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Article

Creating a Standard Risk Assessment of Potential Combinations of Technical and Non-technical Issues Confronting the Multi-purpose Renewable Energy Platform in Port Harcourt, Nigeria

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Abstract: In a multi-purpose offshore platform project, the design, installation, and operation can cause severe impacts on the safety of maritime activities and personnel within the marine environment. The unification of ocean renewable energy design, aquaculture, transport, leisure, and sea mining will be a more efficient and sustainable technology. This report examined the potential likelihood and consequences of numerous oceanic accidents and life-threatening risks that may arise because of this combination. This included an evaluation of the mix, identification of the challenges, and assessment of the risk that may be common to this multi-purpose innovative platform. A risk management framework, with a standard assessment methodology that includes risk identification, analysis, control, as well as risk mitigation, was created. The evaluation revealed an offshore multi-purpose platform to be characterized by complexity, uncertainty, and ambiguity. These can be managed through combined stakeholders and government.

Keywords: Complexity, Multi-purpose Platform, Risk Assessment, Uncertainty.

1. Introduction

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Multi-purpose offshore platform is an innovative ocean platform that syndicates different ocean activities like aquaculture, tourism, transportation, renewable energy farm, and oil and gas production. The grouping of these events can be united into one shared structure, creating potential benefits in reducing the environmental impact, installation/maintenance costs, and increasing resource application Maximilian et al, (2019). Before considering this system, offshore wind and offshore oil and gas have been a previously recognized technology in the subsea with great benefits. The creation of synergies between oil and gas, wind with other Marine Renewable energy technologies like wave, tidal energy, aquaculture, and transportation can be a great innovation of emerging technology. Moreover, this deep-water exploitation will attract an innovative design, create opportunities, and reduce maintenance tasks and operational costs on platform activities. According to Brussels, (2014), the project, which is referred to as "blue economic" by the European Commission, has the capacity to create over 5 million jobs with an expanded volume for further growth.

1.1. Concept and Components of the Multi-purpose Platform (MPP)

According to the work of Abhinav *et al.*, (2020), the idea behind offshore multi-purpose platforms is to unravel the needs of the multifaceted maritime industries, which include offshore energy and aquaculture, the concept that European Union recognizes as "Blue Economic". The World Bank on their part defines the ideas as "the justifiable use of the ocean resources for commercial growth, job creation and enhancement of living, though conserving the wellbeing of the marine ecology" Quevedo *et al.*, (2013) and Menicou and Vassiliou, (2010). The MPP concept aims to explore the interactions and organization of the tautness arising in a closely co-existing system of this kind. In the idea of H2OCEAN project, they acknowledged a distinctive design from the MERMAID and TROPOS projects, incorporating the conversion of energy into hydrogen that can be stored and shipped across the various network. The designed components of a typical multi-purpose platform is as shown in figure 1.1 below:

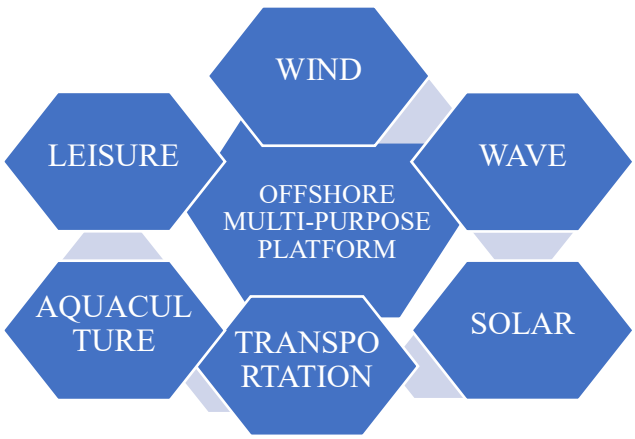

Fig. 1.1: Components of an offshore Multi-purpose platform

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In the setting of a multi-purpose platform according to MERMAID project, (MERMAID, 2015a) and the MARINA EU project ((Ferri, 2016) platforms, Fig.1.1 and Fig.1.2 all show a thought of different integrating multi-purpose offshore platform with a concept of combining renewable energy technologies such as wind turbines, solar and wave energy converter (WEC).

In a careful study of this innovation and combinations in an offshore platform, the risk and hazards are still an issue of more research and studies. The reason is that; there is not much-published document on the strategies and standard of safety, dependability as well as quality in this multi-purpose platform concept.

Fig. 1.2: Multi-purpose platform (Adapted from; maritime research institute the Netherlands, (2020)

1.2. Benefits and Risk Concern of the Multi-purpose Energy Platform

The multi-purpose offshore energy platform will continue to gain momentum in years to come due to its real alternatives and advantage that the industry is presenting. These number of collaborations will promote an upsurge in energy, economic, leisure, and transportation. From the opinion of Perez *et al*, 2013), the platform will enhance global energy yield and round power output. Also, it will create common grid infrastructure, standard foundation systems, and communal operational and maintenance costs, which will enable joint legislative collaborations like in the energy Act, Hillson, (2004) and climate change, Jansen *et al*., (2016), which will impact positively on Nigeria maritime and the environment.

According to Williams *et al*., (2017) on MARIBE (marine project for the blue economy), there are some notable new and developing industries that stand to benefits significantly from the latent potential of such collaboration, promoting the probabilities of economic existence and future expansion. These industries, referred to as blue growth by European Nations, Brussels (2012), include Ocean Renewable Energy, Ocean Biotechnology, Ocean Farm (Aquaculture), and Seabed Mining. At the focus of all these is the risk and safety concern post by this platform.

The drive of this paper is to review a possible risk mixture and recognized the challenges as well as suggesting a risk management instrument that can be used by the industry players in Nigeria to analyze

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and mitigate the risk challenges in a multi-purpose platform operation. It will also establish an overview of the available literature and values of the existing multifunctional platform challenges to this review in terms of risk perception and assessment in entirely new technologies like the MARIBE project.

Risk assessment delivers substantial data and analysis on a way and manner of approach to risk. From the view of Guidance, Natural and Risks, (2011), and Health and Safety Executive, (2015), the risk is the probability of a hazard happening with the suggestion of how severe the penalties can be. Carrying out a risk assessment enables the pertinent stakeholders to contribute an informed choice on the feasibility of every project. It becomes imperative, especially where different stakeholders from different industries are coming together. From ISO 31000 British Standards, London, (2009), a functional and inclusive risk assessment must embrace the procedure of risk identification, risk examination, and risk evaluation.

2. Methodology

Aimed at creating a comprehensive and consistent method at all stages of different activities on the multi-purpose platform marine operation. Due to the intricacy of a multi-purpose platform, quantitative risk assessment approach is employed in reviewing the platform risks and adopting the methodology which is embraced in these order:

2.1. Hazard / Risk Identification

This is carry out in the order as summarized on figure 2.1 below.

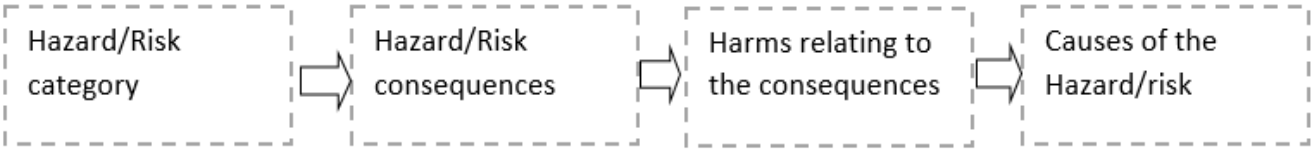

Fig. 2.1: Risk identification links

The primary stages of these process is to identify and record every risk and potential risk within the platform and the proceedings is carry out as presented on figure 2.1 above. The risk source, situations and events that will impact negatively on the platform operations are identified. The platform risks is divergent with uncertainty in areas such as technological catastrophes, political instability, natural disaster and financial market. Figure 2.2 show discrete groups of which the risk is classified.

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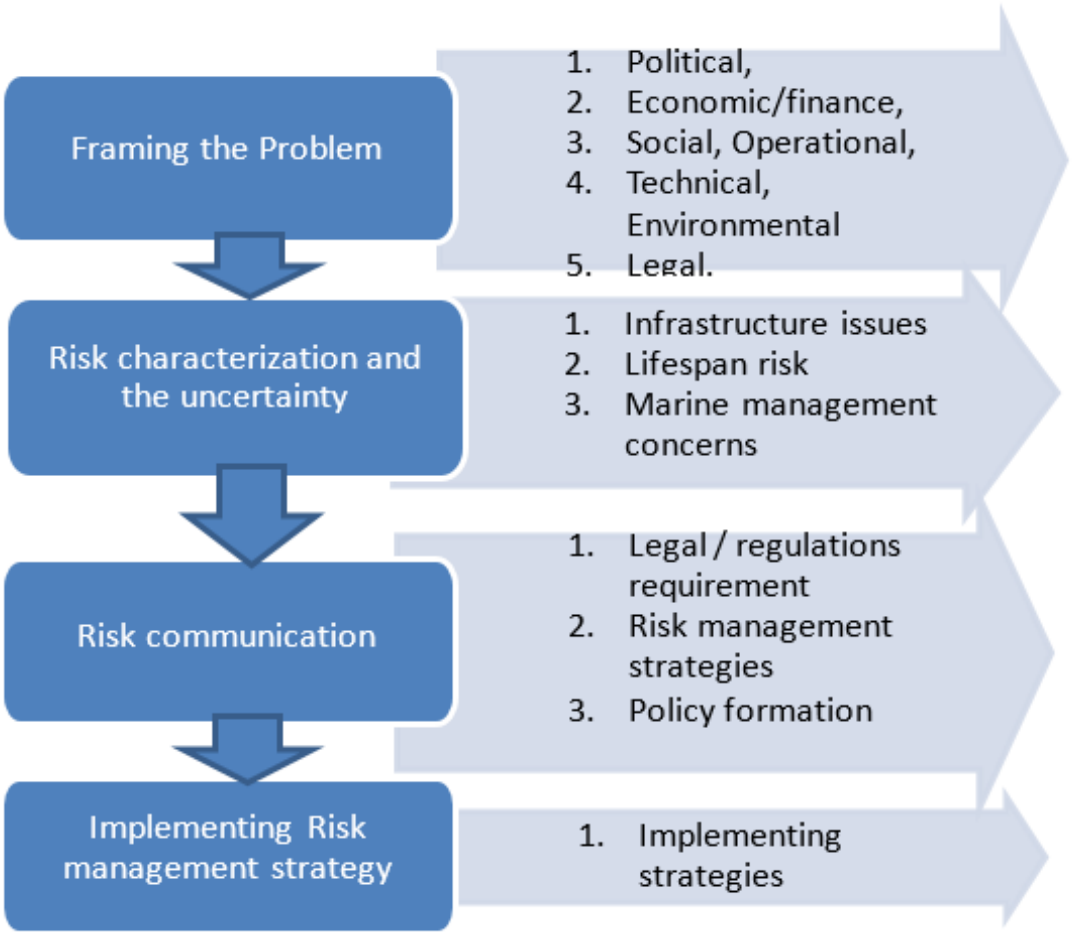

Fig. 2.2: Multi-purpose platform risk assessment framework

2.2. Area of Risk Identification

Having established the different categories, the next phase is to establish some specific areas of potentials risks. These can be reliant on the type of technologies that is used in the platform/project. On this case, the generic issues that is applicable to many multi-purpose platform is considered. The table below give a breakdown of the areas and their identified risks:

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Table 2.1. Areas/ Issues of Risk concern

Area	**Hazard/Risk**
Financial Market	Cost disparity Unforeseen costs Location related matters Supply/demand chain matters Lack of investment support Deficient budget eventuality Production yielding matters End of life or decommissioning costs
Economic and Political	Useful price prediction Supports and grants Compliance to legislation and guideline Inability to move with industry market Exchange rate and currency fluctuation Uncertainty in politics and economic.
Operation	Emergency situation Contamination and effluence Technology and policy Technical/scientific performance System/ component unintended failure Oceanic navigation risk Site and community problem Licensing and legislation Personnel matters Price of goods Decommissioning.
Environment	Environmental impact on biodiversity Environmental legal and regulatory compliance Environmental pollution Impact on water bodies Shipment process Geological processes and coastal effects Vibration, noise and visual effluence
Health	Casualty inline of operation Injury and casualty from electrical equipment Accident from hazardous equipment Accident from lifting equipment Accident from marine vessel interfaces Accident from offshore operation Accident occasion by bad weather Accident from water traffic and collision
Social	Damage due to youth community or local unrest Crime/theft and vandalism Community/municipal health matter Land use and community perception.

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From Figure 2.2, the framework presented to give an explicit link to specific risk assessment with a more directional and system-oriented examination, feeding into risk judgment, and risk management approach development. The vital aspect of this framework is that it gives no room for any risk on the platform to be assessed separately. It is because the risks identified on MPP are measured on a broader working setting of the platform, despite their magnitudes, this is to ensure appropriate and effective utilization of any adopted risk management strategies.

2.3. Hazard/Risk Scoping on the Multi-purpose Platform

The process of risk assessment begins with risk and hazard scoping. Being able to provide answers to questions like, what can happen, how can it happen, when, and where will it happen? This process is involving the acknowledgment and recording of every risk potential point existing in a project from the viewpoint of political, economic, social, technical, environmental, and legal (PESTEL). Although a high number of risks can create multiple impact and effect (systemic risk) causing such to be classified into many categories, these types of risk must be acknowledged in the various groups to give a comprehensive approach. Figure 2.3, below present the different categories of risk based on PESTEL and their inter-winding effect within the platform.

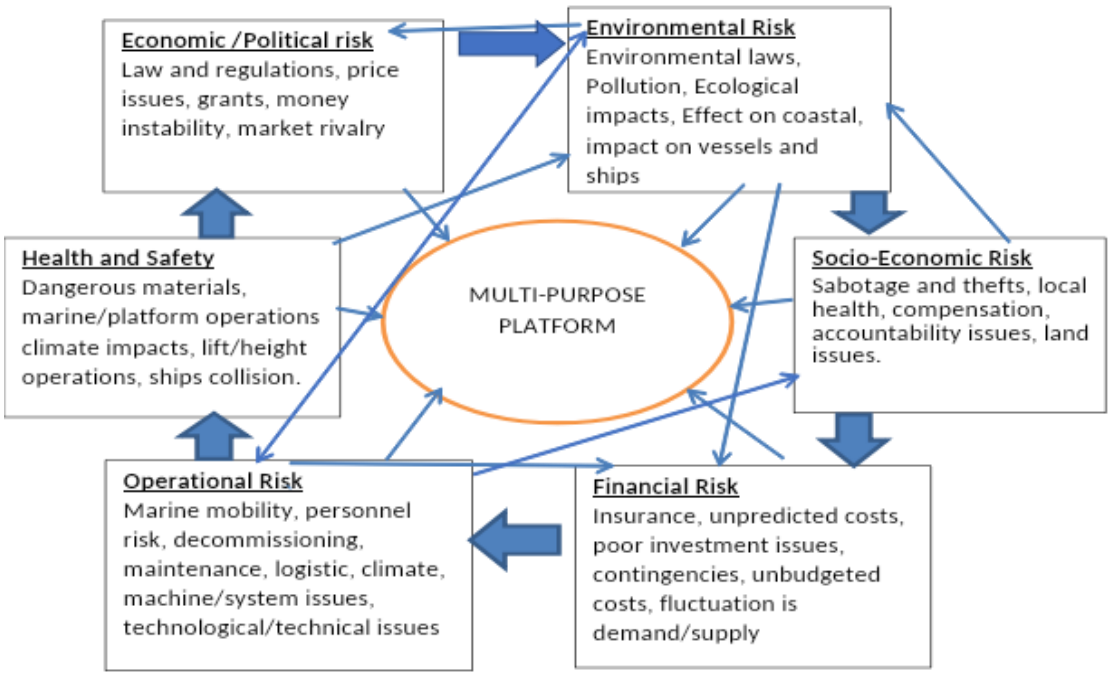

Fig. 2.3: Categories of Risk on the Multi-purpose platform

2.4. Risk Characterization and Uncertainty (the system interdependencies)

The most pertinent issue to note when assessing the risk is, the stressors (hazards) can influence the components (receptors) in multiple forms, and the inappropriate task of likelihood will result in

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uncertainty and the possible mistake of the real risk posed. Handling this demand a well-expressed account to frame the challenge and give an explicit declaration of the system limits. Using frame (fig.2.4) was to help in establishing the characteristics, uncertainty, as well as demonstrating the interdependencies within the system.

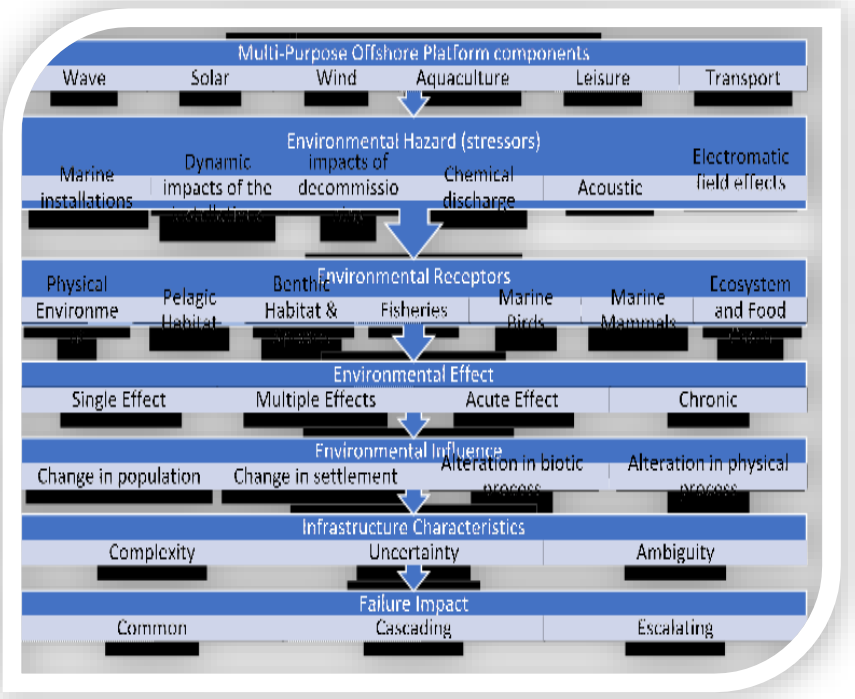

Fig. 2.4: The effects and impacts of the Environmental stressors and receptors links within the platform (Jude *et al.*, 2017)

Consequence	5	Mild	Serious	Very Serious	Very Serious	Very Serious
	4	Insignificant	Mild	Serious	Very Serious	Very Serious
	3	Insignificant	Insignificant	Mild	Serious	Very Serious
	2	Good	Insignificant	Insignificant	Mild	Serious
	1	Good	Good	Insignificant	Insignificant	Mild
		1	2	3	4	5
		Probability				

Fig. 2.5: The probability and consequences assessment of hazard

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2.5. Risk Management Strategies

This is the implementation stage, after combining all the systemic risk elements, an optimal risk management technique capable of dealing with effects associated with environmental security, technical issues, and economic, social, as well as organizational competencies addressed. The combination of these elements allow for an orderly contrast of options used in this risk management approach. The risks can be successful managed using the following strategies

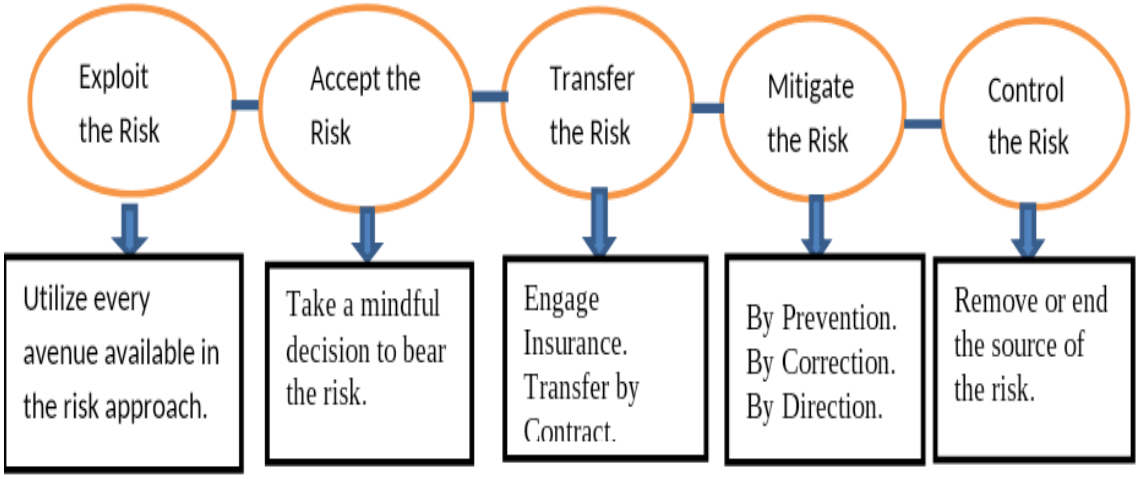

Fig. 2.6: Management Strategies

2.6. Hypothetical Ideas for Assessing the Risk

Risk assessment is the ability to ponder out what possibly might be a source of harm on the platform to the people, installations as well as the environment. Risk assessment, in terms of likelihood and consequence, measure and reply, agent, and penalties, according to Renn *et al*, (2011), has been an interactive exercise for decades. From the International Maritime Organization (IMO), there is a formulated Formal Safety Assessment (FSA) steps whose rationale is based on the following order; Risk identification, Risk analysis with control options, cost-benefit assessment, and recommendations for stakeholders. The word "formal", according to van den Burg *et al.*, (2020) refers to the integration of mathematical judgment to reason the safety assessment procedure as used in Event tree and Fault tree. According to Renn *et al*, (2011), risks frame by calculation and prediction usually upshot in the development of technocratic as well as economic models forms in risk assessment and management. Therefore, it noted that such models could only fit with simple risk with a known cause, the possible adverse significances which can be seem with little uncertainty, presenting barely slightly ambiguity in the risk interpretation.

Furthermore, the Formal Safety Assessment by the International Maritime Organization intended to assess maritime safety whose risks are simple, like shipping, not a complex risk, as in the case of

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multi-purpose platform. It is now a known concept that a combined system like multi-purpose platform is associated with systemic risk, signifying that the risks to personnel and the ecosystem entrenched in a wider set of political, economic, social, as well as the environment, Renn and Klinke, (2004). Systemic risk cannot abridge to arithmetical deliveries; rather, it necessitates an all-inclusive method in risk identification, assessment as well as management, because exploring this risk goes beyond the traditional effect and consequences analysis. To characterize the risk, as presented in figure 2.3, the characteristic of systemic risks is group into complex, uncertain, and ambiguity Renn and Klinke, (2004).

2.6.1. Complexity

In this characteristic, if there is a strong unpremeditated association between an occurrences with a consequence, the complexity will go low. As additional factors like weather or ecological circumstances stimulate the frequency of effects, complexity upsurges. Complexity can be a result of the antagonism or the synergisms among the installations as well as system inter-individual disparity. As a result of complexity, it is unbearable to attain comprehensive deterministic information between the cause and the effect.

2.6.2. Uncertainty

This characteristic links with considerable uncertainty once evaluating risks relating to the upcoming happening or significances Van Asselt and Renn, (2011). The possible consequences might remain clear, then the aptitude to enumerate the likelihoods is not clear; it results in variable grades of uncertainty: example, the uncertainty of production procedures on MPP considering the limitation of reference data in the technology.

2.6.3. Ambiguity

According to Van Asselt and Renn, (2011), this systemic risk characteristic infers that there remain many genuine lookouts from which to appraise if there are or might be opposing effects and if the risk is bearable or satisfactory.

3. Results and Discussion

3.1. Characterizing the Risk

From the MARIBE project, it was established that the risks associated multi-purpose platform will increase with an increase in projects/structures' combination. The combination was believed to increase the individual risk of each technology on the platform. As some of the risks being in the increase by reason of the increase in technology, there are majority of risks that will be at a decreasing rate.

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Following the recommended risk management procedure with proper risks response, high risk would be condensed to reasonable and low risk.

For Rinaldi, (2004) and Willsteed et al., (2017), connectivity and interdependencies will create a significant challenges, which can become importantly overblown by the extensiveness and intricacy of the platform infrastructure; also, these characteristics are reflected upon as complexity, uncertainty, and ambiguity.

Uncertainty unarguably is an issue in the process of multi-purpose platform risk assessment. It can be necessitated by lack of knowledge or complexity relating to risk on this platform, an incapability to regulate an outcome as well as a lack of understanding of the efficiency of specific management approaches. The uncertainty can be classified into two broad dimensions, in epistemic angle, that is, the lack of the system knowledge, and, an essential variability existing in any standard system.

3.2. The Cumulative Impact

The risk assessment must equally be put into consideration, knowing the collective danger that might take place because of the combination of the technology. Since this platform is assembling multiple technologies with each of the technology having its peculiar challenge, a cumulative risk assessment is required due to their combination. Though, in a combination involving ocean farm (aquaculture) and renewable energy platform, there is bound to be an upsurge in risk to both ends of the productions because of their closeness. In the event of an accidental, chemical discharge or leakage from the renewable energy installations, this will impact negatively on the ocean farm. Similarly, some categories of aqua farm will cause an upsurge in bio fouling hazards around renewable energy installations. A suitable control method should be in place for evaluating the consequences of this by way of distancing the positioning of these installations.

Nevertheless, this combined impact can be of great advantage to a multifaceted platform; the combined technology can help in risk reduction. For example, where there is a platform of multiple technology combination, the risk of ship collision and other oceanic accidents will be reduced. The reason is that the platform is going to be large and visible.

3.3. Impact on the Marine Animals

Ocean wind farms as well as other offshore constructions have been noted to be a source of threat and impacted negatively on fauna and flora within the marine environment. The adding of hard substrates makes a novel zone for the possible habitat of species, though the closure of zones for other activities like fishing can result in protected zones. According to Reist *et al.*, (2006), such changes in aquatic mammal profusion around wind farms and with the setting in multi-purpose platform, the impact will undoubtedly increase, describing the changes owing to the hard substrate then augmented food

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availability. Additionally, the building up of seaweed farms (aqua farms) will stimulate local biodiversity with a more sustainable positive effect. On the contrary, the presence of multiple structures and their closeness will act as a trap to large aquatic animals as well as the increasing mortality rate for bats and birds from the collision with wind turbines, van den Burg *et al.* (2017).

Though the fundamental connection with the associated risk is comparatively forthright, the ultimate consequence upon animal populaces rest on some other variables and complication of this risk is assessed. The uncertainty can equally consider to be typical, given the consideration drawn from the impact with other known and the existing platform.

3.4. The Platform Risk Governance

Handling risk should not be the sole responsibility of the governments. The idea of risk governance is dynamic and covers various issues like the regulation of public relevant concern by non-state stakeholders and the inclusion of stakeholders in policymaking, deprived of being able to order and consent such collaboration Offe, (2009). The risk governance in the multi-purpose platform should be made to include official institutions and governments, as well as casual provisions. That consists of the totality of performers, rubrics, agreements, procedures and devices that have to do with how pertinent risk data is gathered, investigated and communicated as well as how regulatory conclusions are reached (IRGC, 2018). The act of risk governance is practically the conversion of the element and the core philosophies of governance addicted to the context of risk management and it's decision-making. The need for Risk governance here comes from a drive to offer a theoretical approach, utilizing a normative foundation for by what method to grip sensibly with uncertain, complex and the ambiguous risks.

Knowing the changing aspects, build up, and purpose of the risk governance procedures associated with multi-purpose offshore platform needs a comprehensive knowledge of the governance scheme. Offshore multifaceted platform setting is still at the theoretical stage. Present risk governance is formed by a jerry-rigged or make-shift of public and private rules.

4. Conclusion

This study aim was to evaluate potential combinations of technical and non- technical issues confronting the offshore multi-purpose platform.

The study has provided an appreciated understanding of the possible combination and the perceived risks in a multi-purpose platform setting. The assessment process employed by MARIBE in their project was healthy but looking at the preliminary issues, the following queries should be addressed for effective risk management.

4.1. The Platform Risk Governance Must Be a Combined Effort of All Stakeholders and Government

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The government norms and guidelines may lead likely to a limitation on some issues; these may be short in supply and need to be complemented by private guidelines. These guidelines from the private, however, are usually technical procedures that describe the process to follow, while the government norms offer legal support. Concerning environmental matters, there exist measures for evaluating the influence of each structure. Government norms and regulations, as well as private standards, should be a step-up bar in endorsing and promoting an industry that stresses additional than is officially obligatory.

4.2. There Should Be an Integrated Risk Assessment in Addressing the Combined Impacts and Effects

Risk assessment and evaluation tend to concentrate on discrete structures such as wave or wind structures along with their distinct risks. The environmental impact consequences from the whole of events, according to Piet *et al.*, (2019), numerous methods to environmental founded management are engaged. Engaging an integrated assessments/evaluations approach will offer understanding into combined effect and impact as well as the possible interactions between political, economic, social, technical, and environmental risks on the platform.

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References

Abhinav, K. A., Collu, M., Benjamins, S., Cai, H., Hughes, A., Jiang, B., Jude, S., Leithead, W., Lin, C., Liu, H., Recalde-Camacho, L., Serpetti, N., Sun, K., Wilson, B., Yue, H. and Zhou, B. Z. (2020). Offshore multi-purpose platforms for a Blue Growth: A technological, environmental and socio-economic review, *Science of the Total Environment*, 734:138256.

British Standards, London, 2009 (2009). Risk management - Principles and guidelines. ISO 31000: 2009.

Brussels (2012). Blue Growth opportunities for marine and maritime sustainable growth, *European Commission*, Communication from the commission to the *European Parliament, the European Economy and social committee* Doi: 52012DC0494.

Brussels (2014). Innovation in the Blue Economy: realizing the potential of our seas and oceans for jobs and growth, *European Commission*, Communication from the commission to the *European Parliament, the European Economy and social committee,* Doi: 52014DC0254R (01).

Ferri, F. (2016). Marina Project, 327: 1–3.

Copyright © 2021 by Modern Scientific Press Company, Florida, USA

Guidance, R. D., Natural, M. and Risks, E. (2011). Guidelines for Environmental Risk Assessment and Management - Green Leaves III, *Risk Management*, 2008(November): 590

Health and Safety Executive (2015). *Controlling the risks in the workplace, HSE*. Available at: https://www.hse.gov.uk/risk/controlling-risks.htm (Accessed: 2 June 2020).

Hillson D. (2004). Effective opportunity management for projects – exploiting positive risk. *New York: Marcel Dekker*.

IRGC (2018). Irgc Guidelines for the Governance.

Jansen, H.M., Van Den Burg, S., Bolman, B., Jak, R.G., Kamermans, P., Poelman, M. and Stuiver, M. (2016). The feasibility of offshore aquaculture and its potential for multi-use in the North Sea, 24:735-756.

Maximilian F. S., Martina B., Daniel D., Andronikos K., Zacharoula K., Ivana L., Angela S. Z., Gesche K., Vincent O., Bela H. B. (2019). Toward a Common Understanding of Ocean Multi-Use, *HYPOTHESIS AND THEORY ARTICLE*. Available at: https://www.frontiersin.org/articles/10.3389/fmars.2019.00165/full (Accessed: 26 May 2020).

MERMAID (2015). Innovative Multi-purpose offshore platforms: planning, design & operation, p. 1. Available at: http://www.vliz.be/projects/mermaidproject/.

.Menicou, M. and Vassiliou, V. (2010). Prospective energy needs in Mediterranean offshore aquaculture: Renewable and sustainable energy solutions, *Renewable and Sustainable Energy Reviews*. 14: 3084–3091.

Offe, C. (2009). Governance: An â□œEmpty Signifierâ€ • ? *Constellations*, 16: 550–562.

Olsson, R. (2007). In search of opportunity management: Is the risk management process enough, *International Journal of Project Management*, 25: 744–753.

Perez-Collazo C., Jakobsen M. M., Buckland H F. (2013). Synergies for awave–wind energyconcept, *Proceedings of the European offshore wind energy conference*. EWEA: Frankfurt, Germany*; 2013:*1–10.

Piet, G., Culhane, F., Jongbloed, R., Robinson, L., Rumes, B. and Tamis, J. (2019). An integrated risk-based assessment of the North Sea to guide ecosystem-based management, *Science of the Total Environment*, 654:694-704.

Quevedo, E., Delory, E., Castro, A., Llinás, O., Hernández, J., Consortium, T., Carton, M., Delory, E., Castro, A., Hernandez, J., Llinas, O., De Lara, J., Papandroulakis, N., Anastasiadis, P., Bard, J., Jeffrey, H., Ingram, D., Wesnigk, J., Llinás, O., Hernández, J. and Consortium, T. (2013). Modular multi-purpose offshore platforms, the TROPOS project approach, *OCEANS 2013 MTS/IEEE Bergen: The Challenges of the Northern Dimension*, 280876851: 1–5.

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Reist, J. D., Wrona, F. J., Prowse, T. D., Power, M., Dempson, J. B., King, J. R. and Beamish, R. J. (2006). Climate Change Effects on Aquatic Biota, Ecosystem Structure and Function, 35: 381–387.

Renn, O. and Klinke, A. (2004). Systemic risks: a new challenge for risk management, 8255305:1-10.

Renn, O., Klinke, A. and Van Asselt, M. (2011). Coping with complexity, uncertainty and ambiguity in risk governance: A synthesis, 40: 231–246.

Rinaldi, S. M. (2004). Modeling and simulating critical infrastructures and their interdependencies, *Proceedings of the Hawaii International Conference on System Sciences*, 37: 873–880.

Williams, H., Willsteed, E.A., Jude, S., Gill, A.B. and Birchenough, S.N.R. (2018). Obligations and aspirations: A critical evaluation of offshore wind farm cumulative impact assessments, *Renewable and Sustainable Energy Reviews*, 577: 2332–2345.

Masters, I., Pletsas, D., Fuentes Grunewald, C., Callaway, R., Dalton, G. and Blanch, M. (2017). A risk assessment methodology for combining marine renewables with other blue economy, 319311916: 817–9

Van Asselt, M. B. A. and Renn, O. (2011). Risk governance, *Journal of Risk Research*, 14: 431–449.

Van den Burg, S. W. K., Röckmann, C., Banach, J. L. and van Hoof, L. (2020). Governing Risks of Multi-Use: Seaweed Aquaculture at Offshore Wind Farms, *Frontiers in Marine Science*, 7: 1–12.

Van den Burg, S. W. K., Stuiver, M., Bolman, B. C., Wijnen, R., Selnes, T. and Dalton, G. (2017) Mobilizing investors for blue growth, *Frontiers in Marine Science*, 3: 1–9.

Willsteed, E., Gill, A. B., Birchenough, S. N. R. and Jude, S. (2017). Assessing the cumulative environmental effects of marine renewable energy developments: Establishing common ground, *Science of the Total Environment*. 577: 19–32.

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