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Information System Adoption and Pollution Prevention in Maritime Industry in Nigeria

OKEKE KINGSLEY JIDEOFOR[1], NWABUEZE EBERE[2], ENYIOKO NEWMAN[3]
[1, 2, 3]*Department of Maritime Science, Rivers State University, Port Harcourt, Rivers State, Nigeria.*

Abstract- The study examined the effect of information system adoption on pollution prevention in maritime industry in Nigeria. The population of the study consisted of 350 staff in the five surveyed government organizations in Nigeria. The study through the use of Monkey Survey, sampled 400 managerial staff of NIMASA and validly used 310 respondents representing 77.50% response rate for data analysis. Computer-based information system marine information system and information technology integration system were used as the dimensions of information system adoption in this study. The study used prevention of water pollution, prevention of marine plastic pollution and prevention of oil/gas pollution to measure pollution prevention. The study used a questionnaire to elicit information from the respondents. The study applied descriptive and inferential statistical tools to analyze the data and test the hypotheses with the help of SPSS 22.0. Results shows that computer-based information system has significant effect on prevention of water pollution. The study also revealed that information technology integration system has no significant effect on prevention of water pollution marine information system has no significant effect on prevention of marine plastic pollution and information technology integration system has no significant effect on prevention of oil/gas pollution of government organizations. The study concludes that the adoption of information system helps in diverse ways to prevent pollution in the maritime sector

Keyword: Maritime Information System, Marine Pollution, Plastic Pollution, Computer Based System

I. INTRODUCTION

In recent years, the advancement of technology has enhanced handling and delivering of services in many aspects of our lives such as maritime, businesses, governance, industrialization, socialization, communication and education (Drew, (2023). Specifically, information system adoption is regarded as a game changer, and a catalyst that improves accessibility to information and services (Tan et al., 2021). The International Maritime Organization (IMO) has adopted more than 25 major Conventions on maritime safety, pollution prevention and liability and compensation and a large number of free-standing mandatory and non-mandatory codes. These instruments have been successful in drastically reducing vessel-sourced pollution and illustrate the commitment of the Organization and the shipping industry towards protecting the environment (Ebad, 2020). EU regional measures complement or enhance the international regulatory regime. In addition, industry has developed its own processes of self-regulation in order to make shipping safe and efficient. The International Safe Management (ISM) Code originates from industry standards and is mandatory across all ships, with obvious beneficial effects. Other examples are the Ship-to-Ship Transfer Guides, the International Safety Guide for Oil Tankers and Terminals, the Safety Guides for tankers and the Ship Inspection Report Programme (SIRE) and the various Classification Societies rules and detailed requirements. However, safety and pollution prevention depend on a chain of collective responsibility, namely flag states, port states, shipowners, ship operators, seafarers, classification societies, insurers and charterers.

Information system (IS) adoption has a significant positive impact on pollution prevention in Nigeria's maritime industry by enabling better management of waste, tracking, and compliance with regulations. Despite the potential, challenges exist, including the need for integrated frameworks, better infrastructure, and the proper integration of various port and agency systems to effectively reduce issues like oil spills and waste discharge (Wang et al., 2021). Thereby, making document management a necessity for the survival of businesses. Information system adoption is a corporate function that has a critical potential in supporting credibility if its principles and values are appropriately implemented. In the absence of proper information system adoption, transparency, accountability and efficiency in public sector would be heavily compromised. Digital automation are the known tools for demonstration of credibility and identification of corruption and other irregularities in maritime sector. Sinay (2023) argues that the development and application of risk assessment and management techniques to maritime security must take into account the complex regulatory and operational context in which the maritime industry operates.

Thielsch and Hirschfeld (2019) maintain that the ability of the maritime sector to protect the rights of the staff and stakeholders and to improve worker-management interaction is a critical issue in an increasingly information system adoption. International Also, Chaputula (2022) emphasizes that information system adoption n the maritime industry a number of administrational management systems are used to provide information and to support decision making both onboard the vessels and ashore in the shipping companies´ offices. Examples of the systems' functionality are financial-, chartering and operations-, personnel-, safety-, quality, document-, procurement-, and maintenance management. In addition there are a number of technical management systems supporting various functions onboard such as navigation-, propulsion & manoeuvring-, machinery monitoring & control-, cargo handling-, and trim & stability systems. The various administrational systems are often utilising distributed databases with a ship specific database onboard and a common database in the office, either system by system, or with integrated functionality of multiple systems with a common user interface. The information is replicated both ways ship/shore and the communication are often performed via satellite lines. Despite that there has been some market consolidation amongst suppliers, the flora of systems and suppliers are ever increasing as well as the systems' functionality of supported processes. In an era dominated by data, the ability to efficiently manage and analyze information is vital (Akintoye, 2015).

Information system adoption provides a structured approach to storing and retrieving data, facilitating better decision-making. Businesses can analyze trends, track performance metrics, and make informed strategic decisions, essential for sustainable growth. Information system adoptions cater to this trend by allowing remote access to documents and enabling collaboration across geographical boundaries. This flexibility is essential for organisations looking to prevent pollution (Giba-Fosu, 2020).

Implementing a information system adoption is more than an operational choice; it's a strategic decision that lays the foundation for future growth. The revolution in information and communication technology in the modern business, social, political organizations and institutions' activities, expedited the advancement in knowledge, and has no doubt impacted the work processes, especially in the public sector organizations, where hitherto, work was drudgery due to reliance on manual applications. Many organizations have adopted the computerized methods of document handling and the use of databases for data analyses and storage. The need to save time, effort and cost has led to the escalation in the number of organizations and institutions adopting electronic formats of document management.

A decade ago, business records were stored and managed on paper, usually regarded as a manual approach. This manual-based approach is characterized by lots of inefficiencies and work-related issues like high time consumption, errors and redundancy during information collection, storage, and retrieval (Abdullah et al., 2019). Due to the dynamic nature of modern organizational operations, including the public sector organizations that require maintaining operational standards of speed, accuracy, and wider coverage, electronic documentation becomes an operational solution. This is in order to ensure interoperability of services, favourable competition and seamless sharing of information.

Several studies have been done to examine the adoptability of information system adoption among government establishments, but few empirical studies have been carried out to ascertain the level of information system adoption among public sector organizations, especially in the developing countries (Al-Darwish & Choe, 2019; Ebad, 2020). This show of indifference, especially in the public sector organizations among the developing nations, which includes Nigeria, may have been triggered by certain fears or threats that relates to the safety or security of vital information stored or housed by the electronic documents.

Pollution prevention in maritime sector is all about preventing information from being leaked, distorted and destroyed. It is also about having the right information available to the right people, and at the right time. Information should not fall into the wrong hands and be misused. Pollution prevention in maritime sector applies to both individuals and organizations, both in business and in public activities. Pollution prevention in maritime sector (IS) therefore covers the whole of society. Pollution prevention in maritime sector covers the tools and processes that organizations use to protect information. This includes policy settings that prevent unauthorized people from accessing business or personal information. IS is a growing and evolving field that covers a wide range of fields, from network and infrastructure security to testing and pollution prevention. Pollution prevention in maritime sector protects sensitive information from unauthorized activities, including inspection, modification, recording, and any disruption or destruction. The goal is to ensure the safety and privacy of critical data such as customer account details, financial data or intellectual property. The consequences of security incidents include theft of private information, data tampering, and data deletion. Attacks can disrupt work processes and damage a company's reputation, and also have a tangible cost.

Research Questions

The following research questions have been raised based on the objectives of the study:

i. What is the significant effect of information system adoption (computer-based information system (CBIS), marine information system (MIS) and information technology integration system (ITIS)) on prevention of water pollution?
ii. Has information system adoption (computer-based information system (CBIS), marine information system (MIS and information technology integration system (ITIS)) any significant effect on prevention of marine plastic pollution?
iii. To what extent does information system adoption (computer-based information system (CBIS), marine information system (MIS and information technology integration system (ITIS)) have significant effect on prevention of oil/gas pollution?

Research Hypotheses

The following research hypotheses have been formulated and will be tested in this study:

Ho_1: Information system adoption (computer-based information system (CBIS), marine information system (MIS and information technology integration system (ITIS)) has no significant effect on prevention of water pollution.

Ho_2: Information system adoption (computer-based information system (CBIS), marine information system (MIS and information technology integration system (ITIS)) has no significant effect on prevention of marine plastic pollution.

Ho_3: Information system adoption (computer-based information system (CBIS), marine information system (MIS and information technology integration system (ITIS)) has no significant effect on prevention of oil/gas pollution.

II. LITERATURE REVIEW

Theoretical Review

Theories are formulated to explain, predict, and understand phenomena and, in many cases, to challenge and extend existing knowledge within the limits of critical bounding assumptions. The theoretical framework is the structure that can hold or support a theory of a research study. The theoretical framework introduces and describes the theory that explains why the research problem under study exists (Ghauri et al., 2020). A theoretical framework is a foundational review of existing theories that serves as a roadmap for developing the arguments used in the research work. Theories are developed by researchers to explain phenomena, draw connections, and make predictions. In other words, your theoretical framework justifies and contextualizes your later research, and it's a crucial first step for any research. A well-rounded theoretical framework sets up the researcher for success later on in the research and writing process. In this section, the theories backing the study have been examined, they include Protection Motivation Theory (PMT), Technology Acceptance Model (TAM) Theory, Instrumental Theory, Substantive Theory and Innovation Diffusion Theory (IDT)

Protection Motivation Theory

Protection Motivation Theory (PMT) was introduced by (Rogers, 1975) and further revised in 1983 (Rogers, 1983) to explain the impact of persuasive communication on behaviour, with an emphasis on cognitive mechanisms underpinning the rationale to follow or not to follow a recommended behaviour. The theory was originally conceptualized for the utilization in the healthcare context (Conner & Norman, 2015). There were several practical and theoretical premises underpinning the development of the theory (Conner & Norman, 2015; Prentice-Dunn & Rogers, 1986). In terms of practical importance, PMT was one of the first theories focusing on the psychological conditions explaining the tendency of people to protect themselves. The theory attempted to distinguish the factors of health-compromising and health-promoting behaviours (Prentice-Dunn & Rogers, 1986; Floyd, Prentice-Dunn & Rogers, 2000). For example, despite the logic of avoiding threat and danger when recommended, individuals may still choose to engage in maladaptive behaviour. Protective behaviours, such as using seatbelts, regular physical examinations, a healthy lifestyle, refraining from mobile phone use while driving, avoiding driving under the influence and using helmets while cycling could be taken to prevent injuries. However, people often do not adhere to preventive measures (Floyd, Prentice-Dunn & Rogers, 2000; Taylor, 2017; Rogers & Prentice-Dunn, 1997).

Protection Motivation Theory (PMT) is a theoretical framework that explains how individuals perceive and respond to threats. It can be applied to various contexts, including information system adoption, to understand and promote secure behaviors. In applying PMT to EDM, there is need to appraise the level of threat - perceived threat, perceived vulnerability to threat and perceived response efficacy. The organization need to assess the perceived threats associated with information system adoption, such as unauthorized access, data breaches, information leakage, or loss of important documents; communicate the potential consequences of these threats, emphasizing their severity and likelihood; highlight the individual's vulnerability to these threats, emphasizing that anyone can be a target and emphasizing the consequences of complacency or negligence; explain the effectiveness of specific security measures and best practices for information system adoption; and demonstrate that taking proper precautions can effectively mitigate the identified threats.

Technology Acceptance Model (TAM)

The introduction of a new technology or operational system, requires that those to apply it, accepts it. The introduction of information system adoption programme in an organization, needs the acceptance of the employees. Although, TAM was originally proposed by Fred Davis in 1985 as a doctoral thesis at the Massachusetts Institute of Technology, current literature indicates that TAM is a highly cited model. Chuttur (2009) argues that the wide acceptance of TAM is based on the fact that the model has a sound theoretical assumption and practical effectiveness. From the time is was proposed in 1985, the model has been refined so as to incorporate variables and relationships obtained from the Fishbein and Ajzen theory of reasoned action (TRA) of 1975. According to (Fishbein, & Azjen,1975), this model is grounded in social psychology theory in general and the Theory of Reasoned Action (TRA) in particular. TRA asserts that beliefs influence attitudes, which lead to intentions and therefore generate behavior. This model has therefore become one of the most widely used models to explain user acceptance behavior.

According to Oye, et al. (2012), an information system adoption (EDM) project will typically go through three phases: planning, implementation and enhancement. This phased process is aimed at providing guidance for the successful implementation and sustainability of the project. There are other specific areas of adoption of TAM identified by researchers. Moon & Kin (2001) used the model to explain the users' acceptance of World-Wide-Web in an educational context; Lin et al. (2007) in Chen & Chen et al. used the model in clarifying e-stock users' behavioral intention, Chen & Chen et al. (2001) adopted the model while investigating automotive telematics users' intention while Stern et al. (2008) used the model in their studies on consumers' acceptance of online auctions. Other researchers, Serenko et al. (2007) used the model to assess user acceptance of interface agents in daily work applications whereas Muller-Seitz et al. (2009) used the same model to determine customer acceptance of Radio Frequency Identification (RFID). Almasri (2014) argues that TAM is an acceptable model and has been employed in many information technology and information system areas such as e-learning, World-Wide-Web, online auctions, Radio Frequency Identification (RFID), e-portfolio systems, wireless LAN, E-government, Ecommerce, internet banking, and mobile learning. In this regard therefore, TAM is a model that can inform technology designers on the impact of the system to the user's behavior. Alharbi & Steve (2014) supports that TAM has been adopted and tested as a useful framework in the field of information science and Learning Management Systems. Many others scholars such as Seyal et al. (2014) also attests that TAM is a sufficiently influential research model, whose tools have provided statistically reliable results.

Instrumental Theory

Instrumental theory offers the most widely accepted view of technology. It is based on the common-sense idea that technologies are "tools" standing ready to serve the purposes of their users. Technology is deemed "neutral," without evaluative content of its own. However, what does the notion of the "neutrality" of technology actually mean? The concept usually implies at least four points. First technology, as pure instrumentality, is indifferent to the variety of ends it can be employed to achieve (Kenneth & Laudon, 2007). Thus, the neutrality of technology is merely a special case of the neutrality of instrumental means, which are only contingently related to the substantive values they serve. This conception of neutrality is familiar and self-evident. Secondly, technology also appears to be indifferent with respect to politics, at least in the modern world, and especially with respect to capitalist and socialist societies. A hammer is a hammer, a steam turbine is a steam turbine, and such tools are useful in any social context. In this respect, technology appears to be quite different from traditional legal or religious institutions, which cannot be readily transferred to new social contexts because they are so intertwined with other aspects of the societies in which they originate (Capgemini, 2008).

The transfer of technology, on the contrary, seems to be inhibited only by its cost. Thirdly, the socio-political neutrality of technology is usually attributed to its "rational" character and the universality of the truth it embodies. Technology, in other words, is based on verifiable causal propositions. Insofar as such propositions are true, they are not socially and politically relative but, like scientific ideas, maintain their cognitive status in every conceivable social context. Hence, what works in one society can be expected to work just as well in another. Lastly, the universality of technology also means that the same standards of measurement can be applied in different settings (Bitner et al., 2000).

Substantive Theory

Despite the common-sense appeal of instrumental theory, a minority view denies the neutrality of technology. Substantive theory, best known through the writings of Jacques Ellul and Martin Heidegger, argues that technology constitutes a new type of cultural system that restructures the entire social world as an object of control. This system is characterized by an expansive dynamic, which ultimately overtakes every prêt-technological enclave and shapes the whole of social life (Gray, Matear & Matheson, 2000). The instrumentalization of society is thus a destiny from which there is no escape other than retreat. Only a return to tradition or simplicity offers an alternative to the juggernaut of progress. Something like this view is implied in Max Weber's pessimistic conception of an "iron cage" of rationalization, although he did not specifically connect this projection to technology (Howells &Tether, 2004).

In adopting a strictly functional point of view, we have determined that eating is a technical operation that may be carried out with more or less efficiency (Howells & Tether, 2004). This example can stand for a host of others in which the transition from tradition to modernity is judged a progress by a standard of efficiency intrinsic to modernity and alien to tradition. The substantive theory of technology attempts to make us aware of the arbitrariness of this construction, or rather, its cultural character (Thomas, P. & Michael, 2011). The issue is not that machines have "taken over," but that in choosing to use them we make many unwitting cultural choices. Technology is not simply a means but has become an environment and a way of life. That is its "substantive" impact. It seems that substantive theory could hardly be farther from the instrumentalist view of technology as a sum of neutral tools. Yet I will show in the next section that these two theories share many characteristics that distinguish them from a third approach I will introduce, the critical theory of technology (Gray, et al., 2000).

Diffusion of Innovations Theory

The Diffusion of Innovations theory offers a framework for understanding the process by which new technologies spread and is adopted within organizations and industries. Given the dynamic nature of digitalization in maritime logistics, this theory can help explain the factors influencing the adoption and diffusion of digital technologies among Nigerian seaports. By examining the characteristics of innovations, adopter characteristics, and communication channels, the study can identify key drivers and barriers to digitalization adoption in Nigerian seaports and provide recommendations for fostering diffusion.

The Diffusion of Innovations Theory, developed by Everett Rogers in 1962, provides a framework for understanding how new ideas, products, or technologies spread and are adopted within a social system over time (Rogers, 2003). This theory posits that the diffusion process is influenced by the characteristics of the innovation, the adopter's characteristics, communication channels, social networks, and the context in which the innovation is introduced (Rogers, 2003).

Hence, the Diffusion of Innovations Theory provides a valuable framework for understanding how new ideas, products, or technologies spread and are adopted within a social system. Recent research in maritime logistics and port operations has applied the Diffusion of Innovations Theory to analyze the factors influencing the adoption of digital technologies, highlighting the role of innovation attributes, adopter characteristics, communication channels, social networks, and the context in which the innovation is introduced.

Conceptual Review

Information System Adoption

Information system (IS) adoption refers to the process of introducing and using new information systems or technology within an organization or by individuals. It involves understanding how people or organizations accept, use, and integrate new technologies, including aspects like user acceptance and the factors that influence the decision to adopt a system (Adam et al., 2020).. This process is often studied through various models and theories, such as the Technology Acceptance Model (TAM) and the Diffusion of Innovations (DOI), which examine how individuals and organizations perceive and react to new technologies (Beau, 2018).

Information system adoption processes are combined in information and communication technology. Information technology makes use of telecommunications tools including phone lines, wireless networks, computers, business software, and other elements that make it simple to access, store, retrieve, and manipulate information. Information system adoption is a general term that is similar to information technology (IT), which refers to a variety of technologies used in information gathering, storing, preserving, and disseminating, including telecommunications networks, data centers, semiconductors, consumer electronics, etc. Emuakpor (2002) described ICT as all forms of technology applied to the processing, storing and transmitting information in electronic form; stressing that the physical equipment used for this purpose include computers, communication equipment and networks; fax machines and electronic, pocket calculator etc. More recent research extended the information system success model and additionally included trust as a central success factor for overcoming risks associated with using information systems (i.e. lack of control, potential errors (Brauner et al., 2019)). Trust was introduced to information technology research within earlier theoretical conceptualisations that differentiated human-technology trust from human-human trust. Showing that humans can develop trust in a technology itself, and not only in its human surrogates, this work paved the way for investigating and emphasising the role that trust plays as users develop usage intentions and behaviours toward a technology (Cabiddu et al., 2022). Based on these theoretical foundations Rainer and Prince (2021) recently developed a model on trust in information systems, that presumes information system adoption and trust development to be dynamic. Specifically, the authors assumed that trust in an information system leads users to develop usage intentions, which ultimately result in the use of the system, thereby enabling users to (re)evaluate their trust in the system in repeated feedback cycles.

Dimensions of Information System Adoption

Information system adoption can be understood through multiple dimensions, including organizational, management, and technology. The organizational dimension encompasses the structure, culture, and processes within an organization (Tam et al., 2019). The management dimension focuses on leadership, strategy, and employee behavior. The technology dimension involves the hardware, software, and infrastructure that support the information system (Bravo et al., 2015). Rainer and Prince (2021) classify five key dimensions of information systems

(IS): Context, People, Process, Information Technology (IT), and Information/Data. Subsequently, the propose is a shared organizational view for quality information systems (QIS), in the context of ISO 9001.

Computer-based information system (CBIS)

A Computer Based Information System (CBIS) uses computers to collect, process, store, and manage data and information to support decision-making and various organizational functions. It encompasses a wide range of systems, including transaction processing systems, management information systems, and decision support systems. CBIS relies on hardware, software, databases, telecommunications, people, and procedures to transform data into usable information (Bravo et al., 2015). The general term, computer-based information systems (CBIS), is a constellation of a variety of information systems, such as office automation systems (OAS), transaction processing systems (TPS), management information systems (MIS), and management support systems (MSS) (Tijan et al., 2024). Management support systems consist of decision support systems (DSS), expert systems (ES), artificial neural networks (ANN), and executive information systems (EIS) /executive support systems (ESS). Executive support systems are executive information systems with added decision support capabilities. The types of CBIS are based on the levels of management, ranging from non-management level (secretaries, clerical workers, etc.), operational level management, and middle level management, to top level (senior) management (Ebad, 2020).

Today, information systems are thought of as computer-based information systems. With the hype surrounding computers, it can blind people to the simple use of their five senses to gain information on which to make decisions and improve ones' law firm. For example, a client says that when he or she called the office the person on the other end was rude. A computer information system is not needed to tell the law firm that this situation has to be dealt with quickly and effectively (Yu et al., 2021).

The information also helps them supervise the operational level by giving managers specific activities that they should perform. Lastly, computer based information systems help senior management make decisions. The systems provide these managers with strategic information, which the managers use to make strategic or unstructured decisions. Such decisions may include setting the objectives and policies of the enterprise. The information they get also helps them to manage other managers within the organization. Senior management gets information from the system detailing trends in costs incurred by the enterprise or even the revenue trends. With this kind of information, senior managers can make decisions aimed at increasing revenues and reducing the costs incurred by the enterprise.

Marine information system (MIS)

Marine Information System (MIS) is a collection of tools and data used to manage and disseminate information about marine environments, activities, and regulations. These systems are designed to support marine licensing applications, decision-making, and marine plan implementation. They often include features like interactive maps, policy databases, and data on marine activities and resources (Turetken et al., 2019). The Marine Information System helps break the plans down into areas of interest so that the firm can really understand what it means for the community, company, industry and marine environment. This interactive tool allows the organization or industry to pick its own area of interest – from climate change to tourism and recreation – and see the plan policies that affect the industry. The organisation can also search geographically, to pinpoint a coastal town, a stretch of beach or an offshore area and see how the plans have taken activities, environmental features or other factors into account (Chasin et al., 2019).

The six identified units are: Service Unit, Operational Storage Unit, Knowledge Discovery Unit, Notification Unit, Graphical User Interface Unit, Environmental Decision Support System Unit. The two-sided component composed of a Workflow manager and a Communication infrastructure can be identified as the middleware of the system. The first part, the Workflow manager, orchestrates business processes in the MIS. An internal business logic engine is included for managing complex sequences of process executions and for coping with branching in the case of connection failures. The Workflow manager incorporates a scheduler of the event driven stream of information/requests. The Communication infrastructure covers the connectivity logic part of the MIS and manages the message-based communications between the single units and services, routing and transforming the needed data and requests.

Environmental Decision Support System - The Environmental Decision Support System (EDSS) is the component that constitutes the MIS intelligence and that is in charge for the detection and monitoring of oil pollutions. EDSS analyzes and combines the heterogeneous multi-source data acquired from several different sensors sources and from the different processing subsystems within the MIS itself . In order to properly detect and monitor oil slicks, issue alarms and support their management, advanced risk analysis models have been developed and applied for characterizing and monitoring the observed sites. In particular, a dynamic risk map is defined for assessing the hazard of oil slicks by evaluating several risk factors through the combination of the data collected by the MIS. This map is used for planning a *prioritization* of the available monitoring resources in order to improve the degree of monitoring and control of specific high-risk areas. This activity is performed autonomously in a proactive way by the MIS, so to improve the knowledge and degree of information about the monitored area. In more detail, as an example, the EDSS could ask a monitoring resource to perform a specific available analysis, or to repeat it with a different frequency, or to ask for a more detailed local monitoring with available resources such as Autonomous Underwater Vehicles, or floating buoys. The design of the EDSS required understanding of the likeliness of a pollution event is determined by the risk analysis or reported by the processing results of one of the other MIS subsystems, the EDSS is in charge of drawing an optimized plan of exploitation of the monitoring resources and of the data analysis models so as to confirm the detection of the event and issue an alarm.

The Concept of Pollution prevention in maritime sector

Information is central to the functioning of modern-day organizations, more specifically, information is the primary factor that holds organizations together (Wang et al., 2018). Safeguarding information in organizations is the responsibility of pollution prevention in maritime sector, which is an important area of information systems that carries several important functions in organizations, including: protection of organization's ability to function, assurance of safe operations of the organization's information technology (IT) infrastructure, and protection of organizational data, information, and other assets (Kumar & Bhatia, 2020). Pollution prevention in maritime sector protects sensitive information from unauthorized activities, including inspection, modification, recording, and any disruption or destruction. Pollution prevention in maritime sector is not only about securing information from unauthorized access. Pollution prevention in maritime sector is basically the practice of preventing unauthorized access, use, disclosure, disruption, modification, inspection, recording or destruction of information (Khidzir et al., 2018). Information can be physical or electronic one. Thus, pollution prevention in maritime sector spans so many research areas like cryptography, mobile computing, cyber forensics, online social media etc. During First World War, Multi-tier Classification System was developed keeping in mind sensitivity of information. With the beginning of Second World War formal alignment of Classification System was done. Alan Turing was the one who successfully decrypted Enigma Machine which was used by Germans to encrypt warfare data (Blaxter et al. 2006).

In medical fields, there have creating medical mobile apps for data transmission. A mobile medical application provides many functions and must meet the regulatory standards of all medical devices. Transmission of the patients' data need to be concerned because there are many deployment scenarios of medical mobile applications that need to be considered to ensure the security of data. Consequently, numerous incidents have occurred, for example, hackers target mobile applications in the form of malicious software to gain access to the servers or databases, unexpected data leaks, users download malicious software in the form of another application or bypassing most inbound filters are usually connected with corporate devices, making them vulnerableto malware attacks, download or an update from an untrustworthy source (Treacy & Mccaffery, 2017).

Measures of Pollution prevention in maritime sector

Pollution prevention in the maritime sector involves various measures to minimize the impact of shipping on the environment. These include regulations, technological advancements, operational changes, and waste management strategies, all aimed at reducing pollution from ships and ports. These principles help in protecting information in a secured manner, and thereby safeguard the critical assets of an organization by protecting against disclosure to unauthorized users (prevention of water pollution), improper modification (prevention of marine plastic pollution) and non-access when access is required (prevention of oil/gas pollution) (Dedić & Stanier 2016).

In 1973, IMO adopted the International Convention for the Prevention of Pollution from Ships, now known universally as MARPOL, which has been amended by the Protocols of 1978 and 1997 and kept updated with relevant amendments. The MARPOL Convention addresses pollution from ships by oil; by noxious liquid substances carried in bulk; harmful substances carried by sea in packaged form; sewage, garbage; and the prevention of air pollution from ships. MARPOL has greatly contributed to a significant decrease in pollution from international shipping and applies to 99% of the world's merchant tonnage.

Preventing marine or ocean pollution involves reducing plastic use, treating sewage before discharge, regulating industrial waste, promoting sustainable fishing, and implementing stricter sea waste disposal laws. Examples of pollution prevention include equipment or technology modifications, reformulation or redesign of products, substitution of less toxic raw materials improvements in work practices, maintenance, worker training, and better inventory control.

Prevention of Water Pollution

Water pollution can be defined as the contamination of water bodies. Water pollution is caused when water bodies such as rivers, lakes, oceans, groundwater and aquifers get contaminated with industrial and agricultural effluents. When water gets polluted, it adversely affects all life forms that directly or indirectly depend on this source. The effects of water contamination can be felt for years to come. Preventing water pollution involves a multifaceted approach, including proper waste disposal, reduced chemical use, and mindful water conservation practices. It also requires addressing industrial and agricultural runoff through effective treatment and management techniques. Finally, public awareness and community involvement are crucial for promoting sustainable water practices.

Water pollution, to a larger extent, can be controlled by a variety of methods. Rather than releasing sewage waste into water bodies, it is better to treat them before discharge. Practising this can reduce the initial toxicity and the remaining substances can be degraded and rendered harmless by the water body itself. If the secondary treatment of water has been carried out, then this can be reused in sanitary systems and agricultural fields. A very special plant, the Water Hyacinth can absorb dissolved toxic chemicals such as cadmium and other such elements. Establishing these in regions prone to such kinds of pollutants will reduce the adverse effects to a large extent. Some chemical methods that help in the control of water pollution are precipitation, the ion exchange process, reverse osmosis, and coagulation. As an individual, reusing, reducing, and recycling wherever possible will advance a long way in overcoming the effects of water pollution.

Prevention of Marine Plastic Pollution

Preventing marine plastic pollution requires a multi-pronged approach, including reducing our reliance on single-use plastics, improving waste management systems, and enacting policies that hold producers accountable for their waste. Individuals can make a difference by choosing reusable alternatives, recycling properly, and supporting businesses that prioritize sustainability (Olanrewaju & Oyebade 2019). Governments and organizations can play a crucial role by promoting recycling, developing new waste management technologies, and implementing legislation that discourages plastic waste and encourages responsible production (Babayemi et al., 2019). In addition to these international efforts, regional groups of governments (in various geographic locations) have started to respond to the marine plastic pollution issue. As of 2019, at least 39 regional policy documents have been adopted, primarily in Europe (Cordier & Uehara, 2019)). Regional policies facilitated by the United Nations Environment Programme (UNEP) and the Regional Seas Programme make up over half of these policies and the remaining policies were adopted by the European Union (EU), Antarctic Treaty signatories, Nordic countries, and East African member states (Cook, 2019). Regional governments including the EU, Baltic Marine Environment Protection Commission (Helsinki Commission), Nordic Council of Ministers, Convention for the Protection of the Marine Environment of the North-East Atlantic, and Secretariat of the Pacific Regional Environment Programme have agreed to phase out plastic microbeads through statements of support and regional action plans.

Nationwide bans on the use of microbeads in cosmetic products have been adopted in the United States, Canada, United Kingdom, New Zealand, Finland, France, Iceland, Ireland, Italy, Luxemburg, Norway, and Sweden (Cordier & Uehara, 2019). Local legislation to reduce plastic pollution has also increased worldwide (Karasik et al., 2020). In cities in the United States, for example, plastic bag bans have become the most common form of local ordinance used to address plastic pollution (Zhu et al., 2020).A minimum of 5.25 trillion pieces of plastic weighing over 250,000 tons were found in the ocean, according to data from 24 oceanic expeditions, but more recent estimates based on the great Pacific garbage patch presume that the amount of plastic may be four to 16 times higher than previously thought (Babayemi, et al., 2019). According to the UNEP (2018), plastic makes up about 80% of all litter, with metal, glass, and paper being much less prevalent in the environment (Galgani, et al., 2010). Microplastics are so pervasive in the environment that they pose a great challenge to scientists, the media, and governmental and non-governmental organizations. The main challenge of microplastics is the awkwardness of getting them out of the ecosystem.

Nigeria's plastic industry is experiencing rapid growth as a result of massive investment. However, based on the volume of plastic imports and consumption between 1990 and 2017, Nigeria was ranked second among some specific African nations (Babayemi, et al., 2019). Given that the use of packaged goods has become a part of our daily lives, the packaging industry is actually the largest consumer of plastics. According to estimates from Patel and Shah, 30% of plastics produced globally are used for packaging purposes. Humans prefer to use plastic to wrap food products rather than using bare hand to hold the food product cheaply because they believe that hand flora contains pathogens which can be harmful (Tiwaria et al., 2019).

Prevention of Oil/Gas Pollution

Oil spill incidents have occurred in various parts and at different times along our coast. Some major spills in the coastal zone are the GOCON's Escravos spill in 1978 of about 300,000 barrels, SPDC's Forcados Terminal tank failure in 1978 of about 580,000 barrels and Texaco Funiwa-5 blow out in 1980 of about 400,000 barrels. Other oil spill incidents are those of the Abudu pipe line in 1982 of about 18,818 barrels, The Jesse Fire Incident which claimed about a thousand lives and the Idoho Oil Spill of January 1998, of about 40,000 barrels. The most publicised of all oil spills in Nigeria occurred on January 17 1980 when a total of 37.0 million litres of crude oil got spilled into the environment. This spill occurred as a result of a blow out at Funiwa 5 offshore station. Nigeria's largest spill was an offshore well-blow out in January 1980 when an estimated 200,000 barrels of oil (8.4million US gallons) spilled into the Atlantic Ocean from an oil industry facility and that damaged 340 hectares of mangrove (Nwilo and Badejo, 2005). According to the Department of Petroleum Resources (DPR), between 1976 and 1996 a total of 4647 incidents resulted in the spill of approximately 2,369,470 barrels of oil into the environment. Of this quantity, an estimated 1,820,410.5 barrels (77%) were lost to the environment. A total of 549,060 barrels of oil representing 23.17% of the total oil spilt into the environment was recovered. Some of the citizens of this country in collaboration with people from other countries engage in oil bunkering. They damage and destroy oil pipelines in their effort to steal oil from them. SPDC claimed in 1996 that sabotage accounted for more than 60 percent of all oil spilled at its facilities in Nigeria, stating that the percentage has increased over the years both because the number of sabotage incidents has increased and because spills due to corrosion have decreased with programs to replace oil pipelines (SPDC, 1996). Pirates are stealing Nigeria's crude oil at a phenomenal rate, funneling nearly 300,000 barrels per day from our oil and selling it illegally on the international trade market. Nigeria lost about N7.7 billion in 2002 as a result of vandalisation of pipelines carrying petroleum products. The amount, according to the PPMC, a subsidiary of NNPC, represents the estimated value of the products lost in the process. Illegal fuel siphoning as a result of the thriving black market for fuel products has increased the number of oil pipeline explosions in recent years. In Nigeria, fifty percent (50%) of oil spills is due to corrosion, twenty eight percent (28%) to sabotage and twenty one percent (21%) to oil production operations. One percent (1%) of oil spills is due to engineering drills, inability to effectively control oil wells, failure of machines, and inadequate care in loading and unloading oil vessels.

Empirical Review

Solic et al. (2015), carried out research titled "Empirical study on ICT system's users' risky behavior and security awareness". In this study the authors gathered information on ICT users from different areas in Croatia with different knowledge, experience, working place, age and gender background in order to examine today's situation in the Republic of Croatia (n=701) regarding ICT users' potentially risky behavior and security awareness. To gather all desired data validated Users' Pollution prevention in maritime sector Awareness Questionnaire (UISAQ) was used. Analysis outcome represent results of ICT users in Croatia regarding 6 subareas (mean of items): Usual risky behavior (x1=4.52), Personal computer maintenance (x2=3.18), Borrowing access data (x3=4.74), Criticism on security in communications (x4=3.48), Fear of losing data (x5=2.06), Rating importance of backup (x6=4.18). From the analysis of data collected.

Gebremeskel et al. (2023), conducted research titled "Pollution prevention in maritime sector challenges during digital transformation". Digital transformation has been defined as a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies (Vial, G., 2019), and a series of organization-wide changes in management and information technologies (IT) in response to new developments in the external environment (Berman, 2019). The above definitions x-rayed the interplay between ICT and information technologies directed at securing information assets of organizations.

van Veenstra & Ramilli (2001), explored Pollution prevention in maritime sector Issues in Public Sector Inter-organizational Collaboration. They studied data control issues for realizing pollution prevention in maritime sector by looking at the application of security patterns in practice. By investigating a case study of inter-organizational collaboration in the Netherlands they explored the use of two security patterns that control access to information: Extended Role-Based Access Control (ERBAC) and Single Access Point/Check Point. Investigating whether those patterns were implemented in the right way and whether they were sufficient for guaranteeing access control, they found issues related to access control to be crucial in realizing pollution prevention in maritime sector, which can only be realized by implementing organizational arrangements in addition to technical solutions. They thereafter recommended the development of a framework for pollution prevention in maritime sector in inter-organizational collaboration including technical and organizational aspects.

Albuquerque Junior & Santos (2015), investigated whether the adoption of Pollution prevention in maritime sector measures in public research institutes is influenced by organizational and institutional factors proposed by Albuquerque Junior and Santos (2014). Research showed that the institutional environment influences the adoption of Pollution prevention in maritime sector measures in most public research institutes that participated in the survey. This influence is mainly through laws, decrees and other regulations published by the Government, and through participation of IT and Pollution prevention in maritime sector professionals in networks for the exchange of experiences and information.

Information System Adoption and Prevention of Water Pollution

Enyoh et al. (2019) in their study revealed that that Computer-based information systems (CBIS) play a crucial role in preventing pollution within the maritime sector by facilitating data collection, analysis, and communication, leading to improved decision-making and pollution prevention efforts. These systems are used for various purposes, including tracking pollution sources, monitoring environmental conditions, and enforcing regulations.

Drew (2023) found that Computer-based information systems (CBIS) significantly impact pollution prevention in the maritime sector by enabling efficient data management, monitoring, and response capabilities. CBIS can help prevent pollution by facilitating real-time tracking of vessel emissions, detecting potential spills, and optimizing routing to avoid sensitive areas.

Notably, initial theoretical models exist that describe and predict pollution prevention development,

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mainly for interpersonal or inter-organisational interactions. For instance, Rousseau et al. (1998) assumed three phases of pollution prevention emergence: (1) building (pollution prevention (re)formation), (2) stability, and (3) dissolution. Söllner and Pavlou (2016) focused on the development of human-technology pollution prevention and proposed a pollution prevention lifecycle consisting of six phases. Accordingly, pollution prevention relationships start with initial pollution prevention levels (phase 1), which are either confirmed or disconfirmed based on first interactions (phase 2). Then, pollution prevention builds in linear patterns within further interactions (phase 3), and stabilises after some time (phase 4). Negative experiences with the target of pollution prevention can lead to pollution prevention dissolutions (phase 5), so that pollution prevention needs to be repaired (phase 6) to finally result in a stable state again. However, these assumptions have not yet been examined empirically in contexts of occupational work (Tijan et al., 2024).

Information System Adoption and Prevention of Marine Plastic Pollution

As explained by Indu et al. (2017), marine information system (MIS) is a subdomain of security. Like security, authentication strongly depends on important aspects of prevention of water pollution, prevention of marine plastic pollution, and prevention of oil/gas pollution; they become obligations in the design of secure systems. As in a single cloud system, the multi-cloud must also guarantee (Tijan et al., 2024): Ease of use: The cloud services can easily be used by malicious attackers, since a registration process is very simple, because we only have one valid credit card. Secure data transmission: When transferring the data from clients to the cloud, the data needs to be transferred by using an encrypted secure communication. Insecure APIs: Various cloud services on the Internet are exposed by application programming interfaces. Since the APIs are accessible from any-where on the Internet, malicious attackers can use them to compromise the prevention of water pollution and prevention of marine plastic pollution of the enterprise customers.

Qamar et al. (2018) present a system called "CHARON", it is a cloud storage system able to store and share data securely and efficiently, using multiple cloud providers and storage repositories to comply with the legal requirements for sensitive personal data. CHARON implements three distinguishing features: (1) it requires no trust in any entity (2) it does not require any client-managed servers, and (3) it efficiently handles large files on a geographically dispersed storage set. With a data-centric leasing protocol, resilient byzantine way. But the use of byzantine-resilient for cloud storage implies increased latency compared to a single cloud. For this solution, the addition of a biometric solution can be more effective in terms of security and, more it allows benefits of functionality, control, verification and biometric authentication.

Information System Adoption and Prevention of Oil/Gas Pollution

Information technology integration system (ITIS) is the procedure of transforming information from a readable format to a scrambled element of information. This is completed to avoid prying eyes from reading confidential information in transit. Information technology integration system (ITIS) can be used on documents, files, messages, or some different form of communication over a network (Tchernykh et al., 2019).

These algorithms guard prevention of water pollution and fuel basic security initiatives such as prevention of marine plastic pollution, authentication, and non-repudiation. The algorithms first authenticate any message to check its origin, and thus check its prevention of marine plastic pollution to test that its contents remained unaltered during transmission. Finally, the non-repudiation initiative avoids senders from weak legitimate activity (Tijan et al., 2024).

There are two main types of information technology integration system (ITIS) such as symmetric information technology integration system (ITIS) and asymmetric information technology integration system (ITIS). In symmetric information technology integration system (ITIS), a single, private password both encrypts and decrypts information. Asymmetric information technology integration system (ITIS) is also defined as public key information technology integration system (ITIS) or public-key cryptography. It needs two keys for information technology integration system (ITIS) and decryption. A shared, public key encrypts the information.

III.METHODOLOGY

Study Area (NIMASA)

NIMASA has been established with a vision to be the Leading Maritime Administration in Africa advancing Nigeria's Global Maritime goals and a mission to achieve and sustain safe, secure shipping, cleaner oceans and enhanced maritime capacity in line with the best global practices towards Nigeria's economic development. The Nigerian Maritime Administration and Safety Agency (NIMASA) has a total of 595 staff. This includes 12 directors, Staff at management level is 146 and non-management level is 437, according to NIMASA Annual Bulletin, 2024.

Research Design

Research design highlights and gives details of the structure, plans and strategies used in collecting and analyzing data for the study in order to test the hypothesized variables' relationships or differences. A research design performs the following functions (Ghauri et al., 2020): (a) it provides the researcher with a blueprint for studying research problems; (b) it dictates boundaries of research activity and enables the investigator to channel his energies in specific directions. (c) it enables the investigator to anticipate potential problems in the implementation of the study; and (d) it helps to provide some estimate of the cost of the research, possible measurement problems, and the optimal allocation of resources.

Population of the Study

he population of the study consisted of NIMASA in Nigeria. This study used a mixed research design which entails both qualitative and quantitative approaches. The population of the study stood at 1,856 as at 2022 (NIMASA, 2024).

Sampling Technique and Sample Size

The sampling technique used in this study is the simple random technique. The choice of this method was predicated on the fact that every element in the study had equal chance of being studied. The sample elements of the study were drawn from the management/managerial staff. The procedure for sample selection first involves the objective selection of the NIMASA' workers who are working as management and supervisory staff in NIMASA. The study used Prof. Taro Yamane's Sample Size Formula to determine the sample size as follows:

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

Where:

n = Sample Size

N = Population of the Study

e = Level of Significance selected at 5%

Accordingly, the sample size (n) for the study is calculated thus:

$n = 1{,}856 / 1+1{,}856\ (0.05)^2 = 1{,}856 / 4.64 = 329.078$.

Sample Size = 330 staff

Method of Data Collection

This study relied on primary data. Essentially, primary data describes the original data collected for the problem under investigation. Primary sources of data are information on events that actually happened, as well as opinions or statements made by those who have personally witnessed or experienced the event. The primary data required for this study was obtained from the use of questionnaires. The structure of the questionnaire was consistent with the specific objectives and corresponding research questions. Section A of the questionnaire focused on the socioeconomic characteristics of the households. Sections B provide questions on the study variables which was structured in five (5) point Likert scale methods of:

Very Large Extent…………………	(5)	VLGE
Large Extent ………………………..	(4)	LGE
Moderate Extent …………………..	(3)	MDE
Low Extent …………………………	(2)	LWE
Very Low Extent..…………………	(1)	VLWE

Operational Measures of Variables

This study has 2 major variables. These variables are; Information System Adoption and Pollution Prevention. Information System Adoption is operationalized into three dimensions namely (i) Computer-Based Information System, (ii) Marine Information System and (iii) Information Technology Integration System. Similarly, Pollution Prevention is operationalized into three measures of (i) Prevention of Water Pollution (ii) Prevention of Marine Plastic Pollution and (iii) Prevention of Oil/Gas Pollution. Furthermore, each of these variables shall be measured by 4 items in the questionnaire. Thus, there are 24 items measuring the variables in the questionnaire.

Goodness of Data

Goodness of data refers to the quality, reliability, and appropriateness of the data collected for a research study. It encompasses various aspects such as accuracy, completeness, consistency, and relevance of the data to the research objectives. Ensuring the goodness of data is essential for producing valid and trustworthy research findings, as data quality directly impacts the validity and reliability of research results.

Reliability of Research Instrument

Reliability in research refers to the consistency, stability, and dependability of measurement tools, procedures, or data over time and across different conditions. It reflects the extent to which a research instrument or procedure yields consistent and reproducible results when applied repeatedly under similar conditions (Ghauri et al. 2020). A reliable measurement tool or procedure should produce similar results upon repeated administration to the same individuals or under the same conditions. There are several aspects of reliability that researchers consider when assessing the reliability of measurement instruments or procedures: internal consistency reliability, test-retest reliability, inter-rater reliability, and parallel-forms reliability.

Validity of Research Instrument

The instrument for this research was subjected to validity test. Its face validity was confirmed by experts consisting of the research supervisor, scholars and managers in the maritime industry who have good knowledge of the subject of study. The content validity was determined by my supervisors and members of the Maritime Department's Post Graduate Board.

Methods of Data Analysis

In this study, percentages, ratios, frequency distribution, scaling, ranking and other statistical tools were used to analyse and achieve the research objectives. Nevertheless, stepwise regression was used to test the moderating variable. Regression analysis was used to test the extent of the effect individual and collective variable(s) on the other. Also, regression analysis was used to test the hypotheses formulated in the study. All these analyses were computed through the use of statistical package for social sciences (SPSS) IBM SPSS Statistics 25 version.

Model Specification

$$Y_1 = b_o + b_1x_1 + b_2x_2 + b_3x_3 + e \qquad 1$$

{for Objective 1, Research Question 1 & Hypothesis 1 (Ho_1)}

PWP = f (CBIS, MIS, ITIS)

Where;

PWP = Prevention of Water Pollution

CBIS = Computer-Based Information System

MIS = Marine Information System

ITIS = Information Technology Integration System

$$Y_2 = b_o + b_1x_1 + b_2x_2 + b_3x_3 + e \qquad 2$$

{for Objective 2, Research Question 2 & Hypothesis 2 (Ho_2)}

PMPP = = f (CBIS, MIS, ITIS)

Where;

PMPP = Prevention of Marine Plastic Pollution

CBIS = Computer-Based Information System

MIS = Marine Information System

ITIS = Information Technology Integration System

$$Y_3 = b_o + b_1x_1 + b_2x_2 + b_3x_3 + e \qquad 3$$

{for objective 3, Research Question 3 & Hypothesis 3 (Ho_3)}

POP = f (CBIS, MIS, ITIS)

POP = Prevention of Oil/Gas Pollution

CBIS = Computer-Based Information System

MIS = Marine Information System

ITIS = Information Technology Integration System

Statistical Model Specification

This study used economic operations, social operations and environmental operation as the dependent (criterion) variables while piracy, drug/human trafficking and armed robbery at sea are to be used as independent (predictor) variables. The model is therefore specified thus:

$Y_1 = b_o + b_1x_1 + b_2x_2 + b_3x_3 + e$;

$Y_2 = b_o + b_5x_5 + b_6x_6 + b_7x_7 + e$;

$Y_3 = b_o + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + e$;

Where;

Y_1 = Economic operations; Y_2 = Social operations; Y_3 = Environmental operation;

X_1= Piracy

X_2 = Drug and Human Trafficking

X_3 = Armed Robbery at Sea

b_o = The parameter which represents the intercept, b_1, b_2, b_3, b_4, b_2, b_3 = the regression parameters were used in determining the significance of the effect of each of the independent variables x_1, x_2, x_3, x_4 on the dependent variables Y_1, Y_2, Y_3, e = Random disturbance term. These include the variables which (although not specified) in this model may also affect maritime security threats and sustainable maritime operation in Nigeria. They include government policies, political instability, corruption, environmental maritime security threats problems etc. The effects of maritime security threats on the dependent variables were measured in interval and ratio scaling. The coefficient of determination (R^2) was used to measure the rate at which the independent variable was explained by dependent variables. The a priori expectations for the coefficients are as follows: $\beta_0 > 0$; $\beta_1 > 0$; $\beta_2 > 0$; $\beta_3 > 0$

IV. RESULTS

Data Refinement

Data refinement is practically done to ensure rationality in the study and the need to show reliability of the instrument in terms of the measurement of the concepts and constructs investigated in the study. To achieve this, reliability has been ascertained relying on Cronbach alpha using the Nunnally and Bernstein's (1994) threshold, alpha values for the examined constructs and items are as follows:

Table 1: Test of Reliability

Construct	No of items	Alpha(α)
Computer-based information system	5	0.861
Marine information system	5	0.771
Information technology integration system	5	0.857
Prevention of water pollution	5	0.722
Prevention of marine plastic pollution	5	0.877
Pollution prevention	5	0.796
Total		4.884
Mean Reliability	4.884 ÷ 6	0.814

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

From the alpha outcomes in Table 1, the instrument is a dependable one and identified with the topic of the study. The information gathering instrument was tried for unwavering quality utilizing Cronbach's Alpha is within the acknowledged scope of 0.70 or more as the overall reliability test of the instrument is 0.814. This has been achieved in line with Okwandu's (2007) position that the use of the SPSS software package would practically help in testing of the reliability of instruments. Validity test was additionally done, utilizing specialists proficient in the subject matter under investigation, experts and supervisors' endorsement to determine that the instruments were significant and measured what they were designed to measure. The predictors and the criterion variables were found to be dependable as the constructs have alpha values above the Nunnally threshold of 0.7 (Akujuru & Enyioko, 2018).

Administration and Retrieval of Questionnaire

Collection of data was carried out by the researcher through Monkey Survey which involved the administration of the copies of questionnaire to the selected email addresses. After administering the instruments, the respondents were given a time space of three months to respond to the instruments. Thereafter copies of questionnaire were retrieved through established email contacts of the maritime sector organisations represented by NIMASA though the help of Monkey Survey. A total number of 330 copies of questionnaire were distributed to the respondents from NIMASA. A total of 325 copies of questionnaire were retrieved from them. After editing the retrieved copies of questionnaire, the copies found useful were 310. The 310 copies of questionnaire were considered as valid and suitable for data analysis in this study. The administration and retrieval of copies of the questionnaire are shown in table 2 below:

Table 2: Questionnaire Administration and Retrieval

Indicate your present job status	Copies distributed	Copies Retrieved	Copies found useful	Response Rate
Administration and Human Resource Department	39	39	37	94.87%

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Health, Safety and Environment Unit	53	52	50	94.34%
Planning, Research and Data Management Services Department	55	54	52	94.54%
Marine Environment Department	42	41	40	95.24%
Shipping Development Department	45	44	42	99.33%
Financial Services Department	56	55	52	92.86%
Maritime Safety and Seafarers' Standard Department	40	40	37	92.50%
Total	330	325	310	93.94%

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 2 shows how the copies of questionnaire were administered to the respondents. In all 330 copies of were administered to the managerial staff of NIMASA and 325 copies were retrieved from the respondents. After going through the collected copies of questionnaire, only 310 copies of questionnaire were found useful and valid for the study, and this figure represent 93.94% response rate of the study.

Demographic Information of the Respondents

The demographic issues raised in this study included gender of the respondents; current job position of the respondents, respondents' years of experience and respondents' education.

Table 3: Gender Distribution of the Respondents

Sex	Number of Respondents	Percentage Performance
Male	219	70.65
Female	91	29.35
Total	310	100.00

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 3 shows the gender distribution of the respondents and this section enables the study to determine the number of men and the number of women that participated in the survey. The Table reveals that 219 males (70.65%) responded correctly to the questionnaire while 91 females (29.35%) responded correctly to the questionnaire. This indicates that the male respondents are in the majority.

Table 4: Respondents' Current Job Position

Indicate your present job status	Number of Respondents	Percentage Performance
Administration and Human Resource Department	35	11.30
Health, Safety and Environment Unit	50	16.10
Planning, Research and Data Management Services Department	51	16.50
Marine Environment Department	40	12.90
Shipping Development Department	41	13.20
Financial Services Department	55	17.70
Maritime Safety and Seafarers' Standard Department	38	12.30
Total	310	100.00

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 4 shows the status of respondents' current job positions. The details of the data indicate that, Administration and Human Resource Department were 35 (11.30%) of the respondents; Health, Safety and Environment Unit/ constituted 50(16.10%) of the respondents; Planning, Research and Data

Management Services Department were 51(16.50%) of the respondents; Marine Environment Department were 40(12.90%) of the respondents; Shipping Development Department were 41(13.20%) of the respondents; Financial Services Department were 55(17.70%) of the respondents while Maritime Safety and Seafarers' Standard Department were 38(12.30%) of the respondents.

Table 5: Respondents' Years of Experience in the Present Government organization

Options	Number of Respondents	Percentage Performance
0 - 5 years	86	27.74
6 - 10 years	55	17.74
11 - 15 years	108	34.84
16 - 20 years	32	10.32
Above 20 years	29	9.35
Total	310	100.00

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 5 shows the years of experience' distribution of the respondents in their present maritime sector organisations. The data reveal that 86(27.74%) of the respondents have been in the maritime sector organisations for 0-5 years; 55(17.74%) of the respondents have been in the maritime sector organisations for 6-10 years; 108(34.84%) of the respondents have worked in their present maritime sector organisations for 11-15 years; 32(10.32%) of the respondents have been in the present maritime sector organisations for 16-20. Finally, table 4.5 shows that 29(9.35%) of the respondents have been in the present maritime sector organisations for above 20 years.

Table 6 Respondent's Level of Education

Options	Number of Respondents	Percentage Performance
SSCE or Equivalent	77	24.84
National Diploma	19	6.13
B.Sc. /BA/B. Ed/HND	142	45.81
Masters and Above	49	15.81
Professional certificate	23	7.42
Total	310	100.00

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 6 shows that 77(24.84%) of respondents got their jobs with SSCE or its equivalent; 19(6.13%) of the respondents are holders of National Diploma; 142(45.81%) of the respondents possess B.Sc. /BA/B. Ed/HND; 49(15.81%) of the respondents are Masters and above degree holders; 23(7.42%) of the respondents are professional certificate holders.

Presentation of Univariate Data

The univariate analysis on each of the operationalized variables is presented. In generating the data on the operationalized variables, the study used a 5-point Likert scale instrument. Therefore, in interpreting the mean values, the study is relying on Asawo's (2016) categorization of responses with mean ($\bar{X}$) thus: 1-2 = low; 2.5-3.5 = moderate; 3.5-4.5 = large and 4.5 and above = very large. In this study the data were measured using a 5-point Likert Scale on the basis of "very large extent" (5); "large extent" (4); "moderate extent" (3); "low extent" (2); "very low extent" (1). Based on this scale; options, responses and associated rating points, the mean, standard deviation, variances and responses to issues raised in the research are presented below, using the SPSS software package window output, version 22.0. The analysis is commenced with the table on computer-based information system.

Computer-based information system as a Dimension of Information system adoption

Table 7 gives the detailed analysis on how computer-based information system as a dimension of information system adoption has been examined to determine its effect on pollution prevention in maritime industry and to show its descriptive statistical outcome based on the questions deposed.

Table 7: Computer-based information system as a Dimension of Information system adoption

S/N	Question Items on Computer-based information system	N	$\bar{X}$	SD
1	To what extent does your organisation use computer-based information system to achieve pollution prevention objectives?	310	2.848	1.225
2	To what extent are staff in your organisation very skillful in computer-based information system activities?	310	3.271	1.128
3	To what extent does computer-based information system offer veritable opportunities for achieving information system adoption in your organisation?	310	2.819	1.647
4	To what extent does your organisation introduce any controlling measures through computer-based information system ?	310	3.074	1.536
5	To what extent do customers talk good about your organisation's willingness to use the best computer-based information system instruments for pollution prevention activities?	310	3.377	1.098
	Grand mean and standard deviation =		3.078	1.362

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 7 shows that five question items represent a dimension in the 5-point scale. The data revealed that with the mean and standard deviation scores of 2.848±1.225, the respondents disagreed that to a large extent public organisation use computer-based information system to achieve pollution prevention objectives. Also, with the mean and standard deviation scores of 3.271±1.128, the respondents agreed that to a large extent staff in maritime sector organisations are very skillful in computer-based information system activities. The data also revealed that the respondents disagreed that to a large extent computer-based information system offer veritable opportunities for achieving information system adoption in maritime sector organisations with the mean and standard deviation scores of 2.819±1.647. With the mean and standard deviation scores of 3.074±1.536 the respondents indicated that to a large extent maritime sector organisations introduce any controlling measures through computer-based information system. Finally, the data in Table 4.7 revealed that with the mean and standard deviation scores of 3.377±1.098, the respondents agreed that to large extent customers talk good about willingness to use the best computer-based information system instruments for pollution prevention activities.

Marine information system as a Dimension of Information system adoption

In order to ascertain the extent to which marine information system as a dimension or component of information system adoption affects pollution prevention in maritime industry, the study used 5 question items on the 5-point scale as shown in Table 8.

Table 8: Marine information system as a Dimension of Information system adoption

S/N	Question Items on Marine information system	N	$\bar{X}$	SD
1	To what extent does marine information system offer veritable opportunities for information system adoption in your organisation?	310	2.581	1.416
2	To what extent does quality of your staff inputs in pollution prevention engender the marine information system of your organisation?	310	2.842	1.319
3	To what extent does passing pollution prevention information in the Marine information system lead to the achievement of the expected pollution prevention results in your organisation?	310	2.258	1.304

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4	To what extent does your organisation give rooms for staff to suggest new ways or approach to marine information systeming of your organisation?	310	2.745	1.224
5	To what extent does marine information system become everybody's business in your organisation?	310	2.023	1.125
	Grand mean and standard deviation =		2.490	1.316

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

As shown in Table 8 above, the responses of the respondents have indicated the mean and standard deviation scores of 2.581±1.416, showing that the respondents collectively disagreed that to a large extent maritime sector organisations marine information system offer veritable opportunities for information system adoption. Also, with the mean and standard deviation scores of 2.842±1.319 it is quite obvious that the respondents indicated on the aggregate disagreement that to large extent quality of staff inputs in pollution prevention engender the marine information system in maritime sector organisations. As to the extent to which the passing of pollution prevention information in the marine information system lead to the achievement of the expected pollution prevention results in maritime sector organisations, the mean and standard deviation scores of 2.258±1.304 indicate aggregate disagreement. The data additionally revealed that the respondents disagreed that to large extent public organisation give rooms for staff to suggest new ways or approach to marine information systeming; this is shown by mean and standard deviation scores of 2.745±1.224. Finally, the mean and standard deviation scores of 2.023±1.125 indicate that the respondents disagreed that marine information system become everybody's business in maritime sector organisations.

Table 9: Information technology integration system as a Dimension of Information system adoption

S/N	Question Items on Information technology integration system	N	$\bar{X}$	SD
1	To what extent does information technology integration system directly influence the performance of your organization?	310	2.903	1.385
2	To what extent does your organisation's information technology integration system contribute to prevention of water pollution?	310	2.658	1.152
3	To what extent are there are opportunities to develop the staff to allow for the information technology integration system in your organisation?	310	3.026	1.811
4	To what extent does your organisation provide for information technology integration system that implement efficient pollution prevention activities?	310	3.158	1.216
5	To what extent does your organisation usually allow for the information technology integration system ?	310	3.084	1.146
	Grand mean and standard deviation =		2.9658	1.416

Information technology integration system as a Dimension of Information system adoption

Table 9 shows the descriptive statistical results on the effect of information technology integration system as a dimension of information system adoption on pollution prevention in maritime industry. The outcomes from the five question items on the 5-point-scale show a distribution indicating that information technology integration system is a veritable platform for information system adoption and it leads to pollution prevention in maritime industry.

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 9 shows that the mean and standard deviation scores of 2.903±1.385 as indicated by the respondents imply that to a low extent information technology integration system directly influence the performance in maritime sector organisations. Also, the mean and standard deviation scores of 2.658±1.152 imply that the respondents were in disagreement to the fact that public organization information technology integration system contribute to prevention of water pollution. The data revealed that the mean and standard deviation scores of 3.026±1.811 as indicated by the respondents show that to a moderate extent there are opportunities to develop the staff to allow for the information technology integration system in maritime sector organisations. The mean and standard deviation scores of 3.158±1.216 depict moderate agreement by the respondents regarding the extent to which maritime sector organisations provide for information technology integration system that implement efficient pollution prevention activities. The respondents were inclined to the moderate extent option as revealed in the mean and standard deviation scores of 3.084±1.146 indicating that to a moderate extent public organizations usually allow for the information technology integration system.

Prevention of water pollution as a Measure of Pollution prevention in maritime industry

Table 10 shows the descriptive statistical results on prevention of water pollution which is measured with five question items on the 5-point scale. The response distribution as shown by the results is indicative that prevention of water pollution will enhance pollution prevention in maritime industry.

Table 10: Prevention of water pollution as a Measure of Public expenditure management in maritime industry

S/N	Question Items on Prevention of water pollution	N	$\bar{X}$	SD
1	To what extent do information system adoption lead to prevention of water pollution of your organisation?	310	2.606	1.655
2	To what extent are you involved in important pollution prevention activities that improve prevention of water pollution of your organisation?	310	2.719	1.371
3	To what extent does your organisation consider the opinion of others before making important decision that affects prevention of water pollution of the organisation?	310	2.577	1.302
4	To what extent do senior pollution prevention staff discuss issues concerning prevention of water pollution in your organisation?	310	3.400	1.510
5	To what extent is prevention of water pollution often used as a key performance index (KPI) to review the effectiveness and efficiency in your organisation?	310	4.013	1.201
	Grand mean and standard deviation =		3.063	1.522

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 10 shows the mean and standard deviation scores of 2.606±1.655 indicating that the consensus opinion of the respondents revealed a disagreement that to a large extent information system adoption led to prevention of water pollution in maritime sector organisations. Also, the mean and standard deviation scores of 2.719±1.371 imply the respondents disagreed that to a large extent staff are involved in important pollution prevention activities that improve prevention of water pollution in maritime sector organisations. The statistical result of 2.577±1.302 (mean and standard deviation scores) show that the respondents disagreed that to a large extent maritime sector organisations consider the opinion of others before making important decision that affects prevention of water pollution of the organisation. Table 4.10 also reveals the mean and standard deviation scores of 3.400±1.510 implying that the respondents agreed that to a large extent senior pollution prevention staff discuss issues concerning prevention of water pollution in your organisation. Finally, the mean and standard deviation scores of 4.013±1.2011 show that the respondents agreed that to a large extent prevention of water pollution is often used as a key performance index (KPI) to review the effectiveness and efficiency in public sector.

Prevention of marine plastic pollution as a Measure of Pollution prevention in maritime industry

Table 11 shows how prevention of marine plastic pollution as a measure of pollution prevention in maritime industry was examined and empirically expressed through the raising descriptive statistical analysis of 5 question items.

Table 11: Prevention of marine plastic pollution as a Measure of Pollution prevention in maritime industry

S/N	Question Items on Prevention of marine plastic pollution	N	$\bar{X}$	SD
1	To what extent are your staff involved in open and robust discussions with the environmental impact assessment activity in order to achieve strategic prevention of marine plastic pollution for the organisation?	310	4.510	1.235
2	To what extent is your organisation's information system adoption affected by prevention of marine plastic pollution?	310	2.868	1.243
3	To what extent is prevention of marine plastic pollution very relevant for your organisation's growth?	310	2.774	1.746
4	To what extent does your organisation ensure that prevention of marine plastic pollution is achieved through regular pollution prevention?	310	3.171	1.312
5	To what extent does your organisation always recognize successful prevention of marine plastic pollution produced through internal audit control?	310	2.623	1.338
	Grand mean and standard deviation =		3.189	1.637

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

As shown in Table 11 above, the responses of the respondents have indicated the mean and standard deviation scores of 4.510±1.235 showing that to a large extent staff involved in open and robust discussions with the environmental impact assessment activity in order to achieve strategic prevention of marine plastic pollution in maritime sector organisations. Also, the mean and standard deviation scores of 2.868±1.243 imply that the respondents disagreed that to a large extent maritime sector organisations' information system adoption affected by prevention of marine plastic pollution. With the mean and standard deviation scores of 2.774±1.746, the respondents have indicated that to a low extent prevention of marine plastic pollution is very relevant for your organisation's growth. Table 11 shows the mean and standard deviation scores of 3.171±1.312 proving that the respondents indicated that to a large extent maritime sector organisations ensure that prevention of marine plastic pollution is achieved through regular pollution prevention. Finally, the data revealed the mean and standard deviation scores of 2.623±1.338 indicating that to a low extent maritime sector organisations always recognize successful prevention of marine plastic pollution produced through internal audit control.

Prevention of oil/gas pollution as a Measure of Pollution prevention in maritime industry

Prevention of oil/gas pollution as a measure of pollution prevention in maritime industry was examined and empirically expressed in table 4.12:

Table 12: Prevention of oil/gas pollution as a Measure of Pollution prevention in maritime industry

S/N	Question Items on Prevention of oil/gas pollution	N	$\bar{X}$	SD
1	To what extent does your organisation value giving satisfactory and accurate information to the environmental impact assessment activity in order to achieve prevention of oil/gas pollution?	310	3.281	1.278
2	To what extent is prevention of oil/gas pollution often used as a key performance index (KPI) to review the effectiveness and efficiency of your organisation?	310	3.555	1.194
3	To what extent does your organisation allow for pollution prevention staff to engage other staff in robust and critical issues pertaining to the performance of your organisation?	310	2.958	1.649
4	To what extent does your organisation allow staff to make variety of suggestions for the growth of internal environmental impact assessment activity?	310	3.648	1.291
5	To what extent does your audit staff have the prerequisite to adopt thorough pollution prevention practices that elicit prevention of oil/gas pollution?	310	2.700	1.582

Grand mean and standard deviation =	3.228	1.426

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output

Table 12 shows that the respondents through their responses aggregated on the mean and standard deviation scores of 3.281±1.278 proving that to a large extent, maritime sector organisations value giving satisfactory and accurate information to the environmental impact assessment activity in order to achieve prevention of oil/gas pollution Also, the mean and standard deviation scores of 3.555±1.194 indicate that to a large extent prevention of oil/gas pollution is often used as a key performance index (KPI) to review the effectiveness and efficiency in maritime sector organisations. The mean and standard deviation scores of 2.958±1.649 indicate the respondents' disagreement that to a large extent maritime sector organisations allow for pollution prevention staff to engage other staff in robust and critical issues pertaining to the performance. The mean and standard deviation scores of 3.648±1.291 indicate that to a large extent maritime sector organisations allow staff to make variety of suggestions for the growth of internal environmental impact assessment activity. Table 4.12 shows that the mean and standard deviation scores of 2.700±1.582 imply disagreement by the respondents that to a large extent maritime sector organisations' audit staff have the prerequisite to adopt thorough pollution prevention practices that elicit prevention of oil/gas pollution

Bivariate Analysis

Having finished with the investigation of the univariate analysis in the past areas, the investigation chose to dive into the bivariate tests and the analysis tried to examine the propositions that contrasted the methods that compared the means of one group with the mean of another group. However, considering the nature of the study, which involved the test of causal effect, the variables involved and the data measurement scale used, the study adopted and applied the descriptive statistical method for the bivariate analysis. Nevertheless, these analyses, respective results and decisions/interpretations of the study were armed and guided by the positions of Cooper and Schindler (2014) on decision scale frame. The interpretation of Cooper and Schindler (2014) correlation decision scale frame as used in this study has been presented as follows:

(a) ±.00 – 19 (Very weak)
(b) ±.20 - .39 (Weak)
(c) ±.40 - .59 (Moderate)
(d) ±.60 - .79 (Strong)
(e) ±.80 - .99 (Very Strong)
(f) ±1 (Perfect)

Correspondingly, choice scale outline for significant effect is articulated on a huge note hence:

(a) 0.00 (No significant effect)
(b) 0.1 – 0.2 (Low/Weak significant effect)
(c) 0.3 – 0.5 (Moderate significant effect)
(d) 0.6 – 0.7 (High/Strong significant effect)
(e) 0.8 – 0.9 (Very high/Very solid significant effect)
(f) 1.0 (Perfect significant effect)

The coefficient of decision scale frame with respect to association; Moser and Kalton (2007) interpreted decidedly as follows:

(a) 0.1 – 0.29 (Weak)
(b) 0.3 – 0.49 (Modest)
(c) 0.5 – 0.79 (Moderate)
(d) 0.8 (Strong)
(e) >0.8 (Very solid)

Note that the level is computed consequently by SPSS, in light of the coefficient of assurance and test estimate. Ritchie, Lewis, Nicholls and, Ormston (2014) contend that the more prominent the example measure the lower the coefficient of assurance must be so as to be measurably huge. Additionally, the littler the example estimate, the more prominent the coefficient of assurance must be keeping in mind the end goal to be factually huge. In correlation based analysis, as Saunders, Lewis and Thornhill (2009) opine that the coefficient n is utilized as the impact of size in conjunction with points of interest of heading of the significant effect (that is, a negative or positive outcome). Note that impact estimate is essentially a method for evaluating the effect and distinction between two gatherings, and a measure of the viability.

Statistical Test of Hypotheses and their Interpretations (Multivariate Analysis)

The study has sought in chapter one to determine the effect of information system adoption on pollution prevention in maritime industry in Nigeria. As a result, five research questions and thirteen hypotheses were raised to that effect. The study analysis tested the outcomes on the examined

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dimensions and measures of the variables in terms of causal effect. Therefore, this section tested and interpreted the hypotheses formulated in this study.

Effect of Information system adoption on Prevention of water pollution

Three hypotheses have earlier been raised to determine the effect of information system adoption on prevention of water pollution. In line with this objective, the study formulated the following hypotheses:

$Ho1A$: Computer-based information system has no significant effect on prevention of water pollution.

$Ho1_B$: Marine information system has no significant effect on prevention of water pollution.

$Ho1_C$: Information technology integration system has no significant effect prevention of water pollution.

The data in Table 4.16 have been used to test hypotheses one, two, three and four in this study

Table 13: Results of Information system adoption (ISA) and Prevention of water pollution (PWP)

Internal audit practices (Independent Variables)	Unstandardized Coefficients		Standardized Coefficients	t - value	Significant/ Probability Value	Decision
	B	Std. Error	Beta			
(Constant)	-0.701	0.149		-4.690	0.000	
Computer-based information system (H_1)A	0.708	0.077	0.482	9.183	0.000	Significant
Marine information system (H_1)B	0.394	0.083	0.277	4.735	0.000	Significant
Information technology integration system (H_1)C	-0.016	0.093	-0.010	-0.177	0.860	Insignificant

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output (Appendix I)

a. Dependent Variable: Prevention of water pollution

b. Predictors: (Constant), Information technology integration system, Computer-based information system , Marine information system

$Y_1 = b_o + b_1x_1 + b_2x_2 + b_3x_3 + e$ -------------(1) {for testing H_1, H_2, H_3}

Y_1(Prevention of water pollution) = -0.701+0.708RA +0.083AS - 0.016AI +e

t = (9.183) (4.735) (-0.177)

Table 13 above shows the results of the test of hypothesized statements - H_1, H_2 and H_3. The result of the hypothesis 1 tested, show positive and significant effect of computer-based information system on prevention of water pollution with t- value outcome of 9.183 @ p0.000< 0.05, meaning that computer-based information system has positive and significant effect on prevention of water pollution, indicating that the alternate hypothesis $1(Hi_1)$ has been accepted and null hypothesis 1(HO1A) rejected hence – "computer-based information system has significant effect on prevention of water pollution in maritime industry". The result of hypothesis 1 (H_1)B revealed strong positive and significant effect of marine information system on prevention of water pollution with t- value outcome of t = 4.735@ p0.001<0.05. By this result the null hypothesis $2(H_{O2})$ has been rejected and alternate hypothesis $1(Hi_1)$B accepted hence – "marine information system has a significant effect on prevention of water pollution in maritime industry". With respect to hypothesis 1 (H_1)C, the result in Table 4.16 revealed negative and insignificant effect of information technology integration system on prevention of water pollution with t-value outcome of -0.177 @ p0.860>0.05. Therefore, the null hypothesis 1 (H_{O1})

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C has been accepted and alternate hypothesis 1(Hi_1) C rejected hence – "Information technology integration system has no significant effect on prevention of water pollution in maritime industry".

From the inferential statistical analysis so far, it can be stated that:

1. Computer-based information system as a dimension of information system adoption has positive and significant effect on prevention of water pollution which is a measure of pollution prevention in maritime industry. This simply means that computer-based information system as an instrument of information system adoption influences prevention of water pollution to elicit good pollution prevention in maritime industry.
2. Marine information system as a dimension of information system adoption has strong positive and significant effect on prevention of water pollution. This simply means that marine information system as an element of information system adoption positively influences prevention of water pollution which is a measure of pollution prevention in maritime industry and it contributes to the success of orgaganisational performance.
3. Information technology integration system as a dimension of information system adoption has negative and insignificant effect on prevention of water pollution as a measure of pollution prevention in maritime industry. This simply means that information technology integration system is negative and insignificant to prevention of water pollution as a measure of pollution prevention in maritime industry.

Effect of Information system adoption on Prevention of marine plastic pollution

To test the effect of information system adoption on prevention of marine plastic pollution, the study formulated the following hypotheses:

Ho2A: Computer-based information system has no significant effect on prevention of marine plastic pollution.

Ho2B: Marine information system has no significant effect on prevention of marine plastic pollution.

Ho2C: Information technology integration system has no significant effect on prevention of marine plastic pollution.

Table 14: Results of Information system adoption (ISA) and Prevention of marine plastic pollution (PMPP)

Information system adoption (Independent Variables)	Unstandardized Coefficients		Standardized Coefficients	t - value	Significant/ Probability Value	Decision
	B	Std. Error	Beta			
(Constant)	1.958	0.099		19.813	0.000	
Computer-based information system (H_2)A	-0.194	0.051	-0.293	-3.799	0.000	Significant
Marine information system (H_2)B	0.077	0.055	0.121	1.407	0.160	Insignificant
Information technology integration system (H_2)B	0.229	0.061	0.304	3.734	0.000	Significant

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output (Appendix I)

a. Dependent Variable: Prevention of marine plastic pollution

b. Predictors: (Constant), Professional competence, Information technology integration system, Computer-based information system , Marine information system

$Y_2 = b_o + b_4x_4 + b_5x_5 + b_6x_6 + e$ -------------(2) {for testing H_4, H_5, H_6}

Y_2 (Prevention of marine plastic pollution) = 1.958 - 0.194RA + 0.077AS + 0.229AI +e

t	(-3.799)	(1.407)	(3.734)

Table 14 above shows the results of the test of hypothesized statements – H2A, H_{2B} and H_{2C}. The result of the hypothesis 2 tested, show negative and significant effect of computer-based information system on prevention of marine plastic pollution with t- value outcome of -3.799 at p0.000 < 0.05, meaning that a negative effect which is significant exists between computer-based information system and prevention of marine plastic pollution, indicating that the alternate hypothesis 2(Hi_2) has been accepted and null hypothesis 2 (HO2A) rejected hence – "computer-based information system has negative and significant effect on prevention of marine plastic pollution in maritime industry". The result of hypothesis 2 (H_2)B revealed that marine information system has positive and insignificant effect on prevention of marine plastic pollution with t-value outcome of 1.407 @ p0.160>0.05. By this result the null hypothesis 2(HO2B) has been accepted and alternate hypothesis 2(Hi_2)B rejected hence – "Marine information system has no significant effect on prevention of marine plastic pollution in maritime industry". With respect to hypothesis 6(H_6) the result in Table 17 revealed that information technology integration system has strong positive and significant effect on prevention of marine plastic pollution with t-value outcome of 3.734@ p0.000<0.05, therefore, the null hypothesis 2 (HO2C) has been rejected and alternate hypothesis 2(Hi_2)C accepted hence – "information technology integration system has a significant effect on prevention of marine plastic pollution in maritime industry.

From the inferential results, it can be stated as follows:

1. Computer-based information system as a dimension of information system adoption has a negative and significant effect on prevention of marine plastic pollution as a measure of pollution prevention in maritime industry. This simply means that computer-based information system as a veritable element for information system adoption significantly affects prevention of marine plastic pollution as a measure of pollution prevention in maritime industry even though negatively.
2. Marine information system as a dimension of information system adoption has a positive and insignificant effect on prevention of marine plastic pollution as a measure of pollution prevention in maritime industry.
3. Information technology integration system as a dimension of information system adoption has a positive and significant effect on prevention of marine plastic pollution as a measure of pollution prevention in maritime industry. The outcome here is indicative of the fact that information technology integration system positively affects prevention of marine plastic pollution as a measure of pollution prevention in maritime industry.

Effect of Information system adoption on Prevention of oil/gas pollution

This subsection was used to critically examine the effect of information system adoption on prevention of oil/gas pollution in maritime industry. To achieve this, the following hypotheses were formulated:

Ho_3 A: Computer-based information system has no significant effect on prevention of oil/gas pollution.

Ho_3:B Marine information system has no significant effect on prevention of oil/gas pollution.

Ho_3:C Information technology integration system has no significant effect on prevention of oil/gas pollution.

Table 15: Test Results of Information system adoption and prevention of oil/gas pollution in maritime industry.

Information system adoption (Independent Variables)	Unstandardized Coefficients		Standardized Coefficients	t - value	Significant/ Probability Value	Decision
	B	Std. Error	Beta			
(Constant)	1.041	0.118		8.839	0.000	
Computer-based information system	0.318	0.061	0.386	5.227	0.000	Significant

Marine information system	0.400	0.066	0.501	6.097	0.000	Significant
Information technology integration system	0.067	0.073	0.071	0.910	0.364	Insignificant

Source: Survey Data, 2025, and IBM SPSS Statistics 22 Window Output (Appendix I)

a. Dependent Variable: Pollution prevention

b. Predictors: (Constant), Professional competence, Information technology integration system, Computer-based information system , Marine information system

$$Y_3 = b_o + b_7x_7 + b_8x_8 + b_9x_9 + e \text{ ----------- } (3)\ \{for\ testing\ H7, H8, H9\}$$

$$Y_3(PEM) = 1.041 + 0.318RA + 0.400AS + 0.067AI + e$$

$$t = (5.227)\ (6.097)\ (0.910)$$

Table 15 shows the inferential statistical test results of the effects of information system adoption on prevention of oil/gas pollution in maritime industry. The result of the hypothesis 7 tested, shows positive and significant effect of computer-based information system on prevention of oil/gas pollution in maritime industry with t- value outcome of 5.227 at p0.000<0.05, meaning that a positive and significant effect exist between computer-based information system and prevention of oil/gas pollution in maritime industry, indicating that the null hypothesis 3(H_7) has been rejected and alternate hypothesis 3(H_{i7}) accepted hence – "Computer-based information system has a significant effect on prevention of oil/gas pollution in maritime industry". The result of hypothesis 3(H_3)B revealed that marine information system has strong positive and significant effect on prevention of oil/gas pollution in maritime industry with t-value outcome of 6.097@ p0.000<0.05. By this result the null hypothesis 3(H_{O3})B has been rejected and alternate hypothesis 3(Hi_3)C accepted hence – "Marine information system has a significant effect on prevention of oil/gas pollution in maritime industry". With respect to hypothesis 3(Ho_3)C the result in Table 4. 15 revealed that information technology integration system has positive and insignificant effect on prevention of oil/gas pollution with t-value outcome of 0.910@ p0.364>0.05, therefore, the null hypothesis 3 (H_{O3})C has been accepted and alternate hypothesis 3(Hi_3)C rejected hence – "information technology integration system has no significant effect on prevention of oil/gas pollution in maritime industry".

From the inferential results, it can be stated as follows:

1. Computer-based information system as a dimension of information system adoption has a positive and significant effect on prevention of oil/gas pollution as a measure of pollution prevention in maritime industry. This simply means that computer-based information system as a channel for information system adoption significantly affects prevention of oil/gas pollution as a measure of pollution prevention in maritime industry.
2. Marine information system as a dimension of information system adoption has a positive and significant effect on prevention of oil/gas pollution as a measure of pollution prevention in maritime industry. This also means that Marine information system contributes favourably to prevention of oil/gas pollution which is a measure of pollution prevention in maritime industry.
3. Information technology integration system as a dimension of information system adoption has a positive and insignificant effect on prevention of oil/gas pollution as a measure of pollution prevention in maritime industry. The outcome here is indicative that information technology integration system positively and insignificantly affects prevention of oil/gas pollution as a measure of pollution prevention in maritime industry.

Table 16: Summary of the Results on Test of the Research Hypotheses

Research Hypotheses	t-value	Significant/ Probability Value	Result	Decision
Ho1A: Computer-based information system has significant effect on prevention of water pollution	9.183	0.000	Positive and Significant Effect	Reject
Ho1B: Marine information system has significant effect on prevention of water pollution	4.735	0.000	Positive and Significant Effect	Reject
$Ho_{1\,C}$: Information technology integration system has no significant effect prevention of water pollution	-0.177	0.860	Negative and Insignificant Effect	Accept
Ho2A: Computer-based information system has significant effect on prevention of marine plastic pollution	-3.799	0.000	Negative and Significant	Reject
Ho2B: Marine information system has no significant effect on prevention of marine plastic pollution	1.407	0.160	Positive and Insignificant Effect	Accept
Ho2C: Information technology integration system has significant effect on prevention of marine plastic pollution	3.734	0.000	Positive and Significant Effect	Reject
$Ho_{3\,A}$: Computer-based information system has significant effect on prevention of oil/gas pollution	5.227	0.000	Positive and Significant Effect	Reject
Ho_3 B: Marine information system has significant effect on prevention of oil/gas pollution	6.097	0.000	Positive and Significant Effect	Reject
$Ho_9$3 C Information technology integration system has no significant effect on prevention of oil/gas pollution	0.910	0.364	Positive and Insignificant	Accept

Source: Research Data 2019, and IBM SPSS Statistics 22 Window Output

Table 16 has revealed in summary that the study rejected hypotheses: Ho1A - Computer-based information system has significant effect on prevention of water pollution in maritime industry; Ho_2 - Marine information system has significant effect on prevention of water pollution in maritime industry; Ho2A - Computer-based information system has significant effect on prevention of marine plastic pollution in maritime industry; Ho2C: Information technology integration system has significant effect on prevention of marine plastic pollution, Ho_7 - Information technology integration system has significant effect on prevention of marine plastic pollution in maritime industry; Ho_8: Marine information system has significant effect on prevention of oil/gas pollution. Table 4.16 also revealed that the study accepted hypotheses: Ho_3 - Information technology integration system has no significant effect on prevention of water pollution in maritime industry; Ho2B - Marine information system has no significant effect on prevention of marine plastic pollution in maritime industry and Ho_9: Information technology integration system has no significant effect on prevention of oil/gas pollution in maritime industry;

V. DISCUSSION

Effect of Information system adoption on Prevention of water pollution in maritime industry in Nigeria

The findings of the study revealed that maritime sector organisations adopt information system adoption to achieve prevention of water pollution. A critical appraisal of the finding reveals that computer-based information system has positive and significant effect on prevention of water pollution (t-value = 9.183); there is positive and significant effect of marine information system on prevention of water pollution (t-value = 4.735); negative and insignificant effect of information technology integration system as a dimension of information system adoption on prevention of water pollution (t-value = -0.177) (Babatunde, 2013; Karadag 2015). Further implication of this finding is that maritime sector organisations successfully use computer-based information systems, marine information system and information technology integration system to execute information system adoption that lead to prevention of water pollution (Mu'azu &Siti, 2013).

Influence of Information system adoption on Prevention of marine plastic pollution in maritime industry in Nigeria

The study found a positive and significant effect of computer-based information system on prevention of marine plastic pollution in maritime industry and this points to the fact that, computer-based information system is one of the key investigative instruments under the information system adoption that impact on prevention of marine plastic pollution in maritime industry. A diagnostic examination of the findings reveals that the effect of marine information system on prevention of water pollution was positive and significant; the effect of computer-based information system on prevention of marine plastic pollution was negative and significant indicating t-value of -3.799; the effect of marine information system as a dimension of information system adoption on prevention of marine plastic pollution was positive and insignificant i.e. t-value of 1.407. The effect of information technology integration system on prevention of marine plastic pollution was found to be positive and statistically significant with a t-value of 3.734. This meant that the ministries and departments had not fully embraced the marine information system which according to Mu'azu and Siti (2013) are policies and procedures that help ensure that organisations' assets and properties are well secured and maintained for further use. The results of this study agree with the works of (Vijayakumar and Nagaraja 2012; Arnold and Artz, 2015; Arnold & Gillenkirch, 2015).

Results further revealed that computer-based information system, marine information system, information technology integration system offer veritable opportunities to optimize information system adoption efficiency in maritime sector organisations by helping to monitor and supervise the activities of the staff in maritime industry in financial matters. The reality of this finding is that these instruments have become potent forces in the internal audit used by maritime sector organisations to manage their expenditures. These findings agree with the views of Unegbu and Kida (2011) that internal audit contributes positively to pollution prevention in the public sector by effectively checking fraud and fraudulent activities.

The study also revealed that the quality of interaction between maritime sector organisations' staff and stakeholders relates to computer-based information system and marine information system that directly influence the decisions in pollution prevention in maritime industry which agrees with the observation of Pietrzak (2014).

The study found that maritime sector organisations value giving satisfactory and accurate information to the environmental impact assessment activity in order to achieve prevention of oil/gas pollution agreeing this, Lee, Johnson and Joyce (2004).

The study also found that government organization ensure that prevention of marine plastic pollution is achieved through regular pollution prevention. This finding is in consonance with Vijayakumar and Nagaraja (2012)

Effect of Information system adoption On Prevention of oil/gas pollution in maritime industry in Nigeria

The result with regard to the effect of information system adoption on prevention of oil/gas pollution in maritime industry, points to the fact that, internal pollution prevention provides prospects and getting of veritable information about the prevention of oil/gas pollution in maritime industry. A critical evaluation of the finding reveals that the effect of information system adoption on prevention of oil/gas pollution discipline is positive and significant. An analytical examination of the findings reveals that the effect of computer-based information system on prevention of oil/gas pollution was positive and significant indicating t-value of 5.227; the effect of marine information system as a dimension of information system adoption on prevention of oil/gas pollution was positive and significant i.e. t-value of 6.097. The effect of information technology integration system on prevention of oil/gas pollution was found to be positive and statistically insignificant with a t-value of 0.910. These findings are in line with Shoommuangpak and Ussahawanitchakit's (2009); Mizrahi and Ness-Weisman (2007); Whittington

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(2001); Davila, Foster and Jia (2014); World Bank (2017)

VI. CONCLUSION

The findings on this study concerning the impact of information system adoption on pollution prevention in maritime industry have shown to be effective and they have helped in diverse ways to transform many maritime sector organisations to achieve the reasons for their existence. The result suggested that internal audit units are performing despite many challenges they encounter with regard to freedom to operate well, financial constrain, inadequate resources and other logistics like cars to enable them to audit all organizations regularly.

Based on the findings of the study, the following conclusions have been made:

1. As maritime sector organisations adopt computer-based information system they achieve their objective of prevention of water pollution positively and significantly. This simply means that computer-based information system as an instrument of information system adoption positively influences the prevention of water pollution to elicit good pollution prevention in maritime industry.
2. As maritime sector organisations conduct computer-based information system it results to negative and significant effect on prevention of marine plastic pollution as a measure of pollution prevention in maritime industry. This simply means that computer-based information system as a veritable element for information system adoption significantly affects prevention of marine plastic pollution as a measure of pollution prevention in maritime industry even though as maritime sector organisations apply marine information system it translates to positive and insignificant effect on prevention of marine plastic pollution as a measure of pollution prevention in maritime industry.

3 As maritime sector organisations adopt computer-based information system it brings about positive and significant effect on prevention of oil/gas pollution as a measure of pollution prevention in maritime industry. This simply means that computer-based information system as a channel for information system adoption significantly affects prevention of oil/gas pollution as a measure of pollution prevention in maritime industry.

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