



Framework for Management and Control of Marine Pollution in Nigeria Seaports

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Abstract: Existing studies show that effort made so far in curtailing marine pollution in ports of developing economies is marred by lack of administrative controls and inadequate provision of waste reception facilities at the ports. In this paper, sources of marine pollution and effects of particularly ship-based pollutants on marine environment were examined. The institutional arrangement for addressing marine pollution from ships visiting Nigeria ports is evaluated within the context of Marine Pollution (MARPOL) convention provisions and the obligations of coastal, flag states and port state control in ensuring compliance. It was found that in Nigeria ports, ship-generated waste control services and provision of waste reception facilities are outsourced to a private company with no requirement for activity audit. Apart from the Nigeria Port Authority (NPA), other government agencies are also involved in pollution monitoring and control. Given this scenario, it is envisaged that functions could be duplicated and monitoring/control efforts potentially weakened by conflicts of interests. An integrated administrative framework model is therefore proposed to address these managerial issues. Policy implications of the model developed are discussed.

Keywords: Marine Pollution, Ship Generated Waste Water, Marine Environment, Nigeria Ports

1. Introduction

The incidence of ship generated marine pollution has increasingly engaged the attention of international maritime community in their effort to promote safe shipping and the protection of marine environment. The growing concern about pollution centres on the potential for shipping business to negatively impact on the marine environment and related biodiversity within the maritime field [1]. Ship-source marine pollutants emanate from cargo carried or waste generated on-board and which usually contain oil or oily mixtures and noxious substances. They accumulate from machinery operation or from domestic activities of crew living on-board. Additionally, shipborne pollutants include garbage, solid wastes and antifouling paints on ship hulls [2]. Extant studies have documented the effects of ship-source pollution

on the marine environment. These include: introduction of non-indigenous species to the aquatic environment (which threaten sea animals' population) and negative effects on the economies of countries that depend on commercial fishing. For example, fisheries in West African ecosystem generate some 500 million Euros annually and over 600,000 men and women depend directly on fishing and fisheries related industries [3].

Against the backdrop of public concern and need for mitigating policies, the shipping industry has sought actively to curtail the negative environmental effects arising from the shipping sector [1]. At the international level, various legal instruments and controls have been provided to encourage regulation and enforcement by flag states, coastal states and port state control. For example, the International Maritime Organization (IMO) Convention on Marine Pollution,

MARPOL 73/78 outlines measures aimed at completely eliminating the wilful and intentional discharge into the seas of oil and noxious or hazardous substances – chemicals, packaging, sewage and garbage. Specifically Annexes I, II, III, IV, V and VI of MARPOL 73/78 identify these sources and by their provisions, port authorities are obligated to provide reception facilities for handling of a range of wastes including oil, chemical and garbage. Ports are also required to produce Port Waste Management Plan, including information on type and location of facilities, notification requirements, details of providers and costs. These plans are to be made available to port users, to ensure that vessels needs are met promptly and with no undue delay.

Measures so far applied by IMO in terms conventions and enforcement by flag states, coastal states and port state control have yielded fruitful results especially in curtailing pollution from accidental spills arising from collisions, see reference [4]. However, pollution from non-accidental sources continues unabated and some port authorities have been found wanting regarding provision of requisite port waste reception facilities. The implication is that rising levels of marine pollution from ship based discharges are expected in these ports in the long run. For example, between the years 2008 and 2011, there were about thirty-two percent (32%) and eighteen percent (18%) increases in quantities of garbage and oily wastes handled respectively, in Nigeria's Tin Can Island port reception facilities alone [5].

The Research Problem

Inadequate waste reception facilities in developing countries' ports are such that vessels have no choice but discharge wastes at sea [6]. 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 [7]. In West and Central African ports specifically, 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, [8]. In Nigeria for example, the Nigeria Ports Authority (NPA) - custodian of national ports does not own or operate waste reception facilities but outsourced that responsibility to a private pollution control company. In the words of the port Authority's managing director, Mohammed [9] the private pollution control company is to provide port reception facilities in all the four (4) 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 [9]. In addition, this company is given the additional responsibility of monitoring waste discharge from vessels visiting 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. Against this background, this paper proposes an administrative model for monitoring and controlling ships' source marine pollution. To achieve the specific objectives of this paper, the following are examined:

1. type of ship generated waste water from vessels berthed at the ports.

2. provisions of IMO conventions on marine pollution.
3. role of port state control, coastal and flag states in marine pollution control
4. legal framework for control of marine pollution in Nigeria

This study will be limited to the analysis of marine pollution from ships in the ports, the regulatory environment of port pollution and implications for an administrative framework for controlling ship-source marine pollution in seaports.

2. Conceptual and Literature Review

2.1. Sources of Marine Pollution

2.1.1. Land-Based Sources of Marine Pollution

On a global scale it is generally recognised that marine pollution is mainly caused by human activities based on land and much less by human activity taking place at sea [10]. Land-based pollution of the coastal and marine areas is also a growing problem in the West African Marine Eco Region [3]. Waste waters from industries carry numerous and different pollutants that frequently end up in the marine environment. Closely related to the land based sources is agricultural source pollution. Chemical residues, fertilizers and soil from agricultural sources are washed by rivers into oceans [3]. This causes eutrophication (over-enrichment with nutrients) in coastal wetlands and estuaries, resulting in biodiversity loss and presumably in the proliferation of toxic marine micro algae [10].

2.1.2. Offshore Oil Exploration and Production

Offshore oil production employing marine vehicles (e.g. mobile rig platforms etc.) is another source of marine pollution. Drilling fluids and other chemical often inadvertently, get discharged into the sea during oil production on rig platforms. The general impacts of exploration and exploitation include, solid and liquid production wastes, increased water column turbidity from dredging, disturbance of the sea bed areas. Others are, avoidance of the area by marine wildlife such as fish and marine mammals due to construction noise, vibration and the presence of erected facilities, and possible invasions of non-indigenous species carried in ballast water of support vessels and oil tankers ([11]; [12]; [13], cited in [3]).

2.1.3. Maritime Transport Based Sources

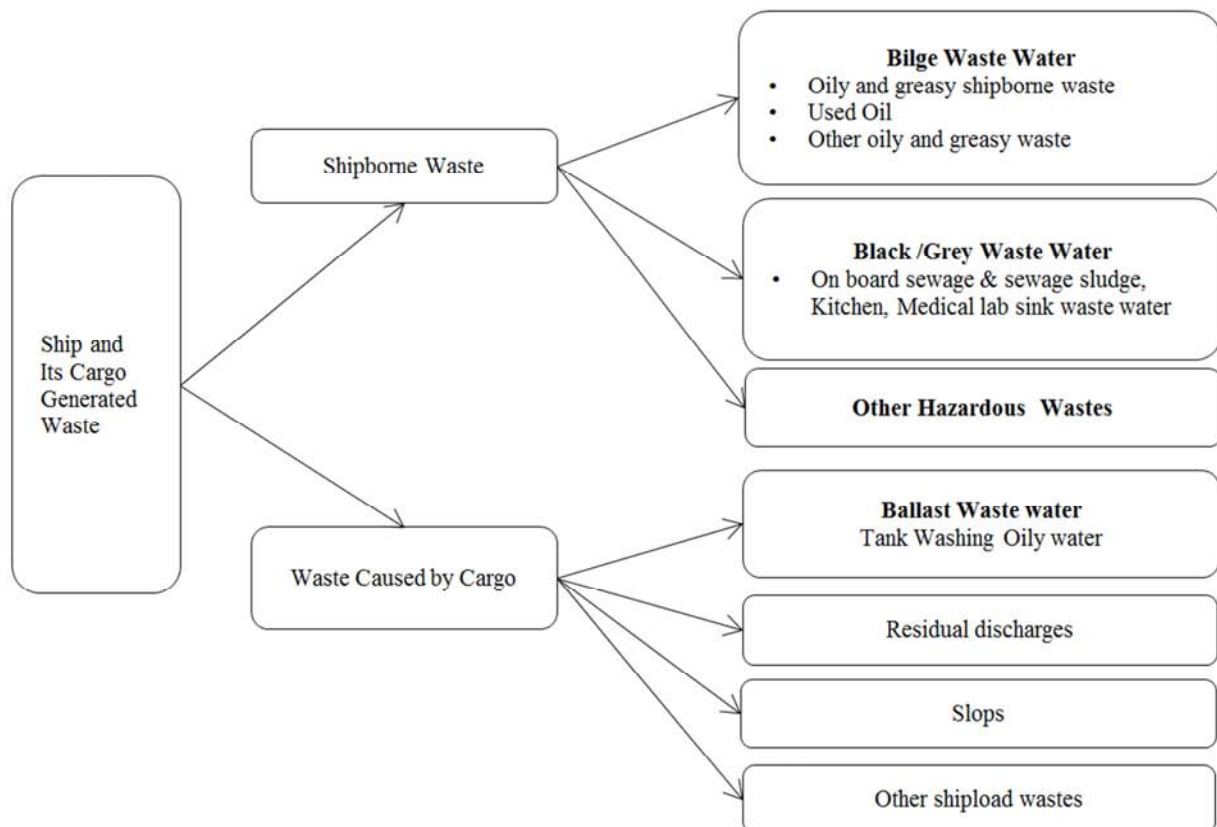
Maritime traffic through the sea constitutes another source of marine pollution. Maritime traffic consists of movement of dry bulk vessels and numerous oil tankers which navigate inland and along coastal waters. Oil Tanker vessels' cleaning operation produces oily mixture which may find its way into the sea. Various techniques have however been developed to reduce pollution through these sources; notable ones being use of segregated ballast tanks, slop tank, Load on Top System (LOT) and Crude Oil Washing system (COW). Closely related to maritime transport based sources of pollution is anti-fouling paints applied on ship hulls. These

paints often contain potent biocides such as Tributyltin (TBT). Biocides reduce the encroachment of marine organisms on the ship's hull. But these substances also leach into the marine environment and may adversely affect several non-target species. The impacts of shipping on the marine environment however can be grouped thus, according to reference [14]:

1. Pollution by oil and hazardous or toxic substances from incidental, operational and illegal discharges;
2. Air pollution through emissions and particulate matter from engine exhaust gases and cargo tanks which may be carried over long distances;
3. Discharge of operational wastes from ships, including discharge of raw sewage and garbage (litter);
4. Release of toxic chemicals used in anti-fouling paints and leaching of heavy metals from anodes;
5. The introduction of non-indigenous organisms through ships ballast water and associated sediments, and fouling on ships' hulls;

6. Pollution and physical impact through loss of ships and cargo;
7. Physical and other impacts including noise and collision with marine mammals.

The effect of these are mainly noticeable in busy shipping lanes and harbours, impact in or close to ecologically sensitive areas or may be more significant in coastal areas [15]. Figure 1 classifies ship-borne waste which may be discharged in deep sea, inland waters or at the ports in the absence of reception facilities. This research concentrates on ship generated waste water including ballast waste water and waste water from domestic activities of crew living onboard. Accordingly, ship generated waste water have been grouped by three basic types: Bilge waste water, Black waste water (sometimes Grey waste water is included to describe waste water free from human faeces) and Ballast waste water, see also figure 1. These are discussed in the proceeding paragraphs:



Source: Adapted from ([12], cited by [13])

Figure 1. Classification of ship and cargo generated waste discharged in and out of port environment.

2.1.4. Black Waste Water

Sewage from vessels also known as “black water,” generally means human body waste-water from toilets and other receptacles intended to receive or retain bodily wastes. The principal international convention addressing discharge standards for vessel sewage is Annex IV of the International convention for the prevention of pollution from ships (known as MARPOL 73/78, or simply MARPOL). MARPOL Annex

IV contains regulations regarding the discharge of sewage into the sea, ships' equipment and systems for the control of sewage discharge, a provision for facilities at ports and terminals for the reception of sewage, and requirements for survey and certification. MARPOL Annex IV generally requires ships to be equipped with either a sewage treatment plant, a sewage comminuting and disinfecting system, or a sewage holding tank.

2.1.5. Bilge Waste Water

Bilge water is the mixture of water, oily fluids, lubricants, cleaning fluids, and other similar wastes that accumulate in the lowest part of a vessel from a variety of different sources including the main and auxiliary engines; boilers, evaporators and related auxiliary systems; equipment and related components; and other mechanical and operational sources found throughout the machinery spaces of a vessel. It is not uncommon on ships for oil or water to leak into the bilge from these sources: various seals, gaskets, fittings, piping, connections, and from related maintenance and activities associated with these systems. In addition to containing oil and grease, bilge water may contain solid wastes such as rags, metal shavings, paint, glass, and a variety of chemical substances [16]. Depending of the types of ship visiting ports, the amounts of bilge water which are delivered could fluctuate between 50 and 30,000 litres per service. The number of services can be estimated at 2.4 - 3 disposal services per ship and year, see table 1, which means that about 9 m³ of bilge water are produced annually [17]. Bilge water regulations are contained in Annex I to the MARPOL 73/78 Convention.

Table 1. Average Amount of Bilge Water for Different Types of Vessels.

Type of Vessel	Average Amount of Bilge Water (M ³ /Service)
Motorised Cargo Vessel	3.7
Tanker ships	4
Push boats	3.5
Passenger liner	1.8

Source: ([15], cited by [16])

2.1.6. Ballast Waste Water

Ballast water is bunkered to stabilize vessels and regulate the draft. If necessary, it is discharged into the waterway long distances away from the origin source. Discharged ballast water could contain pathogens, and moreover be a travel medium for invasive species, which may reproduce rapidly under the new environmental conditions and become ecological pests [18]. Some of the non-indigenous organisms ever introduced to some countries through ballast water include: The Eurasian zebra mussel (*Dreissena polymorpha*), The American comb jelly (*Mnemiopsis leidyi*), The Japanese brown kelp (*Undaria pinnatifida*), The Japanese brown kelp (*Undaria pinnatifida*), Southeast Asian dinoflagellates of the genera *Gymnodinium* and *Alexandrium* etc. [19]. These organisms have cost enormous resources in efforts to contain their negative impacts on marine environment [20].

IMO ballast water management convention (which came into force in the year 2005) delineates the measures that the signatory states must take to minimize risk to the environment, human health, and resources from the transfer of harmful aquatic organisms and pathogens by ships' ballast water and sediment. It requires each state to develop national policies for ballast water management for ships, ports and waters under its jurisdiction. Each must ensure that ballast water sediment reception facilities are provided in the

appropriate ports and terminals. So far, only few countries have ratified the convention and they are: Barbados, Egypt, Kenya, Kiribati, Maldives, Mexico, Nigeria, Norway, Saint Kitts and Nevis, Sierra Leone, South Africa, Spain, Syrian Arab Republic and Tuvalu [7].

2.2. Existing Legal Framework for Controlling Marine Pollution

The International legal framework for addressing vessel source pollution is described in the United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS provides that the legislative and enforcement jurisdiction of a state over a particular vessel varies depending on whether the state is a flag, coastal or port state. The convention has created a uniform system that seeks to safeguard the freedom of navigation and the interest of coastal states in protecting and preserving the marine environment within their jurisdiction [20]. In addition to UNCLOS, vessel source pollution is governed by the various conventions adopted by the International Maritime Organization (IMO). The global mandate of the IMO is implicitly acknowledged in UNCLOS through the expression "competent international organization." The IMO is responsible for setting the standards at the international level to prevent vessel source pollution. These include: discharge and emission standards; construction, design, equipment, manning standards and navigational standards. Parties to all Imo conventions are under obligation to domesticate the provisions of the conventions in their national laws. It is also expected that relevant government agencies or designated organization are set up to enforce compliance to these laws.

In Nigeria, the scope of legal framework in place mainly covers prevention of oil pollution in the petroleum sector. Typical examples of these laws/Acts are Mineral Oil Safety Regulation 1963, Oil in Navigable Waters Regulation 1968, Petroleum Regulations 1967, Petroleum (Drilling and Production) Regulation 1973 and Petroleum Refining Regulation 1974 [21].

Other regulatory measures relating to pollution control can be inferred from the mandate of some of the Nigerian government parastatals established to regulate oil pollution. Examples include: the Federal Environmental Protection Agency (FEPA), now subsumed under Federal Ministry of Environment (FME), which issues standards for water, air, land quality and oil companies operations, The Nigeria Environmental Protection and Department of Petroleum Resources (DPR); which issue environmental guidelines and standards for the petroleum sector in Nigeria and National Oil Spill Detection and Response Agency (NOSDRA) which mandate is to co-ordinate and implement the national oil spill contingency plan. The Nigeria Ports Authority (NPA) as the custodian of Nigeria ports has institutional mandate to provide waste reception facilities. The Authority maintains a pollution monitoring unit even though it has contracted out its waste management responsibility to a private company. However, the Nigeria Maritime Administration and Safety Agency (NIMASA) by the decree establishing it, appears to

be the only parastatal with specific mandate to ensure pollution prevention and control in the marine environment through implementation of domesticated international maritime (IMO) conventions. Thus, the administrative framework in place for controlling pollution in Nigeria depicts overlapping functions of the parastatals involved and represents a potential source of conflict; figure 2 captures essence of this scenario.

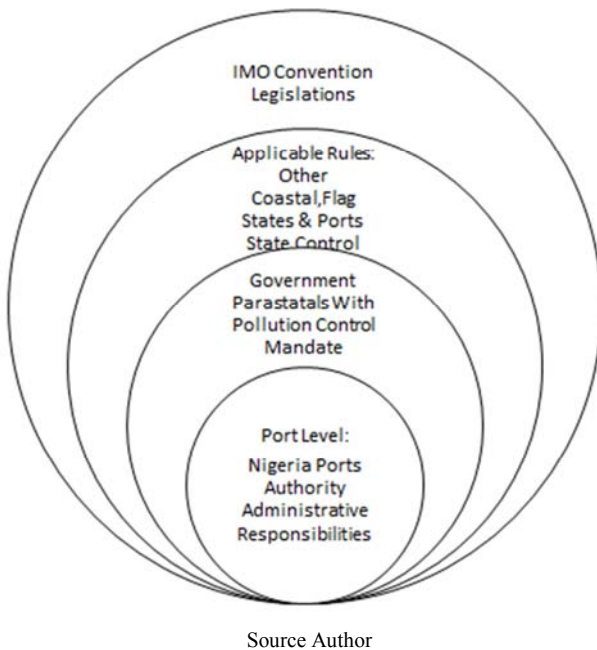


Figure 2. *Overlap of Responsibilities in Management of Marine Pollution: Major Pollution Control Interests.*

2.3. Empirical Studies on Marine Pollution

Few papers specifically examined effects of marine pollution on marine resources in West African coastal region and particularly Nigeria's ports and inland waters. Some of these studies concentrated on identification of the sources and their potential effects. Examples include [22], who identify sewage, industrial effluents, plastics that float on water and other abandoned objects other than vessel based ones, as sources. According to Elenwo and Akankali [22], specific effects of these on marine environment include: degradation, thermal pollution which adversely affects the ecosystem. Others include: eutrophication arising from untreated wastes which can kill sea animals and plants and depletion of dissolved oxygen which affects Biochemical Oxygen Demand (BOD) with obvious implications among others; these findings are consistent with reference paper [23]. A similar study; [2] identify additional marine pollutants namely: oily water discharge from tanker accidents, accidental oil discharge during routine operations, waste water, garbage and solid waste from vessels. Additional sources also include: ballast water or that from machinery spaces, exhausts and antifouling paints from vessel hulls.

However, other papers focused more on examination of

legislations and framework for enforcement of applicable conventions for control of marine pollution. Notable ones include: [21], who examined organizational and institutional framework of oil spillage and pollution management in Nigeria. Specifically they appraised the relevant laws (including international agreements) enacted by the government of Nigeria since 1963 which aim at mitigating the incidence of oil pollution. In addition, they also examined the relevant agencies established to implement procedures bordering on oil pollution and management during oil prospecting or production activities. Companion paper [19], advocate for setting up of a uniform system for managing ship-borne waste. According to the authors such uniform framework would spell out uniform measures for collection and treatment of oil and greasy, cargo and other ship waste.

In terms of challenges in implementation of prescriptions of relevant pollution control legislations, authors of reference paper [1] identify the constraints in the enforcement of low sulphur marine regulation fuel within the Baltic and North Sea's Emission Control Areas (ECA's) (comprising UK and Sweden in particular). Marine fuel burnt in vessels operating within ECA's is limited to 0.1% in sulphur content. In the alternative, sulphur abatement technologies should be employed where high sulphur content marine fuel is used. Their study demonstrates the weakness in enforcement measures based on paper work only; without analysis of water quality to confirm compliance.

Although the above reviews are limited, their findings are rather instructive considering the focus of the present study. For example, it has been established that pollution based on marine sources has negative impacts on marine resources which ultimately affect economy of littoral states, see studies by [22] and [2]. Mitigation measures in form of enforcement of IMO regulations have been hampered by lack of effective and commonly acceptable framework for implementation; see reference paper [22]; [1]; and [20] who advocate for regional model of enforcement and provision of waste reception facilities and financing based on electronic Vignette system. Yet, reference paper [8] contends that waste handling facilities in West and Central African countries are inadequate. This position is also consistent with paper with reference [4]. Author of reference paper [6] however, posits that some developing countries face financial constraints in provision of adequate waste handling facilities in their ports.

From the review, it is established among other challenges that adequate reception facilities and robust monitoring/control mechanisms are lacking in most countries' ports, Nigeria ports inclusive. For example, authors with reference [1] identify weakness in pollution control framework model in place that does not account for prevailing pollution levels. This paper attempts to address present research gaps by proposing an integrated model for management of pollution in marine port environment. The proposed model recognises inputs from the different actors (i.e. national government parastatals with similar pollution control mandate) including influences from international pollution control organisations. This model envisages an

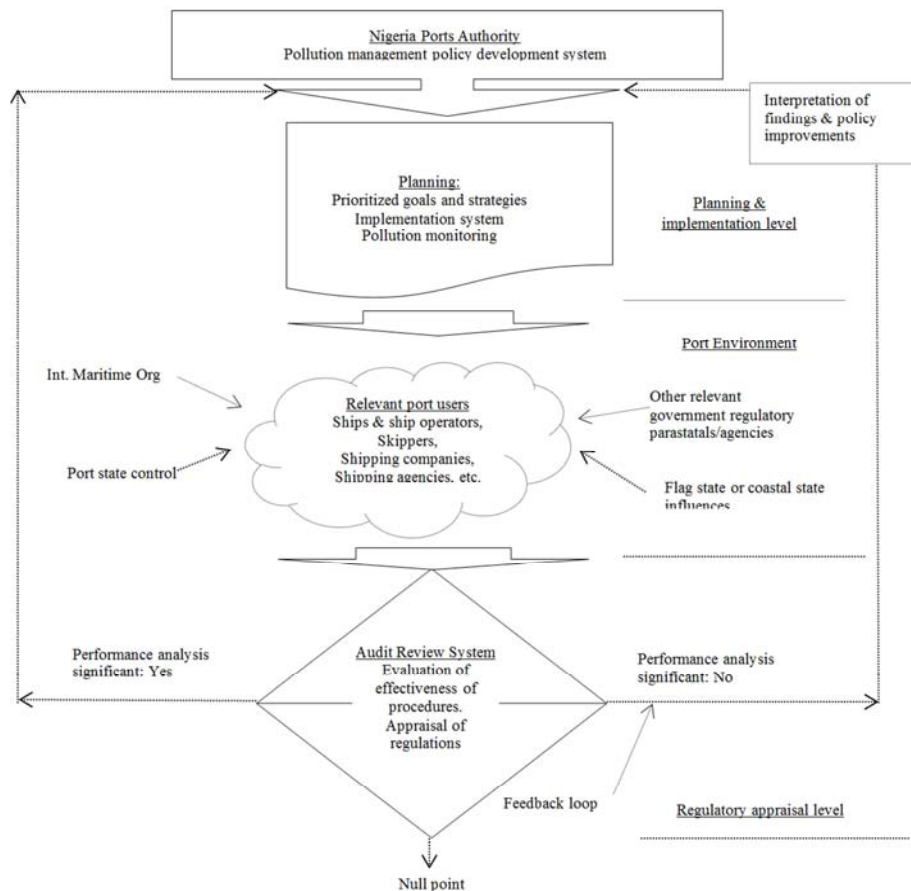
integrated approach that should be adopted by port pollution control administrators.

3. Development of Integrated Framework for Marine Pollution Control

As pointed out in section 2.2, the regulatory authorities namely: the Port Authority- NPA, NIMASA, FEPA, DPR and NOSDRA by the Acts establishing them, have a responsibility to control marine pollution. The overlap of functions existing among them presents areas of conflict of interests. Given this setting, the port authority for example, is not in direct control of pollution control framework in place since it uses a contracting company which is also self-monitoring. Thus, the present scenario therefore casts doubt on outputs regarding marine pollution control in the ports. In this circumstance, we propose an integrative administrative model which incorporates inputs from participating parastatals and specifies for overall coordinating parastatal or authority. In addition this model incorporates inputs from international laws/conventions and obligations in respect of marine pollution as a basis for continuous performance benchmarking.

4. Theoretical Model for Pollution Management and Control in the Ports

1. In figure 3, we articulate the elements of the proposed hybrid model framework. The framework presented in figure 3 aims at introducing a systematic approach to dealing with administrative issues of pollution connecting ports authority, other government agencies with pollution control mandates, and relevant port users (or pollution generators) within the port environment. The framework developed has four parts:
2. a port policy development system, which should produce a general policy statement that relies on identifying and understanding relevant environmental concerns, legislation and pollution generating activities of port users (ship operators/skippers, shipping companies/agencies);
3. a general management system for formulating management-acceptable, prioritised strategies and goals;
4. an implementation system: the mechanism by which the planned improvements are implemented by all stakeholders: port authority and other government agencies.
5. an audit and review system which evaluates the effectiveness of the procedures and determines whether or not they have been carried out.



Source: Authors' own elaboration

Figure 3. Elements of Integrated administrative framework model for marine pollution administration in ports.

5. Discussion

It was found that ship source pollution in the ports essentially emanate from black waste water, bilge waste water and ballast waste water. Their negative impacts on the marine environment have been proven to cost enormous resources to contain according to [20]. Research evidence suggests that pollution from ship based sources has an increasing trend [5] hence adequate facilities are needed in the ports. In recognition of the overlapping and hence weak administrative framework for controlling marine pollution in the ports where provision of waste reception facilities is outsourced, an integrative model is recommended. This model as part of its features incorporates inputs from all relevant government agencies with pollution management mandate. In addition, inputs from the external environment in form of IMO conventions, their subsequent introductions, port state controls and other relevant legislations from coastal, flag and port state control are also incorporated in the model framework. The model thus developed can also be applied for assessing the effectiveness of the pollution control measures in the port sector.

6. Conclusion

Marine pollution management in Nigeria ports' environment requires a coherent framework given the multiplicity of actors involved (the ports authority and other agencies whose interests may potentially undermine results). The present paper proposed the adoption by the federal government of Nigeria of an integrated model for marine pollution administration in port environment. The federal government should constitute a supervisory parastatal vested with the responsibility for coordinating the activities of all the agencies involved. Future studies should adopt techniques of quantitative analysis to further validate the model developed in this study.

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