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Coastal Zone Environment Integrity Assessment for Sustainable Management: Part 1. Development of Adaptive Expert-Driven Coastal Zone Health Index Framework

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Abstract: The coastal zone is the environment that connects terrestrial and marine environments. It is the most productive ecosystem on the planet. It has been estimated that 23 percent of the population lives in the coastal regions. The attractive landscape and seascape of the coastal zone environments attract human settlement and increase the economic activities in the area. Unfortunately, massive human urbanization is also attributed to coastal zone ecosystem degradation. In addition, water-related phenomena due to the changing climate also affect the said environment. The negative impacts of human activities and the water-related phenomena typically deplete the environment's health. Thus, this study developed an adaptive index framework to assess the coastal zone environment condition. The principle of this framework is the sustainable co-existence of human development with the coastal zone environment. The identified coastal cities in the Philippines were utilized as the case study for developing the framework. The results show that the decision-makers are conservationists while extractive. In contrast, environmental educators are conservationists in nature. Moreover, each city has its own unique framework and signifies that the framework is adaptive to the perspective of the decision makers in their city.

Keywords: coastal zone sustainable management; CoZHI; multicriteria decision analysis; analytic hierarchy process; the Philippines

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1. Introduction

The coastal zone is the environment that connects terrestrial and marine environments. The geographical extent of the coastal zone includes areas within a landmark limit of 1 km from the shoreline at high tide and other areas within a seaward limit of 200 m in depth [1]. It is the most productive ecosystem on the planet. Major cities are in coastal zones. It has been estimated that 23% of the world's population lives within 100 km of the coastal regions [2]. The attraction of the coastal landscape and seascape attracts the rapid expansion of human settlement, thus increasing the economic activities in the area. The rapid urbanization and expansion of the cities to the coastal zone have been attributed to the degradation of the coastal zone ecosystems [3]. The major human activities affecting the coastal zone include massive sewage discharge that can bring contaminants to the coastal water [4], pollution [5], overfishing [6], deforestation [7,8], reclamation [9], sand and oil mining [10], tourism [11], trade, energy production [12,13] and the construction of seawalls and other structures [14]. Moreover, engineering activities, such as diversions of waterways and coastal structures, change the circulation patterns and alter the natural ways of sediment transport [15]. Additionally, coastal erosion is a common coastal phenomenon that can be due to human or natural event [16–18]. Coastal zone ecosystem services are often disrupted by human activities. Aside from human activities, the coastal zone environment is also affected by water-related phenomena due to changing climates, such as typhoons [19], storm surges [20–22], tsunamis due to underwater tectonic and volcanic earthquakes [23], rising sea levels [20], and rapid increases in sea surface temperature [24]. The negative impacts of human activities and the water-related phenomena typically result in threats to the economic activities that cause social issues, including unemployment, loss of development, and competition between stakeholders for resources.

Thus, an inclusive framework for understanding the interaction between human impact and climate change in coastal zone ecosystems should be formulated. An integrated and comprehensive coastal resource management framework is highly needed to balance the co-existence of humans living in the coastal zone area. Moreover, the framework should ensure that the coastal ecosystem will not be heavily affected by the natural calamity. The framework ensures the fair utilization of the coastal and marine resources. The framework should align the socio-economic development to the existence of the coastal zone ecosystem to ensure the integrity of the coastal zone environment. Moreover, the plan's development should be coordinated with the local community, policymakers, academic institutions advocating societal sustainability, private sector, business sector, and non-government organization.

Integrated coastal zone management (ICZM) is identified as one of the most effective tools for incorporating conservation and sustainable use of marine and coastal biodiversity aspects into the planning of coastal areas [25]. This framework is a dynamic, multidisciplinary, and iterative process to promote the sustainable management of coastal zones. It is a long-term evaluation to balance socio-economic activities all within limits set by the natural dynamics of the coastal zone environment. It also integrates all relevant policy areas, sectors, and levels of administration (i.e., local, regional, and national) [25,26].

The fundamental purpose of all ICZM initiatives is to maintain, restore or improve the specified qualities of coastal ecosystems and their associated human societies [26]. A defining feature of ICZM is that it addresses needs for both development and conservation in geographically specific places [24].

The study of the Coastal Integrity Vulnerability Assessment Tool (CIVAT) by the Marine Environment and Resources Foundation in the Philippines provides a framework to assess the vulnerability of the coastal zone to physical processes, such as erosion and flooding [27]. The potential impact of these physical processes is a combination of its exposure to coastal dynamics, such as wave action, and its biophysical sensitivity, such as predisposition to erosion. This CIVAT framework tries to analyze the adaptive capacity of the coastal zone areas against physical processes and water-related phenomena. This tool will also estimate how human activities and development affect coastal areas. Its results provide helpful information about the potential effects of climate change on the vulnerability of a coastal area, with sea level rise and other impacts likely to create significant shifts [27].

An ocean health index (OHI) framework was introduced by Halpern et al. [28] to assess the ocean's health using multiple goals. The goals are the following: food provision (subgoals: fisheries and mariculture), artisanal fishing opportunity, natural products, carbon storage, coastal protection, tourism and recreation, coastal livelihoods and economies, sense of place, clean waters, and biodiversity (sub-goals: habitats and species). This framework focuses on understanding the health of the ocean environment, including coastal activities.

Every framework described above has a unique technique and limitations. The OHI framework limitation is the equal weight to each goal in evaluating the environment's health. The paper on OHI did not capture the decision-makers' perception in the study area. However, the coastal zone health index (CoZHI) framework in this study covered the limitation of the OHI framework. Part of the CoZHI framework is to include the policymakers' and the local community's perspectives. The OHI and CoZHI frameworks are similar in understanding the integrity of the coastal zone environment from the past until the present time. On the other hand, the CIVAT further extends the capability of the OHI and ICM frameworks by including the effects of climate change in the future on the coastal area.

The proposed CoZHI framework is multidisciplinary and measures the 10 indicators (or 10 public goals in the OHI framework). The difference between the CoZHI and the OHI is the ability of the CoZHI framework to adapt to the decision-maker's perception. Afar with that, the CoZHI framework will utilize the vulnerability assessment criteria from the CIVAT assessment tool. Furthermore, the exposure variables in the CIVAT are only limited to the sea level rise (SLR) and wave exposure. The CoZHI includes SLR, wave exposure, and sea surface temperature. It also includes the post and pre-exposure of the coastal zone due to extreme events, such as typhoons, tsunamis, and storm surges. Moreover, CoZHI is a multidisciplinary and iterative process that will assess the health and integrity of the coastal zone environment, like the ICZM framework. Unlike ICZM, the CoZHI will assess the current health and integrity of the coastal zone environment and the future scenario using the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6).

Thus, this study focuses on developing an adaptive framework for assessing the coastal zone health index. The framework is flexible to the policymakers' perception, giving input to the coastal zone management plan. The identification of the weight of the indicators can be derived using the analytical hierarchy process (AHP) under multicriteria decision analysis (MCDA). This study aims to establish an expert-driven CoZHI framework and to provide integrated policies on human settlements toward coastal zone resources. This study is part 1 of the complete research on the Coastal Zone Environment Integrity Assessment for Sustainable Management. Part 2 will include the coastal vulnerability assessment with extreme events using CIVAT and the probability of change in the future using the climate change scenario.

2. Material and Methods

2.1. Study Area

The Philippines is an island country in the Southeast Asia Region and situated in the pacific ring of fire facing the Pacific Ocean and the South China Sea. It consists of about 7640 islands categorized into three main geographical divisions (Luzon, Visayas, and Mindanao). The Philippines covers an area of 300,000 km^2. The population of the Philippines is approximately 109 million as of 2020, and it is the 12th most populous country in the world. In this study, the identified study areas are the following: Davao City, Mati City, Cagayan de Oro, Cebu City, Puerto Princesa, Metro Manila, and Laoag City (Figure 1).

Cities in the Philippines are categorized according to income or legal classification. The estimated income per annum for the 1st class city is at least PHP 500 M, followed by the 2nd class city with an income of ranging PHP 320 M to less than PHP 500 M. The 3rd class city has an annual income of at least PHP 240 but less than PHP 320 M. On other hand, the 4th and 5th class city have an income of PHP 160 M but less than PHP 240 M, and at least PHP 80 M but less than PHP 160 M, respectively.

Furthermore, the legal classification is based on the local government code of 1991 (Republic Act No. 7160) [29]. There are three legal classifications of cities in the Philippines. These are highly urbanized cities (HUC), independent component cities (ICC), and component cities (CC). HUC has a minimum population of 200,000, as certified by the Philippine Statistics Authority (PSA), with the latest annual income of at least PHP 50 M or USD 1 M. All five classifications are considered independent (ICC) from the province where they are located, and residents are prohibited from voting for the provincial officials. Component cities that do not meet the requirements of HUC and ICC are considered component cities and are part of the province in which they are geographically located.

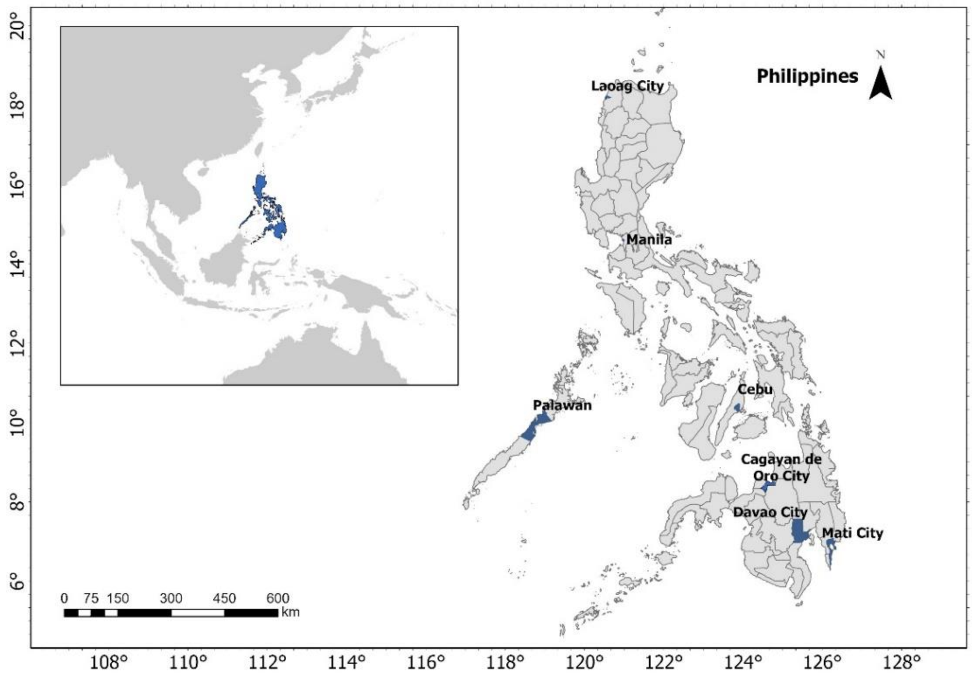

Figure 1. Study areas, the six major coastal cities in the Philippines; Mati, Davao, Cagayan De Oro, Cebu, Puerto Princesa, Metro Manila, and Laoag.

Davao City is a 1st class highly urbanized city in the southern part of the Philippines, with a total area of the city of 2443.61 km^2. Davao City has the largest land area of all cities in the Philippines. It is also the most populated city on Mindanao Island and the third most populous city in the Philippines. It has a population of 1,776,949 [30].

Mati City is a 5th class component city and capital of the province of Davao Oriental, Philippines. It has a population of 147,547 [30]. The city is surrounded by a beautiful mountain range of Mt. Hamiguitan, a UNESCO natural heritage site. This city is recognized as one of the most beautiful bays in the world that are protected landscape and seascape by the Department of Environment and Natural Resources (DENR).

Cagayan de Oro City (also known as CDO) is a 1st class, highly urbanized city in the northern part of Mindanao. According to the 2020 census, it has a population of 728,402 residents [30]. This city also serves as this region's regional center and business hub.

Cebu City is a 1st class, highly urbanized city in the Central Visayas region. It has a population of 964,169 residents as of 2020 [30]. This city is the sixth-most populated city in the nation and the most populous in the Visayas. This city is the Philippines' main domestic shipping port, and approximately 80% of the country's domestic shipping companies are located here.

The City of Puerto Princesa is a 1st class, highly urbanized city located in the western Philippine province of Palawan. It is the westernmost city in the Philippines. It has a population of 307,079 people [30]. This city is the least densely populated in the Philippines, with 110 inhabitants per km^2. This city has the second-largest geographical area of 2381.02 km^2. The small islands are the leading tourist destination in this city, with beautiful beach resorts. Additionally, it is the cleanest and greenest city in the Philippines.

Manila City is the capital of the Philippines. It is the second-most populous city in the country and one of the most populous urban areas in the world. It is highly urbanized and among the most populous and fastest-growing cities in Southeast Asia. The city's total population was 1,846,513 in 2020 [30].

Laoag is the capital city of Ilocos Norte province. It is a 3rd class city. This city is the commercial and industrial hub in the province of Ilocos Norte. Laoag experiences the prevailing monsoon climate and is sometimes experienced by powerful typhoons. The population of Laoag was 111,651 as of the 2020 census [30].

2.2. Methodological Approach

Environmental resource planning is a critical aspect of sustainability assessment where societal development and nature co-exist. The thorough evaluation of the sustainable resource assessment would not only address the requirement for the local government to establish a process that safeguards the environment, but also aid in directing decision makers while enacting sustainable resource policy. The book written by Beinat [31] described three methodologies to support the decision-making process for environmental and resource planning. These methodologies are benefit–cost analysis (BCA), cost–effectiveness analysis (CEA), and multicriteria decision analysis (MCDA). Therefore, this paper's technique focuses on comprehending how policymakers see the environment when constructing sustainable policy, utilizing expert-driven multicriteria decision analysis. Figure 2 illustrates the top-down multicriteria decision analysis methodology of this study. The goal is to develop an adaptive framework to assess the health and integrity of the coastal zone environment. The first step of this approach is to determine the decision-makers perception about being one of the criteria (i.e., conservationist, non-extractive, extractive, and strongly extractive) for the city development plan. The definition of the four criteria is in Section 2.2.1. The last step is to generate the weighted health index framework using the 10 indicators. Table 1 presents the definition of all indicators. The developed index framework is the tool to assess the health and integrity of the coastal zone environment.

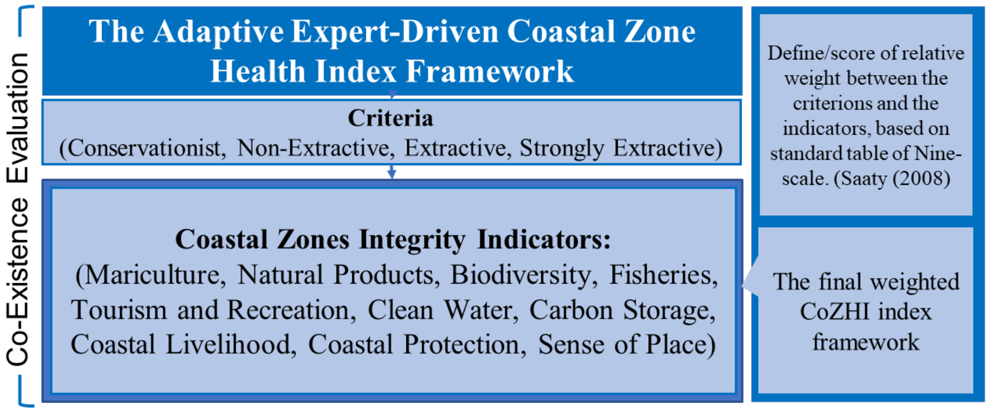

Figure 2. Expert-driven CoZHI framework using MCDA analytical hierarchy process (AHP) in designing flexible resource assessment.

Table 1. Indicators of the CoZHI framework adapted from Wu et al. [32].

Indicator	Abbreviation	Definition
Biodiversity	B	The existence value of biodiversity is calculated by the protection status of marine-related species.
Carbon Storage	CS	Conservation of coastal habitats utilizing carbon storage and sequestration.
Coastal Livelihood	CL	Coastal and marine-related livelihood activities.
Coastal Protection	CP	Protection of the coastal areas (e.g., mangrove forests protect coastal areas from erosion).
Clean Water	CW	Water free from detrimental nutrients, chemical pollution, marine debris, and pathogens.
Fisheries	F	Harvest of sustainable seafood from ocean wildlife engaging in artisanal-scale fishing.
Marine Culture	MC	Cultivation of seafood in the coastal zone.
Natural Products	NP	Naturally produced sea products.
Sense of Place	SP	Cultural, spiritual, or aesthetic relationships are associated with iconic species and the environment.
Tourism and Recreation	TR	Entertainment and enjoyment in coastal areas for locals and tourists.

2.2.1. Criteria and Indicators Evaluation

In this study, the design of the CoZHI framework is based on the societal views of the decision makers using the MCDA-AHP. The following are the steps to generate the framework. First, identify the criteria (i.e., C, E, NE, and SE). The four criteria were adapted and modified from the study of Halpern et al. [28]. In the OHI framework, the weights that are applied to the 10 goals (i.e., indicators in this paper) to calculate the index score were assumed to be equal [24], even though this assumption does not reflect across all stakeholders in the community. Furthermore, Halpern et al. [28] address this limitation by designing four different weight schemes that represent preservationist, extractive, non-extractive use, and strongly extractive use (see Table S4 from Halpern et al. [28]). The OHI framework illustrates that the country can be assessed in one of these four schemes. Unfortunately, this did not address the stakeholders' perspective but rather still the author's perception. The weights in every criterion in the scheme might differ for every stakeholder. Thus, this paper tries to obtain every stakeholder's perspective using MCDA-AHP in their views of their own coastal city.

Second, construct the framework based on the identified indicators. In this way, the framework is adaptive to the views and perspectives of the policymakers in designing a comprehensive coastal zone management plan. The definitions of the four criteria are listed below. Moreover, Table 1 shows the definition of the indicators from the existing literature [32].

- Conservationist (C) is the act of seeking the proper use of environmental resources.
- Non-extractive (NE) is an act of utilizing the services of the environment without extraction. The eco-tourism is an example of this concept.
- Extractive (E) is an act of obtaining natural resources.
- Strongly extractive (SE) is an act of over-extraction that can cause the depletion of natural resources.

2.2.2. Framework Development Using Analytical Hierarchy Process

The pairwise comparison matrix is the first step in the AHP approach, where each criterion/indicator is compared to another using the Saaty scale [33]. The policymakers provide their judgments of the relative importance of one criterion or indicator against another. The higher relative number means the higher the importance of the indicator or criterion than the other.

The second step in the AHP approach is normalization. In this step, each value in the pairwise matrix (C_{ij}) is divided by the sum of each column to obtain the normalized value (X_{ij}) (see Equation (1)). The value in the normalization matrix is a percentage value from the first matrix.

$$X_{ij} = C_{ij} \; / \sum_{i=1}^{n} C_{ij} \tag{1}$$

The next step is to generate the relative weight (W_{ij}) of each criterion or indicator by dividing X_{ij} by the number of criteria or indicators (n), as shown in Equation (2).

$$W_{ij} = \sum_{i=1}^{n} X_{ij}/n \tag{2}$$

The last part of the AHP procedure is the consistency ratio analysis. There are three sub-steps in this part. The first step is to calculate the consistency measure (CM), which can be obtained by multiplying the pairwise matrix with the relative weight [34,35]. The result is divided into the weighted sum vector with criterion or indicator weights. The second step is to calculate the consistency index (CI), as shown in Equation (3). The λmax is the average of the CM. Lastly, the consistency ratio (CR) is computed using Equation (4) below. The relative index (RI) values are shown in Table 2.

$$CI = (\lambda max - n) \; / \; (n - 1) \tag{3}$$

$$CR = CI/RI \tag{4}$$

Table 2. Random index with its corresponding value.

Criteria	2	3	4	5	6	7	8	9	10
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

2.3. Sampling and Data Collection

This paper implemented a purposive sampling approach, where the target respondents are the employees in the city local government unit (LGU). There are three levels of the local government in the Philippines. They are provinces and independent cities, component cities and municipalities, and barangays (village). In this study, the study areas are independent cities. The respondents are planning officers, administrators, management officers, economists, city engineers, and academicians and researchers in the field of environmental studies. This inclusion of respondents can provide recommendations regarding the design of the city's coastal zone management plan.

Data survey is crucial in this study due to the COVID-19 restriction employed in every LGU in the Philippines. Thus, the data were collected online from December 2021 to February 2022. After data screening and validation of the responses using the prescribed criteria ratio in AHP, 4 responses were excluded, and a total of 23 responses were found valid for the analysis. The summary of the respondents is depicted in Table 3.

Table 3. Summary of the respondents.

Respondents	Frequency	Percentage (%)
Job Title		
Faculty/Researcher	14	52
Planning/Economist/Management Officer	7	26
Engineer	6	22
Job Status		
Permanent	18	67
Contract of Service	9	33
Sector		
Government	16	59
Academe	11	41

3. Results and Discussions

The new feature of this framework compared to the OHI framework developed by Halpern et al. [28] is the multicriteria analysis, where the judgment of the decision makers is quantified. The AHP approach under the MCDA ensures the consistency of the respondents' judgment to ensure that the decision is acceptable and reasonable [36].

The pre-identified study areas in the Philippines are the following: Mati City, Davao City, Cagayan De Oro City, Puerto Princesa City, Cebu City, Metro Manila, and Laoag City. All possible members involved in planning the LGU, including the researchers and academicians, were part of the survey respondents. The researcher followed the process of the AHP. The analysis was classified into three. These are research and academician, DMs (i.e., planning officer, economist, management officer, and engineer), and the results based on the city. The consistency of the responses was also evaluated using the CR to ensure that the indices were correct, and the judgment was coherent. The succeeding sub-sections are the processes and results in each classification.

3.1. City-Based Societal Development Views

This section is the perception of the decision makers in their development plan based on the four criteria. Tables 4–10 are the normalized matrices for Mati, Davao, Cagayan De

Oro, Cebu, Puerto Princesa, Metro Manila, and Laoag, respectively. The corresponding pairwise comparison matrix for each normalized matric can be found in the Appendix A.

Table 4. Normalized matrix for Mati City.

Criteria	C	NE	E	SE	Weights
C	0.70	0.77	0.68	0.47	0.66
NE	0.12	0.13	0.20	0.24	0.17
E	0.10	0.06	0.10	0.24	0.12
SE	0.09	0.03	0.02	0.06	0.05
SUM	1.00	1.00	1.00	1.00	1.00

Table 5. Normalized matrix for Davao City.

Criteria	C	NE	E	SE	Weights
C	0.58	0.64	0.58	0.39	0.55
NE	0.14	0.16	0.19	0.22	0.18
E	0.19	0.16	0.19	0.33	0.22
SE	0.08	0.04	0.03	0.06	0.05
SUM	1.00	1.00	1.00	1.00	1.00

Table 6. Normalized matrix for Cagayan De Oro City.

Criteria	C	NE	E	SE	Weights
C	0.43	0.38	0.54	0.25	0.40
NE	0.21	0.19	0.14	0.25	0.20
E	0.21	0.38	0.27	0.42	0.32
SE	0.14	0.06	0.05	0.08	0.09
SUM	1.00	1.00	1.00	1.00	1.00

Table 7. Normalized matrix for Cebu City.

Criteria	C	NE	E	SE	Weights
C	0.48	0.52	0.47	0.36	0.46
NE	0.24	0.26	0.32	0.27	0.27
E	0.16	0.13	0.16	0.27	0.18
SE	0.12	0.09	0.05	0.09	0.09
SUM	1.00	1.00	1.00	1.00	1.00

Table 8. Normalized matrix for Puerto Princesa City.

Criteria	C	NE	E	SE	Weights
C	0.43	0.50	0.43	0.33	0.42
NE	0.21	0.25	0.29	0.33	0.27
E	0.14	0.13	0.14	0.17	0.14
SE	0.21	0.13	0.14	0.17	0.16
SUM	1.00	1.00	1.00	1.00	1.00

Table 9. Normalized matrix for Metro Manila City.

Criteria	C	NE	E	SE	Weights
C	0.55	0.63	0.56	0.36	0.53
NE	0.14	0.16	0.19	0.27	0.19
E	0.18	0.16	0.19	0.27	0.20
SE	0.14	0.05	0.06	0.09	0.09
SUM	1.00	1.00	1.00	1.00	1.00

Table 10. Normalized matrix for Laoag City.

Criteria	C	NE	E	SE	Weights
C	0.39	0.55	0.37	0.25	0.39
NE	0.10	0.14	0.19	0.25	0.17
E	0.39	0.27	0.37	0.42	0.36
SE	0.13	0.05	0.07	0.08	0.08
SUM	1.00	1.00	1.00	1.00	1.00

The CR values for Mati, Davao, Cagayan De Oro, Cebu, Puerto Princesa, Metro Manila, and Laoag are 0.087, 0.043, 0.058, 0.033, 0.017, 0.046, and 0.064, respectively. All CR values are less than 0.10 or 10% meaning that the judgment is reasonably acceptable. Moreover, Figure 3 demonstrates the percentage of each criterion according to the city. The overall result shows that the Philippines is a conservationist with a 47.7% overall rating, followed by extractive, non-extractive, and strongly extractive with 23.9%, 19.7%, and 8.7%, respectively. However, of all cities, Mati City has a higher value for the conservationist criterion, showing that the environment is essential in the city. Addtionally, Mati City and Puerto Princesa are the only cities that give high importance to non-extractive criteria. This means that even though the city is going for development, they are more concerned about the environment as part of their success in the development. These two cities are listed as naturally beautiful cities. Mati City is the location of the UNESCO Natural Heritage site and has three of the most beautiful top bays in the world. Additionally, Puerto Princesa is home of the most picturesque islands and underground rivers. On the contrary, other cities are urbanized cities.

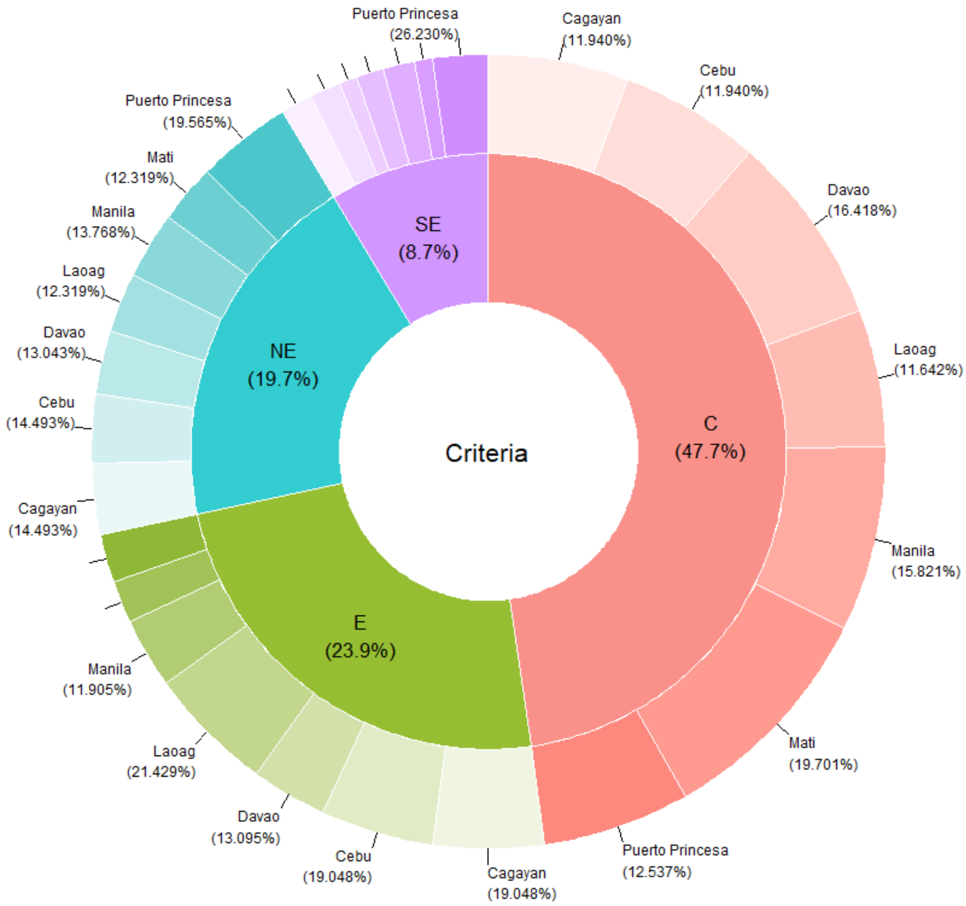

Figure 3. Expert-driven criteria analysis for the seven coastal cities. C, E, NE, and SE indicate conservationist, extractive, non-extractive, and strongly extractive, respectively.

3.2. Educators and Researchers' Societal Development Views

Tables 11 and 12 show the pairwise comparison and normalized matrix in this category. The C, NE, E, and SE weights are 0.60, 0.22, 0.13, and 0.06, respectively. The consistency ratio is acceptable, with a 9.6% rating. The respondents show high importance to the conservationist and non-extractive. The respondents are fully conservationists and are anchored to the reality that they are environmentalists and want to preserve nature.

Table 11. Pairwise comparison matrix for the educators and researchers.

Criteria	C	NE	E	SE
Conservationist (C)	1	4	6	7
Non-Extractive (NE)	0.25	1	3	4
Extractive (E)	0.17	0.33	1	4
Strongly Extractive (SE)	0.14	0.25	0.25	1
Sum	1.56	5.58	10.25	16

Table 12. Normalized matrix with the criteria weights for the educators and researchers (CR = 0.096).

Criteria	C	NE	E	SE	Weights
Conservationist (C)	0.64	0.72	0.59	0.44	0.60
Non-Extractive (NE)	0.16	0.18	0.29	0.25	0.21
Extractive (E)	0.11	0.06	0.10	0.25	0.13
Strongly Extractive (SE)	0.09	0.04	0.02	0.06	0.06
Sum	1.00	1.00	1.00	1.00	1.00

3.3. Decision-Makers' Societal Development Views

This section discusses the DMs perception of societal development views. Tables 13 and 14 display the pairwise comparison and normalized matrix in this category. The C, NE, E, and SE weights are 0.46, 0.18, 0.29, and 0.08, respectively. The consistency ratio is 9.8%. The respondents show to be a conservationist and extractives. The results show that most of the DMs favor the extractive way of development.

Table 13. Pairwise comparison matrix for the decision makers.

Criteria	C	NE	E	SE
Conservationist (C)	1	3	2	4
Non-Extractive (NE)	0.33	1	0.5	3
Extractive (E)	0.50	2.00	1	4
Strongly Extractive (SE)	0.25	0.33	0.25	1
Sum	2.08	6.33	3.75	12

Table 14. Normalized matrix with the criteria weights for the decision makers (CR = 0.098).

Criteria	C	NE	E	SE	Weights
Conservationist (C)	0.48	0.47	0.53	0.33	0.46
Non-Extractive (NE)	0.16	0.16	0.13	0.25	0.18
Extractive (E)	0.24	0.32	0.27	0.33	0.29
Strongly Extractive (SE)	0.12	0.05	0.07	0.08	0.08
Sum	1.00	1.00	1.00	1.00	1.00

3.4. The Development of the CoZHI Framework for Each Coastal City

This section shows the CoZHI framework's generation from each coastal city's perspective. Tables in this section indicate the pairwise comparison matrix with the weights of the indicators. The normalized matrix is no longer shown in this section, but it can quickly compute following the AHP approach and is given in the methodology section.

Tables 15–21 are the pairwise comparison matrices for Mati City, Davao City, Cagayan De Oro City, Cebu City, Puerto Princesa City, Metro Manila, and Laoag City, respectively.

Table 15. Pairwise comparison matrix with indicators weight for Mati City (CR = 0.099).

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weight
NP	1.00	3.00	4.00	4.00	5.00	4.00	3.00	4.00	4.00	4.00	0.25
F	0.33	1.00	4.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	0.17
B	0.25	0.25	1.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00	0.15
MC	0.25	0.25	0.25	1.00	4.00	3.00	3.00	3.00	3.00	3.00	0.11
TR	0.20	0.33	0.25	0.25	1.00	3.00	3.00	2.00	2.00	2.00	0.08
CS	0.25	0.33	0.25	0.33	0.33	1.00	2.00	2.00	2.00	2.00	0.06
CW	0.33	0.33	0.33	0.33	0.33	0.50	1.00	3.00	2.00	2.00	0.06
CL	0.25	0.33	0.25	0.33	0.50	0.50	0.33	1.00	2.00	2.00	0.04
SP	0.25	0.33	0.25	0.33	0.50	0.50	0.50	0.50	1.00	1.00	0.04
CP	0.25	0.33	0.25	0.33	0.50	0.50	0.50	0.50	1.00	1.00	0.04
Sum	3.37	6.50	10.83	14.92	19.17	20.00	19.33	23.00	24.00	24.00	1.00

Table 16. Pairwise comparison matrix with indicators weight for Davao City (CR = 0.095).

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weight
NP	1.00	4.00	5.00	4.00	3.00	4.00	4.00	4.00	4.00	4.00	0.27
F	0.17	1.00	5.00	5.00	4.00	3.00	3.00	3.00	3.00	3.00	0.18
B	0.20	0.20	1.00	4.00	4.00	3.00	3.00	3.00	3.00	3.00	0.14
MC	0.25	0.20	0.25	1.00	4.00	4.00	3.00	3.00	3.00	3.00	0.12
TR	0.33	0.25	0.25	0.25	1.00	2.00	2.00	2.00	2.00	2.00	0.07
CS	0.25	0.33	0.33	0.25	0.50	1.00	2.00	2.00	2.00	2.00	0.06
CW	0.25	0.33	0.33	0.33	0.50	0.50	1.00	2.00	1.00	1.00	0.04
CL	0.25	0.33	0.33	0.33	0.50	0.50	0.50	1.00	1.00	1.00	0.04
SP	0.25	0.33	0.33	0.33	0.50	0.50	1.00	1.00	1.00	1.00	0.04
CP	0.25	0.33	0.33	0.33	0.50	0.50	1.00	1.00	1.00	1.00	0.04
Sum	3.20	9.32	13.17	15.83	18.50	19.00	20.50	22.00	21.00	21.00	1.00

Table 17. Pairwise comparison matrix with indicators weight for Cagayan De Oro City (CR = 0.097).

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weight
NP	1.00	3.00	2.00	4.00	4.00	3.00	2.00	3.00	5.00	2.00	0.23
F	0.25	1.00	2.00	2.00	4.00	3.00	1.00	1.00	3.00	2.00	0.13
B	0.50	0.50	1.00	3.00	7.00	3.00	2.00	4.00	3.00	3.00	0.17
MC	0.25	0.50	0.33	1.00	3.00	2.00	2.00	2.00	2.00	2.00	0.09
TR	0.25	0.25	0.14	0.33	1.00	2.00	1.00	1.00	1.00	2.00	0.06
CS	0.33	0.33	0.33	0.50	0.50	1.00	3.00	3.00	2.00	4.00	0.09
CW	0.50	1.00	0.50	0.50	1.00	0.33	1.00	3.00	2.00	3.00	0.09
CL	0.33	1.00	0.25	0.50	1.00	0.33	0.33	1.00	2.00	2.00	0.06
SP	0.20	0.33	0.33	0.50	1.00	0.50	0.50	0.50	1.00	1.00	0.04
CP	0.50	0.50	0.33	0.50	0.50	0.25	0.33	0.50	1.00	1.00	0.04
Sum	4.12	9.42	7.23	12.83	23.00	15.42	13.17	19.00	22.00	22.00	1.00

Table 18. Pairwise comparison matrix with indicators weight for Cebu City (CR = 0.081).

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weight
NP	1.00	2.00	3.00	4.00	4.00	5.00	5.00	6.00	6.00	7.00	0.27
F	0.50	1.00	2.00	2.00	3.00	3.00	4.00	4.00	5.00	6.00	0.17
B	0.33	0.50	1.00	3.00	3.00	4.00	4.00	5.00	6.00	7.00	0.16
MC	0.25	0.50	0.33	1.00	2.00	2.00	3.00	3.00	4.00	5.00	0.10
TR	0.25	0.33	0.33	0.50	1.00	3.00	3.00	4.00	4.00	5.00	0.09
CS	0.20	0.33	0.25	0.50	0.33	1.00	3.00	3.00	3.00	4.00	0.07
CW	0.20	0.25	0.25	0.33	0.33	0.33	1.00	3.00	4.00	4.00	0.05
CL	0.17	0.25	0.20	0.33	0.25	0.33	0.33	1.00	3.00	5.00	0.04
SP	0.17	0.20	0.17	0.25	0.25	0.33	0.25	0.33	1.00	4.00	0.03
CP	0.14	0.17	0.14	0.20	0.20	0.25	0.25	0.20	0.25	1.00	0.02
Sum	3.21	5.53	7.68	12.12	14.37	19.25	23.83	29.53	36.25	48.00	1.00

Table 19. Pairwise comparison matrix with indicators weight for Puerto Princesa City (CR = 0.067).

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weight
NP	1.00	1.00	1.00	2.00	2.00	3.00	3.00	3.00	4.00	6.00	0.17
F	1.00	1.00	1.00	2.00	2.00	3.00	3.00	3.00	4.00	5.00	0.17
B	1.00	1.00	1.00	1.00	2.00	2.00	3.00	3.00	3.00	5.00	0.14
MC	0.50	0.50	1.00	1.00	5.00	1.00	2.00	8.00	6.00	5.00	0.16
TR	0.50	0.50	0.50	0.20	1.00	3.00	3.00	3.00	4.00	4.00	0.11
CS	0.33	0.33	0.50	1.00	0.33	1.00	3.00	4.00	4.00	4.00	0.10
CW	0.33	0.33	0.33	0.50	0.33	0.33	1.00	2.00	2.00	3.00	0.06
CL	0.33	0.33	0.33	0.13	0.33	0.25	0.50	1.00	3.00	3.00	0.05
SP	0.25	0.25	0.33	0.17	0.25	0.25	0.50	0.33	1.00	2.00	0.03
CP	0.17	0.20	0.20	0.20	0.25	0.25	0.33	0.33	0.50	1.00	0.02
Sum	5.42	5.45	6.20	8.19	13.50	14.08	19.33	27.67	31.50	38.00	1.00

Table 20. Pairwise comparison matrix with indicators weight for Metro Manila City (CR = 0.091).

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weight
NP	1.00	4.00	1.00	4.00	4.00	2.00	1.00	2.00	3.00	2.00	0.19
F	0.25	1.00	2.00	3.00	3.00	2.00	1.00	1.00	3.00	1.00	0.13
B	1.00	0.50	1.00	4.00	7.00	2.00	2.00	4.00	4.00	2.00	0.18
MC	0.25	0.33	0.25	1.00	2.00	1.00	1.00	2.00	1.00	1.00	0.07
TR	0.25	0.33	0.14	0.50	1.00	1.00	1.00	1.00	1.00	2.00	0.06
CS	0.50	0.50	0.50	1.00	1.00	1.00	3.00	3.00	2.00	4.00	0.12
CW	1.00	1.00	0.50	1.00	1.00	0.33	1.00	3.00	3.00	2.00	0.10
CL	0.50	1.00	0.25	0.50	1.00	0.33	0.33	1.00	2.00	2.00	0.06
SP	0.33	0.33	0.25	1.00	1.00	0.50	0.33	0.50	1.00	1.00	0.04
CP	0.50	1.00	0.50	1.00	0.50	0.25	0.50	0.50	1.00	1.00	0.05
Sum	5.58	10.00	6.39	17.00	21.50	10.42	11.17	18.00	21.00	18.00	1.00

Table 21. Pairwise comparison matrix with indicators weight for Laoag City (CR = 0.099).

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weight
NP	1.00	7.00	3.00	5.00	6.00	6.00	2.00	4.00	6.00	4.00	0.29
F	0.14	1.00	3.00	2.00	5.00	6.00	2.00	2.00	2.00	2.00	0.16
B	0.33	0.33	1.00	4.00	5.00	5.00	2.00	3.00	3.00	3.00	0.15
MC	0.20	0.50	0.25	1.00	3.00	2.00	2.00	2.00	2.00	3.00	0.09
TR	0.17	0.20	0.20	0.33	1.00	2.00	2.00	2.00	2.00	1.00	0.06
CS	0.17	0.17	0.20	0.50	0.50	1.00	2.00	1.00	1.00	2.00	0.05
CW	0.50	0.50	0.50	0.50	0.50	0.50	1.00	2.00	2.00	3.00	0.07
CL	0.25	0.50	0.33	0.50	0.50	1.00	0.50	1.00	2.00	1.00	0.05
SP	0.17	0.50	0.33	0.50	0.50	1.00	0.50	0.50	1.00	1.00	0.04
CP	0.25	0.50	0.33	0.33	1.00	0.50	0.33	1.00	1.00	1.00	0.04
Sum	3.18	11.20	9.15	14.67	23.00	25.00	14.33	18.50	22.00	21.00	1.00

The CoZHI framework is based on the indicator weights in every city. Every city has its index showing that the framework's generation relies on the perception of every city and the type of development of the city they wanted. Figure 4 shows the top indicators by city. Moreover, the framework in each city is presented in Equations (5)–(11).

$$\begin{aligned} CoZHI_{Mat.} = \; & NP \times 0.25 + F \times 0.17 + B \times 0.15 + MC \times 0.11 + TR \times 0.08 \\ & + CS \times 0.06 + CW \times 0.06 + CL \times 0.04 + SP \times 0.04 \\ & + CP \times 0.04 \end{aligned} \tag{5}$$

$$\begin{aligned} CoZHI_{Dav.} = \; & NP \times 0.27 + F \times 0.18 + B \times 0.14 + MC \times 0.12 + TR \times 0.07 \\ & + CS \times 0.06 + CW \times 0.04 + CL \times 0.04 + SP \times 0.04 \\ & + CP \times 0.04 \end{aligned} \tag{6}$$

$$\begin{aligned} CoZHI_{Cag.} = \; & NP \times 0.23 + F \times 0.13 + B \times 0.17 + MC \times 0.09 + TR \times 0.06 \\ & + CS \times 0.09 + CW \times 0.09 + CL \times 0.06 + SP \times 0.04 \\ & + CP \times 0.04 \end{aligned} \tag{7}$$

$$\begin{aligned} CoZHI_{Ceb.} = \; & NP \times 0.27 + F \times 0.17 + B \times 0.16 + MC \times 0.10 + TR \times 0.09 \\ & + CS \times 0.07 + CW \times 0.05 + CL \times 0.04 + SP \times 0.03 \\ & + CP \times 0.02 \end{aligned} \tag{8}$$

$$\begin{aligned} CoZHI_{Pue.} = \; & NP \times 0.17 + F \times 0.17 + B \times 0.14 + MC \times 0.16 + TR \times 0.11 \\ & + CS \times 0.10 + CW \times 0.06 + CL \times 0.05 + SP \times 0.03 \\ & + CP \times 0.02 \end{aligned} \tag{9}$$

$$\begin{aligned} CoZHI_{Met.} = \; & NP \times 0.18 + F \times 0.13 + B \times 0.18 + MC \times 0.07 + TR \times 0.06 \\ & + CS \times 0.12 + CW \times 0.10 + CL \times 0.06 + SP \times 0.04 \\ & + CP \times 0.05 \end{aligned} \tag{10}$$

$$\begin{aligned} CoZHI_{Lao.} = \; & NP \times 0.29 + F \times 0.16 + B \times 0.15 + MC \times 0.09 + TR \times 0.06 \\ & + CS \times 0.05 + CW \times 0.07 + CL \times 0.05 + SP \times 0.04 \\ & + CP \times 0.04 \end{aligned} \tag{11}$$

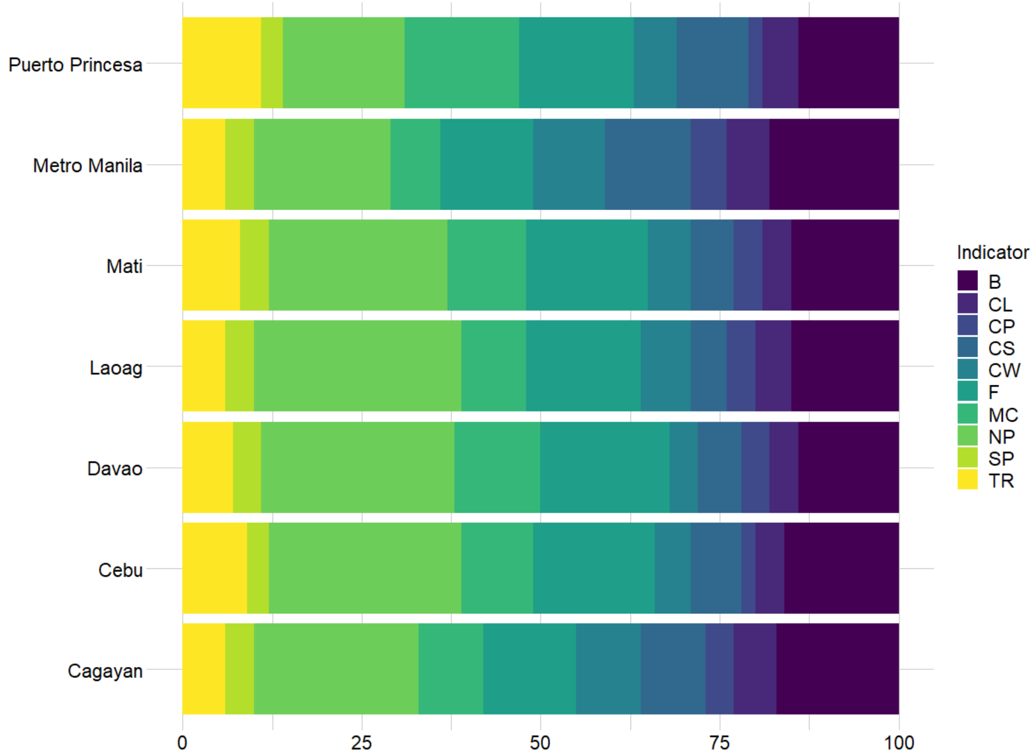

Figure 4. Relative weights of indicators obtained by the expert-driven CoZHI framework analysis for the seven coastal cities.

The CoZHI framework for Mati City shows the top five indicators. These are natural products, fisheries, biodiversity, marine culture, and tourism. The UNESCO Natural Heritage lies in this city. Furthermore, Mati's significant industries are fisheries (Tuna), mariculture (fish cages, fishpond, and seaweed production), and, currently, the beach tourism destination in Mindanao. Mati City received an award last 2021 from the Bureau of Fisheries and Aquatic Resources (BFAR) for the outstanding initiatives and contributions of coastal areas to sustainable fisheries management.

The coastal and marine resources of Davao City contribute significantly to the economy and livelihood of its constituents. The city waters cover about 10% of the total area of Davao Gulf which is a significant fishing and biodiversity conservation area. Another important use of the City's coastal land areas is commercial establishments and industries within the coastal barangays. These commercial establishments have high economic value to the city's local economy. The increasing economic activities have taken their toll on the resources, which poses an urgent need for an integrated management effort toward the sustainable development of these resources. The city proposed coastal and marine management zones with the following classifications, biodiversity conservation zone, fishery management zone, coastal settlement zone, marine and coastal industrial zone, and recreation and tourism zone. These zoning classifications are evidence that the index framework of this study for Davao City is correct. The top 5 indicators are natural products, fisheries, biodiversity, marine culture, and tourism and recreation (Equation (6)).

The 10-year plan of CDO in their coastal management plan includes expanding marine protected areas and establishing zonation along the coastal areas. The plan is to balance the economics and environmental protection in the city. The plan established the zone to identify the areas for tourism and areas prohibited from any development to preserve the seas. The plan of CDO is almost the same as the plan of Davao City. Moreover, the plan of CDO is confirmed in the index framework, as shown in Equation (7).

The Philippine government has mandated the protection, conservation, and sustainable development of the natural resources of the Province of Palawan through the Strategic Environmental Plan (SEP), Republic Act 7611. Puerto Princesa City is under the province of Palawan. The SEP is a comprehensive framework that serves the LGUs as a guide in formulating and implementing plans, programs, and projects affecting the province's environment. The SEP is uniquely designed for Palawan due to its natural archipelagic beautiful landscape and abundance of biodiversity with many endemic animals in the land and sea. Thus, the result of the index framework emphasizes the first essential indicators, the natural products and fisheries, followed by marine culture and biodiversity (see Equation (9)).

The DENR strategy in the Duterte administration is to make the bay beautiful by dredging and removing the coastal pollutants and replacing them with dolomites sand. Fortunately, Metro Manila also has a "Metro Manila Coastal Strategy" initiative. The initiative is to bring back the beautiful old bay. The initiatives are anchored to the historical and religious sites, ecology (mangroves, wetlands, and coral reef), and tourism and recreation. Manila City is a highly urbanized city, yet the conservation of the environment is still part of its management action. In that case, the index framework (Equation (10)) can be the guiding principle in assessing and evaluating the said strategy.

Laoag City is obliged to ensure the development and protection of the coastal areas. The LGU built the redeveloped mangrove picnic park project as it enjoins coastal communities to participate in its intensified mangrove rehabilitation project. This mangrove rehabilitation project protects the coastal communities during typhoon season. It also serves as tourism activities and provides a life support system to fish, crustaceans, and wildlife in the zone area. The priority of the LGU of Laoag is aligned to the index framework shown in Equation (11), prioritizing fisheries and marine culture, natural products, biodiversity, and tourism activities.

The CoZHI framework of all cities is highly aligned to the conservation of the environment. An integrated assessment framework should be established. Moreover, yearly assessments and evaluations should be performed to make sure that the plan is properly monitored for the sustainable development of the city.

3.5. The Development of the CoZHI Framework for Educators and Researchers

This section shows the CoZHI framework for educators and researchers. Table 22 shows the pairwise comparison matrix with the weights of the indicators. The researchers and educators are emphasizing NP (20%), B (16%), F (15%), CW (11%), and MC (8%). The CoZHI framework in these respondents is shown in Equation (12) with an acceptable consistency rating of 9.5%. Figure 5 exhibits the percentage rating per indicator.

$$\begin{aligned} CoZHI = \ & NP \times 0.20 + F \times 0.15 + B \times 0.16 + MC \times 0.08 + TR \times 0.06 \\ & + CS \times 0.07 + CW \times 0.11 + CL \times 0.06 + SP \times 0.04 \\ & + CP \times 0.07 \end{aligned} \tag{12}$$

Table 22. Pairwise comparison matrix with the corresponding weights for the educators and researchers. CR = 0.095.

Indicator	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weights
Natural Products (NP)	1.00	3.00	2.00	4.00	5.00	3.00	1.00	3.00	4.00	2.00	0.20
Fisheries (F)	0.33	1.00	2.00	3.00	5.00	4.00	1.00	1.00	4.00	2.00	0.15
Biodiversity (B)	0.50	0.50	1.00	4.00	6.00	4.00	2.00	4.00	3.00	1.00	0.16
Marine Culture (MC)	0.25	0.33	0.25	1.00	3.00	2.00	1.00	2.00	2.00	1.00	0.08
Tourism & Recreation (TR)	0.20	0.20	0.17	0.33	1.00	2.00	1.00	1.00	2.00	1.00	0.06
Carbon Storage (CS)	0.33	0.25	0.25	0.50	0.50	1.00	1.00	3.00	3.00	1.00	0.07
Clean Water (CW)	1.00	1.00	0.50	1.00	1.00	1.00	1.00	4.00	4.00	1.00	0.11
Coastal Livelihood (CL)	0.33	1.00	0.25	0.50	1.00	0.33	0.25	1.00	3.00	1.00	0.06
Sense of Place (SP)	0.25	0.25	0.33	0.50	0.50	0.33	0.25	0.33	1.00	1.00	0.04
Coastal Protection (CP)	0.50	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.07
Sum	4.70	8.03	7.75	15.83	24.00	18.67	9.50	20.3	27.0	12.00	1.00

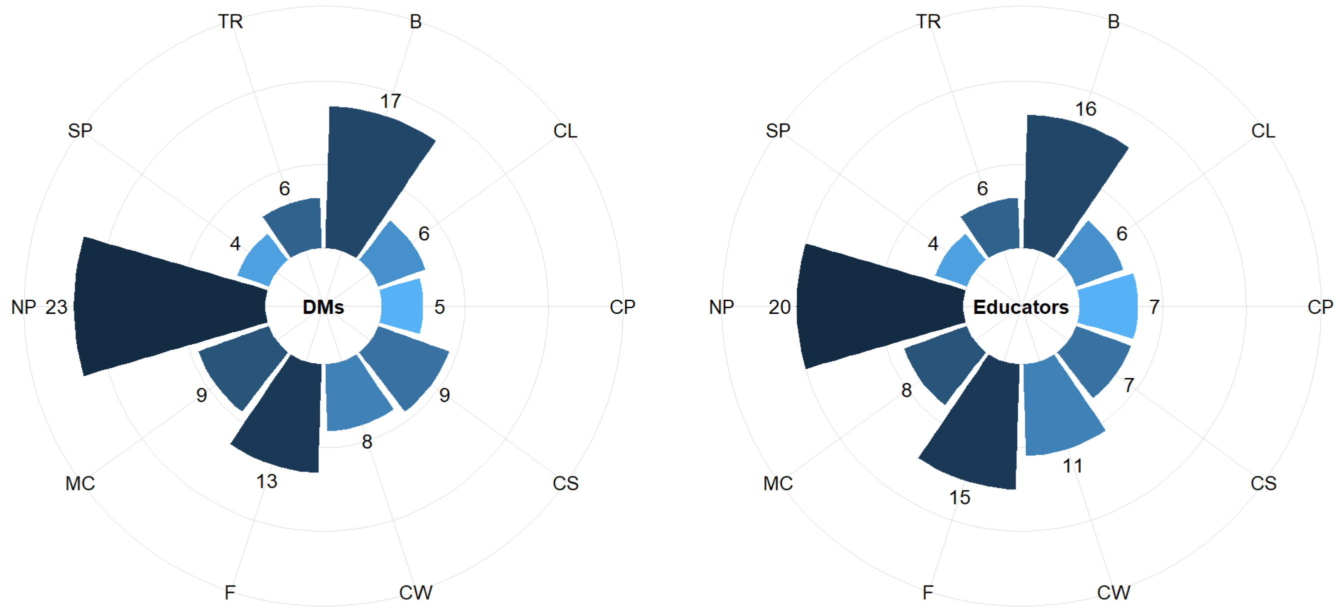

Figure 5. CoZHI-driven relative weights of indicators from (**left**) the decision-maker's perspective and (**right**) the educators and researcher's perspective. See Tables 22 and 23 for the indicators and their weights.

Table 23. Pairwise comparison matrix for the DMs. CR = 0.98.

Indicators	NP	F	B	MC	TR	CS	CW	CL	SP	CP	Weights
Natural Products (NP)	1.00	5.00	2.00	4.00	4.00	3.00	2.00	3.00	5.00	2.00	0.23
Fisheries (F)	0.20	1.00	2.00	2.00	4.00	3.00	1.00	1.00	3.00	2.00	0.13
Biodiversity (B)	0.50	0.50	1.00	3.00	7.00	3.00	2.00	4.00	3.00	3.00	0.17
Marine Culture (MC)	0.25	0.50	0.33	1.00	3.00	2.00	2.00	2.00	2.00	2.00	0.09
Tourism & Recreation (TR)	0.25	0.25	0.14	0.33	1.00	2.00	1.00	1.00	1.00	2.00	0.06
Carbon Storage (CS)	0.33	0.33	0.33	0.50	0.50	1.00	3.00	3.00	2.00	3.00	0.09
Clean Water (CW)	0.50	1.00	0.50	0.50	1.00	0.33	1.00	3.00	2.00	2.00	0.08
Coastal Livelihood (CL)	0.33	1.00	0.25	0.50	1.00	0.33	0.33	1.00	2.00	2.00	0.06
Sense of Place (SP)	0.20	0.33	0.33	0.50	1.00	0.50	0.50	0.50	1.00	1.00	0.04
Coastal Protection (CP)	0.50	0.50	0.33	0.50	0.50	0.33	0.50	0.50	1.00	1.00	0.05
Sum	4.07	10.42	7.23	12.83	23.00	15.50	13.3	19.0	22.0	20.00	1.00

3.6. The Development of the CoZHI Framework for the DMs

This section shows the CoZHI framework for educators and researchers. Table 23 shows the pairwise comparison matrix with the weights of the indicators. The researchers and educators give emphasis to NP (23%), B (17%), F (13%), MC (9%), and CS (9%). The CoZHI framework in these respondents is shown in Equation (13), with an acceptable consistency rating of 9.8%. The blue color bar in Figure 5 shows the percentage rating per indicator of the DMs.

$$\begin{aligned} CoZHI = \; & NP \times 0.23 + F \times 0.13 + B \times 0.17 + MC \times 0.09 + TR \times 0.06 \\ & + CS \times 0.09 + CW \times 0.08 + CL \times 0.06 + SP \times 0.04 \\ & + CP \times 0.05 \end{aligned} \tag{13}$$

4. Conclusions

Every human has a different perspective on understanding the development of society. Furthermore, decision makers and planners in the local government unit have a different outlook on the city development. It is either an environmentally friendly development or not. Nevertheless, the perception of one city is different from another city. Thus, harmonious and wholistic development should be considered.

In the modern era, the development plan is anchored to sustainable development where humans and nature co-exist. This MCDA-AHP approach is an attempt to recognize the perception of the individuals in designing the CoZHI framework for the sustainably coastal zone assessment plan. The CoZHI framework is an extension of the OHI and ICZM. The method of data gathering in all goals in the OHI can be utilized, and the generation of index scores will be conducted using the CoZHI framework. Aside from that, the CoZHI framework can be extended using the vulnerability assessment of CIVAT. CIVAT is a vulnerability assessment of how the external forcing affects the coastal zone environment. The vulnerability assessment will be performed in the second part of this research. Likewise, CoZHI is an iterative process, same as the ICZM framework, to assess the health and integrity of the coastal zone environment. The framework in this study is flexible and adaptive to the local government's perception of the governing bodies. Using this framework, yearly assessment to check the health of the coastal zone environment will guide the local government in their coastal management plan.

The study reveals that the development plan of the individual city is highly connected to the nature of the city in which they are currently situated. Moreover, the environmental educators and researchers are balancing the decision-makers' perceptions. They are preserving nature while the decision makers are pivoting to the extractive development of the city. It is essential that during the sustainable development planning of the city, the environmentalist should be involved to balance the plan, where the development plan is directed to preserving the environment.

The evaluation of giving importance of one indicator to another in the survey instrument is seen as the primary use of AHP. In some cases, as stated in the results section, respondents were inconsistent with their responses. Thus, it might need an actual survey to elaborate the concept of the questionnaire on how to respond to the questions to avoid confusion. Additionally, a triangulation technique to validate the answers should be performed to ensure that all responses are correct.

The study showcases the flexibility of the indices in the framework. The weight of a particular index in the framework differs from one city to another. This paper shows that each city should have a specific implementation of the coastal zone management plan due to the uniqueness of the coastal environment and the stakeholders' views. The role of the national agency (i.e., DENR) is to guide and provide resources in implementing the plan. Furthermore, in utilizing this concept, before assessing each indicator's health in a particular study area, we can ensure generating the framework by conducting a survey using the approach presented in this study. Moreover, in some cases, the framework is flexible in selecting the appropriate indicators to utilize in the respective study area. It might also happen that a particular indicator is not needed, or a new indicator can be introduced.

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Appendix A. Pairwise Comparison Matrices for All Cities, Researchers/Educators, and Decision-Makers

Table A1. Pairwise comparison matrix for Mati City.

Criteria	C	NE	E	SE
Conservationist (C)	1.00	6.00	7.00	8.00
Non-Extractive (NE)	0.17	1.00	2.00	4.00
Extractive (E)	0.14	0.50	1.00	4.00
Strongly Extractive (SE)	0.13	0.25	0.25	1.00
SUM	1.43	7.75	10.25	17.00

Table A2. Pairwise comparison matrix for Davao City.

Criteria	C	NE	E	SE
Conservationist (C)	1.00	4.00	3.00	7.00
Non-Extractive (NE)	0.25	1.00	1.00	4.00
Extractive (E)	0.33	1.00	1.00	6.00
Strongly Extractive (SE)	0.14	0.25	0.17	1.00
SUM	1.73	6.25	5.17	18.00

Table A3. Pairwise comparison matrix for Cagayan De Oro City.

Criteria	C	NE	E	SE
Conservationist (C)	1.00	2.00	2.00	3.00
Non-Extractive (NE)	0.50	1.00	0.50	3.00
Extractive (E)	0.50	2.00	1.00	5.00
Strongly Extractive (SE)	0.33	0.33	0.20	1.00
SUM	2.33	5.33	3.70	12.00

Table A4. Pairwise comparison matrix for Cebu City.

Criteria	C	NE	E	SE
Conservationist (C)	1.00	2.00	3.00	4.00
Non-Extractive (NE)	0.50	1.00	2.00	3.00
Extractive (E)	0.33	0.50	1.0	3.00
Strongly Extractive (SE)	0.25	0.33	0.33	1.00
SUM	2.08	3.83	6.33	11.00

Table A5. Pairwise comparison matrix for Puerto Princesa City.

Criteria	C	NE	E	SE
Conservationist (C)	1.00	2.00	3.00	2.00
Non-Extractive (NE)	0.50	1.00	2.00	2.00
Extractive (E)	0.33	0.50	1.00	1.00
Strongly Extractive (SE)	0.50	0.50	1.00	1.00
SUM	2.33	4.00	7.00	6.00

Table A6. Pairwise comparison matrix for Metro Manila City.

Criteria	C	NE	E	SE
Conservationist (C)	1.00	4.00	3.00	4.00
Non-Extractive (NE)	0.25	1.00	1.00	3.00
Extractive (E)	0.33	1.00	1.00	3.00
Strongly Extractive (SE)	0.25	0.33	0.33	1.00
SUM	1.83	6.33	5.33	11.00

Table A7. Pairwise comparison matrix for Laoag City.

Criteria	C	NE	E	SE
Conservationist (C)	1.00	3.00	2.00	4.00
Non-Extractive (NE)	0.33	1.00	2.00	3.00
Extractive (E)	0.50	0.50	1.00	4.00
Strongly Extractive (SE)	0.25	0.33	0.25	1.00
SUM	2.08	6.33	3.75	12.00

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