawshe (1975) provided a guide for valid value of the CVR for retaining the evaluated questions (items). See table below:

Table 3.1 : Minimum Value of CVR, P = 0.05,

No.of Panelists	5	6	7	8	9	10	11	12	13	14	15	20	25	30	35	40
Minimum Value	.99	.99	.99	.75	.78	.62	.59	.56	.54	.51	.49	.42	.37	.33	.31	.29

Source: (Lawshe, 1975)

The study used expert population between 5 and 10 to validate the content of the survey instrument.

3.3.3 Testing Reliability of the Instrument

Reliability assesses repeatability and consistency of the responses to the survey instrument (Oladimeji, 2013). For example, a response to survey instrument and/or measurement is said to be reliable if it produces the same output or almost the same result when repeated under the same or similar conditions. Testing for reliability is important as it refers to the consistency across the parts of a measuring instrument. Huck, (2007) writes that, a measurement has high internal consistency and reliability if the items of the measurement "hang together" and measure the same construct. To measure the reliability and internal consistency of the survey instrument, we used the Cronbach Alpha coefficient.

It was determined after administering the survey instrument once to overcome the problems associated with testing over multiple time periods. Reliability was thus determined using the slit-half reliability index and the Cronbach Alpha index. The split‑ half estimate will be done by dividing up the test into two parts first half of the items/second half of the items), administering the two forms to the same group of individuals in the population and correlating the responses. The coefficient alpha is the mean (average) of all possible split‑ half estimates while the existence of differences between the two was used to assess reliability.

To estimate coefficient alpha (a), we use:

$a = n/(n - 1)[1 - \text{Sum Var}(Y_i)/\text{Var}(X)]$ -------------------------- (3.3)

Where n = Number of items

Sum Var(Y_i) = Sum of item variances

Var(X) = Composite variance.

Since many respondents, about 400 raters rated their willingness to accept (WTA) some amount of compensation for damages done to the fishery resources in the marine ecosystem upon which they depend for economic sustenance. The **inter-rater-reliability** was also be measured by using the correlation method to compare the correlation between the different responses of the raters (respondents) as with test- retest reliability method.

For decision purposes, the higher the reliability value, the more reliable the measure. Reliability values of 0.70 or higher is most acceptable (Nunnally and Bernstein ; 1994). Hinton et al. (2004) suggests four cut-off points for reliability as follows: excellent reliability (0.90 and above), high reliability (0.70-0.90), moderate reliability (0.50-0.70) and low reliability (0.50 and below).

3.4 Data Analysis Methods

Data analysis involves the use of accurate dataset in developing models that will be reliable enough in estimating the relationships existing between parameters as basis for building the required framework for optimal compensation of marine accident economic losses. This is because, the ability of models to satisfactorily determine and explain relationship between the variables depends on the accuracy of dataset and the analytical tool used in model development. Also, since the first objective of the study seeks to the determine elasticity of relationships between marine damage accidents economic loss and the value of seaborne trade as basis for developing empirical conditions for timely, adequate and sustainable compensation of marine accidents economic loss in Nigeria; OLS estimation and the the average coefficient of elasticity method based on the regression output was used to estimate the elasticity. The second part of the objective is to determine the elasticity of the relationship between marine accidents and economic loss and compensation resources for marine risks over the period was also achived using OLS estimation and the average coefficient of elasticity methods. The third and fourth objectives which demands the valuation of the marine accident economic cost/impact on the marine ecosystem and fisheries (externalities and third parties) as well the output losses to society occasioned by death and injury to maritime workers was achievd by the use of the contingent valuation method (CVM) and the output losses due to fatal and injury accidents was valuated by the use of the Gross Output

Model (GOM). These analyses were carried out by the use of the SPSS version 20 and MATLAB version 8 softwares.

Lastly, the Rate of change Analaysis (RCA) and time-interest relationship analysis (TIRA) were used to achive objective five which demands the establishment of conditions of empirical relationships that will ensure the solvency of marine underwriters in providing timely, adequate and sustainable compensation for marine accidents economic loss in Nigeria.

3.4.1 Model Specification

A multiple regression model is the extension of the simple regression model to the case in which, there is more than one (multiple) independent variables under study. The multiple regression model is a system of equation in which one dependent variable is regressed on more than one explanatory variables to determine the significance of the relationship between the explanatory variables and the dependent variable.

Engle and Granger, (1987) notes that, in general, a K- independent variable multiple regression model has K explanatory variables in the right hand side of the equations (one dependent variable uses each independent variable as explanatory variable).

For example, the general form of a multiple regression model of two independent variables X_1 and X_2 and a dependent variable Y is defined as :

$$Y_t = \sum^n C_i X_t + +CiX_t + \varepsilon_t$$

The regression equation of such time series dataset may be represented as follows:

$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2$ +---- $\beta_t X_t + \varepsilon_t$, ------------ (3.4)

For: t= number of years/ periods/observations

Where ε_t = random error term, .

The above equations contain a dependent variable and two explainatory variables. This is called a multiple regression model.

For such, ordinary least square (OLS) estimation method can be used to estimate the coefficients- β_1, β_2, β_t, etc, and normal hypotheses testing method using OLS holds valid. While β_1 measures the effect of the first explanatory variable on the dependent variable, β_2 measures the effect of the second explanatory variable on the dependent variable over the period, etc. X_t = value of the variable in period t

Using the multiple regression model approach and OLS estimation, the relationship between marine damage accidents economic loss and the value maritime trade (seaborne import and export trade) will be examined and the hypotheses will be tested. For example, the relationship between marine damage accidents economic loss and seaborne import and export trade can be modeled as shown by the equation below:

$$SHALt = \beta_0 + \beta 1EXPSTRADEt + \beta 2IMPSTRADEt + \varepsilon t ----- (3.5)$$

(For shipping accidents economic loss and seaborne trade)

$OFAL_t = \beta_0 + \beta_1 EXPSTRADEt + \beta_2 IMPSTRADEt + \varepsilon_t ------ (3.6)$ (for marine offshore O&G damage accidents economic loss and seaborne trade)

Similarly, OLS estimation may also be done separately using a simple regression model as shown:

$$SHALt = \beta_0 + \beta_1 IMPSTRADEt + \varepsilon_t ------- (3.7)$$

$$OFALt = \beta_0 + \beta_1 IMPSTRADEt + \varepsilon_t ------- (3.8)$$

$$SHALt \; = \beta_0 + \beta_1 EXPSTRADEt + \; \varepsilon_t -------- (3.9)$$

$$OFAL_2 \; = \beta_0 + \; \beta_1 EXPSTRADEt + \varepsilon_t -------- (3.10)$$

Where;

$EXPSTRADE_t$ = Value of Seaborne Export trade over the period t.

$IMPSTRADE_t$ = value of seaborne import trade in period t.

$SHAL_t$ = shipping accidents economic loss over the period

$OFFAL_t$ = offshore O&G damage accidents economic loss over the period

β_0 = Intercept

$\beta_1, \beta_2, \beta_3$ = regression Coefficients.

For purposes of determining the elasticity of the relationships, two appraocahes are obtainable which include the use of the average coefficient of elasticity (E) model to estimate of the level of changes in maritime damage accidents economic loss as a result of changes/growth in value of maritime trade exposed to the perils of the sea; and the use of the constant elasticity model/double-Log-linear model. We define the coefficient of elasticity mathematically as the ratio of percentage changes in quantum of maritime trade (seaborne export and import trade) to percentage changes in marine accidents economic loss.

Using the double-Log-linear (constant elasticity) model, we transform equations 3.5 and 3.6 into Log-linear models by taking the natural log of both sides as follows:

$$InSHALt = \beta 1 InEXPSTRADEt \; + \; \beta 2 \mathrm{In} IMPSTRADEt \; + \; \varepsilon t \; --- (3.11)$$

(For shipping accidents economic loss and seaborne trade); and

$$InOFAL_t \ = \beta_0 + \beta_1 InEXPSTRADEt + \ \beta_2 InIMPSTRADEt \quad + \varepsilon_t - - -(3.12)$$

In the above double-log models, both coefficients of regression $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ estimate the elastcities of marine damage accidents (shipping and offshore O&G accidents economic loss to percentage changes in the values of maritime trade over the period (Gujarati and Porter, 2009).

The average coefficient of elasticity model may also be used as follows:

$E_{is} = \frac{\%\triangle IMPSTRADEt\ /IMPSTRADEt}{\%\triangle SHAL\mathrm{t}/SHAL\mathrm{t}}$ ------------ (3.13) (elasticity of marine/shipping accidents economic loss growth in value seaborne import trade)

$$\rightarrow = E_{is} \frac{\%\triangle IMPSTRADEt}{\%\triangle SHAL\mathrm{t}}$$

$$\rightarrow E_{is} = \frac{\triangle\ IMPSTRADEt/IMPSTRADEt}{\triangle\ SHAL\mathrm{t}/SHAL\mathrm{t}}$$

$$\rightarrow E_{is} = \frac{\triangle\ IMPSTRADEt}{IMPSTRADEt} * \frac{SHAL\mathrm{t}}{\triangle\ SHAL\mathrm{t}}$$

$$\rightarrow E_{is} = \frac{\triangle\ IMPSTRADEt}{\triangle\ SHAL\mathrm{t}} * \frac{SHAL\mathrm{t}}{IMPSTRADEt}$$

Note that, in the Ordinary least square (OLS) regression equation as shown in equation -- (1) the quantity $\frac{\triangle IMPSTRADEt}{\triangle SHAL\mathrm{t}}$ is represented by the coefficient of the explainatory variable $\beta 1$.

Thus; $E_{is} = \frac{\triangle IMPSTRADE\,t}{\triangle SHAL\text{t}} * \frac{SHAL\text{t}}{IMPSTRADE\,t} = \beta 1 * \frac{SHAL\text{t}}{IMPSTRADE\,t} - - - - (3.14)$

Where:

$SHAL$t = mean shipping accidents economic loss over the period covered in the study

$IMPSTRADEt$ = mean seaborne import trade over the period.

$\triangle\, IMPSTRADEt$ = Change in volume/value of seaborne import trade.

$\triangle\, SHAL$t = change in shipping accidents economic loss.

$\beta 1$ = coefficient of the explanatory variable (shipping accidents economic loss)

E_{is} = Coefficient of elasticity of shipping accidents economic loss to changes in value of seaborne import trade.

Similarly, the coefficient of elasticity of shipping accidents economic loss to changes in volume/value of seaborne export trade as well as the coefficients of elasticity of offshore accidents economic loss to changes in volumes and values of maritime trade can be determined based on the regression equation using the formulas:

$$E_{es} == \frac{\triangle EXPSTRADE\,t}{\triangle SHAL\text{t}} * \frac{SHAL\text{t}}{EXPSTRADE\,t} = \beta 1 * \frac{SHAL}{EXPSTRADE\ t} - - - - - (3.15)$$

$$E_{io} == \frac{\triangle IMPSTRADE\,t}{\triangle OFAL_t Xh} * \frac{OFAL_t Xh}{IMPSTRADE\,t} = \beta_2 * \frac{OFAL_t \text{Xh}}{IMPSTRADE\,t} - - - - - (3.16)$$

$$E_{\text{eo}} == \frac{\triangle EXPSTRADE\,t}{\triangle OFAL_t} * \frac{OFAL_t}{EXPSTRADE\,t} = \beta_2 * \frac{OFAL_t}{EXPSTRADE\,t} - - - - - (3.17)$$

Where:

E_{es} = Elasticity of shipping accidents economic loss to changes in Volumes/value of seaborne export trade

$\boldsymbol{E_{io}}$ = Elasticity of offshore damage accidents economic loss to changes in seaborne import trade

$\boldsymbol{E_{eo}}$ = Elasticity of offshore damage accidents economic loss to changes in seaborne export trade.

$\triangle\, EXPSTRADEt$ = Level Changes in value seaborne export trade over the period

$EXPSTRADEt$ = mean seaborne export trade over the period

$\triangle\, OFAL_t$ = Changes in offshore damage accidents economic loss

$OFAL_t$ = mean offshore damage accidents economic loss over the period.

However, double-log model (constant elasticity model) was used in the study to estimate the elasticities (Gujarati and Porter, 2009).

To achieve the second objective of the study aimed at determining the elasticities of compensation funds maintained for insured shipping and offshore O&G risks to changes in shipping and offshore O&G accidents economic loss over the period, we employed the log-linear (constant elasticity model) specified as show below:

$\text{In}MAPRE_t = \beta_0 + \beta_1 \text{In}SHAL_t + e$ -- (3.18)

$\text{In}OGPRE_t = \beta_0 + \beta_1 \text{In}OFFAL_t + e$ -- (3.19)

Where:

β_1 = elasticity coefficients (Gujarati and Porter, 2009).

Using the constant elasticity model/double-lo linear model, we established the coefficients of elasticity of compensation funds (*MAPRE)* maintained for insured shipping accident risks to changes in the shipping accidents economic loss over the period as well as estimated the coefficient of elasticity of the compensation funds (*OGPRE)* maintained for offshore damage accidents risks to changes in offshore damage accidents economic loss over the period (Gujarati and Porter, 2009).

Also note that, when the coefficient of elasticity is less than 1, the response is said to be inelastic. When it is greater than 1, it is said to be elastic; and when it is equal to 1, it is unit elastic.

If $\boldsymbol{E} < |1| \rightarrow$ inelastic response

If $\boldsymbol{E} > |1| \rightarrow$ elastic

If $E = |1| \rightarrow$ unit elastic

3.4.2 Methods for Testing of Models and Hypotheses

The hypotheses corresponding to the primary models developed based on the OLS estimation will be tested using a multiple F-test and T-test. The test statistics include; coefficient correlation (R), the coefficient of determination (R^2), the analysis of variance (ANOVA)/F – ratio), and the t-statistic (t-test). The ANOVA/F-test will be used to establish the significance or otherwise of the whole model. The coefficient of determination R^2 approach equally tests the significance of the whole model. The coefficient of correlation R will be used to test strength of the relationship between the dependent variable and the explanatory variables. The t-test will used to test the level of significance of the explanatory variables (shipping damage accidents economic losses and offshore O&G damage accidents economic losses) on the dependent variables.

In order to carry out the test of hypotheses, it is important to test the model significance first. Carrying out such a test has the advantage of confirming the appropriateness of the model and its significance. Two ways of achieving this as mentioned earlier are:

(1) The analysis of variable approach (ANOVA),

(2) The coefficient of determination approach (R^2).

The ANOVA approach seeks to split the variations of the independent variables (shipping damage accidents economic losses, offshore O&G damage accidents economic losses) and its component parts with variations in the dependent variable that are accounted for by the explanatory variables. The hypothetical ANOVA table is as shown below:

Table 3.2.: Hypothetical ANOVA Table

Source of variation	**Sum of squares**	**Degree of freedom**	**Mean square of error**	**Statistics**
Regression	$ESS = R_2 \text{ x } TSS$	K – 1	$\frac{ESS}{K-1}$	$\frac{Ms\ \Sigma RSS}{Ms\ \Sigma RSS}$
Residual	$RSS = \sum_{t=1}^{n} (e)^2$	N – K	$\frac{RSS}{N-K}$	F – tabulated
Total variation	$\sum_{t=1}^{n} (e)^2 \left(EXPSTRADE_{gt} - EXPSTRADE_t\right)^2$	N – 1		Decision if $F_{cal} > T_{tab}$, reject H_o

The regression models to be generated are represented as:

$$SHAL_{t_t} = \beta_0 + \beta_1 EXPSTRADEt + \beta_2 IMPSTRADE_t + \varepsilon_t - - - (5)$$

$$OFAl_{t_t} = \beta_0 + \beta_1 EXPSTRADE_t + \beta_2 IMPSTRADE + \varepsilon_t - - - (6)$$

For example, rearranging equation of the relationship between seaborne export trade and marine damage accident economic losses above, we have ;

$$\varepsilon_t = SHALt - (\beta_0 + \beta_1 EXPSTRADE_t + \beta_2 IMPSTRADE_t)$$

$$\varepsilon^2 = (SHALt)^2 - (\beta_0 + \beta_1 EXPSTRADE_t + \beta_3 IMPSTRADE_t)$$

Summing both side of equation gives;

$$\sum_{t=1}^{n} \varepsilon_t^2 = \sum_{t=1}^{n} (SHAL_t - \beta_0 + \beta_1 EXPSTRADE_t + \beta_2 IMPSTRADE_t)$$

$$the\ expression\ \sum_{t=1}^{n} \varepsilon_t^2$$

$$= estimate\ of\ the\ population\ disturbance\ or\ noise\ also\ given\ as \sum_{t=1}^{n} e^2,$$

$$called\ residue.$$

Sum of squares (RSS) $= \sum_{t=1}^{n} \left(EXPSTRADE_t - EXPSTRADE_t\ \ \right)^2,$

is the sum of squares of the deviation of the actual shipping accidents economic loss values from the mean value. The explained sum of squares (ESS) is obtained using the formula; ESS = R^2 x (TSS).

where;

R^2 = coefficient of determination

RSS = TSS – ESS

TSS or SST = sum of squares of total variation

ESS = sum of squares of error

RSS = Residual sum of squares

K = number of independent variables

N = Number of observations

Thus testing the model significance using ANOVA, the F – ratio will be used. F -cal. will be compared with f–table.

3.4.3. Test of Model Significance: The R^2 Approach

An alternate approach to testing the significance and explanatory power of the model is the use of the coefficient of determination R^2. It gives the amount of total variation in the dependent variables ($SHAL_t$, $OFFAL_t$,) that will be explained by the explanatory variables ($EXPSTRADE_t$, $IMPSTRADE_t$).

$$R^2 = 1 - \frac{RSS}{TSS}$$

The coefficient of R^2 takes value ranging from between 0 and 1.

–0.0 --- –1.00 (inverse or negative variation).

0.0 --- 0.29 (highly insignificant positive variation).

0.30 --- 0.49 = insignificant positive variation

0.70 --- 1.00 = highly significant positive variation.

Decision Rule

If the F – ratio calculated is greater than the F – ratio tabulated (theoretical F) at alpha (α) level of significance and (N – 1) (N – K) degrees of freedom; we reject the null hypothesis H_0 and accept the alternate hypothesis (i.e. we infer that the developed model is significant since the regressors significantly account for variation in the dependent variable.

Hence f – ratio calculated = $\frac{(R^2)/(K-1)}{(1-R^2)/(N-K)}$

where R^2 = R square of the model

K = Number of variables (both dependent and independent)

3.4.4 Test of Significance of Explanatory variables (T-test)

The significance of the individual explanatory variables in predicting or explaining the independent variables will be tested using the t – test on the estimated parameters.

The test statistic – t–ratio is calculated using the formula:

$T - ratio \ = \frac{B_k}{S_e(B_k)}$,

where;

B_k = estimates for population parameter for the regressors,

$S_e(B_k)$ = standard error of the estimates.

Decision Rule

If the absolute value, $\left|\frac{B_k}{S_e(B_k)}\right| > tn - k$

At $\frac{\propto}{2}$ level of significance, we reject H_0 and accept the alternate to conclude that it has significance effect on the dependent.

3.4.5 Definition of variables of the Models

Dependent variables:

$SHAL_t$ = Level of shipping damage accidents economic losses over the period t.

$OFAL_t$ = offshore O&G damage accidents economic losses over the period t.

Independent variables*:*

$EXPSTRADE_t$ = Value of Seaborne Export trade over the years t.

$IMPSTRADE_t$ = value of shipping import trade in year t.

3.4.6 The Gross Output Model (GOM)

The Gross Output model (GOM) of the the human capital model (HCM) used by World health Organization (WHO, 2012; Ogwude, 1998; Adebiyi ,2008) for valuing human life will be used to estimate the marine accidents economic cost of fatal/death and injury as output losses to the economy. According to the GOM of human capital model, the cost of death is not less than the loss of output to the society which the victim of fatal marine accident would have contributed to the economy if alive. Similarly, the economic cost of injury is not less than the loss of output which the injured would have produced over the period of hospitalization/ injury induced idle time/downtime. WHO, (2012) notes that, valuing the economic costs of death of fatal accident victims by the human capital approach involves taking the discounted value of people killed in the accident, since the loss of output is related to the society and nation.

By the Gross output model (GOM), life is valued as the total discounted value of expected output and per capita output. Thus the value of the gross output represent expected economic benefit to the economy from saving a life in a fatal marine accident or preventing an injury using safety shields, programmes and policies.

For a fatal marine accident involving death, the economic cost of output lost per death is given as;

$$P_N = Y\left[\frac{1}{i}\right]\left[1 - \frac{1}{(1+i)^t} - - - - (3.20)\right.$$

Total output lost per period for several deaths = $P_T = Y\left(\frac{1}{i}\right)\left(1 - \frac{1}{(1+i)^t}\right)N$-- (3.21)

P_N = National output forgone per death due to marine accident

P_T = Total output forgone due to fatal marine accidents involving several deaths.

Y = Average (national) output or per capital output.

i = is the social rate of discount (interest) which for developing countries tends towards 10 to 12 according to World bank records.

t = is the number of working years lost per fatality, defined as retirement age in public sector less national average age of fatality for developing countries, tends towards 25.2 to 29 years.

For injury accidents, hospitalization period if the individual is not permanently deformed such that he is unable to work again in his lifetime is taken to be one year. ie: the period, t = 1.

N = total number of death in fatal marine accident over a period.

Using the method described above and the secondary data on death accident and per capital income, the marine injury and fatal accident economic costs/output losses were valuated for purposes of providing adequate compensation funds for indemnification of maritime labour liability risks in Nigeria.

3.4.7 Contingent Valuation Model (CVM)

The contingent valuation model (CVM) follows the stated preference (SP) approach to generate value for non market goods such as environmental goods (protection of biodiversity) in terms of willingness to pay for protection (WTP) or willingness to accept (WTA) compensation by the sample population in a survey. CVM as a survey research technique determine the benefits and costs implications of regulations, impacts of pollution on ecosystem and public policies by eliciting information directly from the sampled population about their preferences of values for a given policy, programme or regulation. Questions about how much they value the goods and services posed to the respondents enables responses to be gathered on the value the society places on such goods, policies and programmes. It is termed contingent because, the respondent's assignment of values to the goods or services is 'hypothetical' as the researcher will not necessarily provide the goods or services to the respondents in real terms. Thus, economic value for public goods and policy preferences such as environment benefits of pollution control and biodiversity preservation, impacts/cost of damages on ecosystem biodiversity, improvements in water or air quality, reductions in risks of death, etc, for which conventional markets does not exist can be determined by the use of CVM. While the willingness to pay (WTP) approach of CVM asks the sampled population questions on their willingness to pay to access and/or obtain a good such as environment protection of a given ecosystem based on the value they place on the protection of such ecosystem and the benefits expected; the willingness to accept (WTA) approach asks questions on the amount of fiscal value and/or compensation they can accept in order to give up the good.

When public and/or private projects results in disasters with consequent loss of income or other negative effects to people. The affected people in such cases would rightly demand to receive compensation as inducement to forego the lost income or part of their income in order to accommodate the project. The average amount that they are willing to accept as compensation is a measure of the value loss suffered by them. On the other hand, when people derive benefit from a public policy, environmental programme, etc, the average minimum amount preferred to be paid by people in order to the policy and/or progamme implemented is a true measure of its value and benefits derived from the item. Both WTP and WTA are dependent on the incomes of individuals.

Hoyos and Petr (2010) notes that the objective of CVM is to determine the compensating or equivalent variation for the good in question. Compensating variation is the appropriate measure in situations that individuals need the good, for example, improvement in environmental quality. Equivalent variation is appropriate in the case that the individual faces a potential loss of the good. Both compensating and equivalent variation are can be elicited by getting the individuals to report a WTP amount. WTP is thus the amount removed from the individual's income in order to keep his utility (satisfaction from the good and/or environment) constant:

$$V(y - WTP, p,\ q_1\ ) = V\big(y, p,\ q_{0;}\ \big) - - - - - - - - - - - - \quad (3.22)$$

Where:

V = the indirect utility function,

Y = is income of individual,

P= vector of prices faced by the individual; and

$q_{0;}$ and q_1 are the alternative levels of the good or quality indexes (with $q_1 > q_0$, indicating that q_1 refers to improved environmental quality).

WTA is the amount of money an individual facing damage to his environment and/or deterioration in environmental quality accepts in order to keep his utility from the use of the environment constant:

$$V(y + WTA, p,\ q_0\ ) = V\big(y, p,\ q_{1;}\ \big) ------------ \ (3.23)$$

The both equations, the utility derivable from the policy or programme is dependent on the vector of individual characteristics affecting the trade-offs that they are willing to make between income and environmental quality.

The study will use the willing to accept approach of the CVM to determine the quantum of economic losses and impacts of marine accident involving oil spill in the marine ecosystem biodiversity in Nigeria. The mean WTA/ WTP will be estimated based on responses gathered from the respondents. The mean WTA will be multiplied by N, the size of the fishing population dependeing on the marine fisheries and biodiversity for economic sustenance in the coastal zones cost of marine environment and the amount which marine underwriters should provide as compensation benefits. It can equally serve as basis for assessing the performance of maritime environmental safety programmes and determining allocation of economic resources for investment marine safety programmes and policies.

With open-ended questions, WTA/ WTP amounts reported the sampled population is simply averaged and a WTA/WTP estimate obtained:

$$MWTA\ = \frac{1}{n}\sum_{i=1}^{n}(y_i) --------------------- (3.24)$$

$$MWTP\ = \frac{1}{n}\sum_{i=1}^{n}(y_i) --------------------- (3.25)$$

Where: n = sample size,

y = reported WTA/WTP amount.

Sometimes the mean WTP could deceivingly high in situations where few respondents record abnormally too high WTP amounts. Such few very large or very low WTP are normally recommended to be identified in order to reduce their influence on the mean. Carson (1991) suggests that, the use a-trimmed sampled mean in which a is set at predetermined percentage or a weighted average in which a weight of zero is attached to the highest and lowest (i.e a x 100) of the observations to effectively discharge them.

If the WTP/WTA distribution is normal, the mean of the sample is the best (i.e. lowest-variance) estimator of the true population mean. It is however, common to assume that, the mean of CVM is not normal; where this happens that the distribution of population is not a normal,

Carson et al (1998) notes that, if the distribution of the population is not a normal, the sample average remains a valid way to estimate the true population mean, however, the maximum likelihood estimate of mean WTP is more statistically efficient in which estimating the mean by the method of maximum likelihood requires that a distribution be specified for WTP. For instance, If we assume a stochastic or probability distribution; The WTP cumulative distribution function, G_C , and the corresponding probability density function, g_c influence the determination of the maximum WTP. Where respondents stated their maximum WTP directly denoted as A; the chance/probability that the respondent's WTP is equal to A, is given as:

$$\Pr\,(WTP = A) \equiv g_c\,(A).$$

In order to obtain a WTP normal distribution we generate a linear regression on some covariates $(Z\gamma')$ and a normally distributed random term (ε), so that the WTP is:

$WTP = \mu_{WTP} + \varepsilon = Z\gamma + \varepsilon$.--- (3.26)

Where μ_{WTP} = mean willingness to pay

ε = randorm term

$Z\gamma$ = covariates

For Closed-ended, bid and/or dichotomous choice question types, a different statistical approach is needed given that assumption that if a respondent indicates that she is willing to pay the bid amount, her WTP is assuredly greater than the bid amount. When she declines payment of the bid amount, her WTP is assuredly smaller than the bid. In each of the cases above, the researcher could not directly know the respondents actual WTP.

If we represent the unobserved willingness to pay with: WTP*, and assume that it follows a distribution F(θ). Where θ = vector of parameters that form an indicator, I. It takes one (1) as value for every 'yes' response that accepted the bid amount as her WTP and takes value of zero (0) for every 'no' response declining to accept the bid as WTP. The chance/probability of an acceptance of the bid amount or a "yes" (or I=1) as the individual is offered a bid equal to B_i is:

$Pr(I_i = 1) \quad = Pr(WTP^* \geq B_i) = 1 - F\,(B_i;\ \theta)$ ----------- (3.27)

Similarly, probability of getting a "no" (or I=0) is: $F\,(B_i;\ \theta)$. That is, the cumulative distribution function (cdf) of WTP evaluated at the bid value. The log likelihood function of the sample is given as:

$$\sum_{i=1}^{n} \Big(I_i * \log\big(1 - F\,(B_i;\ \theta)\big) + \ (1 - \ I_i) * logF\,(B_i;\ \theta)\Big).$$

If WTP is normally distributed, $F(\cdot)$ is the standard normal cumulative distribution function, and $F\ (B_i;\ \theta) =\ \Phi(B_i;\ \sigma - \mu/\sigma)$, where Φ = standard normal cdf; μ = mean WTP, and σ = standard deviation of the distribution.

If WTP follows the log normal distribution, $F\ (B_i;\ \theta) =\ \Phi(logB_i;\ \sigma - \mu/\sigma)$,

Where: μ = mean of the logarithmic transformation of WTP, σ = the standard deviation.

Mean WTP is = ($\mu + 0.5 \times \sigma^2$). -- (3.28)

There exist other distribution forms.

Using the willingness to accept (WTA) CVM approach discussed above, the study estimated the economic costs to third parties and externalities of the impact of marine oil spill accidents damages to the marine biodiversity and fisheries in Nigeria and providing the basis for its adequate and sustainable compensation.

3.4.8 Time-Interest Relatiosnhip Analysis (TIRA)

The time-interest relationship is an econometric tool for factoring the time value of money into the economic values of social and market commodities. This is because since the economic value of social and markets goods changes over time, interest rate is used to depict these changes in the values over time. To ensure adequate and sutainable compensation of economic cost of marine oil spill accident damages in future years, the present value (***PV***) of the Mean Willingness to Accept (***MWTA***) is related to the compound amount factor – $(1 + r)^n$. Thus, the economic cost of oil spill damages to each third party operator for purposes of compensation in future years (n) from now by incorporating the time value of money, the present value (PV) of the ***MWTA*** amount is determined by using the appropriate/prevailing interest rate (***r***) in the economy and the compound amount factor – $(1 + r)^n$ = $\boldsymbol{MWTA\ [1 + r]^n}$

This compounds the present MWTA amount obtained into future values.

3.4.9 Rate of Change Analysis (RCA)

We estimated the coefficient of the average rate of change of the economic cost of death and injury accidents as basis for projecting the provision of compensation funds for adequate and sustainale compensation of maritime labour liability risks. We estimated the average rate of change of each of the economic cost of death and economic cost of injury; for death and injury accidents over the period covered in the study, for purposes of providing empirical basis and support for reservation of compensation resources for adequate and sustainable indemnification of maritime labour liability (death and injury costs) risks.

Basically, the average rate of change from the interval [t_1------- t_{21}] covering the 21 year period covered in the study can be estimated from the expression:

$$\frac{\mathcal{Q}Y}{\mathcal{Q}t} = \frac{f(t1) - f(t21)}{t1 - t21}$$

For the economic cost of deaths, the average rate of change is determined as:

$$\frac{\mathcal{Q}ECdeath}{\mathcal{Q}t} = \frac{f(t1) - f(t21)}{t1 - t21}$$

For economic cost of injury, the average rate of change over the period is determined as:

$$\frac{\mathcal{Q}ECinjury}{\mathcal{Q}t} = \frac{f(t1) - f(t21)}{t1 - t21}$$

Where $f(t_1)$ and $f(t_{21})$ are the values of the variables corresponding to the first and last year's within the period covered in the study.

It is important to note that using the OLS estimation where the time period [$t1$--- t_{21}] is the independent variable to determine the trend of each variable over the period covered in the study provides us with the average rate of change of each variable over the period as the coefficient of the regression.

For import shipping trade we have the trend equation as:

$\boldsymbol{EC}_{death} = \beta_0 + \beta_{1death} + e$

e = error term, t = time, β_{1death} = coefficient of regression, β_0 = constant.

The coefficient of regression β_{1death} *is* equivalent to the average rate of change of economic cost of death per unit change in time over the period covered in the study.

Thus, $\frac{\partial ECdeath}{\partial t} = \frac{f(t1)-f(t21)}{t1-t21} = \beta_{1death}$

Similarly, the average rate of changes of economic cost of injury occasioned by marine accidents is as shown below:

$$\frac{\partial ECinjury}{\partial t} = \frac{f(t1)-f(t21)}{t1-t21} = \beta_{1injury}$$

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter, the data obtained for the study from various sources is presented and analyzed by employing the quantitative and scientific tools discussed in chapter three. Findings were deduced from the results of the analysis and discussed in line with the objectives of the study.

4.1 Data Presentation

Table 4.1 Growth in Values of Seaborne Export and Import Trade, Marine Damage Accidents Economic Loss and Volume of Compensation Funds Maintained for Insured Marine Risks 1999 - 2019.

Year	$Expstrade_t$ ₦000	$Impstrade_t$ ₦000	$SHAL_t$ ₦000	$OFFAL_t$ ₦000	$MAPRE_t$ ₦000	$OGRE_t$ ₦000
1999	1,188,969,800	862,515,700	1,068,930	999	2,349,660	999
2000	1,945,723,300	985,022,400	440,830	999	3,103,370	999
2001	1,867,955,900	1,358,180,300	790,680	999	3,997,070	999
2002	1,174,964,900	1,669,485,200	900,880	999	7,310,288	999
2003	4,602,781,500	6,889,826,800	1,240,570	999	13,696,362	999
2004	4,602,781,500	10,047,391,100	1,361,470	999	20,989,737	999
2005	7,246,543,800	10,047,391,100	1,266,220	999	21,013,148	999
2006	7,324,680,600	10,433,200	10,493,410	999	7,840,874	999
2007	8,309,758,300	12,221,711,000	1,904,230	999	11,255,655	999
2008	10,161,490,100	15,351,292,700	3,185,000	7,372,950	17,231,092	17,402,580
2009	8,262,326,410	5,115,459,710	4,556,600	3,713,640	16,727,575	31,577,402
2010	11,662,462,540	7,614,656,230	2,965,170	4,651,550	20,097,368	26,092,070
2011	14,826,062,820	10,235,174,220	2,889,548	5,684,600	23,400,508	34,121,742
2012	14,735,977,760	9,084,454,730	6,815,302	3,800,112	26,077,150	55,754,181
2013	14,245,271,800	7,016,814,700	8,009,112	6,025,300	14,726,610	66,813,748
2014	16,030,000,000	7,037,000,000	525,832	774,875	20,715,083	52,870,899
2015	9,059,000,000	6,069,000,000	1,416,759	404,350	19,527,646	51,120,210
2016	8,053,000,000	8,082,000,000	911,864	229,463	19,596,357	54,130,277
2017	13,059,000,000	9,056,000,000	641,591	10,929,363	1,826, 581	63,917,150
2018	18,053,000,000	13,017,000,000	716,512	3,854,393	10,216,080	21,508,560
2019	19,019,000,000	16,096,000,000	756,655	5,004,407	10,546,340	46,518,670

Sources: (i) Central Bank of Nigeria Annual Statistical Bulletin, various editions. (ii) NIA Insurance Digest, various editions. (iii) International Union of marine Underwriters (IUMU)

Table 4.1 shows secondary data on the value of maritime trade (seaborne import (***IMPSTRADE***) and export (***EXPSTRADE***) trades) per annum insured against loss by underwriters between 1999 and 2019. It equally shows the marine damage accidents economic loss comprising of the shipping accidents economic loss ($\boldsymbol{SHAL_t}$) and Offshore O&G accidents economic loss ($\boldsymbol{OFFAL_t}$) per annum over the period covered in the study. The volume of funds from the premium income of underwriters maintained for purposes of indemnifying shipping accidents economic loss (MAPRE) and offshore accidents economic loss (OGRE) were also presented. While seaborne export and import trades were used as independent variables in each case to estimate the relationship between maritime trade and damage accidents economic loss as dependent variable; shipping accidents economic loss ($\boldsymbol{SHAL_t}$) and offshore damage accidents economic loss ($\boldsymbol{OFFAL_t}$) were each used in turns as independent variables to estimate the elasticities of compensation fund reserved for insured marine risks to changes in damage accidents economic loss over the period. SHALt and OFFALt will as be used as dependent variables to estimate the elasticities of marine damage accidents economic loss to changes in maritime trade.

Table 4.2 Respondents Willingness To Accept Compensation for Spill Damages to Third Party Operators in the Marine Ecosystem.

S/N	1	2	3	4	5	6	7	8	9	10	11
Frequency	38	13	18	17	27	22	16	41	14	14	13
WTA Score/year ₦000	1000	1100	1200	1400	1500	1600	1800	2000	2200	2300	2500

Source: field survey.

Table4.2 is primary data sourced from field survey based on the CVM on the amount and willingness of third party operators in the marine ecosystem to accept compensation for oil spill damages to marine biodiversity and ecosystem. Of the total population sampled, about 62% representing 233 respondents provided accurate and useful information of their willingness to accept compensation for oil spill accident damages to marine ecosystem affected third party operators in the environment. The table indicates that the amount of compensation desired by the affected third party operators' form a sample space of 11 items from a minimum of 1million naira to a maximum of 2.5million naira. The frequencies of each of the choices in the sample space which indicates the number of respondents willing to accept each amount in the sample space as compensation for externalities cost of oil spill damages to marine biodiversity per annum was also indicated. The table also indicates that the most preferred amount of compensation by third party operators affected by oil spill damages is 2million naira with frequency of 41, while 1.1million naira and 2.5million naira with frequencies of 13 each are the least preferred amount of compensation preferred by affected third party operators.

Table 4.3 Occupational injury and Death occasioned by accidents in the offshore O&G and Ocean Shipping Sector in Nigeria and the output per capita over the period covered in the study.

Year	frequency	Number of Deaths/fatality	Injury	Gross output per capital (USD)
1999	n.a	n.a	n.a	497.84
2000	n.a	n.a	n.a	567.93
2001	n.a	n.a	n.a	590.38
2002	Na	Na	Na	741.75
2003	n.a	n.a	n.a	795.38
2004	n.a	n.a	n.a	1007.87
2005	n.a	n.a	n.a	1268.38
2006	36	41	61	1656.43
2007	43	197	146	1883.46
2008	51	241	32	2242.87
2009	46	168	35	1891.34
2010	41	38	129	2292.45
2011	44	118	34	2520.40
2012	48	220	22	2746.99
2013	55	398	39	2998.07
2014	32	261	25	3222.69
2015	35	70	47	2730.43
2016	33	24	128	2175.99
2017	41	28	30	1968.56
2018	55	77	40	2028.18
2019	43	26	28	2229.85
total	603	1914	728	

Sources: (i) Offshore O&G industry reports, various editions.(ii) African HSE group, 2017). (iii) World Bank Development indicators (2020)

Table4.3 above was sourced from secondary sources. The table shows that, of a total of 2642 maritime workers involved in 603 occupational accidents in the offshore O&G and shipping industry; a total of 1914 deaths and 728 physical injuries were recorded. This represents an average of approximately 3 deaths and 1 physical injury for each accident that occurred over the period. By implication, the probability of fatal accident in the maritime industry is higher than that of physical injury. The table also shows that averages of 137 deaths and 52 occupational injuries were recorded per annum, over the period covered in the study. Data on the per capital output of Nigeria was also inserted. This is necessary in order that the dataset may be used with the death and injury figures to estimate the economic cost of death and injury accidents in the maritime industry using the Gross Output Model (GOM). This will form the basis upon which underwriters can plan for resources to adequately and sustainably compensate for maritime labour liability risks.

4.2 Results and Discussion of Findings

The results emanating from the analysis carried out to actualize each of the objectives of the research are presented and findings discussed in this section. The results is organized under six sections in line with the objectives and hypotheses of the study as follows:

In section 4.2.1, we formulated a model for predicting shipping accidents economic loss based on its relationship with the value seaborne trade exposed to sea perils in Nigeria. We further established the coefficients of elasticity of shipping accidents (damage accidents) economic loss to growth in value of seaborne import and export trade in Nigeria.

In sections 4.2.2, we established a model of the relationship between offshore O&G accidents economic loss and the value of seaborne trade exposed to perils of the sea in Nigeria. The coefficient of elasticity of offshore O&G accidents economic loss to growth in the value of seaborne import and export trade was als determined. In section4.2.3, we determined the coefficient of elasticity of compensation fund reserved for insured shipping risks to changes in shipping accidents economic loss in Nigeria.

In section4.2.4, we established the coefficient of elasticity of the volume of compensation funds available for the indemnification of insured offshore O&G risks to changes in offshore O&G accidents economic loss in Nigeria.

In section4.2.5, we estimated the economic cost of death and injury accidents in the maritime industry as basis for ensuring adequate and sustainable compensation of maritime labour liability costs.

In section 4.2.6, we determined the externalities cost (economic cost) of marine oil spill accidents damages to marine biodiversity as basis for ensuring adequate and sustainable indemnification of affected third party operators in the Nigeria maritime sector.

4.2.1: To Formulate a Model for Predicting Shipping Accidents Economic Loss Based On the Relationship With Value of maritime Trade Exposed to Sea Perils in Nigeria

Table 4.4: Formulating a model of the relationship between shipping accidents economic loss and growth in seaborne trade in Nigeria

Test-statistic		Coefficient(s)
Mean in dependent variable $IMPSTRADE_t$		7779420252105.26
Mean independent variable $EXPSTRADE_t$		9306226239.52
Mean dependent variable $SHAL_t$		2163028202.3158
Regression coefficient β_1		0.343
Regression coefficient β_2		0.051
Regression Constant β_0		2430145.277
Standard error of regression		1188521.584
R-square		0.691
F-statistic		4.945
Prob(F-statistic)		0.061
F-critical		3.71
T-statistics		P-value(s)
Parameter(s)	Coefficient(s)	
t-score (β_1)	1.913	0.072
t-score (β_2)	1.904	0.073

Source: SPSS output.

The results shows that the mean seaborne import trade per annum over the period covered in the study is 7779420252105.26 naira with a standard deviation of 455096386733.5 while the mean seaborne export trade per annum over the same period is 9306226239.52 naira with standard deviation of 5560597396.28. The avarege shipping accidents economic loss per annum over the period is 2163028202.316 with standard deviation of 2162210840.14. By implication, an average of 2163028202.316 naira was lost per annum by the economy due to shipping accidents affecting seaborne import and export trades exposed to perils of the sea over the period covered in the study. The mathematical model showing the relationship between shipping accdents economic loss and the growth in seaborne import and export trade over the period covered in the study is:

$$SHAL_t = 2430145.277 + 0.34IMPSTRADE_t + 0.051EXPSTRADE_t + e \text{ ------------- } (4.1)$$

By implication, for a unit increase/change in seaborne import trade, shipping accidents economic loss increases/changes by an average of 0.34 while a unit increase in seaborne export trade increases shipping accident economic loss by 0.051 units.

The coefficient of determination R-square which measures the explainatory power of the model is 0.69. this shows that about 69% variations in shipping accidents economic loss over the period is explained by changes in the values of seaborne import and export trade exposed to sea perils over the period. The significance of the relationship is tested under the test of hypotheses in section 4.3 of this chapter. However, a major importance of the above relationship between shipping accidents economic loss and growth in maritime trade over the period is that it offers the needed basis for the estimation of the coefficients of elasticity of shipping accidents economic loss to changes/growth in seaborne import and export trade. These elasticties once determined enables us to develop empirical conditions that guarantees that compensation funds reserved for unexpired insured shipping risks can enable marine underwriters to maintain financial solvency for timely, adequate and sustainable compensation of shipping accidents economic loss in Nigeria. The estimation of the coefficients of elasticity is discussed below in section 4.5.

4.2.1.1 Coefficients of Elasticity shipping accidents economic loss to growth in maritime trade (seaborne import and export trade).

Under this section 4.2.1.1, we determined the elasticity of shipping accidents economic loss accidents economic loss to growth in seaborne import and export trade as shown below:

Table 4.5 Elasticity of Shipping Accidents Economic Loss to Growth in Maritime trade

Variable	*Coeficient(s)*
Test-statistics	
Mean dependent variable $InSHAL_t$	14.2938
Regression constant	7.716
Mean dependent variable $InIMPSTRADE_t$	22.2189
Mean Independent variable $InEXPSTRADE_t$	22.6837
Elasticity coefficient $\boldsymbol{\beta_1} = \boldsymbol{E_{is}}$	0.274
Elasticity coefficients of elasticity $\boldsymbol{\beta_2 = E_{es}}$	0.585
R-square coefficient	0.563
F-statistic	3.511
F-critical	2.71

Source: SPSS output. Note: if $E<1$,= *inelastic;* if $E\geq 1$, = *elastic*

The result indicates that the coefficients of elasticity of shipping accidents economic loss to growth/changes in seaborne import trade over the period is 0.27. This indicates an inelastic relationship between shipping accidents economic loss and growth in seaborne import trade over the period, since 0.27<1. By implication, a 1% growth (change) in seaborne import trade over the period produces an average of 0.27% increase in shipping accidents economic loss. The policy implication for marine underwriters, shippers and shipping policy formulators is that increasing seaborne import trade over a given period of time holds the potentials to increase shipping accidents economic loss by a 1% to 0.27% relation; implying that for every 1% increase in seaborne import trade, compensation fund maintained for insured shipping import trade must increase by about 0.27% in order that underwriters can maintain the right level of financial solvency needed to ensure timely, adequate and sustainable compensation of insured shipping risks. Marine insurance policies can thus be proactively designed to make provision for adequate reservation of compensation funds proportionate to the level of increase in shipping accidents economic loss induced by growing seaborne import trade. Therefore, compensation fund for settling shipping accidents economic risk should increase with increasing seaborne import trade. The increase in compensation funds for shipping accidents economic loss in order to adequately settle claims within the given period, must be greater than or equal to 0.27% of the mean or preceding year value of shipping accidents economic loss.

Similarly, the coefficient of elasticity of shipping accidents economic loss to growth/changes in the value of seaborne export trade *Ees over the period is* 0.56.This also shows the existence of an inelastic relationship between shipping accidents economic loss and seaborne export trade over the period. However, it indicates that a percentage (1%) growth in the value of seaborne export trade over the period covered in the study produced a 0.56% increase in shipping accidents economic loss. By implication, as seaborne export trade increase by 1%, shipping accidents economic loss increase by 0.56%. Therefore, to ensure that marine underwriters remain financially solvent and ensure timely and adequate compensation of insured shipping export risks, compensation funds for insured shipping export risks must increase by a figure equal to or greater than 0.56% of the mean value or preceding year value of shipping accidents economic loss for each percentage increase in seaborne export trade.

In summary, we conclude that though significant relationship exist between shipping accidents economic loss and growth in maritime trade (seaborne import and export trade), there is however an inelastic relationship between damage accidents economic loss and growth in maritime over the period.

The result is in line with the findings of IMF (2013) and Nwaokoro (2015) that the solvency regime of the marine underwriters cannot guarantee adequate, timely and sustainable compensation of insured risks when such risks attached. This situation constitutes the continued motivation of local operators in the maritime industry to seek for alternative ways of securing timely, adequate and sustainable protection of seaborne investments with foreign P&I clubs to the disadvantage of the local economy. The inelastic nature of the relationship of marine damage accidents economic loss to growth in maritime trade cannot favorably guarantee timely, adequate and sustainable indemnification of insured marine accidents risks at the long-run. It however provides information for developing empirical conditions and relationships that will ensure that marine underwriters maintain financial solvency to guarantee timely, adequate and suatainable compensation of insured marine damage accident risks.

Based on the respective coefficients of elasticity of shipping accidents economic loss to growth in seaborne import and export trade; we deduced empirical conditions that marine underwriters must abide with, in order to remain financially solvent by maintaining sufficient volumes of reserve funds, for each class of insured shipping trade, to ensure timely, adequate and sustainable compensation of insured shipping risks. These conditions are shown in the table below.

2.

Table 4.6 Empirical conditions that ensures reservation of adequate volume of funds to ensure underwriters financial solvency, timely, adequate and sustainable compensation of shipping accidents economic Loss affecting shipping import and export trade in Nigeria

s/n	Variable	Elastic relations between variables	Policy effect and Implication for financial solvency, timely adequate and sustainable compensation of insured shipping risks	Remarks
1	*IMPSTRADE*	1% increase	For each 1% increase in value of import shipping trade:	X% Increase in *IMPSTRADE* when X>1 will lead to X(0.274%) increase in $SHAL_t$. ΔMAPRE≥X(0.274%) of mean $SHAL_t$ or preceedng year value Y_s, whichever is greater.
	$SHAL_t$	0.274% increase	Increase/ΔMAPRE≥0.274% of mean value of $SHAL_t$; or ΔMAPRE≥0.274% of preceding year value (Y_s) of $SHAL_t$ [when Y_s>mean value of $SHAL_t$]	
2	*EXPSTRADE*	1% increase	For each 1% increase in export:	X% Increase in *EXPSTRADE* when X>1 will lead to X(0.585%) increase in $SHAL_t$. ΔMAPRE≥X(0.585%) of mean $SHAL_t$ or preceedng year value Y_s, whichever is greater.
	$SHAL_t$	0.558% increase	Increase/ΔMAPRE≥0.585% of mean value of $SHAL_t$; or ΔMAPRE≥0.585% of preceding year value (Y_s) of $SHAL_t$ [when Y_s>mean value of $SHAL_t$]	

Source: Author's calculation.

The implication is that, for underwriters to maintain financial solvency and ensure timely and adequate compensation of insured shipping risks, compensation funds (MAPRE) maintained for compensation of shipping import and export trade must increase proportionately by amounts equal to or greater than the respective coefficients of elasticity of shipping accidents economic loss to growth in maritime trade. For a percentage (1%) increase in shipping import trade, increase in compensation funds reserved by underwriters (ΔMAPRE) must be greater than of equal to 0.274% ($\Delta MAPRE \geq 0.274\%$) of mean value of shipping accidents economic loss over the period ($SHAL_t$); or where the preceding year value (Y_s) of $SHAL_t$ is greater than the mean value, increase in compensation funds reserved by underwriters must be greater of equal 0.274% ($\Delta MAPRE \geq 0.274\%$) of preceeding year value of shipping accidents economic loss (Y_s).

For a percentage (1%) increase in shipping export trade, increase in compensation funds reserved by underwriters for shipping export trade (ΔMAPRE) must be greater than of equal to 0.585% ($\Delta MAPRE \geq 0.585\%$) of mean value of shipping accidents economic loss over the period ($SHAL_t$); or where the preceding year value (Y_s) of $SHAL_t$ is greater than the mean value; increase in compensation funds reserved by underwriters must be greater of equal 0.585% ($\Delta MAPRE \geq 0.585\%$) of preceeding year value of shipping accidents economic loss (Y_s).

4.2.2: To formulate a model of the relationship between Offshore O&G accidents economic loss and the value of maritime trade exposed to sea perils in Nigeria.

Table 4.7: Formulating the relationship between offshore O&G damage accidents economic loss and growth in seaborne trade in Nigeria

Test-statistic		**Coefficient(s)**
Mean in dependent variable $IMPSTRADE_t$		9692043330000.0
Mean independent variable $EXPSTRADE_t$		12728949979230.8
Mean dependent variable OFFAL_t		4052307923.1
Regression coefficient β_1		0.211
Regression coefficient β_2		0.121
Regression Constant β_0		123404.891
Standard error of regression		3604939.633
R-square		0.62
F-statistic		5.317
Prob(F-statistic)		0.017
F-critical		3.71
T-statistics		**P-value(s)**
Parameter(s)	Coefficient(s)	
t-score (β_1)	1.518	0.616
t-score (β_2)	0.716	0.491

Source: SPSS output.

The result of table 4.6 above shows the significance and nature of the relationship between offshore damage accidents economic loss and growth in seaborne trade (seaborne import and export trade). The result shows that average value of seaborne import and export trade per annum over the period is 9692043330000.0 naira and 12728949979230.8 naira respectively with respective standard deviations of 3496980443.013 and 3787959485.2408. The mean offshore damage accidents economic loss suffered by the economy over the period covered in the study is 4052307923100 naira per annum with standard deviation of 3156947.694. . The mathematical model depicting the relationship between offshore damage accidents economic loss and growth in seaborne trade over the period covered in the study is:

$$OFFAL_t = \quad 123404.891 + 0.321 IMPSTRADE_t + 0.121 EXPSTRADE_t + e \text{ ------------ } (4.2)$$

This implies that for each unit increase in each of seborne import and export trade, offshore damage accidents economic loss increases by an average rate of 0.321 and 0.121 respectively. The coefficient of determination R-square which measures the explainatory power of the model is 0.62. This indicates that about 62% variation in offshore accidents economic loss over the period is explained by growth in maritime trade.

The significant relationship between offshore O&G damage accidents economic loss and growth in maritime trade provides support for the estimation of the coefficients of elasticity of offshore damage accidents economic loss to changes in the value of maritime trade. The coefficients of elasticity enables the development of empirical relationships that enables marine underwriters to reserve compensation funds to ensure financial solvency and timely, adequate and sustainable indemnification of insured offshore O&G risks in the Nigerian maritime industry. Table 4.7 below provides the coefficients of elasticity of offshore O&G damage accidents economic loss to changes/growth in maritime trade over the period.

Table 4.8 Coefficient of Elasticity of offshore O&G damage accidents Economic loss to changes in value of maritime trade between in Nigeria

Variable	*Coeficient(s)*
Test-statistics	
Mean dependent variable $InOFFAL_t$	14.6606
Regression constant	-41.769
Mean dependent variable $InIMPSTRADE_t$	23.2248
Mean Independent variable $InEXPSTRADE_t$	22.9363
Elasticity coefficient $\boldsymbol{\beta_1} = \boldsymbol{E_{io}}$	0.055
Elasticity coefficients of elasticity $\boldsymbol{\beta_2 = E_{eo}}$	2.376
R-square coefficient	0.538
F-statistic	5.072
F-critical	3.71

Source: SPSS output. Note: if *E<1,= inelastic;* if *E≥1, = is elastic*

The coefficient of elasticity of offshore O&G damage accidents economic loss to changes /growth in seaborne import trade E_{io} over the period covered in the study is 0.055; This indicates an inelastic relationship; implying that a 1% growth in seaborne import trade produces a small increase of about 0.055% in offshore O&G damage accidents economic loss. This is good for the economy and stakeholders in maritime trade as it depicts that negligible damage is done to the value of maritime trade as a result marine accidents. It however holds vital information for the development of the marine underwriting sector, particularly in the reservation of compensation funds to ensure solvency of marine underwriters in ensuring timely, adequate and sustainable compensation of insured offshore O&G risks. Since a 1% growth in seaborne import trade increases offshore O&G damage accidents economic loss by 0.055%; to timely and adequately indemnify insured offshore

O&G damage accidents economic loss as it relates to seaborne import trade, marine underwriting policy must provide that compensation funds for insured seaborne O&G import trade increase by an amount greater than or proportional to 0.055% of the mean or previous year offshore O&G damage accidents economic loss value for every 1% growth in seaborne import trade.

Furthermore, the coefficient elasticity E_{eo} of offshore O&G accidents economic loss to growth in seaborne export trade is 2.376. This depicts an elastic relationship. The implication of this is that over the period covered in the study, a 1% growth in seaborne export trade increases offshore O&G damage accidents economic loss by 2.376%; adequate compensation of offshore O&G damage accidents economic loss in the seaborne export trade sector requires that marine underwriting policy must provide that compensation funds increase by an amount greater than or equal to 2.376% of the mean or preceding year value of offshore O&G accidents economic loss, for every 1% growth in the value of seaborne export trade.

Based on the respective coefficients of elasticity of offshore O&G accidents economic loss to growth in maritime trade; we determined the empirical conditions that can enable marine underwriters to remain financially solvent by maintaining sufficient volumes of compensation funds for insured offshore O&G risks as shown in the table below.

Table 4.9 Empirical conditions that sufficiently ensures underwriters financial solvency, for timely, adequate and sustainable compensation of offshore O&G damage accidents economic Loss affecting in Nigeria

s/n	Variable(s)	Elastic relations between variables	Policy effect and Implication for financial solvency, timely adequate and sustainable compensation of insured marine risks	Remarks
1	*IMPSTRADE*	1% increase	For each 1% increase in value of seaborne import trade	Similalrly, for X% increase in IMPSTRADE>1%; ΔOGRE≥X(0.055%) of mean $OFAL_t$ or preceedng year value Y_o, whichever is greater
	$OFFAL_t$	0.055% increase	Increase/ΔOGPRE≥0.055% of mean value of $OFAL_t$; or ΔOGRE≥0.055% of preceding year value (Y_o) of $OFAL_t$ [where Y_o>mean value of $OFAL_t$]	
2	*EXPSTRADE*	1% increase	For each 1% increase in export:	For X% increase in EXPSTRADE>1%; ΔOGRE≥X(2.38%) of mean $OFAL_t$ or preceedng year value Y_o, whichever is greater.
	$OFAL_t$	2.38% increase	Increase/ΔOGRE≥2.38% of mean value of $OFAL_t$; Or ΔOGRE≥2.38% of preceding year value (Y_o) of $OFAL_t$ [when Y_o>mean value of $OFAL_t$]	

Source: Author's calculation.

The implication is that for underwriters to maintain financial solvency and ensure timely and adequate compensation of insured offshore O&G risks, compensation funds reserved for each type of trade must increase proportionately by amounts equal to or greater than the respective coefficients of elasticity of offshore O&G accidents economic loss to growth in maritime trade.

For a percentage (1%) increase in seaborne import trade, increase in compensation funds reserved by underwriters for insured O&G risks (ΔOGRE) must be greater than of equal to 0.055% (ΔOGRE≥0.055%) of mean value of offshore O&G accidents economic loss over the period ($OFAL_t$); or where the preceding year value (Y_o) of $OFAL_t$ is greater than the mean value, increase in compensation funds reserved by underwriters offshore O&Grisks must be greater of equal 0.055% (ΔOGRE$\geq$0.055%) of preceeding year value of offshre accidents economic loss (Y_o).

For a percentage (1%) increase in seaborne export trade, increase in compensation funds reserved by underwriters for insured O&G risks (ΔOGRE) must be greater than of equal to 2.38% (ΔOGRE$\geq$2.38%) of mean value of offshore O&G accidents economic loss over the period ($OFAL_t$); or where the preceding year value (Y_o) of $OFAL_t$ is greater than the mean value, increase in compensation funds reserved by underwriters offshore O&G risks must be greater of equal 2.38% (ΔOGRE$\geq$2.38%) of preceeding year value of offshre accidents economic loss (Y_o).

4.2.3 Coefficients of Elasticity of Compensation Funds Resserved for the Indemnification of Insured Shipping Risks to Growth in Value of Shipping Accidents Economic Loss

Table 4.10: Elasticity of compensation funds for shipping risks to growth in value of shipping accidents economic loss in Nigeria

Test-statistic	**Coefficient(s)**
Mean dependent variable In$SHAL_t$	16.2239
Mean In$MAPRE_t$	14.2938
Mean $MAPRE_t$	13829427285.71
Mean $SHAL_t$	2163028202.3158
Regression coefficient β_1 = $\boldsymbol{E_{rs}}$	0.364
Regression Constant β_0	11.021
Standard error of regression	2.568
R-square	0.562
T-score	2.030
Prob(t-statistic)	0.0537
t-tabulated	1.71

Source: Spss output Note: if *E<1= inelastic.;* if *E≥1 = elastic relationship.*

The result shows that the coefficient of elasticity of of compensation funds maintained for insured shipping risks to growth in shipping accidents economic loss over the period is 0.364. The relationship is however inelastic, since 0.364<1. This indicates that the response of of marine underwriters to compensation funds mainatained for insured shipping risks to growing trend of shipping accidents economic loss over the period is inelastic. It does not grow proportionately in line with growth in trend of shipping accidents economic loss.

The equation showing the relationship between compensation funds reserved for insured shipping risks to increasing shipping accidents economic loss over the period is:

In$MAPRE_t$ = 11.021 + 0.364In$SHAL_t$ + e -------------------------------------- (4.3)

The t-score is 2.030 and t-tabulated is 1.71. Since t-score>t-tabulated (ie: 2.030<1.71); we infer that there is a significant relationship between the compensaton funds mainatained for insured shipping risks and the value of shipping accidents economic loss over the period.

The result also shows that the average financial resources maintained by underwriters for compensation of shipping risks per annum over the period covered in the study is 13829427285.71 naira with a standard deviation of 7620009105.5, while the average amount lost due to shipping accidents per annum over the same period amounts to 2163028202.3158 with a standard deviation of 2754278441.28.

The coefficient of elasticity of compensation funds for shipping risks to growth in shipping accidents economic loss of 0.364 implies that a 1% increase in shipping accidents economic loss produced a 0.364% increase in reserved funds for timely and adequate compensation of marine (shipping accidents) risks maintained by marine underwriters over the period. By implication, compensation funds for indemnifying shipping accidents economic loss does not increase proportionately with or above the shipping accidents economic loss rate of increase. This endangers the capacity of marine underwriters to maintain financial solvency for timely and adequate indemnification of insured shipping risks. This findings is inline with the findings of IMF (2013), and Nwokoro (2015). This problem of financial insolvency is the reason for the fear and lack of trust in the operations of the local marine underwriters by the ship-owners and shippers. To ensure that underwriters maintain financial solvency to ensure timely, adequate and sustainable indemnification of shipping accidents economic loss; compensation funds for marine damage accident risks (shipping accident risks) must be made to increase at a rate greater than or proportional to 1% of the mean or previous year value of shipping accidents economic loss, for every 1% increase in shipping accident economic loss in Nigeria.

Table 4.11: Empirical conditions that sufficiently ensures underwriters financial solvency for timely, adequate and sustainable compensation of insured shipping risks based on the Coefficients of Elasticity of compensation funds reserved for shipping risks to growth in shipping accidents economic loss in Nigeria

s/n	Variable	Mean	Elastic relations between variables	Effect and Policy Implication for solvency, timely, adequate and sustainable compensation of insured marine risks	Remarks
1	$SHAL_t$	2163028202.32	1% increase	For each 1% increase in $SHAL_t$:	X% change in $SHAL_t$ when X>1; increase/ΔMAPRE≥X % of mean $SHAL_t$ Or ΔMAPRE≥X% of preceding year value of $SHAL_t$ (Y_s), where Y_s> mean $SHAL_t$
	$MAPRE_t$	13829427285.71	0.364% increase	Increase/ΔMAPRE≥1% of mean $SHAL_t$ or ΔMAPRE≥Preceeding year value of $SHAL_t$ (Y_s), whenY_s>mean $SHAL_t$	

Source: Author's calculation

The implication of the above condition for policy development in the marine insurance sector is that, for a percentage (1%) increase in shipping accident economic loss, increase in compensation funds reserved by underwriters for indemnifying shipping accident economic loss (ΔMAPRE) must be greater than of equal to 1% (ΔMARE≥1%) of mean value of shipping accidents economic loss over the period ($SHAL_t$); or where the preceding year value (Y_s) of $SHAL_t$ is greater than the mean value, increase in compensation funds reserved by underwriters for indemnification of shipping accidents economic loss must be greater of equal 1% (ΔMAPRE≥1%) of preceeding year value of shipping accidents economic loss (Y_s).

4.2.4: To determine the coefficient of elasticity of compensation funds maintained for insured offshore o&g accidents risks to growth in offshore o&g accidents economic loss in Nigeria.

Table 4.12: Elasticity of compensation funds maintained for insured offshore O&G risks to changes in offshore O&G accidents economic loss in Nigeria.

Test-statistic	**Coefficient(s)**
Mean dependent variable **In*OGRE***$_t$	17.4191
Mean independent variable **In*OFFAL***$_t$	14.6606
Mean ***OGRE***$_t$	41139083867.69
Mean ***OFFAL***$_t$	4052307948.6923
Regression coefficient $\beta_1 = E_{ro}$	0.037
Regression Constant β_0	16.879
Standard error of regression	1.722
R-square	0.57
T-score	2.415
Prob(t-statistic)	0.0439
t-tabulated	1.71

Source: Spss output Note: if *E<1= inelastic.;* if *E≥1= elastic relationship*

The result of the analysis on shows that the coefficient of elasticity of of compensation funds reserved for insured offshore O&G risks to growth in offshore O&G damage accidents economic loss over the period is 0.037.

The relationship is however inelastic since 0.037<1. This indicates that marine underwriters responses to reservation of compensation funds for insured offshore O&G risks to growing trend of offshore O&G damage accidents economic loss over the period is inelastic.

Compensation funds for insured offshore O&G risks does not increase proportionately in line with growth in offshore O&G accidents economic loss.

The equation showing the mathematical relationship between compensation funds reserved for insured offshore O&G risks to increasing offshore O&G damage accidents economic loss over the period is:

$$\mathbf{In}\boldsymbol{OGRE_t} \mathbf{= 16.879 + 0.037In}\boldsymbol{OFFAL_t} \mathbf{+ e} \text{ -------------------------------------- } \mathbf{(4.4)}$$

The t-score is 2.42 and t-tabulated is 1.71 (ie: 2.42<1.71); shows that there is a significant relationship between the compensaton funds mainatained for insured offshore O&G risks and the value of offshore O&G accidents economic loss over the period. The result also shows that the average financial resources maintained by underwriters for compensation of offshore O&G risks per annum over the period covered in the study is 41139083867.69 naira while the average amount lost due to offshore O&G accidents per annum over the same period amounts to 4052307948.6923.

The coefficient of elasticity of compensation funds for insured offshore O&G damage accidents risks to changes in offshore O&G damage accidents economic loss of 0.037 implies that a 1% increase in offshore O&G damage accident economic loss produced a 0.037% increase in reserved funds aimed at maintaining the solvency of marine underwriters for timely, adequate and sustainable compensation of insured offshore O&G risks over the period. By implication, compensation funds for indemnifying offshore O&G accidents economic loss does not increase proportionately with or above the offshore O&G damage accidents economic loss rate of increase. This endangers the capacity of marine underwriters to maintain financial solvency for timely and adequate indemnification of insured offshore O&G risks. This findings is inline with the findings of IMF (2013), and Nwokoro (2015) too. To ensure that underwriters maintain financial solvency to ensure timely, adequate and sustainable indemnification of offshore O&G accidents economic loss; compensation funds for offshore O&G damage accidents economic loss must be made to increase at a rate greater than or proportional to 1% of the mean or previous year value of offshore O&G accidents economic loss, for every 1% increase in offshore O&G accidents economic loss in Nigeria.

In order to ensure that marine underwriters maintain sufficient financial solvency at all times to ensure timely, adequate and sustainable indemnification of insured marine risks (both shipping accidents and offshore O&G accidents economic loss) , the following conditions shown in the table below are developed based on the elasticity coefficients of compensation funds reserved for insured marine risks to changes in marine damage accidents economic loss earlier estimated in previous tables. See table 4.15 below.

Table 4.13: Empirical conditions that sufficiently ensures underwriters maintain financial solvency for timely, adequate and sustainable compensation of offshore O&G accidents economic loss in Nigeria based on the elasticity Coefficients**.**

s/n	Variable	Mean	Elastic relations between variables	Effect and Policy Implication for solvency, timely, adequate and sustainable compensation of insured marine risks	Remarks
1	$OFFAL_t$	4052307948.69	1% increase	For every 1% increase in $OFFAL_t$:	X% change in $OFAL_t$ when X>1; increase/ΔOGRE≥X% of mean $OFAL_t$ Or ΔOGRE≥X% of preceding year value of $OFAL_t$ (Y_o), where Y_o> mean $OFAL_t$
	$OGRE_t$	41139083867.69	0.037% increase	Increase/$\Delta OGRE_t \geq 1\%$ of mean $OFFAL_t$ or ΔOGRE≥Preceeding year value of $OFAL_t$ (Y_o), whenY_o>mean $OFAL_t$	

Source: Author's calculation

The conditions expressed in the table above provides that for every X% increase in offshore O&G accidents economic loss, the compensation funds reserved for the insured offshore O&G risks must increase by an amount proportional to or greater than the X% increase in offshore O&G accidents economic loss; if the underwriters must maintain financial solvency to ensure timely and adequate indemnification of the insured offshore O&G risks.

It also implies that, for a percentage (1%) increase in offshore O&G accident economic loss, increase in compensation funds reserved by underwriters for indemnifying offshore O&G accident economic loss (ΔOGRE) must be greater than of equal to 1% ($\Delta MARE \geq 1\%$) of mean value of offshore accidents economic loss over the period ($OFAL_t$); or where the preceding year value (Y_s) of $OFAL_t$ is greater than the mean value, increase in compensation funds reserved by underwriters for indemnification of offshore O&G accidents economic loss must be greater of equal 1% ($\Delta OGRE \geq 1\%$) of preceeding year value of offshore O&G accidents economic loss (Y_o).

4.2.5 The economic cost of injury cum death marine accident as basis for evaluating maritime labour liability costs.

Under section, we evaluated the economic cost maritime labour liability occasioned by injury and death accidents in the Nigerian maritime industry.

Table 4.14: Evaluation of Economic Costs of Injury and Death marine Accidents in Nigeria Using GOM of HCA

s/n	***EC_{death} per annum*** $= P_T = Y\left(\frac{1}{i}\right)\left(1-\frac{1}{(1+i)^t}\right)N$ (USD)	output lost per death (USD) $P_N = Y\left[\frac{1}{i}\right]\left[1-\frac{1}{(1+i)^t}\right.$	$EC_{injury} = P_i = Y\left(\frac{1}{i}\right)\left(1-\frac{1}{(1+i)^t}\right)N$ (USD)
1999	999	999	999
2000	999	999	999
2001	999	999	999
2002	999	999	999
2003	999	999	999
2004	999	999	999
2005	999	999	999
2006	744995.96	15520.7	90938.007
2007	3477416.79	17648.02	247486.644
2008	5064781.75	21015.69	64594.66
2009	297727.18	17721.86	59577.21
2010	81624.98	21480.26	2588153.44
2011	278670.55	23616.15	77124.24
2012	566264.52	25739.29	54390.40
2013	1118058.25	28091.92	105232.26
2014	7881313.39	30196.61	72510.52
2015	179088.90	25584.13	115497.19
2016	48933.66	20389.03	250674.05
2017	51647.14	18445.41	53151.12
2018	146331.16	19004.05	73014.48
2019	54323605.70	20893.69	56192.22
Total	67,167,280.93		3,908,536.44

Source: Authors calculation.

The result shows the economic cost maritime labour liability risks occasioned by death and injury accidents in the Nigerian maritime sector. It indicates that the aggregate economic cost of output losses occasioned by deaths accidents over the period covered in the study is 67,167,280.93USD. This is equivalent to 26,826,610,000 naira at the exchange rate of 399.40naira to 1USD. This amounts to an average output losses of 1,916,186,429 naira (4797662.92USD) per annum due to death accidents in the Nigerian maritime sector. By implication the local marine underwriting sector should develop capacity to provide cover for marine labour liability claims occasioned by death accidents up to the tune of 1,916,186,429 naira per annum in line with the provisions of the Maritime Labour Convention -2006 as amended, which in regulation 4.2 made it the liability of the ship-owners to ensure that seafarers are protected from the financial consequences of work-induced sickness, injury or death occurring in connection with their(seafarers/maritime workers) employment. Item b of regulation 4.2 expressly states that ship-owners shall provide financial security to assure compensation in the event of the death or long-term disability of seafarers due to an occupational injury, illness or hazard, as set out in national laws, the seafarers' employment agreement or collective agreement; while regulation 4.2.1, paragraph 1(b), noted that the ship-owner should be subscribed to an insurance scheme or fund to be able to meet maritime labour liability risks and ensure adequate compensation of seafarers in cases of death and injury arising from work-related accident.

Similarly, the aggregate economic cost and output losses due to injury burden occasioned by marine accidents in the Nigerian maritime sector over the period covered in the study is 3,908,536.44USD (1,561,069,454 naira). This translates to an average of 279181.17USD (111504961 naira) output losses per annum. Thus marine underwriters in order to maintain financial solvency and ensure timely, adequately and sustainable compensation injury costs in the Nigeria maritime sector must develop capacity to raise compensation funds for injury risks to 279181.17USD or above per annum. Thus average economic cost of maritime labour liability risks occasioned by injury and death accidents in the Nigeria maritime sector as the aggregate of the economic cost of death and injury over the period is 5076844.09USD per annum.

It is important to state at this point that an estimate of the coefficient of the average rate of change of both death and injury accidents economic costs in the Nigerian maritime sector will enable the development of empirical conditions and model of relationships that will guarantee adequate and sustainable compensation of maritime labour liability risks at the long-run.

Table 4.15: The Coefficients of the Average Rate of Change and implications for Timely, Adequate and sustainable compensation marine accidents injury cum death cost (maritime labour liability Costs**)**

Variable	Mean		$\frac{\partial Y}{\partial t}$ = average rate of change	∂t = Δt = unit change in time	Policy implication for sustainable compensation of maritime labour liability risks
	USD	₦			
$\boldsymbol{EC_{injury}}$	279181.17	111504959	-29587.876USD	1.0	$MAPRE_{injury} \geq K$, where K = mean EC_{injury}. or decrease/$\Delta MAPRE_{injury} \leq \frac{\partial ECinjury}{\partial t}$ ie: $\Delta MAPRE_{injury} \leq$ -2958.87USD
$\boldsymbol{EC_{death}}$	5304318.57	2118544837	1399708.265USD	1.0	Increase/$\Delta MAPRE_{death} \geq \frac{\partial ECdeath}{\partial t}$ [from mean EC_{death}] ie: $\Delta MAPRE_{death} \geq 1399708.26$ from mean value of EC_{death}. Or Where the preceding year value of $\boldsymbol{EC_{death}}$ is ($\boldsymbol{Y_d}$)>mean $\boldsymbol{EC_{death}}$; Increase/$\Delta MAPRE_{death} \geq \frac{\partial ECdeath}{\partial t}$ [from $\boldsymbol{Y_d}$ ***value***] ie: $\Delta MAPRE_{death} \geq 1399708.26$ from Y_d.

Source: Authors calculation.

The result indicates that the average rate of change of the economic costs of death and injury liabilities of maritime operators over the period covered in the study is 1399708.265USD and -29587.87USD respectively for every unit increase in time within the period covered in the study. It indicates an increasing trend in ouput losses occasioned by death while also indicating a decreasing trend in the economic cost of injury burdens. The trends are better illustrated using the model equations below for death and injury risks respectively:

$$EC_{death} = -5193493.418 + 1399708.265T + e$$

$$EC_{injury} = 501090.244 - 29587.876T + e$$

The effect and empirical implication of this in the development of a policy framework for adequate and sustainable compensation of maritime labour liability risks (death and injury costs) is that, the compensation funds maintained for maritime labour liability risks must change/increase in the same direction with changing death and injury costs (maritime labour liability costs). To boost the confidence of maritime operators and stakeholders in the marine underwriting sector with regards to marine liability insurance; where there is increasing trend in maritime labour liability costs in any given period, the increase in compensation funds maintained by underwriters for marine labour liability costs within the same period must be greater than or proportional to the average rate of change of maritime labour liability costs. With the average rate of change of economic cost of death as 1399708.265USD as shown in the result above, increase in compensation funds maintained for cost of death ($\Delta MAPRE_{death}$) must be greater than or proportional to 1399708.265USD. That is:

$$\Delta MAPRE_{death} \geq 1399708.265USD. \text{-------------------------} \quad (4.5a)$$

The amount of compensation funds required for the timely, adequate and sustainable indemnification of economic burdens imposed by deaths accidents for every unit increase in time ($MAPRE_{deatht=1}$) is the sum/aggregate of the mean economic cost of death over the period or the preceding year value of the economic cost of death (Y_d), whichever is greater.

ie: $MAPRE_{deatht=1} = \sum \boldsymbol{Mean\ EC}_{death} + \frac{\boldsymbol{\partial ECdeath}}{\boldsymbol{\partial t}}.]$ ----------------- (4.5a(i)); or

$MAPRE_{deatht=1} = [\sum \boldsymbol{Y_d} + \frac{\boldsymbol{\partial ECdeath}}{\boldsymbol{\partial t}}.]$ ----------------------- (4.6a(ii)

where: $\boldsymbol{Y_d > mean\ EC_{death}}$.

By implication, the minimum amount of compensation funds that underwriters must maintain for economic risk of death must be proportional to the mean value of 5304318.566USD. To therefore ensure financial solvency, timely, adequate and sustainable indemnifications of maritime labour (death) liability costs, underwriters must increase compensation funds for death risks by an amount equal to the rate of change of economic cost of death over the period, based on the mean value and preceding year value of the economic cost of death. This might have implications on the cost of purchase of marine insurance policy for maritime labour liability risks, as premium for purchase of insurance might increase in order that compensations are timely, adequately and sustainably paid.

The mean value of the economic cost of injury liability is 279181.1744USD, implying that the minimum average amount of compensation funds allowable to be reserved for maritime labour injury costs is 279181.1744USD. The result also indicate that the average rate of change of the economic cost of injury over the period covered in the study is -29587.876USD, indicating a decreasing trend in injury cost. Thus, for underwriters to ensure timely, adequate and sustainable compensation the economic cost of maritime labour injury risks, compensation funds for injury liability ($\boldsymbol{MAPRE}_{injury}$) must be proportional to or greater than the mean economic cost of injury. That is: $\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean}$ 279181.1744USD ---------------- **(4.5b)**.

Though the decreasing average rate of change/trend of injury costs shown in the result suggests that decreasing compensation funds reserved for injury liability by an amount that is proportional to or less than the average rate of change (ie: $\Delta \boldsymbol{MAPRE}_{injury} \leq$ -29587.876USD) will ensure adequate compensation of injury costs/liabilities over the period. However, it is safest to maintain reservations of compensation funds for injury cost within the condition that: $\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury}$. This will provide the most guaranteed financial solvency and sustainable compensation of the economic cost of marine accident injury costs.

4.2.6: Valuation of the Externalities cost of marine oil spill accidents damages to Third Party Oprators in the Marine Ecosystem

The economic cost of marine oil spill accidents damages to marine biodiversity affecting third party operators was estimated by the use of the willingness-to-accept (WTA) compensation method, which employed primary data derived from the field survey. To proceed, we first and foremost tested the data for reliability and normality. The result of the reliability test is as shown below.

Table 4.16: Reliability Test Result

Test type	**Coefficient(s)**		**Sig (2-tailed)**
Pearson Correlation	0.89		0.00
Kendall's tau_b	0.85		0.00
Difference of means	Mean diff.	t	
	3792.45283	0.76	0.43

Source: Authors calculation.

The reliability test shows a Pearson correlation coefficient of 0.89 at a p-value of 0.00. It indicates the existence of about 89% correlation between the two sets of data/ responses of the sampled population on their willingness to accept compensation for damages to the marine biodiversity and ecosystem. It also shows a Kendall's tau_b correlation coefficient of 0.85; indicating also the existence of high degree of positive correlation, about 85% correlation between the dataset. The differences of means test indicate a mean difference of 3792.6, a t-score of 0.76 and p-value of 0.43; which indicates the existence of a non significant difference between the datasets. This implies that the primary data gathered from the respondents can reliably be employed for further analysis.

To determine which among the variants of the WTA methods to use for further analysis, we carried out a normality test on the dataset using the Shapiro-Wilk and Kolmogorov-Smirnov (KS) tests.

Table4.17: Testing for Normality using Shapiro and KS tests

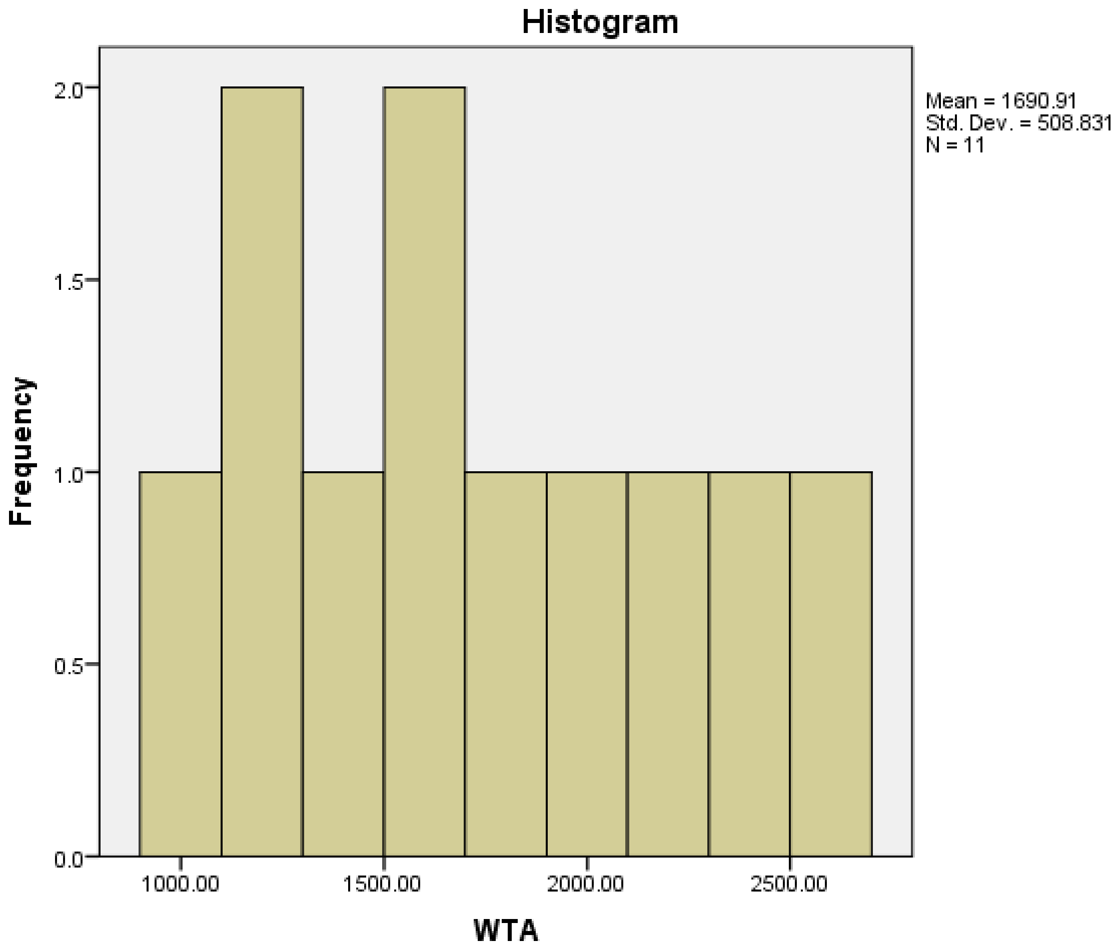
Tests of Normality

	Kolmogorov-Smirnov[a]		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
WTA	0.116	0.200	0.953	0.682

Source: Authors calculation

Given that we used an open ended question type to elicit the WTA compensation from the respondents; to proceed further in the analysis, we tested the dataset obtained as shown above for normality by using the Shapiro-Wilk test and the Kolmogorov-Smirnov test. The test indicates a Shapiro-wilk statistic of 0.95 and P-value of 0.68 at 0.05 confidence level. Since the p-value of Shapiro-Wilk test is greater than the alpha value, i.e: 0.682>0.05; we conclude that the distribution is a normal distribution. Similarly, the Kolmogorov-Smirnov test shows a KS statistic of 0.116 and p-value of 0.200; since 0.200>0.05; the test also indicates that the distribution is a normal distribution. Visualization of the histogram below supports the Shapiro-Wilk and Lolmogorov-Smirnov tests that the distribution is a normal.

WTA



Since WTA distribution is a normal distribution, the average/mean WTA estimate gives the best estimate of the WTA amount. This is achieved by using –(3) that:

$$MWTA = \frac{1}{n}\sum_{i=1}^{n}(y_i) ---------------------- (3)$$

Parameters were already defined in chapter three.

Table 4.18: Estimates of the externaties Cost of marine Oil Spill Accidents damages to Third Party operators in the Marine Ecosystem**.**

MWTA	1629.61 = ₦1,629,610 per annum
Minimum	1,000,000
Maximum	2,500,000
Range	1500000
Std Deviation	508.83110
Std Error	153.41835
N	233
Skewness	0.215

Source: Authors calculation.

The result of the study indicate that the mean amount that third party operators in the marine ecosystem are willing to accept as compensation for damages occasioned by marine accidents to the marine environment and biodiversity is **₦1,629,610** per human capita per annum, with a standard deviation of 508.83 and standard error of 153.42. By implication, the estimated externalities cost of marine biodiversity destructions associated with marine accidents affecting third party operators in the marine environment is an average of **₦1, 629,610** output losses per human capita per annum. Thus, the aggregate annual economic cost of marine accident damages to marine biodiversity ($\boldsymbol{EC_{externalities}}$) suffered by multiple third party operators in the marine ecosystem, is modeled as the product of the mean WTA compensation (***MWTA***) and the aggregate number of the working population/third parties (***X_n***) employed in the marine ecosystem who suffered such damages.

ie: ***$EC_{externalities}$ =[MWTA (X_n)] =*** ₦1,629,610 ***[X_n]*** **------------------- (4.6a)**.

The implication of this to marine underwriters is that, to adequately compensate third party operators for damages to marine biodiversity (externalities costs), an average of **₦1,629,610** per annum must be paid to each operator affected by marine accident damages to biodiversity and who suffered externality cost such that, the compensation received by each must be equal to or greater than the **MWTA**.

That is: ***$COMPEN_{percapitaperannum} \geq MWTA$***; → ***$COMPEN_{percapitaperannum} \geq$ ₦1629610.***

To ensure that marine underwriters have the needed financial solvency to provide timely, adequate and sustainable compensation of externalities costs to multiple third party operators in the maritime sector affected by marine accidents damages to marine ecosystem, marine underwriters must maintain an aggregate level of compensation fund (**$COMPEN_{aggregateexternalitiescost}$**) for third party risks that satisfy the following expression/condition:

$COMPEN_{aggregateexternalitiescosts} \geq EC_{externalities}$

→ $COMPEN_{aggregateexternalitiescosts} \geq MWTA(X_n)$

→ $COMPEN_{aggregateexternalitiescosts} \geq$ ₦1,629,610[X_n]

The implication is that compensation funds maintained by marine underwriters for indemnification of externalities costs occasioned by marine biodiversity damages to multiple third party operators must be greater than the product of the mean willingness to accept compensation and the aggregate number of third party operators in the marine environment affected by marine accident **(X_n)**. Below this level, the underwriters may encounter financial insolvency and cannot ensure timely, adequately and sustainable indemnification of externalities costs to third party operators affaected by marine accidents damages to marine biodiversity.

The maximum and minimum stated preferred amounts of compensation by the respondents is **₦2,500,000** and **₦1,000,000** respectively. The range, indicating the difference between the maximum and minimum preferred amounts of compensation for marine accidents induced damages by operators in the marine ecosystem is **₦1,500,000**. The maximum and minimum WTA compensation amounts are important where the mean WTA amount must not be compulsorily applied. This implies that third party operators in the marine ecosystem suffer disproportionate economic/output losses, following the destruction of the marine ecosystem by oil spill accidents. The sample space of the preferred WTA compensation amounts stated by affected third party operators is such that no operator will receive compensation less than ₦1000000 or above ₦2500000. Thus for adequate compensation of externalities costs, the compensation to be paid by underwriters to each individual affected third party operators ($COMPEN_{thirdpoperators}$) in the marine ecosystem must meet the condition that:

$$COMPEN_{thirdpoperator} \geq ₦1000000 \leq ₦2500000.$$

This is in situation where operators suffered disproportionate losses.

The above empirical relationships and conditions serve as empirical guides for marine underwriters to maintain solvency, ensure timely, adequate and sustainable compensation of externalities costs induced by marine accidents in the marine ecosystem in Nigeria.

For adequate compensation of exernalities costs to third party operators for damages to marine biodiversity, an average of ₦1,629,610 per annum must be paid to each individual operators affected by marine accidents induced oil spill damages to marine biodiversity such that, the compensation received must be equal to or greater than the MWTA. That is:

$$COMPEN_{percapitalperannum} \geq MWTA; \rightarrow \quad COMPEN_{percapitalperannum} \geq ₦1629610.$$

For future/ long-run sustainable compensation of the externalities/third party costs to individual affected operators in the marine ecosystem, the time value of money must be taken into consideration. For determining the externalities costs in future years (n) from now by incorporating the time value of money, the present value (PV) of ***MWTA*** amount (***₦1629610***) in (n) future years must be determined by using the appropriate/prevailing interest rate (***r***) in the economy and the compound amount factor – $(1 + r)^n$.

Thus: $\boldsymbol{MWTA\,[1 + r]^n} = ₦\boldsymbol{1629610[1 + r]^n}$.

This compounds the MWTA amount into future values using the interest rate.

For adequate compensation of externalities cost to multiple operators in the marine biodiversity sector affected by marine accident damages to marine ecosystem, marine underwriters must maintain an aggregate level of compensation ($\mathbf{COMPEN}_{aggregateexternalitiescosts}$) funds that satisfy the following expression/condition:

$\mathbf{COMPEN}_{aggregateexternalitiescost} \geq \boldsymbol{EC_{externalities}[X_n]}$

$\rightarrow \mathbf{COMPEN}_{aggregateexternalitiescosts} \geq \boldsymbol{MWTA\ [X_n]}$

$\rightarrow \mathbf{COMPEN}_{aggregateexternalitiescosts} \geq$ **₦1,629,610** $\boldsymbol{[X_n]}$

The implication is that compensation funds maintained by marine underwriters for indemnification of marine biodiversity damages occasioned by marine accident must be greater than the product of the mean willingness to accept compensation and the aggregate number of third party operators in the marine environment affected by marine accidents (X_n). Below this level, the underwriters can neither provide timely and adequately compensation nor and sustainably indemnify the the externalities costs occasioned by marine biodiversity damages affecting third party operators.

For sustainable compensation of future externalities costs suffered by multiple third party operators; the compound amount factors – $(1 + r)^n$ is used to determine present value of the mean willingness to accept compensation in the future time (n) such that:

$\mathbf{COMPEN}_{\text{aggregateexternalitiescosts}} \geq \boldsymbol{EC_{externalities}}\ \mathbf{[}\boldsymbol{1+r}\mathbf{]}^{\boldsymbol{n}}$

$\rightarrow \mathbf{COMPEN}_{\text{aggregatexternalitiescost}} \geq \boldsymbol{MWTA}\ \mathbf{[}\boldsymbol{X_n}\mathbf{][}\boldsymbol{1+r}\mathbf{]}^{\boldsymbol{n}}$

$\rightarrow \mathbf{COMPEN}_{\text{aggregatexternalitiescost}} \geq$ ₦1,629,610 $\mathbf{[}\boldsymbol{X_n}\mathbf{][}\boldsymbol{1+r}\mathbf{]}^{\boldsymbol{n}}$ **- - - - - - - - - (4.6b).**

The above conditions serve as empirical guides for marine underwriters to ensure financial solvency, timely, adequate and sustainable compensation of externalities costs of marine oil spill accidents damages affecting third party operators in the marine ecosystem in Nigeria.

4.2.7: Test of Hypotheses

Table 4.19: Test of HypothesisH_{01}: There is no significant relationship between shipping accidents economic loss and the value of seaborne trade in Nigeria

F-score	F-Critical	p-value	Decision: Accept H_{01} *if F-score<F-critical*
4.945	3.71	0.061	F-score>F-critical, we reject H_{01}

Source: Author's calculation

The test of hypothesis $\mathbf{H_{01}}$ shows an F-score of 4.945 and F-critical of 3.7 at 0.05 level of significance and 18 degrees of freedom. With F-score>F-critical (4.945>3.71); we reject the null hypothesis H_{01} and conclude that there is a significant relationship between shipping accidents economic loss and maritime trade (seaborne import and export trade) exposed to risks of marine accident in Nigeria.

The t-tests reveal respective t-score of 1.913, p-value of 0.072; and t-score of 1.904, p-value of 0.073, for coefficients of regression $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ **.** Since 0.073>0.05 and 0.072>0.05; it implies that for each coefficient of regression, p-vale is greater than the alpha value (p-value>0.05). We therefore conclude that, individually, there is no significant relationship between shipping accident economic loss and each of import seaborne trade and export seaborne trade over the period covered in the study. One major importance of the above significant relationship between shipping accidents economic loss and growth in maritime trade over the period is that, it provided the needed support for the estimation of the coefficients of elasticity of shipping accidents economic loss to changes/growth in seaborne import and export trade. These elasticties enables us to develop empirical the conditions that guarantees that compensation funds reserved for unexpired insured shipping risks can enable marine underwriters to maintain financial solvency for timely, adequate and sustainable compensation of shipping accidents economic loss in Nigeria.

Table 4.20: Test of Hypothesis H_{02}:The relationship between offshore O&G accidents economic loss and the value of seaborne trade exposed to sea perils in Nigeria is not significant.

F-score	F-Critical	P-value	**Decision: Accept *H_{02}* *if F-score<F-critical***
5.317	3.71	0.017	F-score>F-critical, we reject H_{02}

Source: Author's calculation

The test reveal on F-score of 5.32 and F-critical value is 3.71 at 0.05 level of significance. Since F-score>F-critical (ie 5.32>3.71), we reject the null hypothesis H_{02} and accept the alternate that, there is a significant relationship between offshore O&G accidents economic loss and growth in seaborne trade between 1999 and 2019. The respective coefficients of regression β_1, β_2 has respective t-scores of 1.52 and 0.72 with respectctive p-values of 0.62 and 0.49. Since the p-values each is greater than the alpha value of 0.05; (0.62>0.05; and 0.49>0.05), we conclude that there is no significant relationship between offshore damage accidents economic loss and each of the individual independent variables- seaborne import trade and seaborne export trade.

Table 4.21: Test of Hypothesis H_{03}:The coefficient of elasticity of compensation funds for insured shipping risks to changes in shipping accidents economic loss in Nigeria is zero

Coefficient of elasticity(β_1)= $\boldsymbol{E_{rs}}$	Decision: if $E_{rs}=0$, *Accept* H_{04}
0.364	$E_{rs} = 0.364>0$; *Reject* H_{03}

Source: Spss output Note: if $E<1$, *= inelastic.;* if $E\geq1$, *= elastic.*

The result of the test of hypothesis $\mathbf{H_{03}}$ shows that the coefficient of elasticity of of compensation funds maintained for insured shipping risks, to growth in shipping accidents economic loss over the period is 0.364.

Thus we reject the null hypothesis $\mathbf{H_{03}}$ that, the coefficient of elasticity of compensation funds reserved for insured shipping accident economic risks to growth in shipping accident economic loss is zero. The relationship is however inelastic since 0.364<1. This indicates that the response of compensation funds reserved for insured shipping risks to changes in shipping accidents economic loss over the period is inelastic. Thus we reject the null hypothesis $\mathbf{H_{03}}$ that the coefficient of elasticity of compensation funds mainatained for insured shipping accident risks to growth in shipping accidents economic loss is zero.

Table 4.22: Test of Hypothesis H_{04}:The elasticity coefficient of compensation funds maintained for insured offshore O&G risks to growth in offshore accidents economic loss is zero.

Coefficient of elasticity(β_1)= $\boldsymbol{E_{ro}}$	Decision: if $E_{ro}=0$, *Accept* H_{04}
0.037	$E_{ro} = 0.037>0$; *Reject* H_{04}

Source: Spss output. Note: if $E<1$, *= inelastic.;* if $E\geq1$, *= elastic.*

The result of the test of hypothesis $\mathbf{H_{04}}$ shows that, the coefficient of elasticity of of compensation funds reserved for insured offshore O&G risks to changes in offshore O&G damage accidents economic loss over the period is 0.037.

Thus, we reject the null hypothesis **H_{04}** that, the coefficient of elasticity of compensation funds mainatained for insured offshore O&G risks to growth in offshore O&G damage accidents economic loss is zero. The relationship is however inelastic; 0.037<1. This indicates that the response marine underwriters to the reservation of compensation funds for insured offshore O&G risks, following growth in offshore O&G damage accidents economic loss over the period is inelastic. The compensation funds reserved does not change (increase or decrease) proportionately in line with changes in actual losses recorded. This potends the danger of leading to financial insolvency of underwriters and incapacity to adequately indemnify losses at the time of occurrence. This corroborates the findings of IMF (2013) and Nwokoro (2015).

Table 4.23: Test of Hypothesis H_{05}:The coefficients of average rate of change of the economic cost of injury cum death marine accidents is zero**.**

Variable	Coefficient of average rate of change $(\frac{\square}{\square})$	Decision: if $(\frac{\square}{\square})=0$, *Accept* H_{05}
EC_{injury}	-29587.876USD	$\frac{\square}{\square}$ = 29587.876>*0; Reject* H_{05}
EC_{death}	1399708.265USD	$\frac{\square}{\square}$ =1399708.265>*0; Reject* H_{05}

Source: Spss output.

The result indicates that the average rate of change of the economic costs of death and injury liabilities of maritime operators over the period covered in the study is 1399708.265USD and -29587.87USD respectively for every unit increase in time within the period covered in the study. It indicates an increasing trend in ouput losses occasioned by death while also indicating a decreasing trend in the economic cost imposed by injury burdens. Since in each case, the rate of change $(\frac{\square}{\square})$ is is greater than zero, (ie: = 29587.876>*0;* 1399708.265>*0),* we reject null hypothesis H_{05} and conclude that, the coefficients of average rate of change of the economic cost of injury cum death marine accidents is not zero. The coefficients of the average rate of change of injury cum death marine accidents offers the empirical basis for ensuring that marine underwriters reserve adequate volume of financial resources for timely, adequate and sustainable compensation of insured maritime labour liability risks.

4.3 Discussion of Results

4.3.1 Implications of the Relationship between shipping accidents economic loss and the Value of Seaborne Trade Exposed to Sea Perils in the Reservation of Funds for Compensation of Insured Shipping Risks in Nigeria.

The existence on significant relationship between shipping accidents economic loss and growth in maritime trade in Nigeria as found in the test of hypothesis H_{01} provides support for the development of empirical conditions to ensure that, shipping accidents economic loss adequately, timely and sustainably indemnified in order to ensure sustainable maritime trade and operations. This is because, given the increasing trend of shipping accidents economic consequences, failure to adequately indemnify it will at the long run crash maritime trade and investments and put operators out of business. However, to ensure adequate indemnification, marine underwriters must have financial solvency to do so be reservation of volume of funds that is proportionate to or higher that actual shipping accidents economic consequences. The coefficient of elasticty of shipping accidents to growth in maritime trade value of 0.27 determined in the study provides the empirical information enables underwriters to reserve adequate volumes of funds in line with increase value of maritime trade and shipping accidents economic consequences. Though, the elasticity coefficient of 0.27 indicates an inelastic response of shipping accidents economic loss to growth in value of maritime trade exposed to sea perils; the significant elationship between the duo suggest that, ensuring adequate compensation shipping accidents economic consequences cannot by ignored for seaborne trade to m be sustainable. By implication, a 1% growth (change) in seaborne import trade over the period produces an average of 0.27% increase in shipping accidents economic loss.

The policy implication for marine underwriters, shippers and shipping policy formulators is that increasing seaborne import trade over a given period of time holds the potentials to increase shipping accidents economic loss by a 1% to 0.27% relation; implying that, for every 1% increase in seaborne import trade, compensation funds for insured shipping import trade must increase by about 0.27% of the preceding year value of shipping accidents economic loss or the average value; in order that underwriters can resserve the right level of funds and maintain financial solvency needed to ensure timely, adequate and sustainable compensation of insured shipping risks. Marine insurance policies can thus be proactively designed to make provision for adequate reservation of compensation funds, by increasing compensation funds reserved for indemnification of insured shipping risks, proportionately in line with the level of increase in shipping accidents economic loss induced by growing seaborne import trade (elasticity of shipping accidents economic loss to growth in seabone import trade). Therefore, compensation funds for settling shipping accidents economic risk should increase with increasing seaborne import trade. The increase in compensation funds for shipping accidents economic loss in order to adequately settle claims within the given period, must be greater than or equal to 0.27% of the mean or preceding year value of shipping accidents economic loss.

Similarly, the coefficient of elasticity of shipping accidents economic loss to growth in the value of seaborne export trade (*Ees)* over the period is 0.56.This is also an an inelastic response. However, it indicates that a percentage (1%) growth in the value of seaborne export trade produces a 0.56% increase in shipping accidents economic loss. By implication, as the value of seaborne export trade increases by 1%, shipping accidents economic loss increase by 0.56%. Therefore, to ensure that marine underwriters remain financially solvent and ensure timely and adequate compensation of insured shipping export risks, compensation funds for insured shipping export risks must increase by a figure equal to or greater than 0.56% of the mean value or preceding year value of shipping accidents economic loss, for each percentage increase in value seaborne export trade. Therefore, to overcome the financial insolvency faced by underwriters in compensation of insured shipping risks identified by IMF (2013) and Nwokoro (2015), consequent from the arbitrary provisions of the Insurance Act 2007, for reservation of between 25% to 45% of marine premium income as compensation fund for unexpired risks; the respective coefficients of elasticity of shipping accidents economic loss to growth in values of seaborne import and exports of 0.27% and 0.56% offers the empirical values by which compensation funds for insured shipping import and export trade should be increased using the average or preceeding year values of shipping accidents economic loss as basis.

4.3.2: Implications of the significance of the Relationship between Offshore O&G accidents economic loss and the value of maritime trade exposed to sea perils in ensuring Resservation of Adequate Volume of Funds for Compensation of insured Marine Risks in Nigeria.

The coefficient of elasticity of offshore O&G damage accidents economic loss to growth in value of seaborne import trade (E_{io}) over the period covered in the study is 0.055; This indicates an inelastic response; implying that a 1% growth in seaborne import trade indduces an increase of about 0.055% in offshore O&G damage accidents economic loss. This depicts that negligible damage is done to the value of maritime trade (imports) following exposure to marine perils and accidents. It however holds vital information for the development of the marine underwriting sector, particularly in the reservation of compensation funds to ensure solvency of marine underwriters in ensuring timely, adequate and sustainable compensation of insured offshore O&G risks. Since a 1% growth in seaborne import trade increases offshore O&G damage accidents economic loss by 0.055%. To ensure that marine underwriters maintain financial solvency for timely and adequately indemnification of insured seaborne O&G import trade, compensation funds for insured seaborne O&G import trade must be increased by an amount greater than or proportional to 0.055% of the mean or previous year offshore O&G damage accidents economic loss value, for every 1% growth in seaborne import trade.

Furthermore, the coefficient elasticity (E_{eo}) of offshore O&G accidents economic loss to growth in seaborne export trade is 2.376. This depicts an elastic response. The implication is that, over the period covered in the study, a 1% growth in seaborne export trade increases offshore O&G damage accidents economic loss by 2.376%. To improve the financial solvency of marine underwriters for timely and adequate compensation of offshore seaborne O&G accidents economic loss, marine underwriters must ensure that the volume of compensation funds resserved for compensation of insured O&G export trade increase by an amount greater than or equal to 2.376% of the mean or preceding year value of offshore O&G accidents economic loss, for every 1% growth in the value of seaborne export trade.

4.3.3 Policy Implications of the Coefficient of Elasticity of Compensation Funds available for insured shipping risks to Growth in Shipping Accidents Economic Loss in Nigeria

The study also found the existence of a significant relationship between compensation funds reserved for indemnification of insured shipping risks and shipping accidents economic loss in Nigeria over the period. It found that the coefficient of elasticity of compensation funds maintained for insured shipping risks to growth in shipping accidents economic loss is 0.364, indicating an inelastic response of marine underwriters in the reservation of compensation funds for shipping risks following growing trend of shipping accidents economic loss over the period. It shows that, compensation funds for insured shipping risks does not grow proportionately in line with growth in shipping accidents economic loss. This corroborates the findings of IMF (2013) and Nwokoro (2015).

The coefficient of elasticity of compensation funds for shipping risks to growth in shipping accidents economic loss of 0.364, implies that, with a 1% increase in shipping accidents economic loss, underwriters only increased compensation funds reserved for the indemnification of insured shipping risks by 0.364% over the period. By implication, compensation funds for indemnifying shipping accidents economic loss does not increase proportionately with or above the shipping accidents economic loss rate of increase. This endangers the capacity of marine underwriters to ensure sustainably maintain financial solvency for timely and adequate indemnification of insured shipping risks. This findings is inline with the findings of IMF (2013), and Nwokoro (2015). This problem of financial insolvency is the reason for the fear and lack of trust in the operations of the local marine underwriters by the ship-owners and shippers (onuoha, 2019; Adegbayi, 2017).

To ensure that underwriters maintain financial solvency to ensure timely, adequate and sustainable indemnification of shipping accidents economic loss; compensation funds for insured shipping risks must be made to increase at a rate greater than or proportional to 1% of the mean or previous year value of shipping accidents economic loss, for every 1% increase in shipping accident economic loss in Nigeria.

4.3.4 Policy Implications of the Coefficient of Elasticity of Compensation Funds Available for insured Offshore O&G Risks to Growth in Offshore O&G Accidents Economic Loss in Nigeria

For offshore O&G risks, the coefficient of elasticity of compensation funds maintained for insured offshore O&G damage accidents risks to growth in offshore O&G damage accidents economic loss is 0.037. The implication of this is that, with a 1% increase in offshore O&G damage accident economic loss over ther period, compensation funds reserved by marine underwriters for the indemnification of insured offshore O&G risks increased by 0.037% of the avarega e value. By implication, compensation funds for indemnifying offshore O&G accidents economic loss does not increase proportionately with or above the rate of increase of offshore O&G accidents economic loss. This endangers the capacity of marine underwriters to maintain financial solvency for timely and adequate indemnification of insured offshore O&G risks. This findings is inline with the findings of IMF (2013), and Nwokoro (2015) too. To ensure that underwriters maintain financial solvency to ensure timely, adequate and sustainable indemnification of offshore O&G accidents economic loss; compensation funds reserved for offshore O&G damage accidents economic loss, must be made to increase at a rate greater than or proportional to 1% of the mean or previous year value of offshore O&G accidents economic loss, for every 1% increase in offshore O&G accidents economic loss in Nigeria.

4.3.5 Policy Implications of the Coefficients of the Average rate of Change of the economic cost of death cum injury marine accidents for the Resservation of Adequate Compensation Funds for Indemnification of Maritime labour Liability Risks in Nigeria.

The result indicates that the average rate of change of the economic costs of death and injury liabilities of maritime operators over the period covered in the study is 1399708.265USD and -29587.87USD respectively, for every unit increase in time within the period covered in the study. It indicates an increasing trend in ouput losses occasioned by death accidents while also indicating a decreasing trend in the economic cost imposed by injury burdens. The respective average rate of change coefficients $(\frac{\square}{\square})$ of death and injury costs is; 1399708.265 and 29587.876. The implication of this in the development of maritime labour liability policy aimed at providing timely, adequate and sustainable compensation of maritime labour liability risks (death and injury costs) is that, the compensation funds reserved for maritime labour liability risks must change in the same direction and proportionately with the coefficients of the average rate of change. Increasing death and injury costs (maritime labour liability costs) necessitates that the volume of compensation funds reserved to indemnify these costs must increase above or proportionately with the coefficients of the average rate of change. This is the sole condition that will ensure that marine underwriters maintain financial solvency for timely and adequate indemnification of maritime labour liability risks (death cum injury cost). With the coefficient of the average rate of change of economic cost of death accident as 1399708.265USD, change in compensation funds maintained for indemnification of economic cost of death ($\Delta MAPRE_{death}$) must be greater than or proportional to 1399708.265USD. That is:

$$\Delta \boldsymbol{MAPRE_{death}} \geq \boldsymbol{1399708.265USD}.$$

The amount of compensation funds required for the timely, adequate and sustainable indemnification of economic burdens imposed by deaths accidents for every unit increase in time ($MAPRE_{deatht=1}$) is the sum/aggregate of the mean economic cost of death over the period or the preceding year value of the economic cost of death (Y_d), whichever is greater.

ie: $MAPRE_{deatht=1} = \sum \boldsymbol{Mean\ EC}_{death} + \frac{\partial ECdeath}{\partial t}.]$; or

$$MAPRE_{deatht=1} = [\sum \boldsymbol{Y_d} + \frac{\partial ECdeath}{\partial t}.]$$

where: $\boldsymbol{Y_d} > \boldsymbol{mean\ EC_{death}}$.

By implication, the minimum amount of compensation funds that underwriters must maintain for economic risk of death must be proportional to the mean value of 5304318.566USD. To therefore ensure financial solvency, timely, adequate and sustainable indemnifications of maritime labour (death) liability costs, underwriters must increase compensation funds for death risks by an amount equal to the rate of change of economic cost of death over the period, based on the mean value and preceding year value of the economic cost of death. This might have implications on the cost of purchase of marine insurance policy for maritime labour liability risks, as premium for purchase of insurance might increase in order that compensations are timely, adequately and sustainably paid.

The mean value of the economic cost of injury liability is 279181.1744USD, implying that the minimum average amount of compensation funds allowable to be reserved for maritime labour injury costs is 279181.1744USD. The result also indicate that the average rate of change of the economic cost of injury over the period covered in the study is -29587.876USD, indicating a decreasing trend in injury cost. Thus, for underwriters to ensure timely, adequate and sustainable compensation the economic cost of maritime labour injury risks, compensation funds for injury liability ($\boldsymbol{MAPRE}_{injury}$) must be proportional to or greater than the mean economic cost of injury. That is: $\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury}$.

Though the decreasing average rate of change/trend of injury costs shown in the result suggests that decreasing compensation funds reserved for injury liability by an amount that is proportional to or less than the average rate of change (ie: $\Delta \boldsymbol{MAPRE}_{injury} \leq -29587.876$USD) will ensure adequate compensation of injury costs/liabilities over the period. However, it is safest to maintain reservations of compensation funds for injury cost within the condition that: $\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury}$. This will provide the most guaranteed financial solvency to underwriters as well as sustainable compensation of the economic cost of marine accident injury costs in Nigeria.

4.3.6: Externaties Cost of marine Oil Spill Accidents damages to Third Party operators in the Marine Ecosystem.

The result of the study indicate that the mean amount that third party operators in the marine ecosystem are willing to accept as compensation for externalities costs is **₦1,629,610** per human capita, with a standard deviation of 508.83 and standard error of 153.42. This provides solution to the problems of inadequacy of compensation of externaties costs valuated through court awards (Olukolajo 2017; Babawale 2013; Chima 2011; Bello & Olukolajo 2016; Adekunbi and Nzeribe 2013). By implication, the estimated externalities cost of marine biodiversity destructions associated with marine accidents affecting third party operators in the marine environment is an average of **₦1, 629,610** output losses per human capita per annum. Thus, the aggregate annual externalities cost ($EC_{externalities}$) affecting multiple third party operators in the marine ecosystem, is modeled as the product of the mean WTA compensation (***MWTA***) and the aggregate number of the working population/third party operators (X_n) affected. ie: $EC_{externalities}$ = ₦1,629,610 $[X_n]$.

The implication of this to marine underwriters is that, to adequately compensate third party operators for externalities costs, an average of **₦1,629,610** per annum must be paid to each operator affected by marine accident damages to biodiversity such that, the compensation received by each must be equal to or greater than the **MWTA**. That is: $COMPEN_{percapitaperannum} \geq$ ***₦1629610.***

To ensure that marine underwriters have the needed financial solvency to provide timely, adequate and sustainable compensation of externalities costs to multiple third party operators in the maritime sector, they must resserve an aggregate volume of compensation fund ($\mathbf{COMPEN}_{aggregateexternalitiescost}$) for third party risks that satisfy the following expression/condition:

$\mathbf{COMPEN}_{aggregateexternalitiescosts} \geq$ **₦1,629,610**$[X_n]$

The implication is that compensation funds resserved by marine underwriters for indemnification of externalities costs occasioned by marine biodiversity damages to multiple third party operators must be greater than the product of the mean willingness to accept compensation and the aggregate number of third party operators affected by marine accident **(X_n)**. Below this level, the underwriters may encounter financial insolvency and cannot ensure timely, adequately and sustainable indemnification of externalities costs to third party operators affaected by marine accidents damages to marine biodiversity. The maximum and minimum stated preferred amounts of compensation by the respondents is **₦2,500,000** and **₦1,000,000** respectively. The range, indicating the difference between the maximum and minimum preferred amounts of compensation for marine accidents induced damages by operators in the marine ecosystem is **₦1,500,000**. The maximum and minimum WTA compensation amounts are important where the mean WTA amount must not be compulsorily applied. This implies that third party operators in the marine ecosystem suffer disproportionate economic/output losses, following the destruction of the marine ecosystem by oil spill accidents. The sample space of the preferred WTA compensation amounts stated by affected third party operators is such that no operator will receive compensation less than ₦1000000 or above ₦2500000. Thus for adequate compensation of externalities costs, the compensation to be paid by underwriters to each individual affected third party operators ($COMPEN_{thirdpoperators}$) in the marine ecosystem must meet the condition that:

$COMPEN_{thirdpoperator} \geq ₦1000000 \leq ₦2500000.$

This is in situation where operators suffered disproportionate externalities costs/losses.

For sustainable compensation of future externalities costs suffered by multiple third party operators; the compound amount factors – $(1 + r)^n$ is used to determine present value of the mean willingness to accept compensation in the future time (n) such that: $COMPEN_{aggregateexternalitiescosts} \geq EC_{externalities} [1 + r]^n$

$\rightarrow$ **COMPEN**$_{aggregateexternalitiescost} \geq$ ₦1,629,610 $\mathbf{[X_n][1 + r]^n}$.

The above conditions serve as empirical guides for marine underwriters to ensure financial solvency, timely, adequate and sustainable compensation of externalities costs of marine oil spill accidents damages affecting third party operators in the marine ecosystem in Nigeria.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Summary of Findings

The study has been able to investigate for the first time, the coefficients of elasticity of the marine damage accidents economic loss to growth in maritime trade and the elasticity of compensation funds maintained by underwriters for insured marine risks to changes in marine damage accidents economic loss covering the period, 1999–2019; as basis for developing an empirical relationships and conditions to ensure the financial solvency of marine underwriters and subsequent provision of timely, adequate and sustainable compensation of marine accidents economic loss in Nigeria. It equally estimated the economic cost of marine injury and death accidents, as well as the externalities costs to third party operators affected by oil spill damages to marine ecosystem and biodiversity in the industry as basis for guaranteeing adequate and sustainable compensation of maritime labour liability costs and externalities costs.

The major findings of the study are summarized as follows:

(a) That a significant relationship exists between shipping accidents economic loss and growth in maritime trade (seaborne import and export trade) between 1999-2019. The relationship also shows that for every 1% growth in seaborne import trade, shipping accidents economic loss increased by 0.274% while it increased by 0.558% for every 1% growth in seaborne export trade.

(b) That there is a significant relationship between offshore O&G damage accidents economic loss and seaborne import and export trade over the priod. It also shows that each 1% growth in seaborne import trade, offshore O&G damage accidents economic loss increased by 0.055% while it increased by 2.376% for every 1% increase in seaborne export trade.

(c) The coefficient of elasticity of compensation funds for insured shipping risks to changes in shipping accidents economic loss over the period is 0.364. This implies that for each 1% increase (change) in shipping accidents economic loss, compensation funds maintained for shipping accidents economic risks increases by 0.364%

(d) The coefficient of elasticity of compensation funds maintained for insured offshore O&G damage accident risks to changes in offshore O&G accidents economic loss over the period is 0.037. Thus for each 1% increase in offshore O&G accidents economic loss, compensation funds for offshore O&G risks increased by 0.037%.

(e) That death and injury accidents costs the local maritime industry averages of **₦1916186429** (**5304318.566USD**) and **₦111504961** (**279181.17USD**) per annum respectively with respective average rates of change of **1399708.27USD/year** and -**29587.87USD/year** over the period covered in the study.

(f) The compensation funds maintained for death accidents must increase in line with the average rate of change of economic cost of death over the period such that:

$\Delta MAPRE_{death} \geq 1399708.265USD.$

(g) The amount of compensation funds required for the adequate indemnification of cost of deaths insured for every unit increase in time ($MAPRE_{deatht=1}$) is the sum/aggregate of the mean economic cost of death over the period or the preceding year value of the economic cost of death (Y_d), whichever is greater;

ie: $MAPRE_{deatht=1} = \sum \boldsymbol{Mean\ EC_{death}} + \frac{\boldsymbol{\Delta ECdeath}}{\boldsymbol{\Delta t}}.]$

or

$MAPRE_{deatht=1} =[\sum \boldsymbol{Y_d} + \frac{\boldsymbol{\Delta ECdeath}}{\boldsymbol{\Delta t}}.]$, where: $\boldsymbol{Y_d > mean\ EC_{death}}$.

(h) That compensation funds for injury cost/liability ($\boldsymbol{MAPRE}_{injury}$) must be proportional to or greater than the mean economic cost of injury.

$\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury}$.

(i) That it is safest to maintain reservations of compensation funds for injury cost within the condition that:

$\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury}$.

(j) That the average amount which third party operators are willing to accept as compensation and externalities cost of oil spill accident damages to marine ecosystem and biodiversity suffered per capita (per individual) is ***₦1629610*** per annum.

(k) That for long-run sustainable compensation of the externalities costs to third party operators affected by marine oil spill induced damages to the marine ecosystem, the time value of money must be taken into consideration and the following models of relationship and conditionswhich incorporates the compound amount factor should be used:

$\boldsymbol{MWTA}\ [\boldsymbol{1 + r}]^{\mathbf{n}} \rightarrow ₦\boldsymbol{1629610}[\boldsymbol{1 + r}]^{\mathbf{n}}$.

And; $\boldsymbol{COMPEN}_{percapitaperannum} \geq ₦\boldsymbol{1629610}[\boldsymbol{1 + r}]^{\mathbf{n}}$

5.2 Conclusion

On the basis of the research findings, the study concludes as follows:

(1) The significant relationships existing between marine damage accidents economic loss and growth in maritime trade on one hand, and coefficients of elasticity of compensation funds maintained for insured marine damage accidents risks to changes in marine damage accidents economic cost provide the basis for the development of empirical relationships that ensures that marine underwrieters maintain sufficient finanacial solvency to ensure timely, adequate and sustainable compensation of insured marine risks in Nigeria.

(2) The estimated economic costs of death and injury (maritime labour liability costs) marine accident types cum the avarage rates of change of death and injury costs provided the basis for development of empirical relationships to ensure underwriters solvency, timely, adequate and sustainable compensation of maritime labour liabilities/costs.

(3) The estimated mean willingness to accept (MWTA) amount of **₦1629610** per capita per annum represents the externalities cost to individual third party operators affected by marine oil spill accidents damages to the marine ecosystem and biodiversity. This provided the basis for the development of empirical conditions to ensure underwriters solvency, timely, adequate and sustainable compensation externalities costs to third party operators affected by marine oil spill damages to marine biodiversity and ecosystem.

5.3 Recommendations

(1) Regulators of the marine underwriting sector should ensure that the empirical relationships between economic cost of marine accidents and the corresponding compensation funds maintained for each class of marine risks form the basis for developing policies for the reservation of compensation funds for varied marine accidents economic loss types. This will guarantee adequate and sustainable indemnification of insured losses at the long-run. The arbitrary reservation of between 25% to 45% of premium income from each class of insured marine risks by underwriters without recourse to the history and quantum economic loss and value of maritime trade insured is wrong and should be discouraged.

(2) Underwriters in order to adequately indemnify insured risks must ensure to increase proportionately compensation funds reserved for damage accidents economic loss with expected increases in marine damage accidents economic loss. This should be done for both shipping accidents economic loss and offshore O&G accidents economic loss.

(3) To guarantee long-run sustainable and adequate payment of indemnification of risks insured against, financial resources maintained for compensation of loss must increase in such a manner that at all times, compensation fund/resources maintained must be greater than or equal to the expected quantum of loss.

(4) With growth/increase in maritime (import and export) trade, underwriters should expect increase in accidents induced economic loss, though not proportionately with growth in maritime trade. Thus it is recommended that underwriters increase financial resources for compensation of loss proportionately and in line with the quantum of increase in economic loss.

(5) The externalities costs to third party operators occasioned by oil spill accidents damages to marine ecosystem and biodiversity should be used by underwriters as basis for developing premium policy for comprehensive protection of third party operators in the marine ecosystem.

(6) To guarantee adequate, holistic and comprehensive cover of the local maritime industry, local marine underwriters must adopt a framework that cover comprehensively all the major marine accidents economic loss/risk types namely:

(i) Marine damage accidents economic loss including shipping and offshore O&G accidents economic loss types.

(ii) Maritime labour liability costs encompassing economic costs of death and injury; and,

(iii) Externalities costs/economic cost of damages to third party operators as a result of oil spill and/or pollution damages to marine ecosystem and biodiversity.

5.4 Application of Research Findings and Contribution to Knowledge

The research provided solution to the real World problem of loss of confidence of maritime operators in the business operations of the local marine underwriters, seeming financial insolvency of marine underwriters for timely and adequate indemnification of losses and the preference of the offshore O&G operators to foreign P&I clubs; following the seeming incapacity of marine underwriters to resserve adequate levels of compensation funds to guarantee timely and adequate compensation of insured marine risks to operators; and the longterm question of the capacity of marine underwriters in Nigeria for sustainable indemnification of marine accidents economic loss in Nigeria.

Following from the above, the study has developed a empirical relationships and conditions based on the elasticities of relationships between marine damage accidents economic loss types and the compensation funds maintained for marine risks cum values of seaborne import and export trade exposed to sea perils, covering a 21 year period, to be applied in the development of marine underwriting compensation policy particularly in the reservation of compensation funds (technical reserve funds) by both insurers and regulators in Nigeria to ensure that underwrieters always have financial solvency to indemnify insured marine risks. The empirical relationships, conditions and models, particularly the elasticity coefficients developed by the study will be applied by operators and regulators in the marine underwriting sector to guarantee underwriters financial solvency in each class of marine risks identified to ensure timely, adequate and sustainable indemnification of marine damage accidents economic loss, injury and death liabilities/costs and externalities costs occasioned by marine oil spill damages to the ecosystem and biodiversity affecting third party operators.

The study has made useful contribution to the growth and development of knowledge in this area by developing the following unique models and empirical conditions for the maintaining financial solvency, timely, adequate and long-term sustainable reservation of compensation funds for indemnification of marine accidents economic loss of all types in Nigeria as listed below:

(i) For financial solvency to ensure timely, adequate and sustainable compensation of shipping accidents economic loss:

$$\boldsymbol{SHAL_t = 2430145.277 + 0.34 IMPSTRADE_t + 0.051 EXPSTRADE_t + e}$$

The coefficients of elasticity of shipping accidents economic loss to changes in seaborne import and export trade over the period is 0.274 and 0.558 respectively, which suggests an inelastic relationship between shipping accidents economic loss and the growth in seaborne import and export trade (***0.274<1; 0.558 <1***).

Therefore, to ensure adequate and sustainable indemnification of shipping accidents economic loss, compensation funds maintained for shipping accidents risks must increase by amounts proportional to or greater than the coefficients of elasticity of shipping accidents economic loss to growth in seaborne import and export trade.

Similarly, to guarantee financial financial solvency of marine underwriters for timely, adequate and sustainable compensation of offshore O&G damage accidents economic cost, the model below shows the relationship between offshore damage accidents economic cost and growth in seaborne import and export trade:

$$\boldsymbol{OFFAL_t = 123404.891 + 0.321 IMPSTRADE_t + 0.121 EXPSTRADE_t + e}$$

The coefficients of elasticity of offshore damage accidents economic loss to changes in seaborne import and export trade over the period is 0.055 and 2.38respectively. While the elasticity of offshore damage accidents economic loss to groth in seaborne import trade is inelastic, the elasticity of offshore damage accidents economic loss to growth in seaborne export trade over the period is elastic; (***0.055<1; 2.38>1***).

Therefore, to ensure adequate and sustainable indemnification of shipping accidents economic loss, compensation funds maintained for offshore accidents risks must increase by amounts proportional to or greater than the coefficients of elasticity of offshore damage accidents economic loss to growth in seaborne import and export trade.

(ii) Resservation of Compensation Funds to Ensure Solvency of Marine Underwriters in Compensation of marine Damage Accident Risks.

The empirical relationships expressing the relationship between marine damage accidents economic loss and the value of compensation funds maintained respectively for shipping risks and offshore O&G risks over the period covered in the study is:

$$\mathrm{In}MAPRE_t = 11.021 + 0.364\,\mathrm{In}SHAL_t + e$$

$$\mathrm{In}OGRE_t = 16.879 + 0.037\,\mathrm{In}OFFAL_t + e$$

The respective coefficients of elasticity of the reserved compensation funds to for insured shipping risks ($MAPRE_t$) to changes in shipping accidents economic loss and reserved compensation funds for insured offshore O&G risks to changes in offshore O&G accidents economic loss over the period is 0.364 and 0.037; indicating also inelastic responsesin each case; ($0.364<1; 0.037<1$).

Thus, to maintain solvency and ensure timely, adequately and sustainable indemnification of marine damage accidents economic loss at the long-run, with every one percentage increase in each of shipping accidents economic loss and offshore accidents economic loss, compensation funds for each damage accidents economic loss type must increase proportionately by an amount equal to or greater than one perecent of the mean and/or preceeding year value of shipping accidents economic loss or offshore damage accidents economic loss as the case may be.

(iii) For financial solvency to ensure timely, adequate and sustainable provision of compensation for death and injury Costs

The compensation funds maintained for the death accidents must increase in line with the average rate of change of economic cost of death over the period such that:

$\Delta MAPRE_{death} \geq 1399708.265USD.$

The amount of compensation resources required for the adequate indemnification of cost of deaths insured for every unit increase in time ($MAPRE_{deatht=1}$) is the sum/aggregate of the mean economic cost of death over the period or the preceding year value of the economic cost of death (Y_d), whichever is greater;

ie: $MAPRE_{deatht=1} = \sum \boldsymbol{Mean\ EC}_{death} + \frac{\Delta ECdeath}{\Delta t}.]$

or

$MAPRE_{deatht=1} =[\sum \boldsymbol{Y_d} + \frac{\Delta ECdeath}{\Delta t}.]$, where: $\boldsymbol{Y_d\ mean\ EC_{death}}$.

Similarly, for underwriters to ensure adequate and sustainable compensation maritime labour injury liability/cost, compensation resources for injury liability ($\boldsymbol{MAPRE}_{injury}$) must be proportional to or greater than the mean economic cost of injury.

$\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{meanEC}_{injury}.$

The decreasing average rate of change/trend of injury cost suggests that decreasing compensation resources reserved for injury liability should decrease by an amount that is proportional to or less than the average rate of change, ie:

$\Delta \boldsymbol{MAPRE}_{injury} \leq$-29587.876USD.

This will ensure adequate compensation of injury costs/liabilities over the period. However, it is safest to maintain reservations of compensation resources for injury cost within the condition that:

$\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{meanEC}_{injury}$.

This will provide the most guaranteed sustainable compensation of maritime labour injury liability costs at the long-run when the trend of injury cost is decreasing.

(iv) **For financial solvenvy to ensure adequate and sustainable compensation of Externalities Cost to Third Part Operators Affected by marine oil spill damages to marine ecosystem and biodiversity**

The compensation received must be equal to or greater than the MWTA.

$\boldsymbol{COMPEN_{percapitaperannum} \geq ₦1629610}$.

For long-run sustainable compensation of the economic cost of future marine oil spill induced damages to individual affected operators in the marine ecosystem, the time value of money must be taken into consideration. Thus, the compound amount factor – $[1+r]^n$ determines the present value of the mean willingness to accept compensation in a future time (n) such that:

$\boldsymbol{MWTA[1 + r]^n = ₦1629610[1 + r]^n}$.

Thus for n years ahead, we write that:

$\boldsymbol{COMPEN_{percapitaperannum} \geq ₦1629610\ [1 + r]^n}$

For adequate compensation of multiple third party operators in the marine ecosystem affected by marine oil spill damages to marine ecosystem, marine underwriters must maintain an aggregate level of compensation ($\mathbf{COMPEN}_{aggregatexternalitiescosts}$) funds that satisfy the following expression/condition:

$\mathbf{COMPEN}_{aggregatexternalitiescosts} \geq \boldsymbol{MWTA[X_n]}$

$\rightarrow \mathbf{COMPEN}_{aggregatexternalitiescosts} \geq \mathbf{₦1,629,610}[\boldsymbol{X_n}]$.

For sustainable compensation of externalities costs to multiple third party operators in future years; the compound amount factors – $(1 + r)^n$ is used to determine present value of the mean willingness to accept compensation in the future time (n) such that:

$\mathbf{COMPEN}_{aggregatexternalitiescosts} \geq \boldsymbol{MWT}\ [\boldsymbol{X_n}][\boldsymbol{1 + r}]^{\boldsymbol{n}}$

$\rightarrow \mathbf{COMPEN}_{aggregatexternalitiescosts} \geq$ **₦1,629,610**$[\boldsymbol{X_n}][\boldsymbol{1 + r}]^{\boldsymbol{n}}$**.**

REFERENCES

Abad, E., Bellido, J. M., Punzon, A. (2010). Transfer of fishing effort between areas and fishery units in Spanish fisheries as side effects of the prestige oil spill management measures. *Ocean and Coastal management, Vol*.53:107– 113.

ABS (2000) *Risk Assessment Applications for the Marine and Offshore Oil and Gas Industries*. Houston, American Bureau of Shipping.

Adebiyi, K. A. (2008) Estimation of Air Traffic Accident Cost in Nigeria, *Pacific Journal of Science and Technology 9(2): 420 – 425.*

Aderemo, A. J. (2012) Road traffic accident injuries and productivity in Nigeria. *Journal of Asian Scientific Research*. Vol. 2 **(7)**:334 – 344.

Adeleke, O.O., Salami, A.W., and Oyewo, S.T. (2013) Trend of highway accident in Nigeria using highway accident hazard index. *International Journal of Engineering.vol*. 11: 231 – 236.

Adegbayi A. (2017) It's cheaper to have marine insurance than get fined. Available online at: http//www.vanguardnewsonline.com. Retrieved 23/04/2020.

Afshar B., Ahmad, T., Parviz, B. (2015) Review and evaluation of maritime accidents and rescue in Iranian territorial waters. *Research Journal of Fisheries and Hydrobiology* 10**(9)**:528 – 533.

Agbokhese, O., Yisa, G. L., Agbonkhese, E. G., Akanbi, D. O., Aka, E. O., Mondigha, E. B. (2013) Road traffic accident in Nigeria: causes and preventive measures. *USTE Journal of Civil and Environment Research*, vol. 3 **(13)**:90 – 99.

Akhatar M.J. (2014) Fatigue at sea- a Manning problem, *Journal of Maritime Research XI (III): 27-42.*

Akinforo H. B.(2013) An Assessment of Marine Tanker Accidents on the Nigerian Coastal Environment. Thesis submitted to the Post Graduate School, Federal University of Technology, Owerri.

Akinyeye O. (2018) Evaluating the potentials of the Legislative Framework impacting on the Nigerian Marine Insurance Industry. *The Maritime Newsletter (2018) 1-10*

Allianz (2014) *Safety and shipping 1912–2012*. Available at: http://www.ages.allianz.com. Retrieved on 12/10/2012.

Ahmed H. Abuelenin M. (2017) The impact of shortage implementation of the international regulations on maritime safety. *Cogent Social Sciences,Vol.* 3:1-9, DOI:10.1080/23311886.2017.1335499.

Ando A.W., (2004) *Natural Resource Damage Assessment Methods and Cases, WMRC's Research Report Series.* Available online at: http://www.wrurc.uiuc.edu/ Retrieved on July 6, 2014.

Adekunbi I. and Nzeribe A. (2013) Compensation of oil spill victims in Nigeria: the more the oil, the more the blood? *Singaporean Journal of Business Economics, and Management Studies* 2(3)30-43

Andrea, R., Lara, L.T., Sergi, C., and Joaquim, C., (2009) economic evaluation of damages originated by major accidents in port areas. *Journal of loss prevention in the process industries 4(2)54-62.*

Andreas, W. (2013) *Economics of the sustainable enterprise*. Munchen, Research Technische University, Munchen.

Antao, P., Almeida, A., Jacinto, C., Guedes, C. S. (2008) Causes of occupational accidents in the fishing sector in Portugal. *Journal of Safety Science* **, Vol.64**:885 – 899.

Andre, J. M., and Baslez, M.F., (1994) *Voyager dans I'Antiquite.* Paris, Fayard,.

Anyanwu, J.O. (2014) The Causes and Minimization of Maritime Disasters on Passenger Vessels, *Global Journal of Researches in Engineering 14(2):1-13.*

Arben M. and Ulf P. (2011) A grounded Theory Model for analysis of Marine Accidents. *Accident Analysis and Prevention Journal Vol. 43(2011) 1590-1603.*

Arsham, M., Jakub, M., Jari, N., Pentti, K. (2015). Usability of accident and incident reports for evidence-based risk modeling: A case study on ship grounding reports. *Safety Science Vol***.76**:202 – 214.

Attoma, P. (1976) *Un apercu du Franc-bord des navires an Moyen Age*. Paris, Bulletin Technique du Bureau veritas.

Axel, H. (2014) Safety Assessment of New e-Navigation Systems, International *Journal of e-Navigation and Maritime Economy 1(2014): 14-28.*

Babawale G. K. (2013) Emerging Issues in Compensation Valuation for Oil Spillage in the Niger Delta Area of Nigeria. *Journal of Reviews on Global Economics*, 2013(*2)*31-45.

Band, L., Goodlad, J. (2004) Effects of the Braer accident oil spill on the Shetland seafood industry. *The Science of the Total Environment Vol*. 186: 127 – 133.

Bello O. M. & Olukolajo M. A. (2016) Adequate Compensation as a Tool for Conflict Resolution in Oil-Polluted Wetlands of Niger Delta Region of Nigeria. *Covenant University Journal of Politics & Internationall Affairs Vol. 4(2)38-49*

Branislav Ć. (2013) Research Of Marine Accidentsthrough The Prism of Human Factors. *Promet – Traffic&Transportation, Vol.* 25(4)369-377.

Benjamin, K. S. (2008) The cost of failure: Preliminary assessment of major energy accidents 1907 – 2007. *Energy Policy Vol.*36:1802 –1820.

Bijwaard G. and Knapp S. (2009) Analysis of ship life cycles – the impact of economic cycles and ship inspections. *Marine policy vol. 33: 350-369.*

Bird, F. E. (1974) *Management guide to loss control*. Atlanta. GA, Institute press..

Boisson, P. (1998) *politiques et Droit dela securite maritime*. Paris, O'neil.

Boisson, P. (1999) *Safety at Sea: Policies, Regulations and International Law*. Paris, Burea Veritas, Paris.

BSU (2014) Annual statistical report on maritime casualty investigation by the Bundesstelle fur seeunfalluntersuchung, Germany. Available at http://www.bsu.bun.de. Retrieved on 12/10/2015

Buliaminu, K., Peter, k. O., Ayodele, S. L. (2012) Modeling fatalities of road accident in Nigeria. *Journal of Research in Logistics and Production*, 2**(3)**:239 – 271.

Bull, J. W., (1966) An Introduction to Safety at Sea. Glassgow, Brownson and Ferguson.

CBN (2013) Central Bank of Nigeria Statistical Bulletin, 2013th edition.

Chalk, P. (2009) Maritime piracy: Reasons, dangers and solutions. *RAND Corporation Journal* Vol.3: 2 – 9.

Carson, R.T., W.M. Hanemann, R.J. Kopp, J.A. Krosnick, R.C. Mitchell, S. Presser, P.A. Ruud and V. Kerry Smith. (1998) Referendum design and contingent valuation: the NOAA Panel's no-vote recommendation. *Review of Economics and Statistics*, 80(3)484-487.

Carson, R.T. (1991). *Constructed markets*. In J. Braden and C. Kolstad (eds.), *Measuring the demand for environmental commodities,* Amsterdam: North-Holland, Hudges press.

Chima J.(2011) 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

Cohen, M. J. (1995) Technological disasters and natural resource damage assessment: an evaluation of the Exxon Valdez Oil Spill. *Land Economics* 71**(1)**:65-82.

Cortardan, J., (2009) *The digital hand: How computers changed thew work America Industrial Loss Control Sector*. NewYork, Oxford UniversityPress,.

Coso (2004) Enterprise Risk Management integrated framework. Availableat http//www.coso.org. Retrieved on 23/12/2016

Cronbach L. J. (1951) Coefficient of alpha and the internal structure of tests. *Psychometrika* 1951(16)297‑ 334.

Cristina, E., David C. and Virginija S., (2013) The impact of oil and gas drilling accidents on European union Fisheries. Working Document of the European Parliaments Committee on Fisheries.

Desai S. (2017) Seafarers Claims for compensation following workplace injuries and death in China. Thesis submitted to Cardiff University in fulfillment of the requirements for the Degree of Doctor of Philosophy.

Difford, P. (2011) Redressing the Balance: a common sense approach to causation. U.S.A, Acidental books.

Dollinger, P.H. (1988) La Hanse. Paris, Anbier.

Dogorawa, L.B.,(2012) Marine accidents in northern Nigeria:Causes, prevention and management. *Journal of Academic Research in Business and Social Sciences. Vol.*2(11):378-389..

Eberhard F. and Ulrich H. (1999) The role of insurance in the Adjudication of multiparty accidents. *International review of law and economics Vol. 19:69-85.*

EfficienSea (2012) Methods to quantity maritime accidents for risk – based decision making. A working document of the efficient, safe and sustainable traffic at sea (EfficienSea) for the Baltic Sea region. Document No. W – WP6–4–01.Available at http://www.europart-europa.eu/studies. Retrieved 06/10/2016.

Emrah B. and Shigeru Y. (2015) Are Marine Accident Really Accident? Fallacy of Random Marine Accidents in Dry Cargo Fleet. *The Asian Journal of Shipping and Logistics, Vol*. 31 (2) 217-229

Engle E., and Granger, C. (1987) Cointegration and error correlation: Representation, estimation and testing. *Econometrica*. vol. **(35)**:251 – 276.s

Eliopoulou, E., Papanikolaou, A., Voulgarellis, M. (2016) Statistical analysis of ship accidents and review of safety level. *Safety Science* Vol. 85:282 – 292.

El-ladan, S. B., Turan, O. (2012) Human reliability analysis – Taxonomy and praxes of human entropy boundary condition for marine and offshore applications. *Reliability Engineering and Safety* Vol. 98:43 – 54.

Ellis, N., Bloord, M., Sampson, H. (2010) Patterns of seafarer injuries. *Maritime policy and management* Vol. 51: 862 - 872.

Emre, A. (2015) A hybrid accident analysis method to assess potential navigational contingencies: The case of ship grounding. *Safety Science* Vol.**79**:268 – 276.

EMSA (2008) Maritime Accident Review. An annual statistical report of the European Maritime Safety Agency.

Eric, S. and James, R. T. (2014) CDS as insurance: leaky lifeboats in stormy seas. *Journal of Financial Intermediation* Vol. 23:279-299.

Erick, V., Pedro, A., Nan, O., Francisco, D. C. (2007). Analyzing the risk of LNG carrier operations. *Reliability and Engineering Systems Safety Vol.* **93**:1328 – 1344.

Ert, E &Erev, I.(2008)Theregationof attractivegiantess, Loss aversion and the Iemon avoidable lieuristics. *Journal of economic Psychology,Vol.13:*715-723.

European Union (EU, 2009) Directive 2009/20/EC of the European Parliament and the Council on the Insurance of Ship-owners for Maritime Claims. Available at: https://www.nepia.com/circulars/directive-2009. Retrieved on: 12/01/2022.

Field, A. P. (2005). Discovering Statistics Using SPSS, New York, Sage Publications Inc.

Floris, G. and Jakub, M (2015) Maritime transportation risk analysis: Review and analysis in light of some fundamental issues. *Reliability Engineering and System Safety* Vol. **138**:115 – 134.

Floris, G., Jakub, Montewka (2015) A framework for risk analysis of maritime transportation system: A case study for oil spill from tankers in a ship – to – ship collision. *Safety Science* Vol**.** 75:42 – 66.

Flyvbjerg, B., and Budzier, A., (2011) Why your Project may be Riskier than you Think. *Harvard Business Review 89 (9): 601 – 603.*

Food and Agricultural Organization (FAO, 2017) The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals. Rome, FAO.

Garcia, N. M. C., Villasante, S., Carballo, P. A., Rodriguez, R. G. (2009) Estimating the economic impact of prestige oil spill on the death coast (NW Spain) fisheries. *Marine Policy Vol.* 33: 8–23.

Garza –Gil, M. D., Swris – Regueiro, T. C., Varela-lafuente, M. M. (2006a) Assessment of economic damages from the prestige oil spill. *Marine Policy, Vol.* 36: 544 – 551.

Garza-Gil, M. D., Prada-Rlanco, A., Vazquez-Rodriguez, M. X. (2006b). Estimating the short-term economic damages from the prestige oil spill in the Galician fisheries and tourism. *Ecological Economics*, *Vol*. 88:842–849.

Ghauri, P. & Gronhaug, K. (2005). *Research Methods in Business Studies*. Harlow, FT/Prentice Hall.

Gordon, J. C. D., Gillespie, D., Potter, J., Transtzis, A., Simmouts, M. P., Swift, R., Thompson, D. (2004) A review of the effects of seismic survey on marine mammals. *Marine Technology Society Journal* 34**(4)**:14-32.

Gorkce, C.C., (2004) The impact of shipping accident on marine environment: study of Turkish seas. *European scientific journal vol.10,(23) 1857-788.*

Gujarati, D.N. and Porter D.C. (2009) *Basic Econometrics*, fifth Edition. New York, McGraw-Hill/Irwin. ISBN 978-0-07-337577-9.

Demarco G., & Rob, F. and Thomas A. (1997) The Economic Impacts of Accident on the Marine Industry, Prepared for the U.S. Coast Guard, Standards Evaluation and Development Division, Washington, D.C., USCG.

Grigaulas, T. A., Anderson, R. C., Brown Jr, G. M., Congar, R., Made, N., Sorensen, P. E. (1986). Estimating the cost of oil spills: lessons from the Amoco Cadiz incident. *Marine Resource Economics* 2**(3)**:239-262.

Haddon W. (2003) Energy Damage and the Ten Counter measure Strategies. *The Journal of Trauma, Vol. 13 (4) 142-220.*

Haddon, W. Jr. (1958) The Changing Approach to the Epidemiology, prevention and Amelioration of Truama. The Transition to Approaches Etiologically Rather than Descriptively Based. *Journal of Public Health Vol. 58(8) 70-79.*

Haiying, G., Xiaosheng, W., Shading, Z. (2015) A transportation problem with uncertain cost and random supplies. *International Journal of e-navigation and Maritime Economy* Vol. 2:**1**-11.

Hamed T. (2016)Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research. *International Journal of Academic Research in Management Vol*. 5(3)28-36.

Harilaos, C., (1998) An Analysis of Maritime Transportation Risk Factors, Paper Presentation at ISOPE Conference, Montreal, Canada.

Harris, r. and Sollis, R. (2003) *Applied time series modeling and forecasting*. West Sussex, England, John Wiley and Sons.

Heidi, T., Evelin, P., Tea, n., Aljona, K., Sulev, N., Mikolaj, C., Nick, H. (2016) Valuing the benefits of improved marine environmental quality under multiple stresses. *Science of the Total Environment* Vol. 551:367-375.

Heirich, H. (1959) *Industrial Accident Prevention: A Scientific Approach* (4th edition). New York, McGraw Hill.

Heirich, H.W. (1936) *Industrial Accident Prevention*. New York, McGraw Hill.

Hubbard, D., (2009) *The failure of Risk Management: Why it is broken and how to fix it*. New York, John Wiley and Sons.

Huck, S. W. (2007). *Reading Statistics and Research*. New Jersey,U.S.A., Allyn & Bacon.

IHS fairplay (2010) Annual report on world casualty statistic. London IHS fairplay.

Hoyos D., Petr M. (2010) Contingent Valuation: Past, Present and Future. *Prague Economic Papers*,Vol. 4, (2010) 329 – 343. DOI: 10.18267/j.pep.380.

IMO (1997) FSA Trial Application to High Speed Passenger Catamaran Vessel, London, International Maritime Organization: MSC68/14/2.

IMO (199) Guidelines on ship-owners responsibilities in respect of maritime claims. Resolution A.898(21). Adopted on 25th November, 1999. Available at: http//www.imo.org. Retrieved on 08/01/2022.

International Monetary Fund (2013) Nigeria: Publication of Financial Sector Assessment Program Documentation—Detailed Assessment of Observance of Insurance Core Principles. IMF Country Report No. 13/145 May 2013 Available at**:** http://www.imf.org.

Inter cargo (2011) *Benchmarking bulk carriers. 2010-2011*. London, Inter Cargo.

Isabel, N. C., Gonzahez, L., Diana – Michaela, P. (2015) The economic analysis of maritime catastrophes in sensitive areas: the assessment and calculation of damages in the environment and populations way of life. *Journal of cleaner production Vol. 107:267-278.*

ISO (2009) Risk Management: Principles and guidelines on implementation. International Standard organization. Document no: 31000 – 2009.

ITOPF (2011) Handbook of the international tanker owners pollution federation, London. Available at; http://www.itopt.con/news-and events handbook 11(accessed 30th September 2013.)

Jan, H., Eirik, A. and Ivonne H. P. (2012) Is there a need for new theories, models and approaches to occupational accident prevention? *Safety Science Journal Vol. 48 (2010) 950 – 956*

Jeffery, j. p., James, R. R. (2008) Mitigating damage cost from hurricane strikes along the Southeastern U.S. coast: A role for insurance markets. *Ocean and Coastal Management Vol.* **51**:782 – 788.

Jezequel, R., Pancet, F. (2011) The Erika oil spill, 10 years after: assessment of the natural weathering of the oil and natural recovery of vegetation. International oil spill conference, 23 – 26 May, Potland, OR, USA.

Johansen, S. (2002) A small sample correction for the test of cointegration rank in the vector autoregression model. *Econometrica*, **(70)**:1929 – 1961.

Kaiser, G. F. (1995) Regulatory assessment of supplemental Notice of proposed rulemaking on structural measures for existing single-hull tankers. Available at: http://www.ief.com/document/pdf. accessed15/03/2016

Keeney, R. L., &Raiffa, H.(1976) *Decisions with multiple objectives:Preferences and Value tradeoffs*. New York, John Wiley &Son.

Kin H., Haugen S. and Utue I. B., (2016) Assessment of accident theories for major accidents focusing on the MV SEWOL disaster: Similarities, differences and discussion for a combined approach. *Safety Science Journal Vol.* 82: 410 – 420.

Lame, T. (2008) Book review of HMS Conway 1859 – 1974 by Alfine window. *International Journal of Maritime History,* Vol. xxi (2):383 – 400.

Larsson, A. I., Purser, A. (2011) Sedimentation on the cold-water coral lophielia pertusa: cleaning efficiency from natural sediments and drill cuttings. *Marine Pollution Bulletin,* Vol. 62: 1159 –1168.

Dogarawa, L. B. (2012) Marine accident in Northern Nigeria: Causes, prevention and management. *International Journal of Academic Research in Business and Social Sciences,* 2**(**11)378 – 389.

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology Vol.* 28, 563-575.

Lemug, T.T.P., Talley, D. J., Wayne, K., (2011) The effectiveness of double hulls in reducing vessel accident oil spillage. *Marine Pollution bulletin, Vol.* 62: 2427 – 2432.

Lipton, D. W., Strand, I. E. (1997). Economic effects of pollution in fish habitats. *Transportation of the American Fisheries Society* 126**(3)**:514 – 518.

Loius, A. Leblan C. and Conway, T. R. (1990) A multiple discriminant analysis of vessel accidents. *Journal of Accident Prevention and Analysis* Vol. 33:188 – 199.

Loureiro, M. L., Ribas, A., Loperz, E., Ojea, E. (2006). Estimated costs and Admissible claims linked to the prestige oil spill. *Ecological Economics* Vol. 59:48 – 63.

Ludwig, B. Jr. (1975) Accident Theory and their Implications for Research. Paper Presented at the Joint International Meeting of the American Association for Automotive Medicine and the International Association or Accident and Traffic Medicine, Ann Arbor, Michigan. July 10.

Ludwig, B. Jr. (1979), *Four Accident Investigation Games Simulations of the Accident Investigation Process*. Oakton, VA, Lufred Industries Inc.

Ludwig, B. Jr. (2012) Accident Investigations: A Case for New Perceptions and Methodologies. Available online at //www.ludwigbanner.org., Retrieved on 12/06/2016.

MAIB (2008): Annual Statistical Report of the marine Accident Investigation Boards. Available online at www.amem.at Retrieved on 22/10/2016.

Maria, L. l., Alfonso, R., Edelmiro, L., Elena, O. (2006) Estimated cost and admissible claims linked to the prestige oil spill. *Journal of Ecological Economics* Vol. 59:43 – 63.

Marie, J. and Dilly C. H., (1961) La Securite maritime. Paris, Societe deditions geographiques maritimes et colonials.

Mark, S., Philip, L., Adrian, T. (2009) *Research methods for business students* (fifth edition). London, Prentice Hall.

MIA (1906) Marine insurance Act 1906. Available at: http//www. legislation.gov.uk/ukpga/Edw7/6/41/contents. Retreived 23/04/2016.

Michael, F., Wang H., (2015) Compensating the victims of a European Deepwater Horizon Accident: OPOL revisited. *Marine Policy 62: 25 – 36.*

Moore, L. y., Frotitt, A. J., Reynolds, L. M., Postle, M. G., Floyd, P. J., Feen, T. E., Virani, S. (1998) Sea Empress cost-benefit project. Technological report. P. 119.

Mouhamadou, M. S. Y., Mac-Andre, G., Jean-Micheal M., Valerie N. G. (2016) Uncertainty analysis in past accident risk assessment models: An application of the Fukushim accident. *Annals of nuclear energy, vol,* 86: 234 – 245.

Musk, S. (2012) Trend in oil spill from tankers and ITOPF non-tanker attended incidents. Arctic and Marine Oil Spill Programme (AMOP) Technical report, 5 – 7.

Ndikom, O. B. C. (2006) *The kernel concept of shipping operations, policies and strategies: The industry overview*. Lagos, Bunmico Publishers.

Ndubueze-Ogaraku M.E., Udensi E.U. and Olutayo A. (2017) Assessment of Perceived Impacts of Livelihood Activities among the Rural Dwellers on the Wetland Areas of Rivers State, Nigeria. *Journal of Agriculture and Ecology Research International* 13(4): 1-14.

NIA (2014): Insurance Digest, Annual Statistical Publication of the Nigeria Insurers Association. Lagos, NIA.

NIA (2007) The Nigeria Insurance Act, 2007.

Nigeria Industrial Trawler Owners Association (NITOA, 2014) Report on ocean fisheries in Nigeria. Amahlo piracy reports. Lagos, NITOA.

Nima, K., Sina, K. and Faisal, K. (2014) Probalistic risk assessment of major accidents: application to offshore blowouts in the Gulf of Mexico. DOI working document. No: 10.1007/S1069-014-1271-8.

Nwokoro I.A. (2015) An Evaluation of the Economic and Financial Capacity of Indigenous Underwriting firms for Marine Risk and Investment Cover in Nigeria, *International Journal of Research in Commerce, IT and Management 5(3)62-66.*

Nunnally J. C. and Bernstein I. H (1994) *Psychometric Theory*. 3rd ed. New York: McGraw‐ Hill; 1994.

Nze, I.C. (2013) Analysis of the Fatality Rates of Boat and Ferry Accident on Inland Waterways in Nigeria, *IOSR Journal of Business and Management 11(2): 17-20.*

Nzeribe E. A. (2019) Maritime Claims Subject to Liability Limitation in Nigeria: The Legal Framework. *Journal of Current Research*, 11(08), 6347-6350.

OGUK (2009) Accident statistics for offshore units on the UKCS 1990 – 2007. Available at:http://www.oilandgasuk.co.uk/amsfiles/modules/publications/pdf. Accessed 30th September,2013.

OGUK (2014) Statistical report on offshore O & G accidents in the UKCS. Annual report of the oil and gas United Kingdom. Available at: http://www.oilandgasuk.co.uk/amsfiles/modules/publications/pdf/EHS35.. Accessed 06/10/2015.

Ogwude, I.C. (1998) Valuation of Reduction in Traffic Accidents, *The Trainer: Journal of the Institute of Transport and Logistics Zaria, June-September (1998): 18—27.*

Ohaviro, C . and Parlo, T. (2008) Analysis of maritime accident data with BBN models. Available at http://www.researchgate.net/publications/265594. Retreived28/01/2016.

Oil Spill Intelligence Report (OSIR, 1994) *Financial cost of oil spills*. Arlington, MA, Cutter information corporation.

Okoroji L.I. and Onyemechi C. (2014) An Analysis for Reduction in Economic Loss from Damage Accident in use of Transport Modes: A Comparative Study, *Journal of Economics and Sustainable Development 5(28): 182-189.*

Olsgard, F., Gray, J. S. (1995) A comprehensive analysis of the effects of offshore oil and gas exploration and production on the benthic communities of the Norwegian continental shelf. *Marine Economic Progress, vol*. 122: 277-306.

Oladimeji A. B. (2013) Principles and Methods of Validity and reliability Testing of Questionnaires used in Social Science Researches. *Nigerian Postgraduate Medical Journal. Vol*. 22(4) 195 -201.

Olukolajo M.A. (2017) Monetary Compensation For Oil Spill Damage In Niger Delta Region, Nigeria: A Question of Adequacy. *Oil and Gas Business". 2017*. (5) 138- 154

Onwuegbudunam, D.E. (2013) An Analysis of Determinants of Accident Involving Marine Vessels in Nigeria's Waterways, *Journal of Management Science and Engineering 7(3): 39-45.*

Onuoha R. (2019) Insurers battle shipowners over maritime insurance. Available online at:http//www.vangaurdnewsonline. Retreived 23/04/2020.

Osayomi, T. (2013) Regional determinants of traffic accidents in Nigeria: Identifying risk areas in need of intervention. *African Geographical Review 3(2) 34-42*.

OSHA (2013) Accident Investigation and Control. Available online at //.www.oshatrain.org.Retrieved 12/06/2016.

OSHA (2016) Hazard Analysis and Control. Available online at //www.oshatriain.org.Retrieved12/06/2016.

Osiris A. and Valdez B. (2015) A risk analysis of Winter navigation in finish sea areas. *Accident Analysis and prevention Journal Vol.79: 100-116.*

Pabotysava, K., Purser, A., Wagner, H., Thonner, L. (2011) The influence of offshore drill cutting on the physical characteristics of phytodetrius. *Marine Pollution Bulletin*, vol. 62: 470 – 480.

Pachai, V. P., Elangovan, A. and Rangana, H. R. (2008) Road accident cost prediction model using system dynamics approach. *Transportation research* 23**(1)**:59 – 66.

Pennings, J. M & Smiths, A.(2000) Assessing the Courstuct Validityof risk attitude. *Management Science* vol. 16: 1337-1348.

Loomba P.N., (1978) *Management – A quantitative perspective*. New York, Macmillan publishing.

Payne, J. R., Driskell, W. B., Short, J. W., Larsen, M. L. (2008) Long-term monitoring of oil in the Exxon Valdez spill region. *Marine Pollution Bulletin*. Vol. 56: 2067 – 2081.

Pedro, A.C. and Guedes, S., (2008) Casual factors in accident of high-speed craft and conventional ocean-going vessels. *Reliability engineering and system safety 93: 1292-1304.*

Philippe, B., (1999). Safety at sea. *Policies, Regulations and International Law.* Preface by William O'Neil. Paris, Bureau Veritas ISBN 2–86413–020-3.

Preston, T., Shildher, Gates, E. (1990) An assessment of the impact of the Exxon Valdex oil spill on the Alaska Tourism industry. McDowell Group. Availableat:http://www.evostic.state.ak.us/universaldocuments/publications/economic/Econtourism.pdf. Accessed13thseptember,2013.

Priscah, m., Lisa, S., James, H., Jenifer, B., Wen, H. (2006) Evaluation of the burden of logging injuries using West Virginia workers' compensation claims data from 1996 – 2001. *America Journal of Industrial Medicine*. 49**(12)**:1039 – 1045.

Qingji, Z. and Vinh, V., Thai C., (2016), Fuzzy and grey Theories in failure mode and effect analysis for tanker equipment failure prediction. *Safety Science Journal 83 (2016)74 - 79.*

Raheem A. A., (2015), A web Based Accident Reporting and Tracking Systems (ARTSTS) using sensor Technology. *International Journal of Advances in Engineering and Technology, 8 (5) 678-688.*

Randa, O. M., Giselda, L., Laura, G. (2016). Bayes classifiers for imbalanced traffic accidents datasets. *Accident Analysis and Prevention*, 88:234 – 245.

Rasmusen J. and Svedung I. (2002) Graphic representation of accident scenarios: mapping system structure and the causation of accidents. *Safety science Vol.40(2002) 397 – 417.*

Rasmusen J. and Leplat J. (1983) Analysis of Human errors in Industrial Incident and Accident for Improvement of Work Safety. *Accident Analysis and Prevention Journal 16 (2)77 – 88.*

Reason J., (2001) *Managing the Risks of Organizational Accidents*. London, Hants Ashgate Publishing Limited.

REMPEC (2011) Statistical analysis, Alerts, Accident database and Regional Information System. A working document of the Regional Marine Pollution Emergency Response Center for Mediterranean Sea – RIC C2, pp. 26.

Risto J. and Kim, S. (2009) Safety performance indicators for Maritime Safety, Department of Applied Mechanics, Helsinki University of Technology.

Robert, S., Williams, J. (2007) Update on mortality for workers in the UK merchant shipping and fishing sectors: Report for the Maritime and Coastguard Agency and the Department of Transport. MCGA Research Project. Pp 56.

Rodriguez, J. P., Brown, M. (2007) *International freight movement*. In: Nowles, R., Shaw, J. and Docherty, I. (eds). *Transport Geographies: Mobilities, flows and spaces*. London, Blackwell, Pp 156 – 178.

Rosa E.A. (2013) *The logical structure of the social amplication of risk framework (SARF): meta-theoretical foundation and policy implications*. In N. Pidegeon, R.E. Kaspersen and P. Slovic (eds). *The social amplification of risk*. London, Cambridge University press, Cambridge.

Sajid M. U., Khurrun S. M., Umer F., (2013) Impact of cost of Marine and general Insurance on International Trade and economic growth in Pakistan. *World Applied Sciences Journal, 28 (5) 659-671.*

Seokho, C., Sangwon, H. (2013) Analysis of systems theory for construction accident prevention with specific reference to OSHA accident report. *International Journal of Project management* 31**(7):**1027-1041.

Shanshan Q. (2019) Study on the reward and compensation policy for the engagement of social force in maritime search and rescue in China. World Maritime University Dissertations 1174. Available at: http://www.commons.wmu.se.all_dissertations/1174.

Simo, S., (2012), *Theories of Occupational Accident*. Finland, Finish Institute of Occupational Health.

Srisvastava, C. P. (1983) *Towards Safer Shipping*. London, Fairplay.

Susan H (2001) Law of Marine Insurance. Cavendish Publishing - 2001 - ISBN 1-85941-227-0 - pp 323-326

Straub, D., Boudreau, M.-C. & Gefen, D. (2004). Validation guidelines for IS positivist research. Communications of the Association for Information Systems, 13, 380-427.

Tatyana, P. S. (2004) *Beyond economic growth. An introduction to economic development*. Washinton, *International Bank for Reconstruction and development* (The World Bank).

Tyne K. (2012) An Introduction to P&I Insurance and Loss Prevention, Second Edition, North of England P&I Association. ISBN 978-0-9558257-8-1

Ted, M., Charles, C. and Brain, A. W. (1989) Utility – adjusted impairment years. A low cost approach to morbidity valuation. Paper presentation at the Association of Environmental Resource Economist (AERE) International Conference, Oregon, U. S. A.

Tepp (2012) The gulf of guinea: Military and non-military ways of combating piracy, Baltic security and deference review, 14**(1)**98-108

The International Maritime Organization (IMO, 2011) international shipping facts and figures-information resources on trade, safety, security, environment. IMO Maritime knowledge centre.

The International Union of Marine Insurance (IUMI, 2011) Annual statistical report of the international union of marine insurance (IUMI) http//:iumu.com./statistics/2011 (Retrieved on July 12, 2016).

Theband, o., Bailly, D., Hay, J., Perez, J. (2004) *The cost of oil pollution at sea. An analysis of the process of damage valuation and compensation following oil spills*. In: Prada, A., Vasquez, M. X. (eds) *Economic, social and environmental effects of the prestige oil spill*, pp. 187 – 219.

Thorndyke, R.L., (1951) *The Human factor in Accident*. US Air force School of Aviation Medicine, Project Report, Project No. 21-30-001.

Trevisani, D. (2007) The Direction of change. Milan, Franco Angeli, ISBN: 9788846483775.

Tround, K., Peter, A., Torgeir, H., Stein, H., Jan, E. V., Morten, S. (2015) Decisions and decision support for major accident prevention in the process industry. *Journal of Loss Prevention in the Process Industry* 35:85 – 94.

The United Nations Convention on Law of the Seas (UNCLOS, 1982). London, United Nations.

Umeorizu, C. (2015) An estimation of the economic cost of marine oil spill in Nigeria. A First degree thesis in the Deparment of Maritime Management Technology, Federal University of Technology, Owerri.

United. States of America Department of Interior Minerals Management Services (DOI, 2002) Economic analysis for OCS 5 – years programme 1997 – 2002. A working document.

Ukoji, V. N. and Ukoji, V. U. (2015) Boat accidents in Nigeria: General trends and risks factors June 2006 – May 2015. *Journal of Advanced Research in Humanities and Social Science* 2**(3)**:1 – 9.

UNCTAD (2014) Review of maritime transport. Annual Publication of the United Nations Conference on Trade and Development.

UNCTAD (2012) Liability and Compensation for Ship-Source Oil Pollution: An Overview of the International Legal Framework for Oil Pollution Damage from Tankers. Studies in Transport Law and Policy - 2012 No. 1

UNEP (2011) Marine and Coastal ecosystem service: Valuation methods and their application. UNEP – WCMC Biodiversity series No. 33. Pp. 46.

United States Chamber of Commerce (USC, 2005) Analysis of workers' compensation laws. Available at: http://www.uschamber.com/amch-directory/document/pdf.accessed06/03/2016.

USCG (1997).Oil spill data 1975 – 1996. Research report by the United States Coast Guard (USCG) services.

Viner D. (1991) *Accident Analysis and Risk Control*. New Delhi, Derek Viner Pty Ltd.

Vouker S., (2014) A 2013 annual report on maritime casualty investigation. Federal bureau of maritime casualty investigation, ministry of transport and digital infrastructure, Germany.

Watson, C. (1971) Fault Tree analysis as an aid to improved performance. US Army material command (AMC) safety digest, May 1971.

Wayne K. T., (1999) Determinants of the property damage costs of tanker accidents. *Transportation research part D Vol. 3:413-426.*

Webster (1983) Webster online dictionary. Available online at www.webster.org. Retrieved 12/06/2016

Werner, A . R. (1964) *Traite de droit maritime general*. Geneva, Libraire Droz.

World Health Organization (WHO,2009) WHO Guide to Identifying the Economic Consequences of Disease and Injury. Department of Health Systems Financing, World Health Organization Geneva, Switzerland. ISBN 978 92 4 1598293.

Xavier, D., Amel, B., Aldo, N., Franck, G., Thibaut, E., Benjamin, A. (2012) The contribution of Bayelsian networks to management of risks of maritime piracy against oil offshore fields. Paper presentation at the International Conference on Information Technologies for the Maritime sector, Busan, North Korea.

Yan, F. W., Min, X., Kwai-Sang, C., Xiu, J. (2013) Accident analysis model based on Bayelsian Network and evidential reasoning approach. *Journal of Loss Prevention in the Process Industries* **(26)**:10 – 21.

Young S. T., Dong-Han, H. and Wan C. Y., (2016) Application of Activity Theory to analysis of human-related accident: Method and case studies. *Reliability Engineering and system safety Journal 150 (2016) 22-34.*

Yun-fei, A., Jina, L. and Li, L. (2015) Optimization model for the location of maritime emergency supplies reserve bases and the configuration of salvage vessels. *Transport Research Part E* 83:170 – 188.

Zaloshuja, E., Ted, M., Waehrer, G. (2006) Impact of occupational injury reduction on the US economy. *American Journal of Industrial Medicine* vol. 49**(9)**:709 – 798.

Zobarv, I. A., Kazuhiko, H. (2014) Application of logic programming technique on maritime accident analysis. Paper presentation at the ICSOT International Conference, Indonesia.

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI, DEPARTMENT OF MARITIME MANAGEMENT TECHNOLOGY

This is a survey instrument- questionnaire developed to collect research data from fishermen and farmers associations in the coastal communities affected by marine oil spill damages in Nigeria on the willingness of members to accept compensation for the losses they suffered.

Research Topic: Study on Willingness of Third Party Fishers and farmers in Coastal Communities to Accept Compensation for damages associated with Marine Oil Spill accidents and Pollution in Nigeria.

APENDIX-1

SURVEY INSTRUMENT- QUESTIONAIRE

SECTION A: PRELIMINARY SECTION

Please Fill this section with your personal information and proceed to subsequent sections to kindly provide responses to the questions to the best of your knowledge.

(i) Occupation: --

(ii) Sex: --

(iii) Name of coastal Community:---

(iv) Educational Qualification: ---

(v) Fishing port/farm location :--

(vi) Most Preferred fishing field/farm location: **------------------------------**

(vii) Dominant fish/ptoduct types **: --**

SECTION (B)

The Nigerian coastal coastal environment and adjacent sea waters are rich with diverse seafood types and fish species. Most importantly, they provide income and employment to numerous fishermen, farmers and many others who dependent on the sea for sustenance; while also being reliable source of seafood supply to the general Nigerian and global society.

(Please select the options below that best describes your experience and knowledge of the sub-sector by ticking (√).

(1) Are aware that Nigeria waters are rich with many fish types and seafood species?

Yes	No	Neutral

(2) As a fisherman or farmer, which fish or farm product types do you harvest most in Nigeria waters in recent times -?

(3) Are you aware that many Nigerians, about 1, 200, 000 people, especially those in the coastal communities depend of the fishing and sea farming for employment, income and economic sustenance?

Yes	No	Neutral

SECTION C

The Atlantic coasts of the Niger Delta region of Nigeria is rated as the most damaged marine ecosystem in the World due to frequent marine accidents leading to oil spill and pollution in the area. It is believed that, this has affected fish and seafood output from the region. It is also believed that because of oil Pollution, fishermen and farmers in the coastal communities no longer earn enough revenue from the job to sustain their living and their jobs are at risk.

(4) Have you experienced any case of oil spill and pollution incidences in the coastal waters in the region where you operate?

Yes	No	Neutral

(5) Did you experience any decline in fish and seafood output and income in the months after the very particular oil spill pollution in the waters in your area?

Yes	No	Neutral

(6) Where you paid any compensation by Government or the spiller, following the oil spill in the waters and coastal environment you operate?

Yes	No	Neutral

(7) If you have ever received any compensation following the oil spill in the waters and coastal environment where you operate,; how much were you paid?

Naira (₦)
₦:

(8) Do you agree that the continued pollution of the coastal waters by oil related wastes puts at risks the incomes, job and sources of livelihood of the local fishers and seafood farmers?

Yes	No	Neutral

SECTION D

One way to protect the fishermen and seafood farmers affected by oil spill accident damages from severe economic hardship is to get them to show willingness to accept (WTA) monetary compensation from the spillers and Government for all oil spill damages affecting their output/harvest. To access this compensation however, each affected fisherman and farmer must be willing to accept only an amount of money equivalent to the exact damage suffered by him/her.

(9) Are you willing to accept compensation for all oil spill related damages you suffered without any desire to earn more than the value of what you lost?

Yes	No	Neutral

(10) If yes, what is the most you would be willing to accept as compensation for output and income losses per spill incident affecting your operations? (Please write down the amount).

Amount: ₦

Thank you for your time. God bless you.

Appendix-2: SPSS output of Linear Relationship between Shipping Accident Economic Loss and Maritime Trade

Descriptive Statistics

	Mean	Std. Deviation	N
SHAL	2517007.8571	2754278.46835	21
IMPSTRADE	7517467099.5238	4673692699.90383	21
EXPSTRADE	9306226239.5238	5560597396.28945	21

Correlations

		SHAL	IMPSTRADE	EXPSTRADE
Pearson Correlation	SHAL	1.000	-.177	.173
	IMPSTRADE	-.177	1.000	.684
	EXPSTRADE	.173	.684	1.000
Sig. (1-tailed)	SHAL	.	.221	.227
	IMPSTRADE	.221	.	.000
	EXPSTRADE	.227	.000	.
N	SHAL	21	21	21
	IMPSTRADE	21	21	21
	EXPSTRADE	21	21	21

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.831	.691	.104	2606889.96849	2.280

a. Predictors: (Constant), EXPSTRADE, IMPSTRADE

b. Dependent Variable: SHAL

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29395242084357.250	2	14697621042178.625	4.945	.0614[b]
	Residual	122325755540349.310	18	6795875307797.184		
	Total	151720997624706.560	20			

a. Dependent Variable: SHAL

b. Predictors: (Constant), EXPSTRADE, IMPSTRADE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2430145.277	1188521.584		2.045	.056
	IMPSTRADE	.343	.0200	.555	1.913	.072
	EXPSTRADE	.051	.0110	.552	1.904	.073

a. Dependent Variable: SHAL

Appendix-3: SPSS output of Linear Relationship between Offshore O&G Accidents Economic Loss and Maritime Trade

Descriptive Statistics

	Mean	Std. Deviation	N
OFAL	4052307.9231	3156947.69430	21
IMPSTRADE	9692043330.0000	3496980443.01373	21
EXPSTRADE	12728949979.2308	3787959485.24084	21

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.793[a]	.628	.450	3257676.80133

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13471243515871.354	2	6735621757935.677	5.317	.017[b]
	Residual	106124581419017.560	18	10612458141901.756		
	Total	119595824934888.920	20			

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

	(Constant)	123404.891	3604939.633		.034	.973
1	IMPSTRADE	.211	.023	.168	1.518	.616
	EXPSTRADE	.121	.011	.232	.716	.491

a. Dependent Variable: OFAL

Appendix-4: Coefficient of Elasticity of Compensation Funds for Insured Shipping Risks to Growth in Shipping Accidents Economic Loss

Descriptive Statistics

	Mean	Std. Deviation	N
InMAPRE	16.2239	.79397	21
lnSHAL	14.2938	.92105	21

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.248	1	2.248	4.122	.057[b]
	Residual	10.360	19	.545		
	Total	12.608	20			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.021	2.568		4.293	.000
	lnSHAL	.364	.179	.422	2.030	.057

Appendix-5: Coefficient of Elasticity of Compensation Funds for Insured Offshore O&G Risks to Growth in Offshore O&G Accidents Economic Loss

Descriptive Statistics

	Mean	Std. Deviation	N
InOGRE	17.4191	.52905	21
InOFFAL	14.6606	1.35710	21

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.879	1.722		9.800	.000
	InOFFAL	.037	.117	.095	2.415	.049

Appendix-6 Rate of Change of Economic Cost of Death Marine Accidents

Descriptive Statistics

	Mean	Std. Deviation	N
ECdeathcost	5304318.5664	14302688.77370	21
Xtime	7.5000	4.18330	21

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.691[a]	.470	.098	13582021.19258

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	445714183936416.200	2	445714183936416.200	2.416	.146[b]
	Residual	2213655596108902.200	18	184471299675741.840		
	Total	2659369780045318.500	19			

a. Dependent Variable: Ydeathcost

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-5193493.418	7667304.418		-.677	.511
	Xtime	1399708.265	900479.237	.409	1.554	.146

a. Dependent Variable: ECdeathcost

Appendix-6 Rate of Change of Economic Cost of Injury Marine Accidents

Descriptiv Statistics

	Mean	Std. Deviation	N
ECinjurycost	279181.1744	667793.06901	21
Xtime	7.5000	4.18330	21

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.723[a]	.518	.046	683017.53469

a. Predictors: (Constant), Xtime

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	199163146964.720	2	199163146964.720	.427	.526[b]
	Residual	5598155432270.327	18	466512952689.194		
	Total	5797318579235.047	18			

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

1	(Constant)	501090.244	385576.144		1.300	.218
	Xtime	-29587.876	45283.622	-.185	-.653	.526

a. Dependent Variable: ECinjurycost

Appendix-7 Reliability Tests

Correlations

Correlations

		WTAO	WTAT
WTAO	Pearson Correlation	1	.898**
	Sig. (2-tailed)		.000
	N	384	384
WTAT	Pearson Correlation	.898**	1
	Sig. (2-tailed)	.000	
	N	384	384

**. Correlation is significant at the 0.01 level (2-tailed).

Nonparametric Correlations

Correlations

			WTAO	WTAT
Kendall's tau_b	WTAO	Correlation Coefficient	1.000	.847**
		Sig. (2-tailed)	.	.000
		N	384	384
	WTAT	Correlation Coefficient	.847**	1.000
		Sig. (2-tailed)	.000	.
		N	384	384

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix-8: Difference of means Reliability Test

		Paired Differences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	
					Lower	Upper
Pair 1	WTAO - WTAT	3972.45283	228483.81070	22192.30951	42789.20257	130795.70309

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	WTAO - WTAT	.7601	381	.4300

Appendix-9: **Normality Test**

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
WTA	11	100.0%	0	0.0%	11	100.0%

Descriptives

			Statistic	Std. Error
WTA	Mean		1690.9091	153.41835
	95% Confidence Interval for Mean	Lower Bound	1349.0717	
		Upper Bound	2032.7465	
	5% Trimmed Mean		1684.3434	
	Median		1600.0000	
	Variance		258909.091	

	Std. Deviation	508.83110	
	Minimum	1000.00	
	Maximum	2500.00	
	Range	1500.00	
	Interquartile Range	1000.00	
	Skewness	.215	.661
	Kurtosis	-1.270	1.279

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
WTA	.116	11	.200*	.953	11	.682

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction