Impact of Marine Pollution on the Productivity of Fish and Sea Food Companies in Port Harcourt Metropolis, Rivers State, Nigeria

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ABSTRACT

This study investigated the impact of marine pollution on productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State. The study adopted a descriptive and experimental research design and it is a census study. Primary source of data was generated through self- administered questionnaire. The target population of interest for this study comprised of two hundred and sixty-six managers and supervisors of twenty selected fish and sea food companies in Port Harcourt Metropolis. The major sources of data for the study were via primary sources and lab oratory analysis. Primary data for this research was collected through the administration of a structured questionnaire. Also, laboratory analysis was conducted on the three water bodies which were utilized by shipping and marine food companies' operation. The research instrument was validated through supervisor's vetting and approval while the reliability of the instrument was achieved by the use of the Pearson Product Moment Correlation coefficient and a reliability coefficient of 0.93. Data generated were analyzed and presented using both descriptive and inferential statistical techniques. The hypotheses were tested using the Spearman's Rank Order Correlation Statistics. The findings revealed that there is a significant relationship between oil waste from marine pollution and the productivity of fish and sea food companies in Rivers State [(P =.000) p<0.05]; there is significant relationship between solid waste discharged from marine pollution and the productivity of fish and sea food companies in Rivers State [(P =.000) p<0.05]; amongst others. This finding was further substantiated with the laboratory results which strongly affirmed the above findings. The study recommends that the management of the shipping industries or the fish/sea food companies should ensure they create better ways of oily waste disposal to minimize the rate of marine pollution and enhance the productivity of fish and seafood companies in Port Harcourt Metropolis, Rivers State.

Keywords: *Marine pollution, productivity, oily waste, solid waste, fish, sea foods, companies.*

INTRODUCTION

Background to the Study

Against the backdrop of public concern and the need for mitigating policies, the shipping industry has actively sought to curtail the negative environmental effects arising from the shipping. The marine environment is affected by a number of human induced stressors and the degradation can be seen not only in coastal areas but has spread to very remote areas in the deep seas and well as in polar areas. Coastal areas are being urbanized throughout the world. Marine operations have been conducted through the whole history of man. Transportation of different cargos along the seaways has also been conducted with great skills and under demanding conditions. Environmental pollution is the pollution of air, land and water in many ways. There are several reasons for environmental pollution arising from agriculture, industry, and urban sources. Environmental pollution has drastically changed the air, water and terrestrial ecosystems as a result of the industrial activities (Ainsley, 2008).

Different types of toxic gases and different forms of carbon components are produced from factories, transport, and energy sectors has resulted in different changes in the global climate and weather patterns, and become a source of contamination of land, as well as the ocean environment where the average temperature and acidity are increasing. The marine environment is affected by a number of human induced stressors and the degradation can be seen not only in coastal areas but has spread to very remote areas in the deep seas as well as in polar areas. Coastal areas are being urbanized throughout the world. There has been a global migration of humans from inland areas to the coastal areas, a phenomenon very obvious in Nigeria and most pronounced in Lagos state and Port Harcourt city of Rivers State. Pollution is spreading via water and air as well through direct dumping. Human induced changes in drainage areas affect the input of sediment into coastal waters leading to erosion, and construction, land filling and dredging also results in affected erosion and sedimentation patterns. Fisheries is a major factor affecting the environment of the seas, both because the balance of the ecosystem is affected by the removal of fish, and through the damage caused by the use of destructive fishing gear.

Maritime industry activities, basically ship operations are the prime factor causing maritime pollution, for example from accidents during oil transportation and ballast water tank transfers of harmful aquatic species between different places in the ocean. In addition, there are the wastes disposed into the sea, especially plastics that remaining for several years without decomposition. Ships and marine platforms also release exhaust gases containing SO_2 and NO_2 as well as green-house gases. Ships also release waste water into the sea. Furthermore, it has been estimated that container ships lose over 10,000 containers at sea each year. In addition to that the discharge of cargo residues from bulk carriers has a potential risk of polluting environmentally highly sensitive areas as well as economically and commercially important strategic locations, like ports, channels and beaches, oil spills can have devastating effects on waterways and oceans.

Statement of the Problem

Lack of adequate waste reception facilities in developing countries' ports is such that vessels have no choice but to discharge waste at sea. However, some vessel operators prefer to dump waste at sea, where there is a low risk of being caught, rather than use the provided facilities and thus pay the required user fees. In West and Central African ports, facilities are becoming available in varying forms but remain inadequate hence ship waste collection processes in the ports are not only inefficient but also their management remains poor (Elenwo & Akankali, 2015).

Saraçoğlu, Deniz, and Kılıç (2013) investigated "The Effects of Ship Sourced Emissions in Izmir Port, Turkey" Exhaust gas emissions from ships were calculated by the ship activity-based methodology. Total emissions from ships in the port is estimated as 1923 ton y^{-1} for, 1405 ton y^{-1} for SO_2, 82753 ton y^{-1} for CO_2, ton y^{-1} for HC, and 165 ton y^{-1} for PM in the year 2007. These emissions are classified regarding operation modes and types of ships. The results are compared with the other studies including amounts of exhaust pollutants generated by ships. According to the findings, maritime transportation is a major source of climate change and air pollution. Shipping emissions causes severe impacts on health and environment. These effects of emissions emerged in the Port and its surroundings.

In Nigeria for example, the Nigeria Ports Authority (NPA) custodian of national Ports does not own or operate waste reception facilities but outsources that responsibility to a private pollution control company. In the words of the port authority's managing director, Mohammed, the private pollution control company is to provide port reception facilities in all four navigational districts of Lagos, Port Harcourt, Warri and Calabar. The project is self-financing and contract tenure is 20 years beginning from the year 2006 (Umoh & Nitonye, 2015). In addition, this company is given the responsibility of monitoring waste discharge from vessels visiting the ports and reporting back to the authority. In this circumstance, no independent organization is put in place to audit the activities of pollution control contractors.

Ship operations are one of the main sources of oil pollution of the marine environment, especially operating giant oil tanker vessels to transport oil from production regions to consumers. It is not only the risks for catastrophic oil spills when ships ground or collide. All ships also carry fuel oil which may be as bad to the environment (Momoh, 2013). There are many reasons for potential risks of environmental pollution, not only from accidents but also from the operation in the field of maritime navigation. For example, the dirty water contaminated with even small amounts of oil in the engine room space, causes pollution of the marine environment when pumping out this water into the sea further, the oil leaking from fuel oil bunkering into the sea in highly sensitive areas has the high impacts on the marine environment.

The increasing rate of cases of marine pollution in Nigeria and Rivers port has given the impetus for researching into the effects of Marine Pollution on the productivity of Fish and Sea Food Companies in Port Harcourt Metropolis, Rivers State.

Aim and Objectives of the Study

The aim of this study is to examine the impact of marine pollution on the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State. The specific objectives of the study are to:

1. Determine the effect of oil waste from marine pollution on the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State.
2. Examine how solid waste from marine pollution affects the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State.

Research Questions

The following research questions were answered by this study;

1. To what extent does oil waste from marine pollution affect the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State?
2. To what extent does solid waste from marine pollution affects the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State?

Research Hypotheses

Based on the objective and research questions of the study, the following hypotheses are generated.

$H_{1.1}$: There is significant relationship between oil waste from marine pollution and the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State.

$H_{1.2}$: There is significant relationship between solid waste from marine pollution and the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State.

Conceptual Review

Concept of Marine Pollution

Marine pollution is a broad category, consisting of oil pollution (including accidents with offshore oil and gas installations) and all other marine pollution as defined e.g., in MARPOL and the London Convention. MARPOL, the International Convention for the Prevention of Pollution from Ships, is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. Its annexes list various forms of marine pollution, caused by oil, noxious liquid substances, and harmful substances in packaged form, sewage and garbage from ships, etc. (IMO, 2010)

The marine environment can be described or characterized at a number of different scales, ranging from ocean level processes through to those that occur at species and genetic level. The scales of relevance here are marine landscapes, habitats and species; their inter-relationship can be expressed as follows: Species provide the globally accepted original classification of biological diversity, with well-established rules of taxonomy to distinguish between different types.

On a global scale it is generally recognized that marine pollution is mainly caused by human activities based on land and much less by human activity taking place at sea (Berger, 2012). Specifically, shipping impacts on the marine environment in a number of ways and these according to reference include (Ware, 2009): Pollution by oil and hazardous or toxic substances from incidental, operational and illegal discharges; air pollution through emissions and particulate matter from engine exhaust gases and cargo tanks which may be carried over long distances; discharge of operational waste from ships, including discharge of raw sewage and garbage (litter); release of toxic chemicals used in anti-fouling paints and leaching of heavy metals from anodes; the introduction of non-indigenous organisms through ships' ballast water and associated sediments, and fouling on ships' hulls; pollution and physical impact through loss of ships and cargo; physical and other impacts including noise and collision with marine mammals.

Types of Pollutants

Pollutant types based on the nature of the polluting substance is often categorized fundamentally into Physical, chemical, biological and radioactive pollutants (Institute of Geo-Sciences and Space Technology, 2000). However, there is a further classification, based on the on the environment of occurrence, source of the pollutant or even mode of impact.

Energy pollutants: There are various forms of energy sources available to man either naturally or enhanced and exploited by man as forms of artificial energy. Some of these forms of energy include Noise, Heat, Nuclear, Vibration and solar (Ultraviolet and other forms of radiation).

Organic or Biological pollutants: Life processes of organisms leads to the generation of a class of pollutants that inevitably impacts the aquatic environment. Some of these include urine, faeces and various other products of decay process of organics from living or dead organisms. Incidentally, geometric increases in human population and the need to keep up with providing food for the astronomically rising global population has led to corresponding increases in crop and animal productions.

Domestic pollutants: For decades, communities, settlements and municipalities have utilized water courses for domestic chores, transportation and as the sink for waste. However, sewage depletes the much-needed dissolved oxygen and contains high concentration of bacterial and viral life forms, some of which could be pathogenic.

Synthetic pollutants: Synthetic pollution involves pollutants from substances that are manufactured or synthesized by man from factories and laboratories. In other words, they are artificially formulated compounds, which man utilizes as raw materials, drugs, herbicides and pesticides.

Sources of Water Pollution

There are several criteria for categorizing pollution in terms of their sources. These criteria are usually based on the mode of the discharge of the pollutants into the environment, the nature of the facility from which the pollutant is emanating from, the type of processes generating the pollutants, the biological, chemical and physical properties of the pollutants etc. Some of the pollution sources based on these criteria include:

Point source and non-point source pollution: Sources of pollution in aquatic environment could be broadly classified into "point source" and "non-point source" pollution. The point source pollution is those polluting substances emanating from specific and relatively confined cum limited spheres or channels. Examples of point sources aquatic pollution from human activities include "pipeline" discharges of polluting chemicals fluids such as crude oil into receiving waters from blow out, leaks emanating either from equipment failures, accidents or outright vandalism.

Land based pollution sources: Most ocean pollution begins on land due to the oceans and seas constituting the eventual natural sink for virtually all natural and anthropogenic activities on the globe. Land-based sources (such as agricultural run-off, discharge of nutrients and pesticides and untreated sewage including plastics) account for approximately 80% of marine pollution, globally. Agricultural practices, coastal tourism, port and harbours developments, damming of rivers, urban development and construction, mining, fisheries, aquaculture, and manufacturing, among others, are all sources of marine pollution threatening coastal and marine habitats.

Household/domestic sources of pollution: Household/domestic source of water pollution constitutes a complex waste stream. It contains virtually all forms of wastes; biodegradable and non-biodegradable solid wastes including metals and plastics, liquid wastes, organics of different classes, chemical wastes etc. In most cases, these wastes are not segregated at source especially in developing countries prior to disposal.

Marine litters/garbage sources of pollution: There are several kinds of marine litters and garbage's being dumped into the marine environment annually in thousands of tonnages cumulatively. However, plastics appear to be the most noticeable and problematic of marine litters and garbage's for several reasons.

Operational sources such as fishing vessels boats/ships: Pollution sources at sea or even on inland waters such as Rivers, lagoons, seas, harbours and estuaries constitutes sources of significant pollution to the marine environment. Some of these activities include accidental and deliberate discharges of oil during bunkering operations, operational dumping of garbage (particularly plastics, metallic and non-metallic objects).

Other sea activities sources: Bunkering activities both legal and illegal of crude oil constitutes a very serious source of pollution into the marine environment. In Nigerian coastal waters, especially within the Niger Delta Region, the current unprecedented high level of illegal crude oil bunkering has led to heavy discharges of crude oil into the coastal environment of the entire coastal areas lining the Gulf of Guinea (Akankali & Jamabo, 2012).

Oil Waste (Oily-water Discharge from Ship):
The operation of ships' power plants often results in spills of lubricating oil, fuel oil, grease and water into bilges. The resulting emulsified water and oil, if pumped into the sea or river when oily-water separator is not fitted or if fitted and is faulty becomes a source of marine pollution from ships. Another source of oily-water pollution is ballast water pumped into oil cargo tanks. Such water usually contains some quantities of oil residues and foreign species that would have to be pumped overboard before fresh crude oil is loaded. Also, the cleaning process of crude oil tanks of these vessels contributes to marine pollution because the oily water from the cleaning process contains detergent, solid matters, rusty scales from corrosion which are discharged overboard.

Industrial growth has accelerated the emission of various oily waste from the sources such as petrochemical and metallurgical industries. Transportation & domestic sewage. These oily wastes are one of the major pollutants of the aquatic environment. The special attention has been focused on the discharge of waste water & oily water & its regulatory restriction has become stricter. Oil water separation processes using polymeric or inorganic membranes have been proposed as effective & cost competitive alternative to conventional oil removal technologies but in present the commercial use of membrane in waste water treatment is currently limited by their low efficiency as well as high capital & operating cost (Borunoun & Nabbout, 2016).

Solid Waste (Discharged from Ships)
Non-oil pollutants such as garbage and other solid waste from ships are normally dumped into the sea or river when there is no enforcement. Solid waste generated on a ship includes glass, paper, cardboard, aluminum and steel cans, and plastics. It can be either non-hazardous or

hazardous in nature. Solid waste that enters the ocean may become marine debris, and can then pose a threat to marine organisms, humans, coastal communities, and industries that utilize marine waters.

Wastewater on the ship can be divided into sanitary and oily bilge wastewater. Oily bilge water is a mixture of water, oily fluids, lubricants, cleaning fluids and other similar wastes that are collected in the ship's bilge tank and produced by main and auxiliary machinery, boilers and other mechanical machines. As oily water it is regulated in Annex I of MARPOL Convention. Sanitary wastewater in order to increase efficiency and disposal is divided into black water or sewage and grey water. Black water is discharge from all types of toilets and urinals; discharge from the medical rooms; discharge from spaces with live animals, and any other wastewater if mixed with these discharges and it is regulated by Annex IV of MARPOL Convention. Grey water contains water from sinks, baths, showers, washing machines, saunas, swimming pools, sinks and water generated from washing ship's surface, and it is not recognized as pollutant by the International Maritime Organization (IMO, 2010).

Heavy Metals

Metals are the major elements on the periodic table. The most recent periodic table consists of 118 elements out of which 23 of these elements are called heavy metals. Examples of heavy metals include antimony (Sb), arsenic (As), bismuth (Bi), cadmium (Cd), cerium (Ce), chromium (Cr), cobalt (Co), copper (Cu), gallium (Ga), gold (Au), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), platinum (Pt), silver (Ag), tellurium (Te), tin (Sn), uranium (U), vanadium (V) and zinc (Zn) (Glanze, 1996).

From this list of heavy metals, it is surprising to see metalloids such as As, Sb and Te considered as heavy metals making the term, 'heavy metals' appearing as if it is a misnomer. According to Dara (2005), as regards environmental pollution, metals may be widely grouped under three classes as follows: (i) Non-toxic but accessible (ii) Toxic but non-accessible and (iii) toxic and accessible. The third class of toxic and accessible metals have caught much attention in the light of pollution of the environment and public health. The toxic and accessible metals actually occur in the earth crust in very small amount, (less than 1000ppm) and are therefore referred to as 'trace metals'

Concept of Productivity

Stevenson, (1998) noted that the productivity of an organization/ business is the ability it has to produce a good or service. More specifically, productivity of an organization is the measure of how its specified resources are managed to accomplish timely objectives as stated in terms of quality and quantity. The purpose of measuring firm-level of productivity is to evaluate the efficiency with which inputs are transformed into outputs. The most common type of productivity measures is the simple or single factors, ratio of output to a specific type of input.

Vora, (1992) posits that productivity is an objective concept. As an objective concept it can be measured, ideally against a universal standard. As such, organization can monitor productivity for strategic reasons such as corporate planning, improvement, community development or comparison to competitors. It can also be used for tactical reasons such as project control or controlling performance to budget.

Theoretical Framework

The theoretical framework for this study will be hinge on two schools of economics views, the classical and neo-classical economics proponents. One of the orthodoxies, in the person of Ricardo (1772-1823), as cited in Liu and Maes (2017), posited in his "Law of Comparative Advantage", that countries engaging in international trade should specialize in producing and exporting goods that can be produced at a lower relative cost than other countries. In his views, he stressed that advantages of international trade are influenced, relatively, by what he described as "cost differences". Ostensibly, it can be surmised that trade has been responsible for environmental degradation, since most economic agents would like to explore and exploit environmental resources, for profit motives in trade, with little or no regard to the impact their trade has caused on the environment negatively.

Say (1900), in his text on political economy published in the early 19th century (Kloff & Wicks, 2004), opined that, "Supply creates its own demand", which is often referred as 'Say's law of market.' Say (1900) was trying to typify the importance of production that is clearly determined or influenced by demand, interestingly, one would concur with the views of Say, empirically, that businesses exist to produce goods or services that are demanded for by the consumers, at profit goal, and that this is the exact purpose of capitalism and capitalistic interest.

On the contrast view, the people who reside in the environment where these resources are massively exploited to fan the whims and caprices of the producers are indifferent to the products of the natural resources as are developed. How could one imagine when the people are indifferent and absolutely ignorant of the values of the natural resources developed in their environment, such that they could jealously preserve them from undue exploitation and abuse which could be to their detriment, taking a peculiar case, the Niger-Delta Regions of Nigeria as a case study among others.

Empirical Review

Abdel–Waheed, Shaker and Elnady (2018) in their study on fish farming management water quality on growth performance of fish in Egypt, adopted two fish farming systems. Result showed that there is a significant increase in the growth and performance of the fish farming system (ponds) containing high quality water than those in ponds of contaminated or pelleted water as evidence higher average daily weight gain, specific growth rate, higher production and higher total income (profit). The study concludes that there is a significant positive relationship between water pollution (quality water) and aquatic resources/business performance.

Onwuegbuchunam, Ebe, Okoroji and Essien (2017) carried out a study on the analysis of marine pollution in Nigeria seaports. They adopted a scientific based integrated model to address the managerial problem based on the control of marine pollution in Nigeria ports. The findings also revealed that marine pollution control in the ports of developing economies is marred by a lack of administrative control and inadequate provision of waste reception facilities. The study therefore recommended that a more effective regulations and managerial skills and innovations should be applied to control marine pollution and enhance aquatic resources.

Similarly, Upadhi *et al* (2013) observed bio accumulation of heavy metal beyond permissible limits in sediment of Owubo Creek and digestive system of fish (*Tilapia zilli*) a major

component of food chain. Also, Onwuteaka *et al* (2015) also had similar report of the high accumulation levels in shellfish such as crabs had been used as bioindicator. In some studies, Hector *et al.* (2014) noted that Cd, Cd, Hg, As, Fe and Pb were far beyond WHO limits with excessive coefficient of variation of as high as 150% in some cases comparing metal concentration between crab and prawn, Olowu *et al.* (2010) established that prawn samples in the study tend to accumulate more heavy metals than crabs. This could be a result of differences in feeding habit of both animals. However, the accumulation level was also reported to be within the range of NAFDAC standard for aquatic food (Olowu *et al.*, 2010).

Koleni and Haji (2014) assessed the metal concentration in species of fish along the coast seaport of Zanzibar. Fish samples such as sardine, barracuda and tuna fish studied to ascertain levels reveal significant levels of these organism. Concentrations of Fe, Pb, Cr, Ni, As, Cu and Zn were found to be higher in sardine while Hg was found to be higher in changu species of Cd and Mn were found below detection limits in all sample species, but Hg was only detected in changu species.

Salam *et al.* (2019), Akpayung *et al.* (2014) assessed the accumulation of heavy metals of zinc, copper, iron, cadmium and leads in various organs of four fishes *Euthynus affinis, Pampus argenteus, Descap terus macrosoma,* and *Leioganathus daura*), prawn (*Fenneropenaeus indicus*) and crab (*Porttunus pelagicus*) and the health associate with the consumption of these animals and found concentrations showed remarkable differences among the species and organs. The concentration of heavy metals in the gill was the highest of all fish species followed by in the liver and flesh though concentrations were not high enough to pose human health risk. It had been long established that industrial activities such as oil exploration and refining is a source of Heavy metals in aquatic system.

Methodology

This study adopted a descriptive and experimental research design and the area of this study is Port Harcourt metropolis of Rivers State. The population of the study comprised of two hundred and sixty-six managers and supervisors of twenty selected fish and sea food companies in Port Harcourt Metropolis. Simple random sampling technique was used to sample fifty percent (50%) of this population, which yield a sample of 206 postgraduate students registered with the Ignatius Ajuru University of Education Library. The instrument was a structured questionnaire titled Marine Pollution on the Productivity of Fish and Sea Food Companies Questionnaire (MPPFSFC). Also, laboratory analysis was conducted on the three water bodies which were utilized by shipping and marine food companies' operation. The research instrument was validated through supervisor's vetting and approval while the reliability of the instrument was achieved by the use of the Pearson Product Moment Correlation coefficient and a reliability coefficient of 0.93. The Data collected was analyzed using descriptive statistical tools such as frequency and percentage; mean and standard deviation were used to respond to the research questions, while Spearman's Rank Order Correlation was used to test the hypotheses at 0.05 level of significance.

RESULTS AND DISCUSSION OF FINDINGS

Research Question 1: To what extent does oil waste from marine pollution affect the productivity of fish and sea food companies' performance in Rivers State?

Table 1: Impact of oil waste from marine pollution on the productivity of fish and sea food companies' performance

SN	Items	$\bar{X}$	SD	Remark
1	Our company encounters oily water from marine activities.	3.5000	1.18388	Agreed
2	Our fish and sea food business are affected by oil waste.	3.8437	1.25138	Agreed
3	Oil waste affects business opportunities in our company	3.8828	1.05458	Agreed
4	Our company complains about oil waste in the water in the course of doing business.	3.8281	1.09479	Agreed
	Grand mean	**3.7637**	**1.14616**	Agreed

Source: Field Survey, (2021)

Table 1 shows the extent oil waste from marine pollution affect the productivity of fish and sea food companies' performance in Rivers State. The result shows that the grand mean = 3.7637 indicating that oil waste from marine pollution affect the productivity of fish and sea food companies' performance in Rivers State to a high extent. The result further shows the responses derived from the respondents to include; Our company encounters oily water from marine activities ($\bar{X}$ = 3.5000±1.18388), Our fish and sea food business are affected by oil waste ($\bar{X}$ = 3.8437±1.25138), and Our company complains about oil waste in the water in the course of doing business ($\bar{X}$ = 3.8281±1.09479).

Research Question 2: To what extent does solid waste discharged from marine pollution affect the productivity of fish and sea food companies' performance in Port Harcourt Metropolis, Rivers State?

Table 2: Impact of solid waste from marine pollution on the productivity of fish and sea food companies' performance

SN	Items	$\bar{X}$	SD	Remark
1	Our organization comes into contact with muddy water as a result of marine activities.	3.1797	1.50293	Agreed
2	Solid waste has an impact on our fish and seafood industry.	4.1484	1.24287	Agreed
3	Our company's business potential is detrimentally affected by muddy waste.	4.0625	1.22153	Agreed
4	In the course of performing our operations, our company has complained about solid wastes in the water	3.7910	1.10272	Agreed
	Grand mean	**3.4629**	**1.26751**	Agreed

Source: Field Survey, (2021)

Table 2 shows the extent solid waste from marine pollution affect the productivity of fish and sea food companies' performance in Rivers State. The result shows that the grand mean = 3.4629 indicating that solid waste from marine pollution affect the productivity of fish and sea food companies' performance in Rivers State detrimentally. The result further shows the responses derived from the respondents to include; Our organization comes into contact with muddy water as a result of marine activities ($\bar{X}$ = 3.1797±1.50293), Solid waste has an impact on our fish and

seafood industry ($\bar{X}$ = 4.1484 ±1.24287), Our company's business potential are detrimentally affected by muddy waste ($\bar{X}$ = 4.0625 ±1.22153), and In the course of performing our operations, our company has complained about solid wastes in the water ($\bar{X}$ = 3.7910±1.10272).

Test of Hypotheses

Hypothesis 3: There is no significant relationship between oil waste from marine pollution and the productivity of fish and sea food companies in Rivers State

Table 7: Relationship between oil waste from marine pollution and the productivity of fish and sea food companies

Correlations					
			Oil Waste	Productivity	Decision
Spearman's rho		Pearson Correlation	1	.749	Rejected
		Sig. (2-tailed)		.000	
	Oil Waste	N	228	228	
	Productivity	Pearson Correlation	.749	1	
		Sig. (2-tailed)	.000		
		N	228	228	

***S= Significant p<0.05**

In the statistical testing of hypothesis one, a strong positive relationship was revealed to exist between oil waste from marine pollution and the productivity of fish and sea food companies in Rivers State, this can be shown in the correlation coefficient value of rho = 0.749 (72.9%). Furthermore, the null hypothesis which states that there is no significant relationship between oil waste from marine pollution and the productivity of fish and sea food companies in Rivers State was rejected and the alternate hypothesis upheld [(P =.000) p<0.05].

Hypothesis 2: There is no significant relationship between solid waste discharged from marine pollution and the productivity of fish and sea food companies in Rivers State

Table 4: Relationship between solid waste discharged from marine pollution and the productivity of fish and sea food companies

Correlations					
			Solid Waste	Productivity	Decision
Spearman's rho		Pearson Correlation	1	.768	Rejected
		Sig. (2-tailed)		.000	
	Solid Waste	N	228	228	
	Productivity	Pearson Correlation	.768	1	
		Sig. (2-tailed)	.000		
		N	228	228	

***S= Significant p<0.05**

In the statistical testing of hypothesis two, a strong positive relationship was revealed to exist between solid waste discharged from marine pollution and the productivity of fish and sea food companies in Rivers State, this can be shown in the correlation coefficient value of rho = 0.768

(76.8%). Furthermore, the null hypothesis which states that there is no significant relationship between solid waste discharged from marine pollution and the productivity of fish and sea food companies in Rivers State was rejected and the alternate hypothesis upheld [(P =.000) p<0.05].

Result of Laboratory Analysis

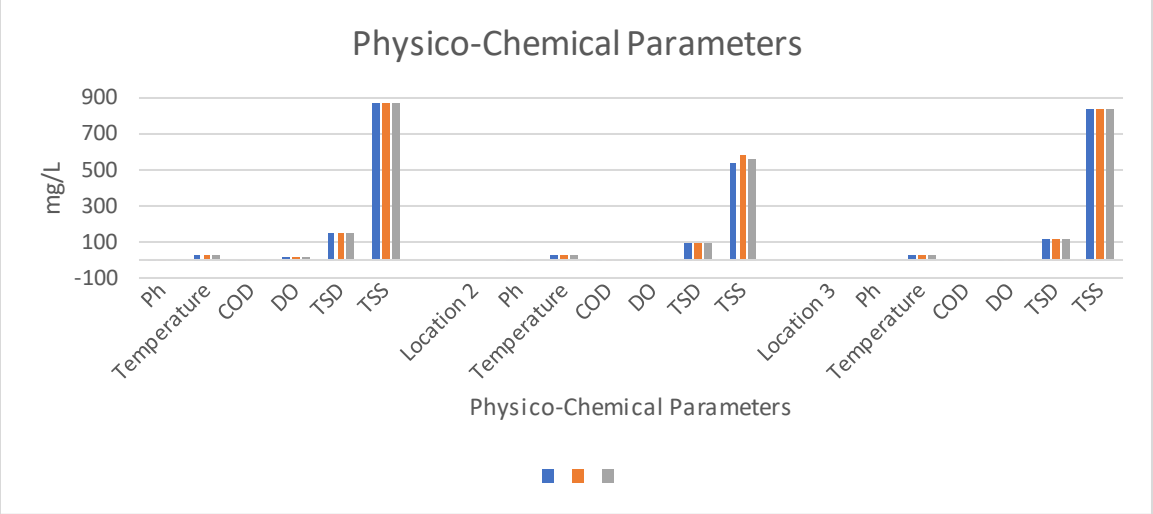

Figure 1: Chart showing the mean concentration of physico-chemical parameters in water

Table 5: Physico-Chemical Analysis of Water

S/N	PARAMETER	$\bar{X}_1$ SD$_1$ (mg/L)	$\bar{X}_2$ SD$_2$ (mg/L)	$\bar{X}_3$ SD$_3$ (mg/L)	Standard Permissible Limit (mg/L)	Source
1	pH	5.37±0.051	6.01±0.075	6.89±0.040	5.5-9.0	USEPA (2018), FMEnv (2011)
2	Temperature	28.15±0.017	28.17±1.21	27.55±0.075	<5^{O}C	USEPA (2018), FMEnv (2011)
3	Chemical Oxygen Demand	11.35±0.066	5.17±0.055	1.09±0.144	<5	USEPA (2018), FMEnv (2011)
4	Dissolved Oxygen	25.97±0.187	14.87±0.11	5.64±0.158	6.5-8	USEPA (2018), FMEnv (2011)
5	Total Dissolved Solid	155.42±1.45	99.51±2.12	214.73±0.38	<600	USEPA (2018), FMEnv (2011)
6	Total Suspended Solid	870.67±4.041	564.33±23.54	587.07±435.50	<100	USEPA (2018), FMEnv (2011)

Legend

$\bar{X}_1$ SD$_1$	**Samples from Location One**	**Location One Rumuolumeni River**
$\bar{X}_2$ SD$_2$	**Samples from Location Two**	**Location Two Reclamation Site**
$\bar{X}_3$ SD$_3$	**Samples from Location Three**	**Location Three Abuloma River**
ND	**Undetected**	

Table 5 shows the mean concentration and standard deviation of physico-chemical parameters in mg/L and the maximum permissible limit of the parameters in water. Mean concentration of temperature, and total suspended solid in all three location were above the permissible limits

(28.15±0.017 mg/L, 28.17±1.21 mg/L, and 27.55±0.075 mg/L; 870.67±4.041 mg/L, 564.33±23.54 mg/L, 587.07±435.50 mg/L) respectively; while pH in Rumuolumeni River was below the standard permissible limit (5.37±0.051 mg/L), chemical oxygen demand was above the permissible limit in Rumuolumeni River (11.35±0.066 mg/L), and total dissolved oxygen was below the standard permissible limit in Abuloma River (214.73±0.38 mg/L). The findings from the laboratory analysis on Physico-chemical parameters give credence to the result derived from the survey conducted. Hence, based on the results, it can be concluded that the water quality of the three locations were impacted by the operations of marine companies and other pollutants that erode into the water bodies

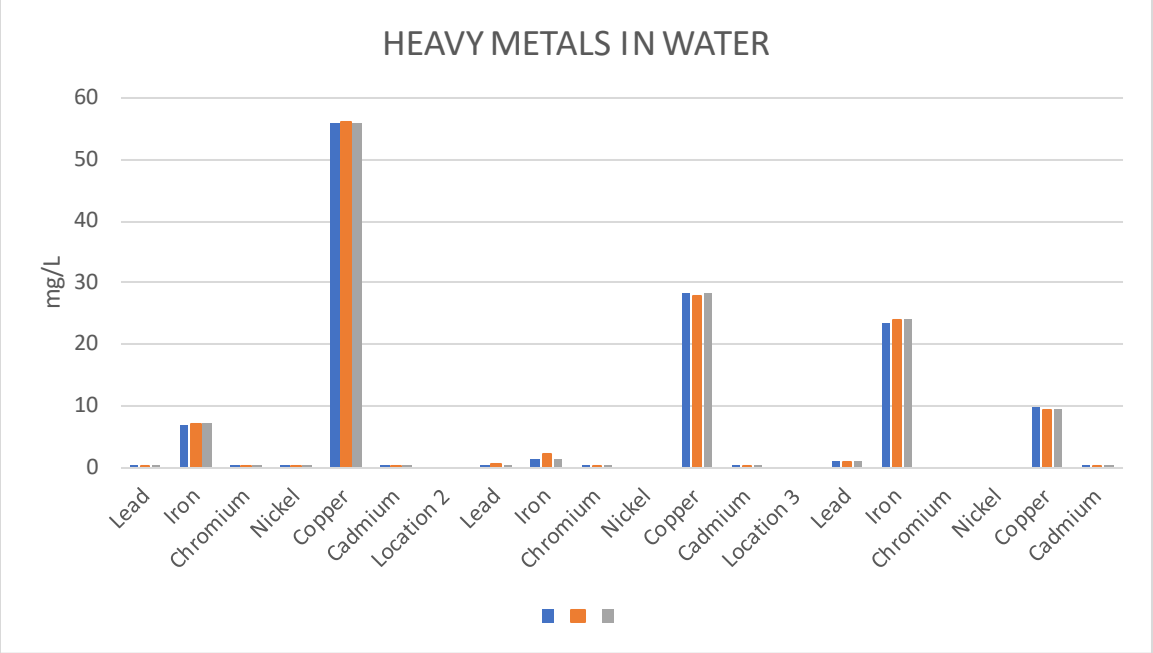

Figure 2: Chart showing the mean concentration of heavy metals in water

Table 6: Heavy Metal Analysis of Water

S/N	PARAMETER	$\bar{X}_1$ SD_1 (mg/L)	$\bar{X}_2$ SD_2 (mg/L)	$\bar{X}_3$ SD_3 (mg/L)	Standard Permissible Limit (mg/L)	Source
1	Lead (Pb)	0.13±0.021	0.36±0.035	0.87±0.001	0.64	USEPA (2018), FMEnv (2011)
2	Iron (Fe)	7.04±0.059	1.21±0.035	23.91±0.308	1.95	FAO/WHO (2013)
3	Chromium (Cr)	0.36±0.021	0.06±0.006	ND	0.05	USEPA (2018), FMEnv (2011)
4	Nickel (Ni)	<0.001±0.000	ND	ND	0.1	USEPA (2018)
5	Copper (Cu)	56.04±0.072	28.15±0.30	9.64±0.22	1.3	USEPA (2018), FMEnv (2011)
6	Cadmium (Cd)	<0.001±0.000	<0.001±0.000	<0.001±0.000	0.01	USEPA (2018), FMEnv (2011)

Legend 5 applies

Table 6 shows the mean concentration and standard deviation of heavy metals in water in mg/L and the maximum permissible limit of the metals in water. Mean concentration of copper in all three locations were above the permissible limits (56.04±0.072 mg/L, 28.15±0.30 mg/L, and 9.64±0.22mg/L) respectively; while lead in location three only was above the standard permissible limit (0.87±0.001 mg/L), iron was above the permissible limit in Rumuolumeni River and Abuloma River respectively (7.04±0.059 mg/L and 23.91±0.308), and chromium was above the standard permissible limit in Rumuolumeni River and not detected in Abuloma River (0.36±0.021 mg/L), amongst others. The findings from the laboratory analysis on the concentration of heavy metals in water give credibility to the result derived from the statistical analysis reported earlier. Hence, based on the results, it can be concluded that the water quality of the three locations were impacted by the operations of marine companies and other pollutants that erode into the water bodies

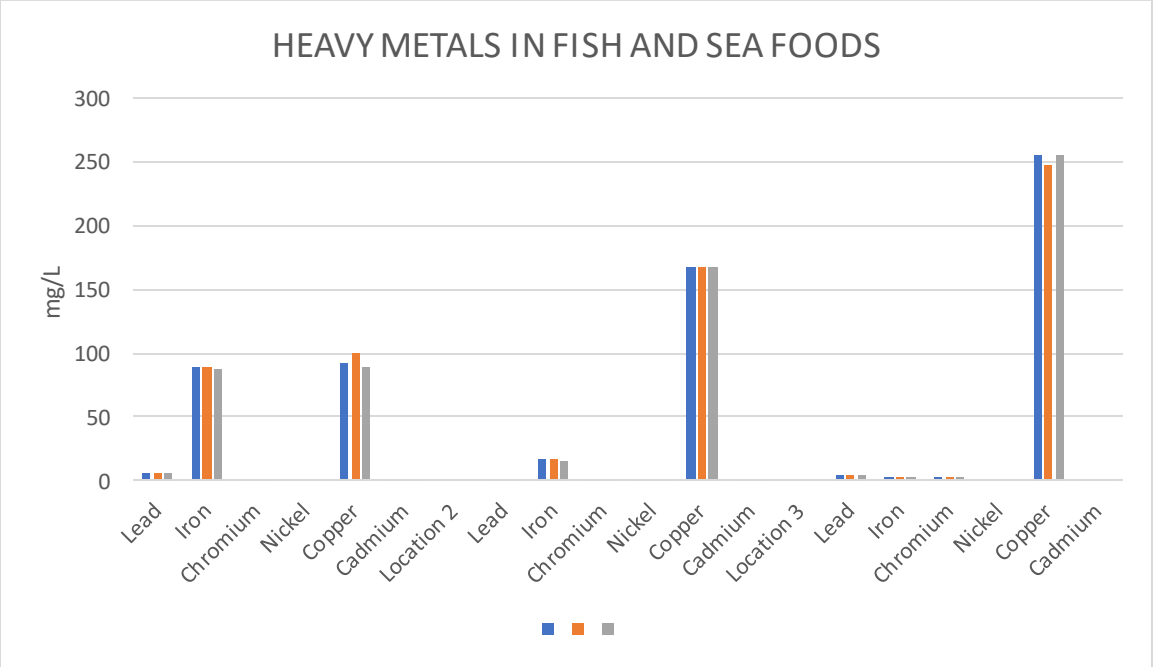

Figure 3: Chart showing the mean concentration of heavy metals in fish and sea foods

Table 7: Heavy Metal Analysis of Fish and Food

S/N	PARAMETER	$\bar{X}_1$ SD_1 (mg/L)	$\bar{X}_2$ SD_2 (mg/L)	$\bar{X}_3$ SD_3 (mg/L)	Standard Permissible Limit (mg/L)	Source
1	Lead (Pb)	5.78±0.241	1.48±0.080	4.36±0.278	0.5	WHO (2007)
2	Iron (Fe)	87.37±.122	16.47±0.602	3.26±0.092	0.05	FAO/WHO (2007)
3	Chromium (Cr)	0.87±0.06	1.44±0.031	2.63±0.256	0.05	USEPA (2013), WHO (2007)
4	Nickel (Ni)	ND	0.05±0.006	ND	0.1	WHO (2007)
5	Copper (Cu)	93.93±5.013	167.68±0.603	252.73±5.061	0.5	FAO/WHO

						(2007)
6	Cadmium (Cd)	<0.001±0.000	0.002±0.000	0.001±0.000	0.05	USEPA (2013, FAO (2007)

Legend 5 applies

Table 7 shows the mean concentration and standard deviation of heavy metals in fish and food in mg/L and the standard permissible limit of the metals in fish and sea foods. The table shows that the mean concentration of lead, iron, chromium, and copper, in all three locations were above their respective permissible limits (5.78±0.241 mg/L, 1.48±0.080 mg/L, and 4.36±0.278 mg/L; 87.37±.122 mg/L, 16.47±0.602mg/L and 3.26±0.092mg/L; 0.87±0.06 mg/L, 1.44±0.031mg/L and 2.63±0.256 mg/L, and 93.93±5.013 mg/L, 167.68±0.603 mg/L and 252.73±5.061 mg/L) respectively; while nickel was undetected in Rumuolumeni River and Abuloma River, amongst others. The findings from the laboratory analysis on the concentration of heavy metals in fish and sea foods give support to the result derived from the statistical analysis reported earlier. Hence, based on the results, it can be concluded that the fishes and sea foods in all three locations were impacted by detrimentally by the operations of marine companies and other pollutants that erode into the water bodies

Discussion of the Findings

This study considered the relationship between marine pollution and the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State. The findings revealed that there is a positive and significant relationship between marine pollution and the productivity of fish and sea food companies in Port Harcourt Metropolis. The finding of the study corroborates with Abdel – Waheed, Shaker and Elnady (2018) in their study on fish farming management water quality on growth performance of fish in Egypt, adopted two fish farming systems. The study was performed in earthen ponds situated in North Nile Delta. The first system was the feed fish farm that depended on pelleted diet (25% crude protein) as feed input, while the other system was the fertilizer fish farm which utilized both organic fertilizer and crushed macaroni as supplementary feed. Each system had four replicate ponds (8400m^2 each) the experiment duration was one year including four months of overwintering. Nile tilapia (Orechromisnitoticus), millet (mugilcephalus) and catfish (clariasgariepinus) were cultured in each pond at initial weight of 2, 30 and n35 grams, respectively. The study concludes that there is a significant positive relationship between water pollution (quality water) and aquatic resources/business performance. The study also agrees with the study by Onwuegbuchunam, Ebe, Okoroji and Essien (2017) who carried out a study on the analysis of marine pollution in Nigeria seaports. They adopted a scientific based integrated model to address the managerial problem based on the control of marine pollution in Nigeria ports. In their study, they conducted a physico-chemical and microbiological analysis of samples of ships wastewater to determine the status of marine pollution in Port environment. The findings also revealed that marine pollution control in the ports of developing economies is marred by a lack of administrative control and inadequate provision of waste reception facilities.

Conclusion

This study empirically investigated the impact of marine pollution on the productivity of fish and sea food companies in Port Harcourt Metropolis, Rivers State. Specific variables considered

were oil waste from ship and solid waste from ship, and their impact on the productivity of fish and sea food companies

Based on the research findings it was concluded that; the industrialization of Port Harcourt Metropolis is a positive conception geared towards the improvement of the economy of the area, the state, the nation and other neighbouring international communities. This effort has increased social services, job opportunities, rapid infrastructural developments and the overall living standard of the people. However, it is unpleasant to note that the industrialization processes and activities are accompanied with operations which impact the environment detrimentally and disrupts the normal functioning of the environment.

Recommendations

Based on the study findings, the following recommendations were made:

1. The management of the industries or the fish/seafood, oil companies should ensure they create better was of oily waste disposal to minimize the rate of marine pollution.
2. The solid waste produced should also be ensured that they follow the proper way of disposal so as to avoid marine pollution.
3. In order to avoid hazards induced by industrial activities, the statutory rule of citing industries far away and out of environmental sensitive areas should be strictly enforced.

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