Strategic Environmental Assessment (SEA) and Sustainability Options' Integration into the Pakistan's Merchant Marine Policy 2001 (Revised 2019)

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Abstract

Strategic Environmental Assessment (SEA) is a valuable tool to formulate, coordinate, and deliver a broad vision and policies in a country and meet at least sustainable development objectives more quickly. However, some policies do not consider SEA in their formulation and continue to update with new policies without regard to the current environmental and social problems concerning the development and the measures that a nation's government can embrace. The objective of this study was to incorporate the Strategic Environmental Assessment (SEA) into the Pakistan Merchant Marine Policy, which was revised in 2019. The method used in the study was an analysis of existing maritime policy and international conventions. The baseline environmental data was obtained through focus discussions with stakeholders' consultation and field assessment. Impacts were assessed, and potential ecological issues were examined using the SEA framework. Stakeholder involvement was paramount in admitting all the acceptable solutions in the objectives' revision of the Pakistan Maritime Policy. The study highlighted the environmental impacts of the shipping industry, including invasive species, air pollution, water pollution, and noise pollution. It evaluated sustainable alternatives for mitigating these impacts, focusing on realistic, viable, and implementable solutions. Recommendations include marine conservation strategies, low-carbon vessel designs, and ballast water regulation, addressing policy gaps in sustainability for Pakistan's Merchant Marine Policy (revised, 2019). The study devised specific alternatives to the policy when revised next time.

Keywords: Strategic Environmental Assessment, Sustainable Development Goals, Pakistan Merchant Marine Policy, Biodiversity, Environmental Impact Assessment.

Introduction

Strategic Environmental Assessment (SEA) is a higher form of an integrated approach to policymaking that incorporates stakeholder engagement, strategic choice, and proper policy implementation for sustainable development with a minimal negative impact on the environment and population's health. Nonetheless, SEA practice in Pakistan is significantly underdeveloped, as environmental issues remain on the periphery of the country's political agenda, and there is a lack of professionals capable of conducting SEA (Ullah et al., 2021). However, integrating SEA in such

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important projects as the Gilgit city master plan and AJK hydropower plants still poses major challenges to its effective application. The first issue is at the provincial level, where SEA is not systematically incorporated into practice. Considering Pakistan's current and prospective policies, SEA is a unique chance to develop a sustainable and effective system that connects environmental issues to policies. It can enhance Pakistan's policy formulation by systematically evaluating the environmental impacts of proposed policies (Waheed et al., 2023). It ensures that environmental interests are integrated early in decision-making, fostering sustainable development. SEA aligns policy objectives with environmental protection and sustainability goals by identifying potential adverse effects and mitigation measures. environmental protection strategy. One policy that should attract the attention of authorities is the Pakistan Marine Merchant Policy, which was revised in 2019 and does not have an effective environmental management plan (Pakistan National Shipping Corporation, 2019). The lack of a Strategic Environmental Assessment (SEA) in the policy weakens the government's ability to reduce the environmental effects of maritime activities, especially on emissions regulation and marine ecosystem preservation. Endorsement of SEA in the policy would help in the implementation of environmental objectives as a part of the policy goal of protecting the marine ecosystem in the waters of Pakistan. The implementation of SEA in countries like Portugal and Bangladesh has been successful, which indicates the viability of influencing sustainable policy results. In Portugal, SEA was efficiently applied to draft the Integrated Coastal Zone Management (ICZM) Strategy. This was primarily aimed at managing about 1800 km of the coastline by balancing the need to protect ecosystems and meet development goals. This is particularly because SEA was not mandatory in Portugal at the policy level, yet its implementation allowed for the analysis of environmental risks and opportunities. It formed a policy framework that preserved and sustained natural coast behavior, the ecosystem and other cultural aspects, indicating that SEA embodies the spirit of strategic planning and sustainability. Similarly, Bangladesh offers a powerful testimony of SEA in tackling the climate issues in the coastal areas of SEA (Islam et al., 2018). Having an area of 47,201 square kilometers and a population of more than 36.8 million, the Bangladesh Coastal Area is highly vulnerable to disasters, specifically cyclones and floods, leading to an annual average exposure of $2.5 billion and over 700 deaths. The use of SEA has helped to reduce these risks because it provides direction regarding the planning and construction of important infrastructures such as 5,017 kilometers of coastal revetment, and has contributed to climate change policy and measures. Moreover, SEA helped Bangladesh and India maintain effective cooperation and equitable use of the Sundarbans' mangrove forest, which is indispensable for environmental conservation. These examples demonstrate how far SEA has come to mainstream sustainability into national policies. For Pakistan, which relies on maritime transport for over 95% of its trade, adopting SEA within the framework of merchant marine policy could effectively address environmental issues of concern, such as pollution of the seas and their ecosystems. According to the key objectives of Pakistan Marine Merchant Policy (Pakistan National Shipping Corporation, 2019) the emphasis is on the expansion of trade and transportation that will be useful for the development of the whole economy of the country and further development of the maritime sector, based on the coastline of 1050 km of Pakistan (Shakoor & Mahmood, 2023). However, the problem is that they do not discuss environmental occurrences such as oil slicks arising from shipping or ballast water, which transfer invasive species into Pakistan's marine environment. In objectives (iv) and (viii) of the policy, there is a clear statement about increasing (5 to 40%) sea-borne trade to its maximum potential through fleet flying the Pakistan flag and expansion of maritime institutions and industries (Pakistan National Shipping Corporation, 2019). However, there is no discussion on how this can

be done sustainably, let alone discussing the operationalization of a sustainable approach or the increased likelihood of risk that this entails. It is also important to realize that no stance is taken regarding accidental oil spillage and disaster management. Even though Pakistan has acceded to 24 instruments of IMO, including SOLAS-1974, MARPOL and the London Convention 1972 (Convention on the Prevention of Marine Pollution by the Dumping of Wastes and Other Matter, 1972) to name a few [IMO, 2021]. Concerning objective (ix), it does not discuss the Operational Health and Safety (OHS) practice while using trained human resources; even when referring to the extension of training amenities by the IMO conventions under the targets section, they only make a point about the expansion of the training amenities. They are still not viable because Pakistan is a signatory to ILO sea conventions (Khan et al., 2016).

Methodology

The essential aspect of the strategic environmental assessment is that they only gather baseline data. Then, we can measure the changes in the environment following the work of the project, plan, program, and policy (Fischer, 2023). We used primary and secondary research methods to obtain baseline data for the Pakistan shipping sector (Hussain et al., 2022). Some primary sources include interviews with worried authorities, while secondary sources include data from previous existing studies, journals, research, etc. The Merchant Marine Policy 2001 was revised in 2019 to increase the size of the shipping sector and obtain a more significant portion of the benefit from the Pakistan deep water reserves (Aslam et al., 2023). When undertaking the Strategic Environmental Assessment for a particular policy, plan or program, it was necessary to undertake the scoping process. While in scoping, we obtained information on an area where the strategy, policy or program is being implemented to know what happens on the ground and how the strategic decision will affect it or put it in context. In the scoping activity, we identified and compiled data on backgrounds, legal requirements, environmental factors, and the strategic plan. Table 1. below represents the list of PMMP professional stakeholders (involved in this research) and their designations.

Table 1: Professional Stakeholders engaged in the SEA of PMMP

Sea experts	Designations
Dr. Kanwar Muhammad Javed Iqbal	Senior Policy Specialist, National Institute of Maritime Affairs
Dr. Nadia Akhtar	Teaching/ Research Associate, Environmental Science Department, International Islamic University, Islamabad
Muneeb Salman	Research Associate, Maritime Study Forum
Dr. Muhammad Luqman	Assistant Professor (TTS) Environmental Sciences Department, University of Veterinary and Animal Sciences, Lahore
Lt. Adnan Iqbal	Lieutenant Pakistan Navy

Furthermore, all stakeholders of the Pakistan Marine Merchant Policy (PMMP) were considered. The shipping industry in Pakistan involves various stakeholders, including the Ministry of Maritime Affairs (MoMA), Pakistan National Shipping Corporation (PNSC), All Pakistan Shipping Association (APSA), and Port of Karachi, along with employees, buyers, sellers, seafarers, shipping agents, and stevedores (Iqbal & Haider, 2019). As a member of the International Maritime Organization (IMO), Pakistan adheres to multilateral conventions related

to sea-borne trade, shipping, and transport (Yasin & Qureshi, 2023). In 2018, IMO introduced guidelines to reduce greenhouse gas emissions globally, which Pakistan is obligated to follow (de Jong et al., 2020). One significant environmental challenge involved is ballast water, which is carried for stability during transport but can introduce invasive species to new ecosystems (Lee et al., 2019). Over 3-5 billion tons of ballast water is transferred annually, sometimes causing ecological disruption, as seen in the case of the golden mussel in Argentina (Maritime Executive, 2007). In response, IMO introduced the Ballast Water Convention in 2004 which was also considered as Pakistan should capitalize on initiatives like the Glo Ballast Program to develop sustainable policies (Hub, 2015). MARPOL Convention was also considered as it is important for Pakistan to mitigate marine pollution while expanding port capacities. The Maritime Labor Convention (MLC) 2006 addresses employment, working conditions, and health and safety for seafarers (Chang & Khan, 2023). Although Pakistan has not signed the MLC, it was advised by the professional stakeholders involved that it should review its regulations concerning safe sea-borne trade and the well-being of Pakistani seafarers (International Labour Organization, 2013). Although, the adoption of the South Asian Seas Action Plan (SASP) demonstrated Pakistan's commitment to marine conservation in the past, but strategic plans must align with international conventions to maintain competitiveness. Baseline data considered as useful, significant and crucial for the shipping sector was gathered as part of the SEA methodology. It encompassed the data of physical characteristics of the location, climate, marine life, and socioeconomic factors. Pakistan's Exclusive Economic Zone is approximately 200 nautical miles from the coastline extending into the sea. The area under this zone is the southern coastal region that comprises Indus delta, Karachi, and the Makran coast. Another 50,000 Km^2 of an area was extend recently (MFF Pakistan, 2016). The Pakistan Sea intersects the sea lines of communication (SLOCs) arising from the choke point of the Indian Ocean: the strait of Malacca, the strait of Hormuz and the Red Sea (Mehmood & Javaid, 2016). The climate of coastal zone can be characterized as mild, and the primary source of those climate forming winds are sea breezes. The power of maritime retains the temperature even throughout the day. The average temperature for the month still stays high at about 32 degrees Celsius and the best months are May, June and October. October is hot because of the dry wind originating from the South Eastern desert. The rainfall is negligible which is mostly received during the monsoon season while the two region of Karachi and the Rann of Kutch receives the most of this kind of rainfall. On the other hand, the Makran coastal belt receive most part of their precipitations during winter season. The level of humidity is relatively high peaking to 50% from the month of April to September (Khan et al., 2018). Because of climate change the general temperature of the world is rising, and so is the temperature of the coastal areas. The Intergovernmental Panel on Climate Change estimates that since 1900, the mean rise in temperature in the coastal areas of Pakistan is from 0.6 to 1°C and the decreases in rain up to 10 to 15% (Karim et al., 2023). This change of the climate is as a result of the emission of greenhouse gases by the maritime sector as well as the terrestrial industries. The coast line of Pakistan is also very rich in biosystem, the current production of fish and shellfish reached 475000 million tons in 2023 (Rafique, 2023). The species of marine life with in the EEZ and within the jurisdiction of Pakistan, include the demersal fish, shrimp, snapper, crabs, lobster, croakers, and catfish (MFF Pakistan, 2016). The copepods, chaetognath, crustaceans' eggs and larvae and the large zooplankton such as calanoid copepods and luciferase were found high in June to September. Large pelagic fish are Tuna and marlins. The fish species includes the Indian mackerel, sharks, rays, catfish, mullets, squid, eels, etc. prominent marine creatures. The marine mammals include the dolphins, porpoises and the whale (MFF Pakistan, 2016).

Results

While 90% of the trading is through sea, the shipping industry major impacts include air pollution, marine water pollution, spread of invasive species, underwater noise pollution among others (Garcia et al., 2020). If the current increase in the fleet size had not taken into consideration the environment, adverse consequences would have been observed (de Jong et al., 2020). Table 2 gives information on the pollution type originating from the shipping industry and its effects on environment and biological species.

Table 2: Impact Matrix for Baseline Data in Ship Life Cycle Operations

Problems	Impacts	Sources	Types of Impacts		
			Primary	Secondary	Cumulative
Air Quality (Topic et al., 2021).	Emission of NOx, SOx, CO_2, Global Warming, Acidification, Deposition of NOx, Ozone formation	Burning of fossil fuels in the ships	Primary impact on the environment	-	Emissions from the nearby industries and ship
Water Quality (Ullah et al., 2021).	Damage to aquatic biota, damage to fishery resources, Hypoxic conditions for bottom biota	Discharge of bilge water, oily wastes, sewage, garbage from the ships	Direct impact on the marine biology by the discharge	Indirect impact by the industrial discharge and waterfront activities	Cumulative impact by the ships and industrial discharge on marine biology.
Invasive Species (United Nations Conference on Trade and Development, 2023).	Competition with indigenous species toxic dinoflagellates or harmful algal blooms	Release of Ballast water	Direct impact on the native species	-	-
Noise pollution and Vibration (Yasin & Qureshi, 2023).	Disturbed sound-based communication, Disturbed mate and prey detection, orientation, echolocation, communication	Sound from cargo ships, sonar.	Direct impact on the whales and dolphins	-	Cumulative impact of noise from the pile driver, oil drilling and ships (cargo and cruise)
Social and cultural issues (Iqbal & Haider, 2019).	Health impacts, Wages, Diverse culture, Safety measures	Jobs created by the improvement in shipping sector crew members, pilots, tug services, stevedoring, seafarers,	Direct impact on the employees coming from diverse background	-	-

Different SEA frameworks and protocols including EU directive and UNECE protocol considered in identifying an option which provides policy alternatives and then selecting out of appraisal those that most sustainable in nature. Unfortunately, no such direction is available by any authority in

Pakistan. It is an adopted practice in SEA to screen and assess alternatives to any policy, plan, or program. According to SEA, if alternatives are assessed under SEA, they must meet the four tests to be effective; they must be practicable, reasonable, feasible and achievable (Kroon, 2024). The criteria given below was considered:

Realistic: The chosen alternatives should possess capability of how merchant marine policy seeks to achieve its objectives after factoring the environment.

Reasonable: These alternatives must take into account baseline data defined for the policy area and other international and national law provisions.

Viable: The chosen alternative should be social and economically proactive so that it can be incorporated in plans and programs under the policy.

Implementable: The options selected must allow for implementation with suitable time frame and with reasonable employments of resources.

Based on baseline data of Pakistan's marine environment and discussions with key stakeholders outlined in table 1,the broad strategies to attain policy aims were presented in four types of alternatives. Since the policy being discussed has important implication on the merchant trade operation in sea water, emphasis was made to the options that appeared as solid alternatives in avoiding harm to the marine ecosystem. Table 3 represents those alternatives:

Table 3: Alternatives to Achieve PMMP Objectives

Alternative Type	Description
Strategic (policy-Based)	**Alternative 1:** Constitution of top policy-making as well as spatial oriented maritime strategy depicting, operational areas elaborately. **Alternative 2:** Creation of the policy driven matrix of future growth and development of the city, without reference to spatial zoning.
Strategic (Geography-Based)	**Alternative 1:** National strategic development plan of the maritime activities irrespective of the strategic regional or local policy planning of focus. **Alternative 2:** One comprehensive and elaborate action plan for the whole country with consensus conference on the arguments based on the arguments presented by regional or local legislations and policies.
Governance-Based	**Alternative 1:** Business as usual **Alternative 2:** Integration of vessel type and fuel type in issuance of license for the operating the sea vessels.
Prioritization-Based	**Alternative 1:** Business as usual **Alternative 2:** Maritime related activities targeted under the basic eight environment themes including; natural, person, community, built, cultural, financial, social and natural capital. **Alternative 3:** The prescription of selected climatic factors and biodiversity concerns as activities of high priority for sectors to address.

The alternatives indicate that various alternatives may be categorized under one number but present different scenarios. Among these it is crucial that evaluation of reference to the baseline data as well as the impact indicators is done with the aim of selecting the best. These alternatives must also satisfy the criteria stated in the previous section. This implies that it would be useful to evaluate alternatives based on the ranking factors that are available for instance in the case of an

alternate fuel for deep-sea vessels. A rank of the factors would be crucial as a way of identifying what options decision makers need to consider when choosing fuel for deep-sea vessels in the short-term by 2030, the mid-term by 2050 and in long-term beyond 2050 (Moshiul et al., 2023). At final selection phase, these alternatives may be selected permanently or they may be selected sequentially depending on how one or the other of the alternatives can meet objective requirements. Table 4 represents the evaluation of alternatives as per criterion elements of identification of sustainability.

Table 4: Evaluation Criteria for Identification of Sustainable Alternatives

Proposed Alternative	Criteria			
	Realistic	Reasonable	Viable	Implementable
SP1	✓	✓	✓	✓
SP2	-	-	✓	✓
SG1	✓	-	✓	✓
SG2	✓	✓	✓	✓
Gov1	-	-	✓	✓
Gov2	✓	✓	✓	✓
Prior1	-	-	✓	✓
Prior2	✓	✓	✓	✓
Prior3	✓	✓	✓	✓

Table 5 demonstrates substitution or replacement of the PMMP in reference to the impact indicators:

Table 5: Impact indicators for Substitution or Replacement of Alternatives

Proposed Alternatives	Indicator					
	Air and climate quality*	Water quality*	Biodiversity*	Ambient noise	Social and cultural integration	Human health*
SP1	I	+	++	I	0	+
SP2	I	+/-	_	I	0	I
SG1	0	0	0	0	_	0
SG2	0	0	0	0	++	0
Gov1	_	_	_	_	0	_
Gov2	++	+	+	++	0	+
Prior1	_	_	_		+/-	+/-
Prior2	+	+	+	+/-	++	++
SP1	++	+	++	+	+	++

Key: + Positive Impact; - Negative Impact; ++ Highly Position Impact; +/- Either Unclear Impact or Both Positive and Negative; **I** Depends on Implementation; **0** No Significant Impact *Important Indicators in Sea Process;

Some measures for mitigation were recommended for the proposed alternatives to assist the decision-makers in the next revision of PMMP (Ullah et al., 2021). Table 6 describes the mitigation options for each theme:

Table 6: Potential Environmental Mitigation Measures

Themes	Mitigation Options
Air and climate quality	Design and manufacturing of marine vehicles with low carbon emission design. Granting license only to those vehicles which are energy efficient. Scheduling control of the ships in terms of time of departure and time of arrival in order to reduce the comprehensive effect.
Water Quality	Strengthening practices of managing and tracking storm events. Controlling check systems for ballast water installed in the vehicles. It is necessary to regulate the dumping of unnecessary wastes on the port. The contingency plans for oil spill incidents have to be incorporated in the policy.
Biodiversity	Zoning and delimitation of the trade route in an attempt to avoid intrusion into the sensitive areas that are known to harbor significant bio-diversity records. Implementation of strategic framework that covers marine conservation and assessment of marine water. Assist in encouraging the establishment of mangrove trees on the shore lines to check erosion by the construction of ports and harbors.
Ambient Noise	Improvement of the next generation of propellers. Promotion of ship pooling. Promoting low speed in marine environment. Monitoring and maintenance of the ambient sea noise level regulation.
Social and cultural integration	Environmental tax credit provided depending on the implementation of green ship designs. The introduction of multi-tiered committees especially for marine exercises. Integration of other sectors in the plans and programs under this policy. Conservation of habitats that are vulnerable to the impacts from coastal inundation and flooding along the coastline.
Human Health	Control of the issue of protective clothing and equipment for any ship crew. Training and development of marine professionals and providing professional training to the crew staff. Incorporation of environmental management system in the design and operation of port and ship environment.

Discussion

Despite being a critical document for marine businesses, the Pakistan merchant marine policy lacks key sectoral factors involving sustainability and environmental compliance. After a technical and logical evaluation of the policy, this study has gauged that these shortcomings must be addressed to implement the policy in letter and spirit while fulfilling national and international compliance requisites. Based on the previously explained SEA methodology and suggestions, the policy must be revised to be sustainable and forward-forward in the marine industry. The marine trade is not merely the emissions of freighters. Still, it is a blend of multiple factors that directly influence and damage the environment at various stages of trade and transport (Gilliam, 2023). Keeping in view the key factor, i.e. climate change, it is evident that coastal industries are playing a huge role in

polluting the environment, just like ungreen vessels operating on engines that are not environment-friendly. The emissions of these coastal industries producing goods and/ or materials required in packaging items for maritime trade, including imports and exports, vastly impact marine life. Fortunately, the European Union is rooting for a European Green Deal to decarbonize the naval industry, and they aim to go carbon neutral by 2050. Still, countries like Pakistan and other non-EU countries pose a significant threat to the global vision for carbon neutrality and sustainable practices because of non-existent mitigation measures and environmental protection initiatives. Funding could be one of the most important challenges for this sustainable transition. Thus, it calls for establishing a special funding regime through policymaking (Baştuğ et al., 2024). The policy also does not address environmental effects related to oil spills. These oil-carrying vessels actively sail against environmental threats; ignoring them renders the policy document obsolete. It is pertinent to mention here that these oil spills had caused an international outcry, particularly from environmentalists in the past when the Exxon Valdez Spill and Water Horizon Spill were caused in 1989 and 2010, respectively. These are notable examples from the past that necessitate addressing oil spills in maritime trade and related processes. These spills prove fatal to the marine ecosystem as they invade the marine process and disrupt the aquatic environment by forming a layer on the sea surface, preventing sunlight from reaching every nook and cranny of the sea. This blockade results in damaging the oceanic flora and fauna. This doesn't stop here, as spills that stay for a more extended period ultimately evaporate in the air, which, in turn, adds carbon content to the environment. These oil spill cases emphasized crisis management and preemptive and proactive measures because even the countermeasures have specific effects on the environment (Murawski et al., 2023).

Furthermore, the infrastructural development at an abnormal pace without considering environmental compliance also threatens the mangrove population along the country's coastal belt. The overall economic pressure has led to rapid growth in all sectors, including industrial units to boost exports, rehabilitation of road network for vehicular transportation, and even cargo transportation to reach ports for marine trade, as well as development or revamping of ports and hangars that in return affect the marine habitat or the mangrove population as stated above. The macroeconomics of Pakistan has fueled such growth, but this growth is inversely proportional to the degree of sustainability of the marine biome. Other factors include the arrival of foreign invasive species facilitated by ballast water discharge by the ships. This discharge of water and sediments should be dealt with in line with the Ballast Water Management Convention, which is ignored in Pakistan (Akbar, 2022). However, this discharge governance is imperative for the environment and marine ecosystem as travelling marine species invade our regional marine ecosystem and disrupt the marine food supply for the existing marine life. If it goes unchecked, this invasion results in loss of habitat and species and damage to local flora and fauna. This disruption doesn't end here, as the industrial units and the heavy-duty machinery deployed for construction and infrastructural development ultimately cause noise pollution for the neighbouring areas and the local inhabitants. This sound of machinery operating beyond safe hearing levels creates a continuous noise disturbance, often leading to permanent damage. So, it is essential to note the increase in the average value of older vessels due to the demand for older tonnage. The financial fluctuations and pressure in countries like Pakistan and Bangladesh also impact the ship recycling industry by curtailing its operations. It is pertinent to mention here that the recycling of bulkers, gas carriers, and containerships is 31 per cent, 2 per cent, and 3 per cent, respectively (Mishra, 2018). Bulker recycling accounted for 31 percent of recycling, while gas carriers made up only 2 percent and recycling of containerships was limited to 3 percent. The recently enacted

Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (the Hong Kong Convention) for Bangladesh and Liberia, effective from June 2026, adds another layer of significance to ship recycling (United Nations Conference on Trade and Development, 2023).

Consequently, it is safe to claim that the policy under discussion is not only short-sighted but shall eventually fail to deliver its core objective of a trade boost. All such policies that are devoid of sustainable climate action and preemptive measures lack substance and impede their implementation in letter and spirit. These policies, which are either silent or ignorant of the fact that marine trade is directly related to marine friendliness, would be rendered useless in the long run. Pakistan has already been declared one of the top five countries badly affected by climate change; its vulnerability has exposed it to smog and floods. The issue of SMOG started around 2017 and has worsened air quality over the past few years, especially in the provincial capital of Punjab, the most populous province in Pakistan. As a result, the metropolitan city of Lahore and even the southern Punjab are adversely affected by air quality issues throughout the year. Ignoring causative and triggering factors of the issue has aggravated the problem because policymakers failed to pay heed to the matter timely. The way the world is inching towards the United Nations' Sustainable Development Agenda, which will be met by 2030, Pakistan needs to incorporate the same agenda in its policymaking and decision-making processes. In this case, compliance with UN SDGs for the sustainability of the marine ecosystem shall eventually help marine trade and allied sectors. Focused groups with stakeholders and critical analysis of the available data led the researchers to identify the most suitable and viable solutions from each category. Regarding the policy-based strategic alternative, researchers found SP1 to be more appropriate as it meets the criteria to serve as a sustainable alternative.

Furthermore, the said option is also environmentally compliant because it parallels the key indicators specified in the baseline. Conversely, SP2 would make no substantial contribution to environmental management and would have no profound negative impact either.

Regarding geography-based strategic alternatives, SG2 was reported to have positive effects on socio-cultural indicators with an overall neutral impact. However, SG1 – in addition to being neutral – had no positive effect either. It is pertinent to mention here that while Gov1 reported a negative impact on key critical indicators by representing the BAU scenario, Gov2 not only met the requirement of alternative identification but also reported positive impacts as far as all key environmental indicators are concerned except for socio-cultural, which was neutral. While analyzing prioritization alternatives, a blend of prior two and prior three was the most suitable and viable solution. The combination addresses environmental and socio-cultural factors and incorporates the same compliance activities in the policy consideration, ns, which will eventually make it risk-averse regarding critical indicators.

The policy objectives reflect a disregard for and avoidance of key environmental factors that could otherwise benefit masses and communities directly and indirectly influenced by policy lacunae. The policy was drafted to safeguard the interests of stakeholders and key players in the sector without even considering the hardships of the sectoral workforce or environmental compliance gaps. Therefore, these objectives must be revised after keeping sustainability and suitability in consideration:

- Develop a favourable marine business and work environment for the marine workforce and safeguard their health and safety for collective sectoral growth.
- Rehabilitate biodiversity and marine ecology while discouraging and prohibiting activities that negatively impact flora and fauna.

- Facilitate conservation/ preservation and ecosystem management through the joint action plans of the public and private sectors.
- Make shipping practices environmentally compliant so that no transactions disturb coastal contours, the ocean's current flow, or mineral content imbalance.
- Rationalize shipping processes and tasks to preserve/ conserve allied/ nearby natural water bodies while meeting international standards.
- Bringing marine trade under safe emission readings scale to minimize air pollution from shipping practices. Facilitating industry and utilizing strategic interventions to shift to renewable and efficient energy sources.
- Deployment of state-of-the-art infrastructure and tech solutions to reduce GHG in pursuit of protecting the environment
- Shift to viable, long-term solutions for reducing hazardous footprints and boosting sustainable marine practices/ methodologies.
- Develop and expedite processes for an environment-friendly intervention fueled by the private sector's active engagement to protect and promote national and cultural heritage for local and international consumption w.r.t. trade and shipping.
- Facilitate the development of a robust and sustainable legal and implementation framework for real-time analysis and its utilization to protect marine ecology against any form of threat.

Conclusion

In conclusion, the United Nations has listed Pakistan among countries with high risks and vulnerability to the effects of Climate change, and this country is facing not only critical challenges associated with environmental degradation. Combating climate change and reducing the incidence of ecological destruction requires intentional modification of human behaviour and the use of resources. Another issue is the policy structure in Pakistan, namely the Pakistan Merchant Marine Policy (PMMP), revised in 2019. Still, some critics pointed to the fact that the framework remains outdated. In this sense, the policy remains overly simplistic, its scope restricted to trade and economic gains while essential environmental and human health issues are disregarded. Here, it should have been seen as a significant deficiency and a conscious shirking of certain ethical obligations by those in power. To address this, policymakers need to review and enhance the PMMP to have clear goals and objectives, including environmental integration and recognition of health impact. Since the policy deals with the management of one of the largest ecosystems in the world, our oceans, integration of these factors is desirable and a moral imperative to comply with global sustainable development and the legal application of standards.

References

- Akbar, S. (2022). *Exploration of occupational safety and health in Pakistan's ship breaking and recycling industry*.
- Aslam, B., Iqbal, K. M. J., Akhtar, N., Mottaeva, A. B., Fedorovna, T. T., Barykin, S., & Khan, M. I. (2023). Coherence analysis of national maritime policy of Pakistan across shipping sector governance framework in the context of sustainability. *Sustainability, 15*(9), 7665. https://doi.org/10.3390/su15097665.
- Baştuğ, S., Akgül, E. F., Haralambides, H., & Notteboom, T. (2024). A decision-making framework for the funding of shipping decarbonization initiatives in non-EU countries: Insights from Türkiye. *Journal of Shipping and Trade, 9*(1), 12. https://doi.org/10.1186/s41072-024-00103-7.

- Byrnes, T. A., & Dunn, R. J. (2020). Boating-and shipping-related environmental impacts and example management measures: A review. *Journal of Marine Science and Engineering, 8*(11), 908. https://doi.org/10.3390/jmse8110908.
- Chang, Y. C., & Khan, M. (2023). The Maritime Labour Convention 2006 in human rights context: An appraisal. *Marine Policy, 154,* 105688. https://doi.org/10.1016/j.marpol.2023.105688.
- de Jong, C. A. F., Harmsen, J., Bekdemir, C., & Hulskotte, I. J. (2020). *Reduction of emissions and underwater radiated noise for the Belgian shipping sector.*
- Fischer, T. B. (2023). *Strategic environmental assessment in transport and land use planning.* Routledge.
- Garcia, B., Foerster, A., & Lin, J. (2020). The shipping sector and GHG emissions: The initial strategy for a zero-carbon pathway. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.3587166.
- Gilliam, L. (2023). Shipping and the ocean. In *The Ocean and Us* (pp. 123–135). Springer International Publishing. https://doi.org/10.1007/978-3-031-11017-2_12.
- Hussain, I., Wang, H., Safdar, M., Ho, Q. B., Wemegah, T. D., & Noor, S. (2022). Estimation of shipping emissions in a developing country: A case study of Mohammad Bin Qasim Port, Pakistan. *International Journal of Environmental Research and Public Health, 19*(19), 11868. https://doi.org/10.3390/ijerph191911868
- Hub, I. (2015). Ballast Water Management Convention nears entry into force. *SDG Knowledge Hub, IISD.* Retrieved from http://sdg.iisd.org/news/ballast-water-management-convention-nears-entry-into-force/
- IMO. (Retrieved 2021). *International Convention for the Prevention of Pollution from Ships (MARPOL).* Retrieved from https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx
- International Labor Organization. (2013). *MLC Convention.* Retrieved from https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:91:0::NO:91:P91_INSTRUMENT_ID:312331:NO.
- Iqbal, K. M. J., & Haider, B. (2019). *Pakistan shipping sector 2019: An appraisal.* https://doi.org/10.13140/RG.2.2.14509.41444.
- Islam, M. S., & Zhang, Y. (2018). The potential of strategic environmental assessment to reduce disaster risks through climate change adaptation in the coastal zone of Bangladesh. *International Journal of Climate Change Strategies and Management*, *11*(1), 137-153.
- Karim, R., Tan, G., Ayugi, B., Babaousmail, H., Alriah, M. A. A., & Ngoma, H. (2023). Surface air temperature variability over subregions of Pakistan during 1970–2014. *Pure and Applied Geophysics, 180*(11), 3971–3993. https://doi.org/10.1007/s00024-023-03107-y.
- Khan, M., Chang, Y. C., & Bibi, A. (2024). Navigating Pakistan's maritime industry potential in the context of the blue economy: An analysis of the necessity for ratification of maritime labour convention 2006. *Marine Policy, 165,* 106150. https://doi.org/10.1016/j.marpol.2024.106150.
- Khan, S., Alvarez, L. C. M., & Wei, Y. (2018). Sustainable management of municipal solid waste under changing climate: A case study of Karachi, Pakistan. *Asian Journal of Environmental Biotechnology, 2*(1), 23–32.
- Kholdebarin, A., Mozaffari, N., Vambol, V., & Vambol, S. (2020). Impact of ship's ballast water on invasive species occurrence, and as a consequence on environmental and public health: A short review. *Labour Protection Problems in Ukraine, 36*(1), 18–21.
- Kroon, T. (2024). *Unlocking the potential: A study on the potential role of the Sustainable Development Goals in the Dutch Strategic Environmental Assessment* (Master's thesis, University of Twente).
- Lee, P. T. W., Kwon, O. K., & Ruan, X. (2019). Sustainability challenges in maritime transport and logistics industry and its way ahead. *Renewable and Sustainable Energy Reviews, 94,* 1217–1228. https://doi.org/10.1016/j.rser.2018.07.030.
- Mehmood, S., & Javaid, U. (2016). Development of shipping sector in Pakistan: Options and proposed strategy. *Journal of Political Studies, 23,* 537–559.

- MFF Pakistan. (2016). *A handbook on Pakistan's coastal and marine resources.* MFF Pakistan.
- Maritime Executive (2007). Gold Medal to Ballast Film. *The Maritime Executive.* Retrieved from https://maritime-executive.com/article/2007-05-10gold-medal-to-ballast-film
- Mishra, S. (2018). Non-entry into force of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009: An analysis from the perspective of India, Pakistan and Bangladesh. *Journal of International Maritime Safety, Environmental Affairs, and Shipping, 2*(1), 22-30.
- Moshiul, A. M., Mohammad, R., & Hira, F. A. (2023). Alternative fuel selection framework toward decarbonizing maritime deep-sea shipping. *Sustainability, 15*(6), 5571. https://doi.org/10.3390/su15065571.
- Murawski, S. A., Schwing, P. T., Patterson III, W. F., Sutton, T. T., Montagna, P. A., Milligan, R. J., & Gilbert, S. (2023). Vulnerability and resilience of living marine resources to the Deepwater Horizon oil spill: An overview. *Frontiers in Marine Science, 10*, 1202250. https://doi.org/10.3389/fmars.2023.1202250.
- Pakistan National Shipping Corporation. (2019). *Pakistan merchant marine policy – 2001 (Amended vide Notification dated 15 November 2019).* Retrieved from https://pnsc.com.pk/PMMP2001Amended.pdf.
- Peng, C., Zhao, X., & Liu, G. (2015). Noise in the sea and its impacts on marine organisms. *International Journal of Environmental Research and Public Health, 12*(10), 12304-12323. https://doi.org/10.3390/ijerph121012304.
- Rafique, A. (2023). World Fisheries Day 2023: Experts advocate unlocking potential of fisheries sector to drive blue economy growth. *Islamabad Scene.* Retrieved from https://www.islamabadscene.com/world-fisheries-day-2023-experts-advocate-unlocking-potential-of-fisheries-sector-to-drive-blue-economy-growth/#:~:text=Quick%20facts%20about%20Pakistan's%20fisheries.
- Shakoor, M., & Mahmood, S. (2023). Analysis and forecasting of coastline morphology in Pakistan using digital shoreline analysis. *Intercontinental Geoinformation Days*, *7*, 9-12.
- Topic, T., Murphy, A. J., Pazouki, K., & Norman, R. (2021). Assessment of ship emissions in coastal waters using spatial projections of ship tracks, ship voyage, and engine specification data. *Cleaner Engineering and Technology, 2,* 100089. https://doi.org/10.1016/j.clet.2021.100089.
- Ullah, Z., Wu, W., Wang, X. H., Pavase, T. R., Shah, S. B. H., & Pervez, R. (2021). Implementation of a marine spatial planning approach in Pakistan: An analysis of the benefits of an integrated approach to coastal and marine management. *Ocean & Coastal Management, 205,* 105545. https://doi.org/10.1016/j.ocecoaman.2021.105545.
- United Nations Conference on Trade and Development. (2023). *Review of maritime transport 2023.* Retrieved from https://unctad.org/system/files/official-document/rmt2023_en.pdf.
- Waheed, A., Fischer, T. B., Kousar, S., & Khan, M. I. (2023). Disaster management and environmental policy integration in Pakistan—An evaluation with particular reference to the China–Pakistan Economic Corridor Plan. *Environmental Science and Pollution Research, 30*(48), 105700-105731. https://doi.org/10.1007/s11356-023-26215-7.
- Yasin, A., & Qureshi, S. N. (2023). Domestic legal framework on marine pollution – A critical appreciation. *Pakistan Journal of International Affairs*, *6*(2), 1-15.