Journal of ETA Maritime Science 2023;11(1):28-38

Sustainable Compensation Strategies for Ship Owners Liability for Occupational Injury and Death Costs Affecting Seafarers in Nigeria

Theophilus Chinonyerem Nwokedi

Federal University of Technology, Department of Maritime Management Technology, Owerri, Nigeria

Abstract

The study developed strategies for reserving funds for adequate and sustainable compensation of injury and death costs affecting seafarers in Nigeria. This study aims at quantifying the output losses resulting from occupational injury and death suffered by seafarers, as well as calculating the coefficients of the average rate of change of injury and death costs between 2006 and 2019 in Nigeria. The study utilized time series data from secondary sources. The Gross Output Method was used to assess the costs of occupational injury and death affecting seafarers for which ship owners are liable to provide compensation. The rate of change analysis was employed to estimate the coefficients of the average rate of change of injury and death costs. The results provided the basis for developing empirical relationships to ensure the reservation of sufficient funds by underwriters to sustainably compensate injury and death costs affecting seafarers in the Nigerian maritime industry.

Keywords: Compensation, Strategies, Injury cost, Death costs, Seafarers, Ship owners, Liability

1. Introduction

Maritime is an extremely demanding and risky industry. Illnesses, injuries, and fatalities occurring while working at sea are significantly higher compared to other occupational groups [1,2]. The Maritime Labor Liability policy provides insurance coverage and/or protection against illnesses, injuries, and fatalities experienced by maritime workers (seafarers) during their employment. Ship owners' liability with regards to compensating maritime workers/seafarers in the event of occupational-related illnesses, injuries, or death is derived from the provisions of the Maritime Labour Convention (MLC), 2006, by the International Labour Organization (ILO) [3]. Regulation 4.2 of the MLC 2006 establishes that the ship owners are responsible for securing sufficient measures to guarantee that seafarers/maritime workers are safeguarded from the financial repercussions of occupational-related illnesses, injuries, or death, occurring in association with their employment [3]. The stipulations of the MLC (2006) apply to seafarers working on a vessel of a country that has ratified the MLC 2006, or where a vessel trades in a country that has ratified the MLC 2006. It applies to all vessels engaged in commercial activities at sea, without extension to ships engaged in trade in and navigating the inland waterways. Additionally, it may not apply to vessels involved in fishing activities, warships, and other categories of coastal vessels that local regulations and laws specify. Regulation 4.2 section (b) explicitly states that ship owners ought to provide financial security to guarantee compensation in the instance of the death or long-term disability of seafarers due to an occupational injury, illness, or hazard, as established in national laws, the seafarers' employment agreement or collective agreement; while Regulation 4.2.1, paragraph 1(b), specifies that the ship owner should be subscribed to an insurance scheme or fund to be able to meet maritime labor liability risks and ensure adequate compensation of seafarers in cases of death and injury arising from work-related accident [3].

Address for Correspondence: Theophilus Chinonyerem Nwokedi, Federal University of Technology, Department of Maritime Management Technology, Owerri, Nigeria
E-mail: nwokeditc@gmail.com
ORCID ID: orcid.org/0000-0002-9441-7311

Received: 05.09.2022
Last Revision Received: 16.01.2023
Accepted: 24.02.2023

To cite this article: T.C. Nwokedi. "Sustainable Compensation Strategies for Ship Owners Liability for Occupational Injury and Death Costs Affecting Seafarers in Nigeria." *Journal of ETA Maritime Science*, vol. 11(1), pp. 28-38, 2023.

The convention stipulates the conditions under which a ship owner may be exempt from liability. Nigeria ratified the MLC 2006 on June 18th, 2013, when the government deposited the instrument of ratification with the International Labour Office [2,3]. According to the ILO, Nigeria is the 37th ILO Member State and the fifth state from the African region, after Benin, Liberia, Morocco, and Togo, to have ratified the MLC 2006 in 2013.

However, the Nigerian maritime industry is deeply concerned about the seriousness and approaches to enforcing the provisions of the MLC, 2006. Several reports of seafarer abandonment by ship owners (employers) following work-related injuries and deaths have been received. To comply with the MLC, 2006, ship owners purchase marine insurance policies to provide adequate funds for compensating work-related illnesses, injuries, and deaths of seafarers. Marine underwriting firms are required to provide compensation for maritime labor liability risks when they occur. The International Monetary Fund (IMF) [4] has reported faults in the Nigerian insurance sector, identifying the lack of financial solvency and capacity to adequately compensate insured risks. The behavior of ship owners abandoning local seafarers without compensation in the event of occupational injury, illness, and death is viewed as a consequence of the financial insolvency and incapacity of marine underwriters and insurers to provide adequate compensation in the event of an insured risk [4-6].

Studies referenced in [7,8] have identified the insolvency problem faced by underwriters in the Nigerian marine insurance industry. The issue stems from the arbitrary allocation of 25% to 45% of generated premium income to the technical reserve fund, as stipulated in the Nigeria Insurance Act [8,9]. This has resulted in many insurers becoming insolvent when compensating claims, particularly those related to maritime labor liability in Nigeria. Furthermore, the Nigerian marine insurance subsector is currently underdeveloped in terms of the maritime labor/employee liability insurance trade, as stated in [9-12]. Financial insolvency is another challenge that has limited underwriters' capacity to indemnify claims, thereby influencing ship owners' decisions to evade, limit, and/or deny liability for injury, illness, and death costs affecting seafarers. Ship owners outsource seafarers' employment to third-party contractors and crewing companies that differ from their own. The MLC, 2006, exempts ship owners from illness, injury, and death liabilities for employees who are not direct employees of the ship owners, such as contract staff [13]. One of the challenges faced by marine underwriters in addressing these issues is the problem of the database, which has made it impossible to develop empirically based knowledge and models of relationships that can guide underwriters in providing an adequate volume of funds as a technical reserve for unexpired risks. Overcoming the challenges of financial insolvency requires addressing this problem and developing better risk assessment and management models.

To formulate a maritime labor liability insurance regulation that can address the challenges of financial insolvency in compensating insured risks for both public and corporate (private/individual firm) levels, a historical overview of the burden of occupational injury and death affecting seafarers in Nigeria must be examined to determine the compensation needed. This analysis will provide an understanding of the trend of occupational injury and death burden affecting seafarers, along with the associated costs that marine insurers must adequately and sustainably provide compensation for annually. The second step requires evaluating the average rate of change of the cost of occupational injury and death associated with seafarers. Since underwriters are responsible for adequately compensating the economic cost, the amount of annual loss/cost will influence the funds to be reserved for risk compensation, which in turn affects the premium that underwriters will be willing to charge for providing coverage to affected employees/seafarers and their families [14-17].

The average rate of change for both the cost of injury burden and death will serve as the basis for establishing an empirical model that enables insurers to reserve adequate funds to address financial insolvency challenges for sustainable compensation of insured maritime labor liability costs in Nigeria. It is essential to note that despite the loopholes and problems identified in the current marine underwriting practices and the provision of compensation funds for insured employee liability costs that ship owners are responsible for in Nigeria, such as the insolvency of underwriters in maintaining adequate compensation funds for timely and sufficient compensation of injury and death costs affecting seafarers, and the lack of a basis to ensure adequate protection and compensation of maritime labor liability risks in line with the provisions of the ILO's MLC, the available empirical literature has only focused on identifying the inadequacies of the prevailing compensation regime in the Nigerian marine insurance sector. There has been no attempt to provide empirical knowledge-based approaches to overcome these inadequacies. This study aims to achieve the following objectives as a contribution to knowledge and in response to the identified research questions.

2. Aim and Objectives of the Study

This study aims to establish empirical relationships that ensure the adequate reserve of funds by marine

underwriters for sustainable compensation of injury and death costs affecting seafarers in Nigeria, for which ship owners are liable**.**

The study has specific objectives, which are as follows:

(i) To assess the economic costs of occupational injuries in the Nigerian maritime industry affecting seafarers, for which ship owners bear responsibility.

(ii) To estimate the cost of work-related deaths in the Nigerian maritime industry affecting seafarers.

(iii) To determine the coefficient of the average rate of change of the economic cost of occupational injuries in the Nigerian maritime industry affecting seafarers.

(iv) To estimate the coefficient of the average rate of change of the cost of work-related deaths affecting seafarers in the Nigerian maritime industry.

(v) To develop empirical conditions of relationships for the reservation of funds for adequate and sustainable compensation of maritime labor liability risks in Nigeria.

2.1. Research Questions

Per the objectives of the study, the following research questions have been identified:

(i) What is the economic cost quantum of occupational injuries that affect seafarers in the Nigerian maritime industry, for which ship owners are liable?

(ii) What is the estimated cost of work-related fatalities that affect seafarers in the Nigerian maritime industry?

(iii) What is the coefficient of the average rate of change of the economic cost of occupational injuries that affect seafarers in the Nigerian maritime industry?

(iv) What is the coefficient of the average rate of change of the cost of work-related fatalities that affect seafarers in the Nigerian maritime industry?

(v) What empirical conditions can ensure the reservation of adequate funds for the sustainable compensation of maritime labor liability costs in Nigeria?

3. Literature Review

The dangers associated with ship-based accidents are complex and multifaceted. In addition to the risk of loss of human capital due to fatalities and injuries, many seafarers who have experienced major ship-based accidents suffer significant psychological trauma that may prevent them from returning to sea [18-21]. The death, injury, and traumatic experiences associated with occupational accidents in the maritime sector have led to symptoms closely related to post-traumatic stress disorder (PTSD) among affected seafarers. Although existing labor laws in Nigeria do not provide for compensation for PTSD, the ILO [3]. MLC explicitly states that it is the ship owner's responsibility to compensate seafarers for losses resulting from occupational illnesses, injuries, and deaths [22-25].

The MLC, 2006 provides that the ship owner should use available instruments, such as insurance protection and Protection and Indemnity (P&I) cover, to secure adequate compensation for affected seafarers. However, it is uncertain to what extent this provision of the MLC 2006 can be employed to secure compensation for seafarers who have suffered from trauma-related disorders, as ship owners in Nigeria tend to disregard compensation for trauma while also evading compensation for physical injuries, illness, and death, which were expressly identified in the MLC, 2006 as falling under the ship owner's liability. In some cases, they tend to focus only on compensation for physical injuries and work-related deaths, and their capacity to fulfill the indemnification of injury and death costs, which are liabilities placed on them by reference [3], seems inadequate, resulting in their evasion and limitation of liability for injury and death costs affecting maritime workers [16,26].

It is important to note that marine accidents resulting in occupational injuries and deaths, in addition to causing loss of crucial workforce and human resources in the marine industry, negatively impact output performance and productivity of the industrial subsector [27-31]. This underscores the need for adequate and sustainable methods of compensating such losses to guarantee sustainable maritime operations. Furthermore, to overcome the problem of financial insolvency faced by marine underwriters, affecting their capacity to provide timely, adequate, and sustainable compensation for insured employee liability risks, there is a need for the development of empirically based knowledge to ensure adequate funds are reserved for that purpose. Achieving this will require a historical estimation of injury and death cost burdens associated with seafarers' exposure to occupational accidents and hazards over the years.

Reference [32] estimated the economic cost of traffic accidents in Nigeria using the Human Capital Model-Gross Output Model (GOM) to determine the wastages and loss in output and productivity of the road transport subsector due to injury and death of personnel. Extending the model to the maritime subsector, one can estimate the output losses associated with occupational injury and death affecting maritime workers [33,34]. Human resources constitute a major component of the maritime industry capital and the productivity and output of the industry depend on the capital resources employed. Therefore, losses, illness, and incapacitation of human capital cannot optimally contribute to output and performance, leading to a decline in productivity and output and making it impossible to

guarantee sustainable maritime operations in the long run. Figure 1 below compares the number of deaths of seafarers in the global and Nigerian maritime industries due to work-related accidents.

The figure above illustrates the loss of life globally and in Nigeria due to marine accidents, resulting in a decline in workforce capacity and subsector performance. The study shows an increasing trend in seafarer deaths in Nigeria while global loss of life is decreasing. This trend is likely due to poor compliance with standard safety rules and regulations in the Nigerian maritime industry. The economic losses suffered by the nation, the marine industry, individual seafarers, transoceanic maritime transport, and domestic industry are significant [1,2,35]. Ship owners and companies are responsible for adequately compensating for this economic loss through marine insurance and/or P&I clubs.

The offshore industry safety report by the Department of Petroleum Resources (DPR) [36] highlights the losses incurred in human capital output due to crew injury and death, which have not been adequately compensated for over the years. The report indicates that between 2015 and 2016, an average of 47 maritime/offshore workers died from work-related accidents, while an average of 88 maritime workers suffered serious injuries. Current marine underwriters' practices in Nigeria do not prioritize protecting seafarers from output losses caused by occupational injury and death, which is provided for in the ILO's 2006 MLC. Local seafarers are left to seek personal life insurance protection for occupational injuries and death, which is the ship owners' and operators' liability under the ILO. The local marine underwriting sector can prioritize this need by developing a marine accident human capital cost database for future projections of the economic resources needed to ensure adequate protection and compensation.

The IMF [4] conducted a study on insurers' solvency in Nigeria to provide timely and adequate compensation for insured risks. The study found that local insurers in Nigeria make arbitrary reserve funds for the compensation of insured risks, leading to insolvency challenges in compensating insured parties when insured risks occur. However, the study did not investigate the situation faced by seafarers in getting compensated by ship owners for injury and death costs affecting them during their work. Furthermore, it only focused on other classes and types of insurance trade without extending to marine employee liability insurance.

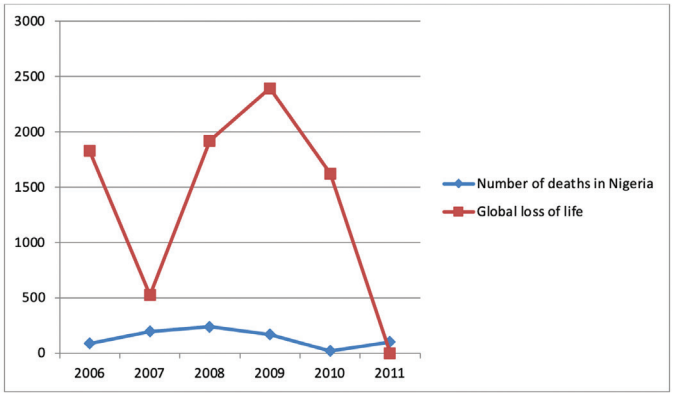

Figure 1. *Trend of marine accidents from 2006 to 2011*

Source: Compiled by author with data from (a) IMO report (2011) (b) Ukoji and Ukoji [35]

In a similar but distinct study, references [8] and [10] also obtained results akin to those of the IMF [4]. Reference [8] examined the ability of local underwriters to provide adequate compensation for offshore oil and gas risks. Its findings revealed that local underwriters lacked the sufficient capacity for the sustainable provision of compensation to affected parties in the sector. Similar to the IMF [4] study, this study did not consider marine employee liability insurance, which addresses the compensation of death and injury costs incurred by seafarers and other maritime workers. Reference [10] modeled the economic loss compensation for shipping accidents by local underwriters in Nigeria. The findings of this study also suggest a shortage of capacity for the appropriate and sustainable provision of compensation to affected shippers for insured shipping risks. Once again, the study did not consider seafarers as critical stakeholders in the shipping industry who also suffer injury and death costs due to marine accidents and must be compensated by ship owners in line with the provisions of the ILO.

Therefore, a gap exists in the literature whereby existing empirical studies seem to have failed to consider seafarers and other maritime workers as critical stakeholders in the maritime industry who bear the costs of injury and death associated with marine accidents. Given this gap, there is a lack of available empirical literature and knowledge on what constitutes the costs and burdens of injury and death suffered by Nigerian seafarers over the years and how or whether such costs have been compensated in accordance with the ILO's MLC, as existing empirical literature has focused more on identifying shortcomings in compensation for shippers and oil and gas industry operators only. Previous studies have also been unable to establish a basis for reserving adequate funds for the timely and sustainable provision of compensation for injury and death costs to affected seafarers by ship owners and marine underwriters.

The failure of existing empirical literature over the years to establish any knowledge and understanding of the economic costs incurred by maritime workers due to death and injury resulting from occupational (ship-based) accidents, as well as what constitutes the coefficients of the average

rate of change of these costs, to guide marine underwriters in providing the necessary volume of funds to maintain financial solvency for the timely, adequate, and sustainable indemnification of insured maritime labor liability risks, constitutes the gap that this study has filled, contributing to the body of knowledge in this area of study in Nigeria.

4. Data and Methods

The study utilized an ex-post facto research design, employing time series secondary data. Secondary data was gathered on the number of seafarers who suffered from occupational-related illnesses, injuries, and deaths, for which ship owners are liable to compensate the affected seafarers. This data was obtained from the DPR Annual Statistical Report, the Fair Play database, and other secondary sources. In addition, data on per capita output in Nigeria was obtained from various editions of the Central Bank of Nigeria (CBN) Statistical Bulletin [37]. The time series data covered a 14-year period between 2006 and 2019 for each identified variable. The obtained data were analyzed using the GOM and Rate of Change Analysis (RCA) methods.

4.1. The Gross Output Model

The World Health Organization utilizes the GOM of the Human Capital model to assess the economic cost of fatalities and injuries resulting from work-related accidents that affect seafarers in Nigeria between 2006 and 2019. The objective is to estimate the annual cost burdens that ship owners in the economy are expected to compensate the illness and death affecting seafarers in their employment. Since ship owners are expected to employ risk transfer measures to fulfill these liabilities, the estimated injury and death costs will serve as empirical guides to maritime underwriters in determining the funds to be reserved for the adequate and sustainable indemnification of maritime labor liability costs in Nigeria.

According to the GOM, the cost of death is equal to the loss of output to the society that the victim of a fatal accident would have contributed to the economy if alive. Similarly, the economic cost of injury is equivalent to the loss of output that the injured person would have produced during hospitalization or injury-induced idle time. Reference [38] explains that valuing the economic costs of dead accident victims using the human capital approach involves considering the discounted value of people killed in the accident, as the loss of output is related to society and the nation.

By the GOM, life is valued as the total discounted value of expected and per capita outputs. Therefore, the gross output value represents the expected economic benefit to the economy from saving a life in a fatal marine accident or preventing an injury using safety shields, programs, and policies.

For a fatal marine accident involving death, the economic cost of output lost per death is determined as follows:

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

Total output lost per period for several deaths =

$$= P_T = Y\left(\frac{1}{i}\right)\left(1-\frac{1}{(1+i)^t}\right)N \quad (2)$$

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

t= The number of working years lost per fatality, as defined by the difference between the retirement age in the public sector and the national average age of fatality in developing countries, approximates 25.2 to 29 years.

For injury accidents, the hospitalization period is considered one year unless the individual is permanently disabled and unable to work for the remainder of their lifetime. This duration is denoted as t=1.

The total number of deaths resulting from fatal marine accidents over a given period is represented by N.

Employing the aforementioned method and utilizing secondary data on seafarers who have experienced death due to work-related accidents, as well as per capita income, the expenses incurred by ship owners for injury and death compensation were assessed. This evaluation was carried out to determine the adequate funds required for the indemnification of maritime labor liability risks in Nigeria.

4.2. Rate of Change Analysis

We have estimated the coefficient for the average rate of change in the economic cost of occupational death and injury affecting seafarers. This estimation serves as the basis for projecting the provision of compensation funds to ensure adequate and sustainable compensation of maritime labor liability costs. In addition, we have calculated the average rate of change for each of the costs associated with death and injury over the 14-year period covered in this study. This empirical evidence supports the reservation of compensation funds for sufficient and sustainable indemnification of the risks associated with maritime labor liability, including death and injury costs.

In essence, the coefficient for the average rate of change from the interval $[t_1–t_{14}]$, which spans the 14-year period studied, can be estimated using the following expression:

$$\frac{\partial Y}{\partial t} = \frac{f(t1) - f(t14)}{t1 - t14} \quad (3)$$

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

$$\frac{\partial ECdeath}{\partial t} = \frac{f(t1) - f(t14)}{t1 - t14} \quad (4)$$

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

$$\frac{\partial ECinjury}{\partial t} = \frac{f(t1) - f(t14)}{t1 - t14} \quad (5)$$

where $f(t_1)$ and $f(t_{14})$ denote the variables corresponding to the first and last year's within the period covered in the study. It is important to note that utilizing Ordinary Least Square estimation, where the independent variable is the period [t_1-t_{14}], enables us to determine the trend of each variable over the study period, providing us with the regression coefficient as the average rate of change of each variable over the period covered in the analysis.

For the cost of death, the trend equation is:

$$EC_{death} = \beta_0 + \beta_{1death} + e$$

where e denotes the error term, t denotes the time, β_{1death} denotes the coefficient of regression, β_0 denotes a constant. The coefficient of regression β_{1death} represents the mean rate of change in the economic cost of mortality per unit of time within the studied period.

Thus, $\frac{\partial ECdeat}{\partial t} = \frac{f(t1)\text{-}f(t14)}{t1\text{-}t14} = \beta_{1death}$ (6)

The average rate of change in the economic cost of injuries resulting from marine accidents is illustrated below:

$$\frac{\partial ECinjury}{\partial t} = \frac{f(t1)\text{-}f(t14)}{t1\text{-}t14} = \beta_{1injury} \quad (7)$$

It is important to note that the empirical basis for determining a model of relationship that ensures an adequate volume of compensation fund reserved from the premium income of marine underwriters (MAPRE) for the compensation of maritime labor liability risks affecting ship owners and seafarers lies in the relationship between the mean value of output losses associated with each instance of injury/illness and death of seafarers, as well as the coefficient of the rate of change of the costs associated with each instance of injury and death.

4.3. Limitations of the Study

The secondary data utilized in this study were sourced from the CBN Statistical Bulletin, the DPR offshore/marine accident records, and Fair Play reports. However, it is plausible that certain ship accidents that affect seafarers and lead to injury, illness, or fatalities may go unreported, and consequently, the public may not be informed. Hence, the precision of the findings and estimations presented in this study may be somewhat impacted by the accuracy of the data accessed.

Table 1. *Result showing the economic costs of injury and death associated with work-related injury and death affecting seafarers in Nigeria between 2006 and 2019, using GOM*

s/n	EC_{death} *per annum* = (USD) $= P_T = Y\left(\frac{1}{i}\right)\left(1 - \frac{1}{(1+i)^t}\right)N$	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)
2006	744,995.96	15,520.7	90,938.007
2007	3,477,416.79	17,648.02	247,486.644
2008	5,064,781.75	21,015.69	64,594.66
2009	297,727.18	17,721.86	59,577.21
2010	81,624.98	21,480.26	2,588,153.44
2011	278,670.55	23,616.15	77,124.24
2012	566,264.52	25,739.29	54,390.40
2013	1,118,058.25	28,091.92	105,232.26
2014	7,881,313.39	30,196.61	72,510.52
2015	179,088.90	25,584.13	115,497.19
2016	48,933.66	20,389.03	250,674.05
2017	51,647.14	18,445.41	53,151.12
2018	146,331.16	19,004.05	73,014.48
2019	54,323,605.70	20,893.69	56,192.22
Total	67,167,280.93		3,908,536.44

Source: Authors calculation

5. Results and Discussion

The results on Table 1 above indicate the economic costs of maritime labor liability risks resulting from occupational accidents that affect seafarers in the Nigerian maritime sector. Ship owners are liable for these accidents. The aggregate cost of output losses due to the death of seafarers affected by occasional accidents over the study period is USD 67,167,280.93 equivalent to 26826610000 Nigerian naira at an exchange rate of 399.40 naira to 1 USD. On average, this amounts to output losses of 1,916,186,429 naira (4,797,662.92 USD) per year due to the death of seafarers affected by accidents in the Nigerian maritime sector. Therefore, the ship owners in the local industry must be able to compensate the affected workers with about 1916186429 NGN annually, per the MLC's provisions, 2006.

In the absence of a local P&I club in Nigeria and the capital-intensive nature of securing membership of foreign P&I clubs, local ship owners employ the risk transfer instruments available in the local insurance industry. Therefore, the local marine underwriting sector should develop the capacity to provide cover for marine labor liability claims resulting from the death of seafarers due to work-related accidents up to the tune of 1.9 billion naira per year in line with the provisions of the MLC 2006, as amended. Regulation 4.2 of the Convention makes 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 connexion with their 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. Regulation 4.2.1, paragraph 1(b), notes that the ship owner should subscribe to an insurance scheme or fund to meet maritime labor liability risks and ensure adequate compensation of seafarers in cases of death and injury arising from work-related accidents.

Similarly, the total economic cost and output losses resulting from the burden of injuries on seafarers due to work-related accidents in the Nigerian maritime sector during the study period amount to USD 3,908,536.44 (1561069454 NGN), with an average of USD 279,181.17 (111504961NGN) in output losses per year. Therefore, marine underwriters must develop the capacity to raise compensation funds for injury risks to USD 279,181.17 or above more annually to maintain financial solvency and ensure timely, adequate, and sustainable compensation for injury costs in Nigeria.

The average economic cost of maritime labor liability risks due to injury and death burdens affecting seafarers between 2006 and 2019 in Nigeria is USD 5,076,844.09 (1929200754 NGN) per year. It is important to note that estimating the coefficients of the average rate of change of both death and injury costs for which ship owners are liable can facilitate the development of empirical conditions and models of relationships that will ensure adequate and sustainable compensation for injury and death output losses affecting seafarers in Nigeria in the long run (Table 2).

The findings reveal that the mean rate of variation in the economic costs of death and injury liabilities for ship owners during the studied time frame is 1,399,708.265 USD and -29,587.87 USD, respectively, for each unit change in time (i.e. a one year increase). These results suggest an upward trend in output losses attributable to fatalities while simultaneously demonstrating a downward trend in the financial burden of injury costs. The model equations

Table 2. *The coefficients of the average rate of change and implications for timely, adequate and sustainable compensation marine accidents injury cum death cost (maritime labor 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 labor liability risks
	USD	₦			
EC_{injury}	2,791,81.17	111504959	- USD2958.876	1.0	$MAPRE_{injury} \geq K$, where K = mean EC_{injury}. or decrease/$\Delta MAPRE_{injury} \leq \frac{\partial ECinjury}{\partial t}$ i.e.: $\Delta MAPRE_{injury} \leq$-USD29587.876
EC_{death}	5,304,318.57	2118544837	USD1399708.265	1.0	Increase/$\Delta MAPRE_{death} \geq \frac{\partial ECdeat}{\partial t}$[from mean EC_{death}] i.e.: $\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/$\Delta MAPRE_{death} \geq \frac{\partial ECdeat}{\partial t}$ [from $\boldsymbol{Y_d}$ ***value***] i.e.: $\Delta MAPRE_{death} \geq$1399708.26 from Y_d.
Source: Authors calculation					

below provide a clearer illustration of the trends in death and injury costs, respectively:

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

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

The impact and empirical implications of this on the development of a policy strategy for reserving funds to adequately and sustainably compensate maritime labor liability costs (including costs associated with death and injury) suggest that the compensation funds allocated for each type of maritime labor liability cost must increase in the same direction as changes in death and injury costs. In addition, to increase the confidence of maritime operators (i.e., ship owners) and stakeholders in the marine underwriting sector in relation to maritime employee liability insurance, in instances where there is an increasing trend in employee liability costs during any given period, the increase in compensation funds maintained by underwriters for maritime labor/employee liability costs within the same period must be greater than or proportional to the coefficient of the average rate of change of maritime labor liability costs.

Given that the coefficient of the average rate of change of economic costs associated with death affecting seafarers is 1,399,708.265 USD, as indicated in the above result, any increase in compensation funds maintained for the cost of death $(\Delta MAPRE_{death})$ must be greater than or proportional to 1,399,708.265 USD:

$$\Delta MAPRE_{death} \geq 1{,}399{,}708.265 \text{ USD} \quad (1)$$

The quantification of compensation funds necessary to provide prompt, sufficient, and lasting reimbursement for the financial impacts incurred by fatalities of seafarers as a result of work-related accidents per incremental change in time ($MAPRE_{deatht=1}$) equals the total of the average economic expense of mortality during the period or the previous year's economic cost of mortality (Y_d), whichever is greater.

i.e.: $$MAPRE_{deatht=1} = \sum \textbf{Mean } EC_{death} + \frac{\partial ECdeath}{\partial t}] \quad (2);$$

or

$$MAPRE_{deatht=1} = [\sum Y_d + \frac{\partial ECdeath}{\partial t}] \quad (3)$$

Where: $Y_d > \textbf{mean } EC_{death}$.

The implication is that underwriters responsible for compensating work-related deaths among seafarers in Nigeria must maintain a minimum compensation fund proportional to the mean value of USD 5304318.566. To ensure financial stability and timely, adequate, and sustainable compensation for ship owners' liability for work-related deaths, underwriters must increase compensation funds for death risks/liabilities by an amount equivalent to the coefficient of the average rate of change of economic cost of death over the study period, based on the mean and preceding year's economic cost of death values. This could impact the cost of purchasing marine insurance policies (premium) for maritime labor liability risks, as premiums may increase to enable timely and sustainable compensation.

The mean value of the cost of injury liability is USD 279181.1744, which implies that underwriters must reserve a minimum average compensation fund of USD 279,181.1744 for maritime labor injury costs. The results also indicate that the coefficient of the average rate of change of the cost of injury burden for which ship owners are liable over the study period is USD -29,587.876, indicating a decreasing trend in injury cost/liability. Therefore, to ensure timely, adequate, and sustainable compensation for work-related injuries affecting seafarers, compensation funds for injury liability ($MAPRE_{injury}$) must be proportional to or greater than the mean economic cost of injury.

$$MAPRE_{injury} \geq \textbf{mean USD } 279{,}181.1744 \quad (4)$$

Although the results indicate a decreasing trend in injury costs, it is advisable to reserve adequate compensation funds for injury liabilities to ensure financial solvency and sustainability. This can be achieved by reducing compensation funds reserved for injury liability by an amount proportional to or less than the coefficient of the average rate of change ($\Delta MAPRE_{injury} \leq$USD -29587.876. However, it is recommended to maintain compensation fund reservations for injury costs within the condition that $MAPRE_{injury} \geq mean\ EC_{injury}$. This will provide the most secure and sustainable compensation for injury cost liabilities.

Policy Implications of the Coefficients of the Average Rate of Change of Death-cum-Injury Costs and Liabilities in Developing Strategies for the Reservation Funds for Compensation of Maritime Labor Liability Risks in Nigeria:

The results indicate that the average rate of change of the costs associated with death and injury liabilities of maritime operators during the study period were USD 1399708.265 and USD - 29587.87, respectively, for every unit increase in time (i.e. every year) within the study period. These results suggest an increasing trend in output losses due to work-related accidents resulting in the death of seafarers while also indicating a decreasing trend in the economic costs associated with injury burdens affecting seafarers. The respective average rate of change coefficients ($\partial Y/\partial t$) for death and injury costs are 1399708.265 and 29587.876. The implications of these results for the development of compensation funds to provide timely, adequate, and sustainable compensation for insured risks (death and injury costs) are significant. Specifically, the compensation funds reserved for each cost class (death or injury) must change in the same direction and proportionately with the

coefficients of the average rate of change. If death and injury costs (maritime labor liability costs) increase, then the volume of compensation funds reserved to indemnify these costs must increase proportionately with the coefficients of the average rate of change. This condition will ensure that marine underwriters maintain financial solvency for timely and adequate indemnification of maritime labor liability risks (death and injury costs). With the coefficient of the average rate of change of economic cost of death accidents being USD 1399708.265, the change in compensation funds maintained for indemnification of the economic cost of death ($\Delta MAPRE_{death}$) must be greater than or proportional to 1,399,708.265 USD.

$\boldsymbol{\Delta} MAPRE_{death} \geq 1{,}399{,}708.265$ USD.

The calculation for the compensation funds necessary to provide timely, sufficient, and sustainable indemnification for the economic burdens resulting from seafarers' deaths due to occupational accidents can be expressed as follows: $MAPRE_{deatht=1}$ equals the sum of the mean economic cost of death over the period and the preceding year's economic cost of death value (Y_d), whichever of the two is greater. It is important to note that this formula considers the unit increase in time.

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

or

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

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

By implication, underwriters must maintain compensation funds for death costs proportional to the mean value of USD 5,304,318.566 to ensure financial solvency and provide timely, adequate, and sustainable indemnification of death liabilities. To achieve this, underwriters must increase compensation funds for death liabilities by an amount equal to the rate of change of the economic cost of death over the period, based on the mean value and the preceding year's value of the economic cost of death. This may increase the cost of purchasing marine insurance policies for maritime labor liability risks, as insurance premiums may increase to ensure timely, adequate, and sustainable compensation payments.

The mean value of the economic cost of injury liability is USD 279,181.1744, indicating that the minimum average amount of compensation funds allowable for injury costs is USD 279,181.1744. The results also indicate that the average rate of change of the economic cost of injury over the study period is USD -29,587.876, indicating a decreasing trend in injury costs. Therefore, underwriters must ensure timely, adequate, and sustainable compensation for injury costs and liabilities by maintaining compensation funds for injury liability ($\boldsymbol{MAPRE}_{injury}$) proportional to or greater than the mean economic injury cost.

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

The results indicate a declining trend in injury costs over time, suggesting reducing the amount of compensation funds reserved for injury liability in proportion to or less than the average rate of change ($\Delta\boldsymbol{MAPRE}_{injury} \leq$-29,587.876 USD) may be sufficient to adequately cover injury costs over the period. However, it is prudent to maintain compensation fund reserves for injury costs at a level where $\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury.}$ This approach ensures the greatest financial stability for underwriters and sustainable compensation for the costs associated with injury burdens borne by seafarers resulting from occupational accidents in Nigeria.

6. Conclusion

The estimated costs of death and injury burdens associated with occupational accidents affecting seafarers in Nigeria between 2006 and 2019 were an aggregate of USD 67,167,280.93 and USD 3,908,536.44, respectively. The average rate of change coefficients for death and injury costs were USD 1,399,708.265 and USD –29,587.876, respectively. These coefficients provide the basis for the development of empirical relationships to ensure the reservation of adequate funds. This is necessary to ensure that marine underwriters maintain solvency for timely, adequate, and sustainable compensation of maritime employee liabilities.

To ensure that ship owners and marine underwriters reserve sufficient funds for the sustainable compensation of costs associated with the death of seafarers in Nigeria, the amount of funds to be reserved per annum must satisfy the condition that $\Delta MAPRE_{death} \geq$USD 1,399,708.26. In addition, this amount must be based on the mean cost of death, which was USD 5,304,318.57 over the period.

Similarly, to ensure that ship owners and marine underwriters reserve adequate funds for the sustainable compensation of costs associated with injury to seafarers in Nigeria, the amount of funds to be reserved per annum must satisfy the condition that $\Delta MAPRE_{injury} \leq$USD -2,958.87. Furthermore, this amount must be based on the mean cost of injury, which was USD 279,181.17 over the period.

7. Recommendations

It is recommended, per the findings of the study, that:

(a) The compensation funds maintained for the economic cost of occupational deaths affecting seafarers in Nigeria must increase proportionately to the coefficient of the average rate of change of the economic cost of death over time. The recommended minimum increase in compensation funds is $\Delta MAPRE_{death} \geq 1{,}399{,}708.265$ USD. This is necessary to ensure that ship owners and marine underwriters can adequately compensate affected seafarers in the future.

(b) The amount of compensation funds required for the adequate indemnification of the cost of insured deaths for every unit increase in time ($MAPRE_{deatht=1}$) should be the sum 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.

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

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

The sole assurances to ensure that ship owners and marine underwriters can adequately compensate affected seafarers in the future are as follows.

(c) The compensation funds allocated for injury cost and liability ($\boldsymbol{MAPRE}_{injury}$) should be proportional to or exceed the mean economic cost of injury, that is, $\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury}$.

(d) The most prudent approach is to reserve compensation funds for injury costs under the condition that $\boldsymbol{MAPRE}_{injury} \geq \boldsymbol{mean\ EC}_{injury.}$ This is the only guarantee that ship owners and marine underwriters have sufficient funds to compensate affected seafarers who may incur injury costs due to future marine accidents.

8. Suggestions for Further Studies

Given the projected economic costs associated with the death and injury burden imposed upon seafarers in the Nigerian maritime sector due to occupational accidents, it is imperative to conduct additional research to compare the costs of death and injury and to identify the vessel types that pose the greatest risk to seafarers. The outcome of the additional research will be valuable in prioritizing compliance with safety standards for specific vessel types, per the ILO's provisions for the living and working conditions onboard.

Peer-review: Externally and internally peer-reviewed.

Funding: The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

[1] I. Altinpinar, and E. Basar, "Comparison of the safety cultures of Turkish aviation and maritime transportation workers," *International Journal of Occupational Safety and Ergonomics*, vol. 26, pp. 459-468, Sep 2020.

[2] İ. Altinpinar, and E. Başar, "Investigation of the effect of vessel type on seafarers' safety culture," *International Journal of Occupational Safety and Ergonomics*, vol. 28, pp. 1618-1623, Sep 2022.

[3] "International Labour Organization. Maritime Labour Convention, 2006." Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---normes/documents/normativeinstrument/wcms_090250.pdf.

[4] "International monetary fund. 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: https://www.elibrary.imf.org/view/journals/002/2013/145/002.2013.issue-145-en.xml

[5] Adegbayi A. (2017) It's cheaper to have marine insurance than get fined. Available online at: http//www.vanguardnewsonline.com. Retrieved 23/04/2020.

[6] G.K. Babawale, "Emerging issues in compensation valuation for oil spillage in the Niger Delta Area of Nigeria," *Journal of Reviews on Global Economics,* vol. 2, pp. 31-45, 2013.

[7] E. Abad, J.M. Bellido, and A. Punzon, "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, pp. 107-113, March 2010.

[8] I.A. Nwokoro, and T.C. Nwokedi, "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,* vol. 5, pp. 62-66, 2015.

[9] NIA (2007) The Nigeria Insurance Act, 2007.

[10] T.C. Nwokedi, "Modeling marine accidents economic loss and the compensation in Nigeria," (Ph.D. Thesis), *Submitted to the Department of Maritime Management Technology, Federal University of Technology, Owerri, Nigeria,* 2021.

[11] O.M. Bello, and M.A. Olukolajo, "Adequate compensation as a tool for conflict resolution in oil-polluted Wetlands of Niger Delta Region of Nigeria," *Covenant University Journal of Politics & International Affairs,* vol. 4, pp. 38-49, Dec 2016.

[12] R. Onuoha, "Insurers battle ship-owners over maritime insurance." Available online at: https://www.vanguardngr.com/2019/10/insurers-battle-ship-owners-over-maritime-insurance/. Retreived 23/04/2020.

[13] S. Robert, and J. Williams, "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, 2007.

[14] J. Chima, "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,* vol. 2, pp. 17 – 32, April 2011.

[15] IMO. Guidelines on ship-owners responsibilities in respect of maritime claims. Resolution A.898(21). Adopted on 25th November, 1999. Available at: https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.898(21).pdf.

[16] K.A. Adebiyi, "Estimation of air traffic accident cost in Nigeria," *Pacific Journal of Science and Technology,* vol. 9, pp. 420-425, Nov 2008.

[17] O.O. Adeleke, A.W. Salami, and S.T. Oyewo, "Trend of highway accident in Nigeria using highway accident hazard index," *International Journal of Engineering,* vol. 11, pp. 231-236, 2013.

[18] Ć. Branislav, and D. Petar, "Research of marine accidents through the prism of human factors," *Promet - Traffic&Transportation,* vol. 25, pp. 369-377, Sep 2013.

[19] N. Ellis, M. Bloord, and H. Sampson, "Patterns of seafarer injuries," *Maritime Policy and Management,* vol. 51, pp. 862-872, Mar 2010.

[20] P. Chalk, "Maritime piracy: Reasons, dangers and solutions," *RAND Corporation Journal,* vol. 3, pp. 2-9, 2009.

[21] A.J. Aderemo, "Road traffic accident injuries and productivity in Nigeria," *Journal of Asian Scientific Research*, vol. 2, pp. 334-344, 2012.

[22] K.S. Benjamin, "The cost of failure: Preliminary assessment of major energy accidents 1907 – 2007," *Energy Policy,* vol. 36, pp. 1802-1820, May 2008.

[23] P. Mujuru, L. Singla, J. Helmkamp, J. Bell, and W. Hu, "Evaluation of the burden of logging injuries using West Virginia workers' compensation claims data from 1996 – 2001," *America Journal of Industrial Medicine*, vol. 49, pp. 1039-1045, Dec 2006.

[24] K. Tyne, "An Introduction to P&I Insurance and Loss Prevention, 7nd Edition, North of England P&I Association, 2012.

[25] S.T. Young, H. Dong-Han, and C.Y. Wan, "Application of activity theory to analysis of human-related accident: Method and case studies," *Reliability Engineering and System Safety Journal,* vol. 150, pp. 22-34, June 2016.

[26] 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.

[27] A. Hahn, "Test Bed for Safety Assessment of New e-Navigation Systems," *International Journal of e-Navigation and Maritime Economy,* vol. 1, pp. 14-28, Dec 2014.

[28] T.C. Nwokedi, C.U. Odumodu, C.C. Ibe, L.A. Gbasibo, C.E. Anyanwu, and I.I. Okonko, "Measuring the Probabilities of fatal and non-fatal Accidents Risks in upstream Ocean Energy Drilling Operations in Nigeria," *Journal of Multidisciplinary Engineering Science Studies,* vol. 5, pp. 2454-2459, Feb 2019.

[29] E. Zaloshuja, M.R. Ted, and G. Waehrer, "Impact of occupational injury reduction on the US economy," *American Journal of Industrial Medicine,* vol. 49, pp. 709-798, Sep 2006.

[30] Shanshan Q, "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: https://commons.wmu.se/cgi/viewcontent.cgi?article=2173&context=all_dissertations.

[31] M.J. Cohen, "Technological disasters and natural resource damage assessment: an evaluation of the Exxon Valdez Oil Spill," *Land Economics,* vol. 71**,** pp. 65-82, Feb 1995.

[32] L. Band, and J. Goodlad, "Effects of the Braer accident oil spill on the Shetland seafood industry," *The Science of the Total Environment,* vol. 186, pp. 127-133, 2004.

[33] ABS, "*Risk Assessment Applications for the Marine and Offshore Oil and Gas Industries*," Houston, American Bureau of Shipping, 2000.

[34] I.C. Ogwude, "Valuation of reduction in traffic accidents," *The Trainer: Journal of the Institute of Transport and Logistics Zaria, pp.* 18-27, 1998.

[35] V.N. Ukoji, and V.U. Ukoji, "Boat accidents in Nigeria: General trends and risks factors June 2006 – May 2015," *Journal of Advanced Research in Humanities and Social Science,* vol. 2, pp. 1-9, May 2015.

[36] DRP, *"Department of Petroleum Resources Offshore Oil and gas Industry Report,"* 2017.

[37] CBN, *"Central Bank of Nigeria Statistical Bulletin,"* 2020th edition.

[38] World Health Organization, "WHO Guide to Identifying the Economic Consequences of Disease and Injury," *Department of Health Systems Financing, World Health Organization Geneva, Switzerland.* http://apps.who.int/iris/bitstream/handle/10665/137037/9789241598293_eng.pdf