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Article

Multi-Criteria Relationship Analysis of Knowledge, Perception, and Attitude of Stakeholders for Engagement towards Maritime Pollution at Sea, Beach, and Coastal Environments

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Abstract: The external influence due to the severe repercussions of unprecedented and un-attended pollution has put vulnerable marine ecosystems at high risk of irreversible damage. This business-as-usual scenario could render them unfit to offer sustenance along with innumerable ecosystem services. Since the Stockholm Conference on Human Environment 1972, there have been global efforts to raise awareness, build capacity, and govern the pollution issue for a sustainable solution. However, there is a growing concern about the adequacy of the desired level of mobilization and readiness so far achieved at the level of various stakeholders to respond to the issue of maritime pollution. In this context, the present study was aimed at assessing the relationship between knowledge, perception, and attitude of the stakeholders regarding their engagement towards maritime pollution at sea, beach, and coastal environments, by incorporating multi-criteria quantitative analysis method for a case study of Karachi area in Pakistan. The structured questionnaire incorporates Knowledge, Perception, and Attitude as three key variables for three principles; four standardized criteria each, with eighteen indicators transformed into queries by applying MCDA's Simple Multi Attribute Rating (SMART) technique for scoring to quantify the feedback of 304 respondents through a ratio scale having nominal qualifiable classes. The analysis has offered insight into the ways the stakeholders are perpetrating pollution and how their respective actions are important in the abatement of marine pollution. One-tailed Pearson Correlation analysis reveals insignificant relationship between the variables, indicating that the level of understanding of the stakeholders has not developed opinions to an extent that would enable an appropriate behavioral approach toward the abatement of the pollution. It suggests inducing awareness, mobilization, and reforms to encourage collective action by all actors.

Keywords: maritime pollution; knowledge; perception; attitude; stakeholder engagement; MCDA

1. Introduction

The business-as-usual irrational, un-attended and un-regulated marine pollution is a growing trans-national global challenge for sustainability, primarily due to the severe ecological, economic, social, and aesthetic impacts [1,2]. It is termed as the anthropogenic introduction of materials or energy into the marine ecosystems that can harm the life underwater and their dependents, along with altering the ways in which the sea and its resources are used [3]. Coastal and marine pollution is produced from various point and non-point sources including solid municipal, commercial and industrial waste; along

with chemically-rich effluents discharged into the internal waters [4–6]. Along with urban and agricultural runoffs, atmospheric depositions and sub-surface contaminant transport also add to marine pollution [7]. Coastal zones typically host industries that pollute the surrounding waters with plastic waste, organic pollutants, and concentrated effluents that disrupt the nutrient content, food availability, and temperature balance in water [8–10].

Despite the increasing global understanding of pollution and its management, humankind is still embarked on an essentially inconsistent course. Now, along with the traditional types of wastes that end up degrading marine environments, there are a variety of novel waste types being produced and introduced into the natural ecosystems [11]. Microplastics and nano plastics are some forms of plastic waste deemed extremely dangerous to the environment and living beings due to their characteristics [12]. These particles were earlier discovered in the Mariana Trench—the deepest known spot to humans in the ocean [13] but recently, they have been found in the human bloodstream, which is an alarm for humans to be mindful of their creations [14,15]. Moreover, masks, gloves, and other personal protective equipment (PPE) have been abundantly utilized in the last three years around the globe due to the prevailing COVID-19 pandemic. This has given rise to a new waste type being termed the ‘COVID waste’ [16,17]. With the aforementioned newer wastes, coupled with the traditional municipal, commercial and industrial waste, it has become ever-increasingly difficult to protect the ‘ultimate disposal sites’ i.e., oceans from the repercussions of these wastes.

Currently, more than 40 percent of the world’s population lives within 100 km of the nearest coast, forming densely populated metropolises due to the ease of industrial activity, maritime trade operations and connectivity [18]. Such development pattern has put the integrity of delicate ocean ecosystems in peril around the world due to increased human intrusion and particularly, pollution introduction in the coastal and marine environments. According to UNEP, about 80 percent of the marine pollution load is originated from land—domestic, industrial and commercial activities being the major culprit [7]. With the ongoing population rise, the business-as-usual case of unsustainable capitalistic production/consumption and the subsequent pollution generated, the state of marine ecosystems could worsen globally [5]. Target 14.1 of the SGDs is to “prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution” by 2025. Moreover, the UN Decade of Ocean Science for Sustainable Development (2021–2030) has an agenda specifically relating to the identification and reduction of marine pollution [19], stressing the need for swift action on national and global level.

Effective source reduction and management of marine-bound waste supersedes the beach and sea cleanup activities [2]. In this regard, the behavior of stakeholders that contribute to such pollution is vital. Various studies have discovered a significant connection between the level of understanding and opinions of people with the eco-conscious behavior that helps in reducing pollution and advocating for it [20,21]. Knowledge, Perception, and Attitude have been recognized as key variables in determining the level of understanding, opinion and behavioral approach of various stakeholders [20–25]. But the existing literature lacks the assessment of these variables in the context of marine pollution to offer an insight into the level of understanding, behavior, and engagement of stakeholders in remediating the issue [26–30].

To bridge the gap, this paper has evaluated the said variables for the coastal metropolis of Karachi, the largest, most populated city of Pakistan and an important port in the Arabian Sea. Like other developing countries, Pakistan’s territorial waters are also facing a doom as the coastline of over a thousand kilometers has been subjected to abuse and neglect over the years, with municipalities, onshore industries, ports and harbors being major culprits. Arabian Sea is the ultimate disposal site for the effluents and solid waste being carried from the coastal cities like Karachi (IUCN, 2021). There have been various studies vis-à-vis the profiling of the coastal belt of Karachi on the basis of their pollution [31–34]. The accumulation of single-use plastics, hazardous hospital wastes, nuclear discards, and factories contribute greatly to the coastal pollution [35]. Likewise, tanneries release

chemically rich effluents into the coastal water and the heavy metals originating from these sources get concentrated in the marine life, and ultimately get biomagnified in the final consumer—that is human—resulting in toxicity [36–38].

A study [31] assessed the level of pollution at the ports and fishing harbors of Karachi and found heavy metal contamination in the coastal waters originating from the port and harbor operations. A similar study [33] found the water analyzed from Lyari River mouth, Fish Harbor, and KPT boat building area highly contaminated with heavy metal pollution. Due to the uninhabitable waters, fish are often seen washed up dead on the beaches. Karachi beaches and islands were once the breeding and nesting grounds for various turtle species, which are now unviable for the same [39]. The beaches have been rendered unable to visit as the unrestrained drainage of sewage has turned seawater grey and the stench of dead fish and garbage is unbearable for people.

Various studies have shown that the coastal waters are unfit for leisurely activities as the water quality has surpassed the permissible limit provided by the NEQS, and it's a public health hazard to go into the water [40]. The city's popular tourist attraction of live fishing and dining is also at threat due to the polluted waters, and hence, a lack of healthy catches of fish, crabs and other sea delicacies [32]. Underwater activities such as scuba diving and snorkeling have also been affected tremendously as the waters are becoming increasingly polluted, and the industrial activities—coupled with the impacts of climate change—have resulted in coral bleaching on a massive scale and a loss of marine life [8]. All these events have huge impacts on the communities directly dependent on ocean; and the aesthetic effects of pollution affect the tourism in the area.

Despite being signatory to various international and regional conventions on pollution control and management, the country faces a persistent situation where waste production is at its highest, and waste management and treatment is a rare practice. Karachi experiences a ghastly situation of garbage and trash management, with local waste management authorities being dubbed ineffective [41]. Similarly, the illegal burning of trash as a way to easily get rid of it adds to the detrimental air quality in the city all year round [42]. The trash that does not get picked up, burnt, or disposed of in the handful of landfills in the city contributes to choking the waterways and sewers [43]. This situation results in the sewers' overflow during rains and the lengthy monsoon season—spreading the trash and discards everywhere, again, while giving birth to water and vector-borne diseases amidst an already-prevalent global pandemic i.e., COVID-19 [44–46].

Although, recently, provincial and municipal authorities have started focusing on curbing the issue through regulations and increased efforts to instill understanding [47], there is a growing concern about the adequacy of active engagement through desired level of mobilization and readiness so far achieved at the level of various stakeholders to respond the issue of maritime pollution in the city.

In this context, a question has arisen: is a strong correlation achieved so far between knowledge, perception, and attitude of stakeholders to address the issue of marine pollution adequately? To explore the answer, the present study was aimed at assessing the relationship between knowledge, perception, and attitude of the stakeholders for their engagement towards maritime pollution at sea, beach, and coastal environments, by incorporating multi-criteria quantitative analysis method for a case study of Karachi area in Pakistan. The outcome of the study adds new knowledge by informing the audience about the current standing of the stakeholders to respond to the multifaceted challenge of maritime pollution.

2. Methodological Framework

2.1. Scope of Study

The study focuses on assessing the relationship between knowledge, perception, and attitude of the stakeholders for their engagement towards maritime pollution originating from Karachi city and its municipalities, industries, and ports. Naturally, the scope of the study encompassed the analysis of stakeholders' ability to tackle beach and sea pollution in Karachi.

2.2. Geographical Scope

The study is focused on the coastal city of Karachi, south of Pakistan. The analysis considers the opinions and behavioral approach of the visitors at the beaches and adjoining areas, along with stakeholders at ports and associated industries.

2.3. Approach

The study was aimed at assessing the relationship between Knowledge, Perception, and Attitude of the stakeholders for their engagement towards maritime pollution at sea, beach, and coastal environments, by incorporating multi-criteria quantitative analysis method following a mix-method approach. The analysis for the objective under the scope of this paper was primarily quantitative by employing Multiple-Criteria Decision Analysis (MCDA) method considering the involvement of multiple variables. It was clubbed with qualitative part, particularly for the development of PCIs and questionnaire through tools prepared using qualitative research methods including situational analysis, scenario building, and network diagrams.

Research shows that the behavior of public and other stakeholders is vital in remediating the issue of marine and coastal pollution. Multiple studies demonstrate that the behavior of people is influenced by their level of understanding and the opinions they carry regarding a certain issue [48–51]. The interrelation of these factors was explored in the form of a network diagram in a focus group session with experts in the field as shown in Figure 1.

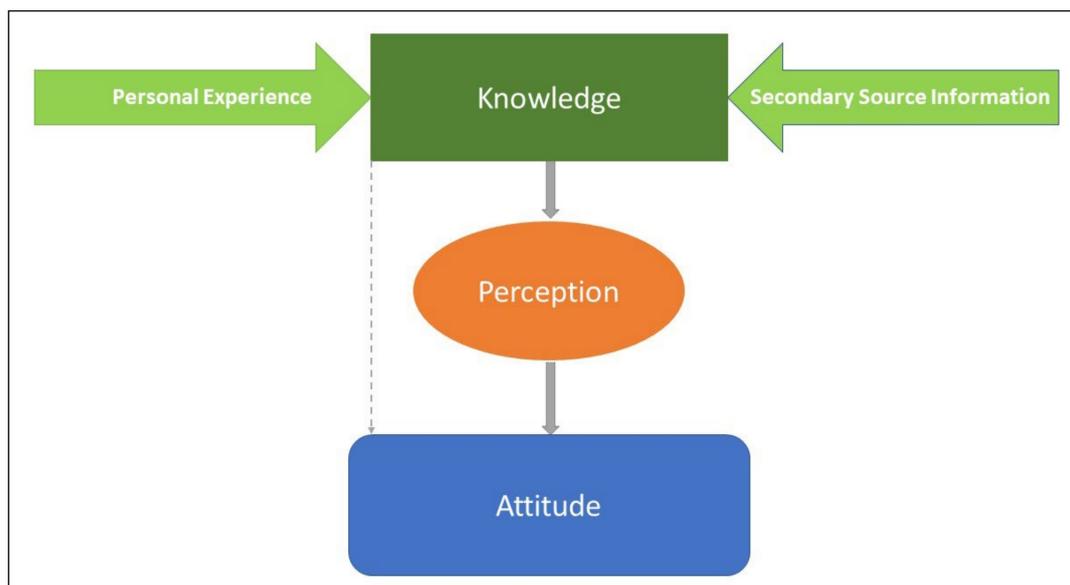


Figure 1. Linkage between Knowledge, Perception and Attitude.

The figure depicts that humans acquire information and understanding from various means, including personal experiences through sensory features, along with secondary sources such as news, media, and other human beings [52,53]. The human brain then processes it with respect to its already-formed biases and develops opinion. Then comes the point when the garnered understanding and formed opinion shape the behavior of the human. They may then speak about the problem or act on it in numerous ways, depending upon the circumstances and opportunities [48–50,54].

2.4. Development of Principles, Criteria, and Indicators

To determine the ability of the various stakeholders, various parameters were identified through screening of literature and three focus group discussions with experts on the subject. Subsequent upon situational analysis, three crucial parameters i.e., Knowledge,

Perception and Attitude were identified to formulate principles, criteria and indicators for the assessment of the ability of stakeholders to mitigate marine pollution [48,49,54].

The formulated three novel principles include: Principle 1 = Knowledge about marine pollution; Principle 2 = Perception about marine pollution, and Principle 3 = Attitude about marine pollution (See Table 1). To complement all three principles, a set of four criteria were developed which are generic to the principles and specific to the marine pollution by covering the aspects of the environmental degradation of beach and sea, damage to tourists' hotspots, environmental ethics, and legal arrangements to control pollution. The set of criteria against each principle is shown in Table 1. In addition, various set of indicators were determined as means of verification against respective principles and criteria as shown in Table 1.

Table 1. Principles, Criteria and Indicators.

Principles	Criteria	Indicators
PP-1 Knowledge about Marine Pollution	PC-1.1: Knowledge about environmental degradation of beach and sea	PC-1.1.1 Awareness about sea and beach pollution on Karachi coast
	PC-1.2: Knowledge about damage to tourists' hotspots	PC-1.2.1 Realization that pollution has deteriorated tourists' hotspots on the beaches of Karachi
	PC-1.3: Knowledge about environmental ethics	PC-1.3.1 Giving environmental pollution some moral, ethical and religious values
	PC-1.4: Knowledge about legal aspects to control pollution	PC-1.4.1 Awareness about pollution prevention regulations (plastic bag ban, littering on the beach)
PP-2 Perception about Marine Pollution	PC-2.1: Perception about environmental degradation of beach and sea	PC-2.1.1 Considering change in lifestyle, a cause of sea and beach pollution
		PC-2.1.2 Believing that his/her personal responsibility in sea and beach pollution.
		PC-2.1.3 Considering commercial giants (plastic bottles/packaging producers etc.) as responsible for sea and beach pollution
	PC-2.2: Perception about damage to tourists' hotspots	PC-2.2.1 Idea of beach pollution damaging beach and underwater tourists' attractions
		PC-2.2.2 Realizing that pollution (odor, visual) deteriorated the aesthetic value of sea and beach.
	PC-2.3: Perception about environmental ethics	PC-2.3.1 Considering individual's actions are important in preventing the pollution of beach and sea?
		PC-2.3.2 Considering him/her as contributing factor to beach and sea pollution in Karachi.
		PC-2.3.3 Believing beach and sea pollution as an ethical issue at various levels.
PC-2.4: Perception about legal aspects to control pollution	PC-2.4.1 Government authorities effectively handle the issue of beach and sea pollution in Karachi	
	PC-2.4.2 Believing on strict enforcement of environmental regulations to reduce pollution	

Table 1. Cont.

Principles	Criteria	Indicators
PP-3 Attitude about Marine Pollution	PC-3.1: Attitude about environmental degradation of beach and sea	PC-3.1.1 Feeling worried about pollution of beach and sea of Karachi
	PC-3.2: Attitude about damage to tourists' hotspots	PC-3.2.1 Influence of beach and sea pollution on decision to visit beach for leisure.
	PC-3.3: Attitude about environmental ethics	PC-3.3.1 Considering moral, ethics religious teachings and ecological aspects while contributing to beach and sea pollution
	PC-3.4: Attitude about legal aspects to control pollution	PC-3.4.1 Influence of marine environmental protection regulations (Plastic bag ban, littering) on behavior

To ensure identity, specific codes were assigned to each Principle, Criterion, and Indicator. The code for Principle = PP-N; where, P = Pollution Response Principle, N = Principle number, i.e., PP-1, PP-2 and PP-3. The code for Criterion = PC-PN.CN; where PC = Pollution Response Criterion, PN = Principle number, CN = Criterion number, e.g., PC-1.1, PC-1.2, PC-1.3, PC-1.4. The code for Indicator = PC-PN.CN.IN; where PC = Pollution Response Criterion, PN = Principle number, CN = Criterion number, IN = Indicator number. For example, Principle 1, CN, Indicator 1 = PC-1.1.1, PC-1.2.1, PC-1.3.1, PC-1.4.1; Principle 1, CN, Indicator 2 = PC-1.1.2, PC-1.2.2, PC-1.3.2, PC-1.4.2; and Principle 1, CN, Indicator 3 = PC-1.1.3, PC-1.2.3, PC-1.3.3, PC-1.4.3 etc.

2.5. Development of the Questionnaire

The PCI matrix (Table 1) was transcribed into a structured questionnaire by transforming the indicators into queries for respondents and applying MCDA's Simple Multi Attribute Rating (SMART) technique for scoring to quantify the feedback of surveyed population to be used to assess the interrelation between variables. For the purpose, ratio scale was selected along with formulation of its nominal classes so that the quantitative results can also be examined qualitatively. The selected ratio scale along with corresponding nominal classes are 0 = Nil, 0.01 to 1.99 = Negligible; 2.00 to 2.99 = Very Poor; 3.00 to 3.99 = Poor; 4.00 to 4.99 = Moderate; 5.00 to 5.99 = Fair; 6.00 to 6.99 = Satisfactory; 7.00 to 7.99 = Good; 8.00 to 8.99 = Very Good, 9.00 to 9.99 = Excellent; 10 = Exceptional. The versatility of the questionnaire allows for its effective use for stakeholders' assessment regarding marine pollution response in any of the coastal urban city across the world.

2.6. Sampling Area

The sampling locations i.e., the beaches were chosen based on the influx of visitors, accessibility to the public, and proximity to Karachi city, Pakistan. The Sea View and Clifton beaches were selected to carry out the questionnaire due to the aforementioned factors. The months of July and September were selected as the beaches experience an influx of visitors due to the seasonal heat. 304 responses were collected over a period of 8 days: 5 days in July and 3 days in September. Figure 2 shows the sampling area.

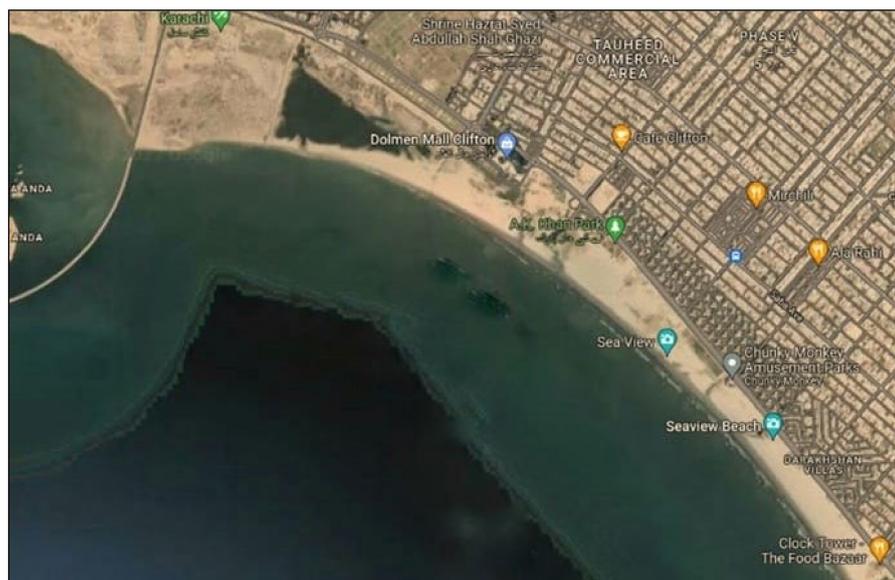


Figure 2. Stakeholder' assessment's sampling area in Karachi.

2.7. Sampling Technique

Purposive sampling technique was employed for recording the responses of beachgoers, which was particularly aimed at transgenders and preference given to females considering their relatively less presence on the beaches. Within sample population for males and females, the random sample approach was clubbed in order to minimize the errors due to biasness.

2.8. Collection of Primary Data

For data collection, months of July and September were chosen to make trips to Karachi city. The selected beaches were visited, and the people were approached to fill out the questionnaire to be used in a research study on their consent. Although it was difficult to record views of females due to cultural values and comparatively less presence at the beach, 117 responses were managed to be recorded. Whereas 181 males and 5 transgenders responded, totaling to 304 responses over a period of 8 days: 5 days in July and 3 days in September.

2.9. Data Entry and Cleaning

MS Excel 365 was used for data entry, initial sorting, and cleaning. The Excel sheet for data entry included entries such as serial number, date of sampling, gender, and responses. Three incomplete responses were excluded from the dataset to avoid errors in data analysis.

2.10. Sample Analysis

MS Excel 365 was employed for the arithmetic operations, basic statistics, and graphical representations of results. One-tailed Pearson correlation was employed to observe the relationship and interdependence of various principles using "IBM SPSS Statistics 25".

3. Results

Overall Index of all three principles i.e., Knowledge, Perception, and Attitude is shown in Figure 3. Whereas principle-wise detail of results is given in subsequent sub-sections.

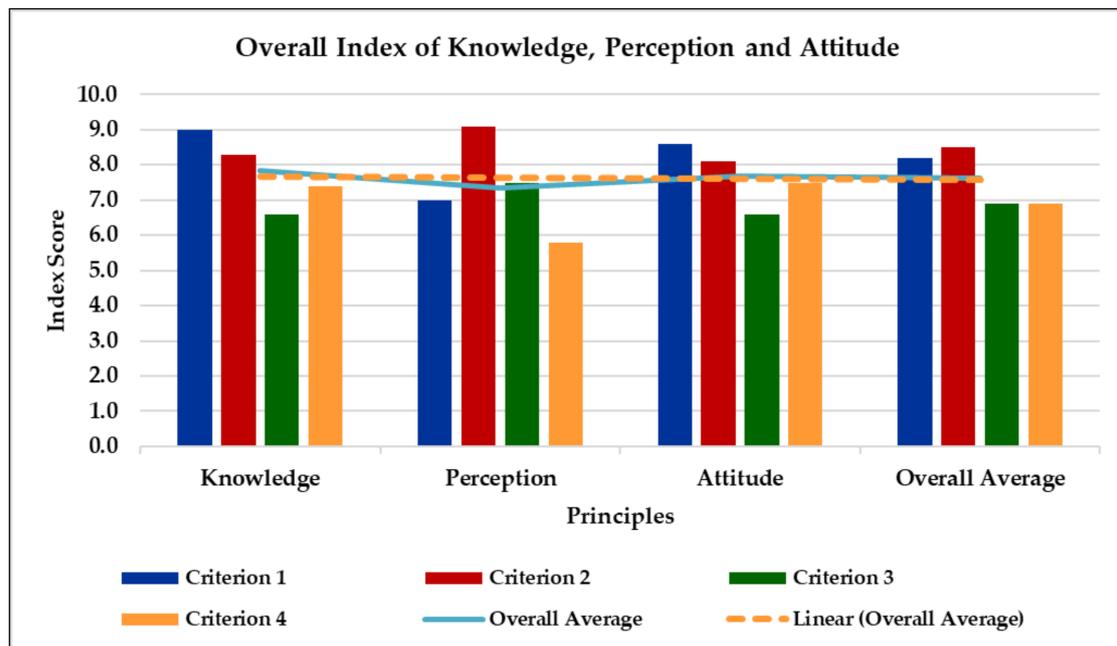


Figure 3. Overall Index of Principles (Knowledge, Perception, and Attitude).

3.1. Results—Principle 1: Knowledge about Marine Pollution

Principle 1 deals with evaluating the awareness of the respondents about marine pollution. An assessment of Knowledge regarding various elements of marine pollution is particularly important as this knowledge tends to shape people's opinions, and then these both decide their approach towards the issue. Sources of people's awareness regarding the subject are multiple, ranging from firsthand experiencing the pollution at the beach and at sea; watching the news and reading materials on the subject; to hearing other people's experiences of encountering pollution. The most authentic of all is the experience of pollution (seeing, smelling, touching) on site. Considering this, the questionnaire was targeted toward people visiting the beaches (and the ones who visit frequently) to gather the true extent of awareness of the residents of the city. Furthermore, this Principle also aimed to assess the respondents' understanding of the ethical & religious ideologies concerning marine pollution. Table 2 depicts the criteria-wise index score and their corresponding class based on the Principle of Knowledge, while Figure 4 shows its graphical radar.

Table 2. Criteria-wise Knowledge Index.

Criteria	Knowledge Index (Average Score)	Corresponding Class
C-1.1: Knowledge about environmental degradation of beach and sea	9.0	Excellent
C-1.2: Knowledge about damage to tourists' hotspots	8.3	Very Good
C-1.3: Knowledge about environmental ethics	6.6	Satisfactory
C-1.4: Knowledge about legal aspects to control pollution	7.4	Good
Overall Average	7.8	Good

[Scale: 0 = Nil, 0.01 to 1.99 = Negligible, 2.00 to 2.99 = Very Poor, 3.00 to 3.99 = Poor, 4.00 to 4.99 = Moderate, 5.00 to 5.99 = Fair, 6.00 to 6.99 = Satisfactory, 7.00 to 7.99 = Good, 8.00 to 8.99 = Very Good, 9.00 to 9.99 = Excellent, 10 = Exceptional].

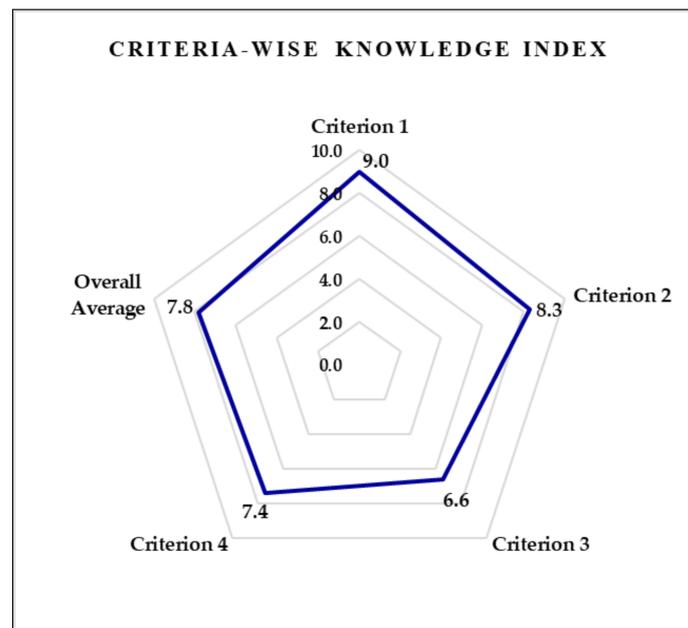


Figure 4. Criteria-wise Radar of Knowledge Index.

In the first Principle i.e., Knowledge, the first criterion aimed to assess the awareness of the respondents regarding the environmental degradation of beach and sea in Karachi and showed that the respondents are well aware of the ongoing pollution of marine resources in their city. Similarly, the second criterion sought to measure the experience of the respondents who have experienced the degradation of beach and sea tourist spots due to pollution on various levels and it tells that a significant majority of respondents have experienced the pollution of marine resources in Karachi in varying capacities. The next criterion was to gauge the level of understanding of the respondents regarding the various ethical and religious principles which play a part in determining the attitude of the population, and the findings revealed that the respondents are decently aware of the ideologies that deal with preventing and mitigating pollution of various kinds at different levels. The final criterion was to assess the level of awareness of the past and current pollution prevention regulations of the respondents to get an insight into the updated information of the population, and a vast majority of the respondents are aware of the pollution prevention regulations in Karachi city. Overall, it is understood that the populace has a decent level of understanding of the very real phenomenon of the degradation of marine ecosystems in Karachi, along with the associated factors it entails, which ideally would further shape the opinion, and ultimately, the actions.

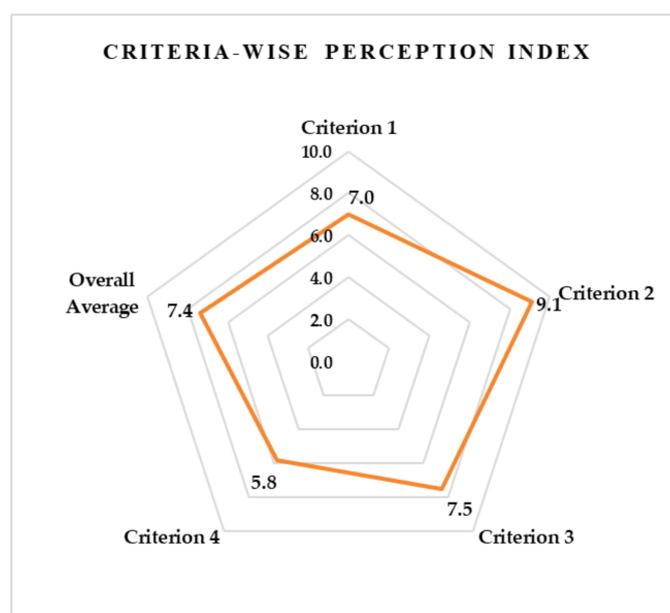
3.2. Results—Principle 2: Perception about Marine Pollution

Principle 2 deals with the opinion of people regarding the various aspects of marine pollution. The human mind tends to process the information gained from various sources to form an opinion on a certain issue. In the case of Karachi city where the prior information of marine pollution molds the opinion of the people and allows them to think and reexamine their own actions, as well as of other individuals/groups. Ultimately, the opinion formed through this, coupled with the awareness, decides the behavior/actions of the stakeholders in addressing the issues at hand. Table 3 depicts the criteria-wise index score and their corresponding class based on the Principle of Perception, while Figure 5 shows its graphical radar.

Table 3. Criteria-wise Perception Index.

Criteria	Perception Index (Average Score)	Corresponding Class
C-2.1: Perception about environmental degradation of beach and sea	7.0	Good
C-2.2: Perception about damage to tourists' hotspots	9.1	Excellent
C-2.3: Perception about environmental ethics	7.5	Good
C-2.4: Perception about legal aspects to control pollution	5.8	Fair
Overall Average	7.4	Good

[Scale: 0 = Nil, 0.01 to 1.99 = Negligible, 2.00 to 2.99 = Very Poor, 3.00 to 3.99 = Poor, 4.00 to 4.99 = Moderate, 5.00 to 5.99 = Fair, 6.00 to 6.99 = Satisfactory, 7.00 to 7.99 = Good, 8.00 to 8.99 = Very Good, 9.00 to 9.99 = Excellent, 10 = Exceptional].

**Figure 5.** Criteria-wise Radar of Perception Index.

Principle 2 deals with the opinion of people regarding the various aspects of marine pollution. The findings suggest that a significant subset of the respondents is decently aware of the various factors adding to the environmental degradation of beach and sea in Karachi. Similarly, a significant portion of the respondents considers that lifestyle changes are causing sea and beach pollution. The rampant introduction of single-use plastics in daily use items, the popularity of fast fashion, and eccentric consumption patterns have molded lifestyles in such a way that it has allowed for increased waste production that is ultimately adding to the beach and sea pollution in Karachi. Intriguingly, just half of the respondents consider themselves to be a contributor to sea and beach pollution in Karachi on a regular basis. On the other hand, most of the respondents think that commercial giants (plastic bottles/packaging producers etc.) are responsible for sea and beach pollution. Understanding from these statistics, it is reported that the respondents consider that the introduction of plastic in items of common use by the producers is enabling the consumer behavior to purchase discardable items. People also have a strong opinion of the sea and beach pollution's impact on the tourist hotspots. An overwhelming majority of the respondents think that sea and beach pollution damages beach and underwater tourist attractions in and around Karachi. Similarly, a vast majority of the respondents think that the aesthetic impacts of sea and beach pollution—including odor and visual pollution from garbage and sewage—are evident in Karachi. Fortunately, a significant number of respondents are aware of the environmental ethics pertaining to sea and beach pollution.

Respondents' majority also think that individual action is crucial in curbing sea and beach pollution in Karachi. It could be in the form of refusing to purchase products that produce trash. It could also range from buying in bulk to incorporating the practices of reusing and recycling at domestic levels. Again, only a fraction of respondents believes that they contribute to beach and sea pollution in Karachi in varying capacities, with responses ranging from negligible contribution to high contribution. To question which gauges if ethics on various levels play a part in Karachi city's sea and beach pollution shows that the respondents believe that ethical considerations play a significant part in dealing with the aforesaid issue. Evidently, the respondents are not satisfied with the current progress of municipalities and other law enforcement institutions in the handling of the issue in question. The other question to assess whether the implementation of stricter laws would encourage individual action to reduce pollution in Karachi says that a significant subset of respondents think that individuals would abide by pollution prevention regulations if there were a continual check by the relevant authorities. Ban on certain polluting products, littering ban, and other kinds of rules with considerable penalties could ensure cleaner beach and sea—with an auxiliary effect of inducing a civic sense of responsibility and ownership of the natural resources and the city at large among the public.

3.3. Results—Principle 3: Attitude to Combat Marine Pollution

Principle 3 deals with assessing the behavior of the respondents in combating the issue of marine pollution. Having previously measured Knowledge and Perception, the measure of the Attitude determines how the subset of the population will tackle the prevalent issue. Table 4 depicts the criteria-wise index score and their corresponding class based on the Principle of Perception, while Figure 6 shows its graphical radar.

Principle 3 assesses the Attitude in combating the issue of marine pollution in Karachi. Evaluation of the concern of the respondents regarding the pollution of beach and sea in Karachi shows that a significant portion of the respondents has a worrisome stance towards the degradation of the marine resources of Karachi. Moreover, the effect of beach and sea pollution and its associated aesthetic impacts on the willingness of the respondents to visit these spots for a picnic and other leisurely activities is strong. Similarly, the measure of the behavior of respondents regarding environmental ethics and if they consider religious, ethical, and ecological aspects when doing something which potentially contributes to beach and sea pollution reveals that a decent sum of respondents bases their decisions on various ethical aspects when doing something potentially harmful to marine ecosystems. Likewise, a significant majority of the respondents keep in mind the laws that protect (the marine) environment (plastic bag ban, littering etc.).

Table 4. Criteria-wise Attitude Index.

Criteria	Attitude Index (Average Score)	Corresponding Class
C-3.1: Attitude about environmental degradation of beach and sea	8.6	Very Good
C-3.2: Attitude about damage to tourists' hotspots	8.1	Very Good
C-3.3: Attitude about environmental ethics	6.6	Satisfactory
C-3.4: Attitude about legal aspects to control pollution	7.5	Good
Overall Average	7.7	Good

[Scale: 0 = Nil, 0.01 to 1.99 = Negligible, 2.00 to 2.99 = Very Poor, 3.00 to 3.99 = Poor, 4.00 to 4.99 = Moderate, 5.00 to 5.99 = Fair, 6.00 to 6.99 = Satisfactory, 7.00 to 7.99 = Good, 8.00 to 8.99 = Very Good, 9.00 to 9.99 = Excellent, 10 = Exceptional].

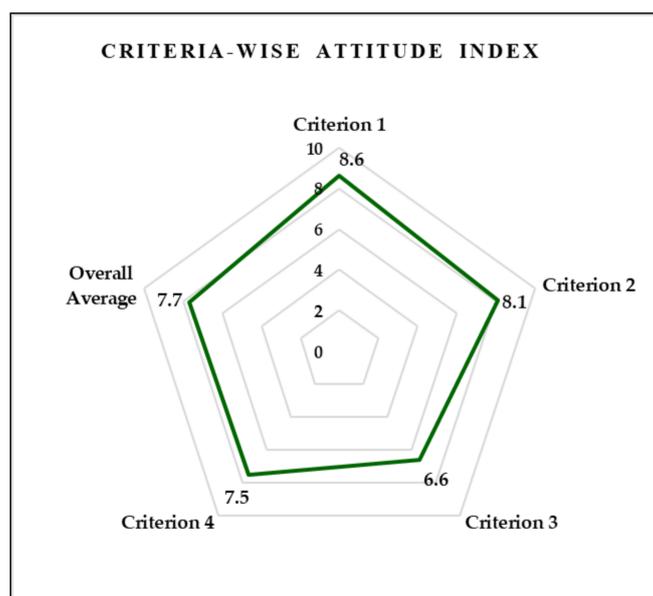


Figure 6. Criteria-wise Radar of Attitude Index.

3.4. Statistical Analysis Results

The application of the one-tailed Pearson correlation enabled the portrayal of relationships, impacts, and the dependence of variables, which further provided clarity on the interdependence of all variables to create a better understanding vis-à-vis various perspectives and approaches regarding the abatement of marine pollution. Table 5 shows results of Pearson correlation.

Table 5. Results of Pearson Correlation Test.

Pearson Correlations				
Variables and Parameters		Knowledge	Perception	Attitude
Knowledge	Correlation Value	1		
	Significance (<i>p</i> -value)			
Perception	Correlation Value	0.266 **	1	
	Significance (<i>p</i> -value)	0.000		
Attitude	Correlation Value	0.371 **	0.185 **	1
	Significance (<i>p</i> -value)	0.000	0.001	

** Correlation is significant at the 0.01 level (1-tailed).

4. Discussion

4.1. Discussion and Findings on Correlation

Table 5 depicts the results of the Pearson Correlation among Knowledge, Perception, and Attitude. There are different arguments regarding the scale for the evaluation of correlation [55–57]. It is widely agreed upon that the value of correlation coefficients ≤ 0.5 is taken towards the lower side and also termed an insignificant relationship while its value ≥ 0.5 is considered towards the higher side and also termed a significant or strong relationship subject to attaining the desired level of statistical significance in terms of its *p*-value [58]. The SPSS output clearly indicates that the relationship between all variables is insignificant with a *p*-value < 0.001 . The relationship between Knowledge and Perception is very weak with a value 0.266 (*p*-value < 0.001). Whereas the relationship value between Knowledge and Attitude is 0.371 (*p*-value < 0.001), which is relatively better than the combination of Knowledge and Perception. However, the correlation between

Perception and Attitude, with a value 0.185 (p -value < 0.001), is on the lowest side among all relationships.

It is inferred from the analysis that the public is well-informed about the current situation of marine pollution in Karachi and how it is impacted by the actions of various stakeholders i.e., individuals and industries/companies. The weak association between Knowledge and Perception shows that sensitivity is lacking among the population despite a reasonable level of awareness. The other two correlations substantiate that the sensitivity is not developed among the population to the level that it would promote the development of a suitable approach among the individuals to effectively reduce and mitigate the issue of marine pollution in Karachi.

4.2. Overall Discussion about Results of the Study

The issue of Karachi city's beach and sea pollution is multifaceted [59–62]. Commercial producers, consumers, municipalities, law-making, law-enforcement and regulatory authorities and other segments have stakes in enabling waste and effluent generation that degrade the marine ecosystem of the city [63–65]. It is understood that the people are highly aware of the pollution happening in and around the marine environments of Karachi, which is claimed based on their first-hand experiences, especially gained from personal encounters of marine ecosystems' degradation. The respondents have adequate familiarity of the ethical and religious ideologies regarding pollution, along with of past and current pollution prevention regulations, which they have deemed futile in curbing the said issue. Based on the analysis, the aforementioned statements are reaffirmed as the respondents believe that the big companies are as much responsible for the city's marine environment's degradation as the individual action is. In the wake of the global pattern, Pakistan's consumer market has been flooded with products and commodities in 'easy' packaging that adds to the municipal waste. In this regard, the public could be provided with an awareness of such products, their eco-friendly alternatives, and how they can mobilize activism to mainstream such products. With the newly in place ban on the import of foreign products in the country, it is an opportunity for the local producers to tap the eco-friendly, locally sourced and produced market that would secure both the economy and the environment. Along with that, the consumption patterns of the biggest city of the country allow the big corporations to produce more such plastic and trash-based products that end up polluting the marine ecosystems.

According to the respondents, the metropolitan's municipalities and decision-makers have forsaken the waste reduction/management infrastructures to focus more on unsound urban development, allowing wastes and effluents to get dispersed and end up in the marine environments, untreated and uncounted for. An overwhelming majority of the respondents thinks the aesthetic impacts of sea and beach pollution—including odor and visual pollution from garbage and sewage—are exceptionally evident in Karachi. They say that sea and beach pollution damages beach and underwater tourist attractions in and around Karachi and highly influences their decision to choose the public beaches as a leisure spot for their recreation, especially after the high tide days when the ocean dumps the garbage back on the beach which is unsightly. Although only a portion of respondents believes that they actively contribute to pollution, it is a matter of ethical values that vary among the population. In this regard, awareness of personal action and its impacts is crucial. Additionally, the respondents believe that having strict regulations, along with their effective enactment by the implementing authorities, on littering in place would be helpful as it would ensure a less-polluted environment. Ban on certain polluting products, littering ban, and other kinds of rules with considerable penalties could ensure cleaner beach and sea—with an auxiliary effect of inducing a civic sense of responsibility and ownership of the natural resources and the city at large among the public. Evaluation of the concern of the respondents regarding the pollution of beach and sea in Karachi shows that a significant portion of the respondents has a worrisome stance towards the degradation of the marine resources of Karachi. The consequence of beach and sea pollution and its

associated aesthetic impacts on their willingness to visit these spots for picnic and other leisurely activities is strong.

However, the correlation between Knowledge, Perception, and Attitude as previously assessed and successfully established by [48–50,54] has not been determined in the current study. The variable Perception is not being influenced by Knowledge, which would, in turn, compel the formation of Attitude which would then encourage the abatement of marine pollution at Karachi port, beach and sea.

4.3. Practical Implications of Results

This necessitates suitable sensitization among the public which would create the will to address the issue of marine pollution. Similarly, the need for an active waste management and treatment/disposal mechanism is reaffirmed for the city of Karachi considering the colossal amount of waste being generated. The findings also suggest that, as long as the public—the biggest stakeholder—does not alter its behavior, consumption and disposal patterns (also the management-level stakeholders who enable such endeavors), along with probing the commercial actors to manufacture sustainable products, the business-as-usual case of escalating marine pollution will prevail.

5. Conclusions

The study has explored whether a substantial behavioral approach of the stakeholders of Karachi city's marine pollution has developed yet to adequately address the issue by analyzing the correlation between knowledge, perception, and attitude. Furthermore, the analysis has offered insight into the ways the stakeholders are perpetrating pollution and how their respective action is important in the abatement of marine pollution in Karachi. The stakeholders of Karachi city's marine pollution are aware and alarmed about the worsening situation of beach and sea pollution, which is rooted in the individuals' ethics, unsustainable capitalistic production patterns, and toxic consumerism. Moreover, the study has found insignificant relationship between the variables Perception and Attitude, indicating that the level of understanding of the stakeholders has not developed opinions to an extent which would enable appropriate behavioral approach towards the abatement of pollution. Keeping it in view, the study calls for the need to induce effective understanding of issue at hand for stakeholders to develop opinion, which would in turn affirm pro-environment behavior. It advocates inducing awareness, mobilization, and reforms to encourage collective action by all actors. This can be achieved through awareness drives and formal education initiated by various authorities on municipal as well as the metropolitan level. In addition, the public is aware of the effects of big corporations on the natural environment, but they are required to be educated regarding the suitable alternatives that are eco-friendly, while mobilizing and equipping them for collective action to mainstream less-polluting consumer products. The importance of individual action in preventing beach and sea pollution is reaffirmed by the respondents. The relevant authorities must explore ways to allow people to explore the variety of ways pollution in the city can be reduced. Since the law-making, law enforcement, and regulatory authorities concerning the metropolis have been deemed ineffective in handling the issue of pollution, they and should consider an efficacious approach to reduce and manage various forms of pollution. For that, strict regulations involving fines, serving time, and legal action should be employed as supported by the public, along with resource-effective waste treatment and disposal mechanisms as a mitigation approach.

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