

Article

Promoting Stakeholders' Support for Marine Protection Policies: Insights from a 42-Country Dataset

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Abstract: Stakeholders' support is essential for the effective and successful implementation of policies that prioritize enhancing and preserving ocean and coastal ecosystems. However, cross-national studies examining factors influencing stakeholders' policy support are still lacking. The current study aimed to provide preliminary evidence on factors (e.g., socio-demographic factors, country income levels, and perceived impacts of marine and coastal ecosystems) that affect stakeholders' endorsement of a policy centered on preserving marine and coastal ecosystems. To conduct the study, we applied the Bayesian Mindsponge Framework (BMF) to a dataset of 709 stakeholders from 42 countries generated by MaCoBioS—a research project funded by the European Commission Horizon 2020. The BMF allowed us to adopt a distinctive and innovative approach to analyzing the data and drawing valuable policy development and implementation insights. The results show no differences in policy endorsement levels across stakeholders with different ages, education, and country income levels. However, female stakeholders tended to support the policy prioritizing ocean protection more than their male counterparts. Stakeholders perceiving the impacts of marine and coastal ecosystem preservation on human wellbeing, climate and weather, and climate change reduction also tended to support the policy more strongly. Meanwhile, the perceived impacts of ocean and coastal ecosystems on global and local economies had an ambiguous effect on stakeholders' policy support. Based on these findings, we suggest that raising the awareness and knowledge of stakeholders can help improve their support for ocean and coastal preservation policies. Moreover, it is necessary to concentrate more on communicating the adverse consequences induced by the ocean and coastal ecosystems' loss (e.g., climate change and health) and less on the economic aspects. The study underscores the significance of environmental education and awareness-raising campaigns in disseminating environmental information and cultivating an eco-surplus culture. This culture inspires stakeholders to actively participate in environmental conservation efforts, going beyond mere sustainability and aiming to create positive environmental impacts.



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1. Introduction

The world's oceans and coasts have played a crucial role in human development throughout history, providing essential services, supporting human activities, such as fishing, tourism, transportation, and recreation, and preserving ecological balance [1]. Given that millions of people depend on marine resources for their livelihoods and as a source of protein, the world's oceans also make significant contributions to global food security [2,3]. However, unsustainable exploitation of marine resources as a result of population growth has led to significant concerns about the biodiversity and health of marine ecosystems [2]. Overfishing, habitat loss, pollution, and the impacts of climate change are among the many issues that place the health of the marine environment in danger [1,4]. For example, the loss of seagrass meadows induced by local anthropogenic disturbances can lead to unstable sediment surfaces and the disappearance of the unique fluctuating chemical habitat, exacerbating the climate change impacts on coastal regions [5]. Such impacts include ocean acidification, temperature fluctuations, and sea level rise [2].

Successfully protecting and conserving marine and coastal areas requires proactive actions and policy improvements to address the range of challenges mentioned above [6–9]. As highlighted by Bennett and Dearden [9], suitable policies are essential for enhancing the management and governance of marine resources, improving ecological balance, protecting vulnerable species and ecosystems, and ensuring the long-term sustainability of marine resources.

Recently, there has been a noticeable increase in research focusing on public support for marine and coastal preservation, indicating its significance and relevance to conservation policymaking. Studies have highlighted the need to involve various stakeholders in these conservation efforts, including local communities, businesses, governments, non-governmental organizations, and scientists [10,11]. In addition, the literature widely agrees on the significance of understanding different stakeholders' attitudes, opinions, and willingness to engage in conservation initiatives while developing focused and effective policies [12].

Studies also suggest the significance of identifying the factors that influence public perception and awareness, which in turn shape their support for marine and coastal conservation. To begin with, these drivers include perceived environmental impacts, perceived benefits or costs, and the effectiveness and efficiency of management and governance policies, institutions, and procedures [4,9,13]. For example, findings from previous research conducted in one case in Siquijor, Philippines, located in the Coral Triangle, showed that the equitable distribution of benefits within the village was found to be crucial for generating support for marine protected areas (MPAs) [13]. The results from another case study, focusing on a 'tengefu' site in Kenya, highlighted the critical importance of broad community participation and equitable distribution of benefits throughout the project implementation, leading to beneficial social and ecological outcomes for establishing and managing community-based MPAs [14].

Furthermore, the effort to enhance stakeholder support for marine protection strategies is a multifaceted undertaking that encompasses the examination of educational, cultural, and social dimensions [15–17]. Public awareness and education campaigns, which have received an extensive amount of scholarly attention, are essential aspects of this effort [18,19]. Notably, these studies particularly draw attention to the potential for synergy in enhancing stakeholder support for environmental education, climate change mitigation, and marine preservation policy, thereby strengthening the potential for a more robust and sustainable approach to conservation [20,21]. Similarly, recent scholarly investigations have shown an intricate relationship between social and cultural factors and the perspectives held by stakeholders. For example, when a community's interactions with maritime ecosystems are intertwined with well-established cultural practices and traditions, they foster a strong sense of stewardship [22,23]. This complex interrelationship highlights the considerable impact that such cultural factors can influence the fundamental support for marine conservation efforts [24].

In addition, the legitimacy and credibility of policies depended on public support, leading to greater compliance and collaboration among stakeholders [14]. For example, in their research, McNeill, Clifton, and Harvey [7] argued that stakeholder support is necessary to ensure voluntary compliance and obtain a ‘social license to operate’ for MPA projects. Another example is the case of the West MPA (WMPA) in Indonesia. The WMPA, which demonstrated exceptional performance, succeeded by employing strategic planning to enable resource utilization and generate sufficient benefits for fishermen and tourism operators. Such a comprehensive approach not only built trust in the local leadership but also enforced regulations effectively and ensured better compliance with regulations for successful MPA management [4]. Effective policy implementation can enable local community members to contribute their knowledge and expertise to promote innovative sustainable resource management [25,26]. In turn, when local people actively support and participate in the initiatives, it can facilitate knowledge exchange, foster creativity, and enable the discovery of workable solutions to diverse challenges [27].

Although there has been an increase in research on stakeholders’ support for marine protection policies, several major research gaps require attention. The impact of contextual factors on public support for marine and coastal conservation varies significantly across nations [7,28]. The contextual variation encompasses a wide range of social, cultural, political, economic, and historical factors [13,14]. As scientific insights that can be generalized to countries with different contexts can help the policies be implemented more effectively and reduce the cost of doing science, a cross-national study is required to capture the general pattern across countries with different contextual factors [29]. Even if the general pattern cannot be found, the cross-national research endeavor can help detect the contextual factors that might have varying impacts across countries, guiding the directions for subsequent comparative studies.

Moreover, while various studies have examined stakeholders’ or community residents’ perceptions of climate, weather, and climate change [20–24], how they affect stakeholders’ support for ocean preservation policy remains limited. In the context of climate change and ocean management, involving stakeholders in decision-making processes is essential. Engaging local communities, businesses, governments, NGOs, and scientists in this process allows for a comprehensive understanding of diverse perspectives and needs [30]. Consequently, comprehensive research is necessary to understand the factors influencing stakeholders’ support for marine protection policies. By understanding these factors, policymakers and decision-makers can develop more effective and targeted strategies that resonate with different stakeholder groups, thereby increasing their support and fostering a stronger sense of connection and responsibility toward marine preservation. This strategy could reduce the resources needed compared to alternative strategies, such as strong regulatory enforcement [13].

Applying the mindsponge mechanism, a theoretical framework that describes how people perceive and process information [31,32], This research seeks to fill these gaps and contribute novel insights to marine protection policies. This study aims to provide preliminary evidence of factors contributing to stakeholders’ support for marine and coastal preservation across 42 countries. In general, understanding the factors influencing stakeholders’ support for policies centered on marine and coastal preservation is a central objective of this research. Thus, we aim to address the following research questions:

RQ1. What are the impacts of socio-demographic factors on stakeholders’ support for a policy centered on marine and coastal preservation?

RQ2. How does the national economic background impact stakeholders’ support for a policy focused on marine and coastal preservation?

RQ3. What are the perceived impacts of oceans on stakeholders’ support for a policy focused on marine and coastal preservation?

The paper follows a structured approach, starting with an introduction outlining the importance of the research issue in protecting ocean and coastal ecosystems and the research questions. Details of the Bayesian Mindsponge Framework (BMF) analytics, statistical

models, and dataset of 709 stakeholders in 42 countries are described in Section 2. Then, results and a discussion of their theoretical and practical implications are presented in Sections 3 and 4, respectively. Section 5 outlines the key findings and acknowledges any potential research limitations.

2. Methodology

2.1. Theoretical Foundation and Assumption

The current study employed the Mindsponge Theory to provide a theoretical foundation for the third research question. It should be noted that the first and second research objectives are to find the socio-demographic factors that can consistently affect stakeholders' support for ocean protection policy across countries. Meanwhile, the third research objective is explorative.

Mindsponge Theory is a psychological and social theory of minds developed from the mindsponge mechanism and induced by the most recent findings from the brain and life sciences [31,33]. The theory is based on the approach of information processing to studying human minds. The approach considers information as the foundation upon which physical reality is built, enabling the investigation of complex phenomena that need multidisciplinary knowledge [34]. Various studies have used the theory as the theoretical underpinning for investigating sociopsychological phenomena, including environmental and conservation psychology [35–41].

The Mindsponge Theory (MT) was chosen as the theoretical framework for this research because it can capture the interconnected components of our complicated topic, which entails comprehending the factors influencing stakeholders' support for marine preservation policies. The MT provides a dynamic viewpoint on information processing, complementing the current psychological and social theories and frameworks, clarifying concepts, resolving contradictions, and establishing connections at the level of human cognition that underlies them. In the context of this research, the Mindsponge Theory's capability makes it a useful tool for generating insights into the underlying motivations behind stakeholders' support for marine protection policies.

Specifically, the theory views the mind and the environment as two main spectrums. The mind is referred to as an information collection-cum-processor, while the environment is conceptually a wider information-processing system (e.g., the Earth system, the social system, etc.) that includes the human mind. The main goal of the mind is to prolong the existence of the system in one way or another, such as through survival, growth, and reproduction. The mind is represented by the mindset, the buffer zone (or comfort zone), and the multi-filtering system. While a mindset is defined as a collection of highly trusted information or core values in a human mind, the buffer zone is a conceptual area where information is temporarily kept before being reviewed by the multi-filtering system.

Information integration and differentiation are the two main functions of the multi-filtering system [42]. When environmental information is absorbed by the sensory systems and enters the mind, it is processed in two different ways. The absorbed information is synthesized and integrated if it is consistent with the mindset's core values (or highly trusted information). However, suppose that the new information significantly differs from the existing core values. In that case, it undergoes evaluation through differentiation, where the cost and benefit of accepting or rejecting the emerging information (or replacing existing information with the new one) are assessed. In general, in case the new information is perceived as potentially beneficial, it will be accepted to enter the mindset and influence subsequent thinking, filtering processes, and behaviors; in case it is perceived to be costly, the information will be rejected; in case the perceived costs and benefits are not clear, it will be stored in the buffer zone for later evaluation when the information required for assessment is sufficient [32].

Based on this reasoning, we assume that if the stakeholders perceive the importance of the ocean and coastal ecosystems, their information-processing mechanism will prioritize seeking, absorbing, and integrating information that can preserve the values of the ocean

and coastal ecosystems to maximize the stakeholders' perceived benefits or minimize the perceived costs [27,31]. One of the alternatives is supporting policies that focus on enhancing and preserving ocean and coastal ecosystems. Thus, to test our assumptions, we examined how the stakeholders' perceived impacts of ocean and coastal ecosystems on human wellbeing, climate and weather, climate change reduction, and global and local economies might influence their support for an ocean-focused policy. Perceived impacts of ocean and coastal ecosystems on human wellbeing, climate and weather, climate change reduction, and global and local economies were chosen according to data availability. It should be noted that previous studies have employed similar information-processing reasoning to explain and validate the impacts of subjective cost-benefit evaluation on humans' perceptions and attitudes, such as attitudes towards biodiversity conservation and support for a biodiversity loss countermeasure [43].

2.2. Model Construction

2.2.1. Variable Selection and Rationale

The dataset employed in the current study was generated by the MaCoBioS (Marine Coastal Ecosystems Biodiversity and Services in a Changing World) project, which received funding from the European Commission H2020. Data were collected through an online self-administered survey accessible on the Qualtrics internet platform from 16 November 2021 to 16 February 2022. The questionnaire was available in English, French, Spanish, and Italian and deposited in Mendeley Data in four languages as "Survey_EN.pdf," "Survey_FR.pdf," "Survey_SP.pdf," and "Survey_IT.pdf." The survey interface was tailored to the device used. The final dataset has 709 respondents in total and is available in Mendeley Data as "Survey_Fonsecaetal_07122022.xlsx" [44].

The survey was designed for stakeholders with an interest in marine and coastal ecosystems, climate change, and ecosystem management. The questionnaire included questions about climate change attitudes, responses, socio-demographic information, and the importance of and threats to coasts, oceans, and animals. It was initially tested on a sample of 20 respondents. Respondents were given a participant information form and asked to grant informed permission before proceeding. Most questions required a response, while demographic questions offered the option of "prefer not to answer." Participation was optional, and respondents were permitted to exit the survey and return later to complete it. The data were anonymized, ensuring that respondents' IP addresses, location data, or contact information were not recorded. Respondents were given the opportunity to submit additional comments and contact information, which have been omitted from the dataset to protect respondents' confidentiality.

Purposive snowball sampling was used to recruit participants, which can be useful for reaching out to hard-to-reach populations [45]. The sampling method allows the survey collectors to reach specific coastal and marine stakeholders' populations. Specifically, the poll was promoted on MaCoBioS's social media sites (i.e., Twitter and Instagram). Moreover, the survey collectors also contacted and asked 105 stakeholder groups representing conservation, tourism/recreation, and fishing/seafood interests in multiple countries (i.e., UK, Norway, Ireland, France, Italy, Spain, Bonaire, Martinique, and Barbados) to disseminate the survey through their members' and referrals. Moreover, as the project aimed to conduct a cross-national survey of the coast and marine stakeholders' perceptions of climate change, human impacts, and the value and management of marine and coastal ecosystems, it was not feasible to conduct other types of sampling (e.g., stratified or random sampling) due to the tremendous incurred costs [46]. However, the sample cannot be assumed to be representative of the wider population. The survey was designed for individuals aged 18 or older.

In the current study, we employed nine variables to construct the model (one outcome and eight predictor variables). The outcome variable is *SupportforPolicyFocus*, representing the respondents' support for marine and coastal ecosystem enhancement and preservation to be centered on policies addressing climate change, nature conservation, and sustainable

development. Three predictor variables demonstrating respondents' socio-demographic factors were included to address the first research objective: *Age*, *Gender*, and *Education*. For the second research objective, we included the variable *CountryIncomeLevel* into the model to examine whether stakeholders from countries with distinct income levels also had different perceptions. We based our calculations on the United Nations classifications of countries by income level to generate the variable with four levels [47]: 'low-income country,' 'lower-middle-income country,' 'upper-middle-income country,' and 'high-income country.' *Impacts_HumanWellbeing*, *Impacts_WeatherandClimate*, *Impacts_ClimatechangeReduction*, and *Impacts_GlobalandLocalEconomies* variables were also included to fulfill the third research objective. They reflect the degree to which stakeholders thought marine and coastal ecosystems would majorly influence human wellbeing, weather and climate, climate change reduction, and global and local economies, respectively. Detailed descriptions of these variables are shown in Table 1.

Table 1. Description of variables.

Variable	Description	Type of Variable	Value
Age	The stakeholder's age	Numerical	1: <18 years old 2: 18–30 years old 3: 31–40 years old 4: 41–50 years old 5: 51–60 years old 6: >60 years old
Gender	The stakeholder's gender	Categorical	0: Female 1: Male
Education	The stakeholder's educational level	Numerical	1: Did not attend school 2: High/secondary school, or equivalent 3: Bachelor's degree (e.g., BA, BSc) 4: Master's degree (e.g., MA, MSc, MRes, MEd) 5: Doctorate (e.g., PhD)
Income	The stakeholder's country income level (based on the United States classification)	Categorical	1: Low income 2: Low to middle income 3: Upper middle income 4: High income
<i>Impacts_HumanWellbeing</i>	The degree to which the stakeholder thinks the health of marine and coastal ecosystems is critical for human wellbeing	Numerical	1: Strongly disagree 2: Disagree 3: Neither agree nor disagree 4: Agree 5: Strongly agree
<i>Impacts_WeatherandClimate</i>	The degree to which the stakeholder thinks marine and coastal ecosystems have a major influence on weather and climate	Numerical	1: Strongly disagree 2: Disagree 3: Neither agree nor disagree 4: Agree 5: Strongly agree
<i>Impacts_ClimatechangeReduction</i>	The degree to which the stakeholder thinks marine and coastal ecosystems are essential for reducing or slowing climate change	Numerical	1: Strongly disagree 2: Disagree 3: Neither agree nor disagree 4: Agree 5: Strongly agree
<i>Impacts_GlobalandLocalEconomies</i>	The degree to which the stakeholder thinks marine and coastal ecosystems are essential for supporting global and local economies	Numerical	1: Strongly disagree 2: Disagree 3: Neither agree nor disagree 4: Agree 5: Strongly agree
<i>SupportforPolicyFocus</i>	The degree to which the stakeholder thinks enhancing and preserving marine and coastal ecosystems should be a key focus of policies that address climate change, nature conservation, and sustainable development	Numerical	1: Strongly disagree 2: Disagree 3: Neither agree nor disagree 4: Agree 5: Strongly agree

2.2.2. Statistical Models

The following model was constructed to fulfill all three research objectives [48]:

$$\text{Support for Policy Focus} \sim \text{normal}(\mu, \sigma) \quad (1)$$

$$\begin{aligned} \mu_i = & \alpha_{\text{CountryIncomeLevel}[i]} + \beta_1 * \text{Age}_i + \beta_2 * \text{Gender}_i + \beta_3 * \text{Education}_i + \beta_4 * \\ & \text{Impacts_HumanWellbeing}_i + \beta_5 * \text{Impacts_WeatherandClimate}_i + \beta_6 * \\ & \text{Impacts_ClimatechangeReduction}_i + \beta_7 * \\ & \text{Impacts_GlobalandLocalEconomies}_i \end{aligned} \quad (2)$$

$$\alpha \sim \text{normal}(M_\alpha, S_\alpha) \quad (3)$$

$$\beta \sim \text{normal}(M_\beta, S_\beta) \quad (4)$$

The probability around the mean μ is determined by the shape of the normal distribution, where the width of the distribution is specified by the standard deviation σ . μ_i indicates the stakeholder i 's support for a policy focused on marine and coastal ecosystems enhancement and preservation; $\text{CountryIncomeLevel}[i]$ indicates the country's income level of stakeholder i ; Age_i indicates the age of stakeholder i ; Gender_i indicates the gender of stakeholder i ; Education_i indicates the education level of stakeholder i ; $\text{Impacts_HumanWellbeing}_i$ indicates the degree that stakeholder i thought marine and coastal ecosystems have a major influence on human wellbeing; $\text{Impacts_WeatherandClimate}_i$ indicates the degree that stakeholder i thought marine and coastal ecosystems have a major influence on weather and climate; $\text{Impacts_ClimatechangeReduction}_i$ indicates the degree that stakeholder i thought marine and coastal ecosystems have a major influence on climate change reduction; and $\text{Impacts_GlobalandLocalEconomies}_i$ indicates the degree that stakeholder i thought marine and coastal ecosystems have a major influence on global and local economies.

Model 1 has 13 parameters: the coefficients (β_1 – β_7), the intercepts of stakeholders' country income levels ($\alpha_{\text{CountryIncomeLevel}[\text{Low income}]}$, $\alpha_{\text{CountryIncomeLevel}[\text{Lower-middle income}]}$, $\alpha_{\text{CountryIncomeLevel}[\text{Upper-middle income}]}$, $\alpha_{\text{CountryIncomeLevel}[\text{High income}]}$, and α), and the standard deviation of the "noise", σ . The parameters of the intercepts of the stakeholders' country income levels are distributed as a normal distribution around the mean, denoted M_α , and with the standard deviation, denoted S_α ; the coefficients are distributed as a normal distribution around the mean, denoted M_β , and with the standard deviation, denoted S_β . The logical network of Model 1 is shown in Figure 1.

2.3. Analysis and Validation

The Bayesian Mindsponge Framework (BMF) is a novel analytical approach applied in cognitive and psychological research that combines the strengths of the Mindsponge theory in reasoning with the inference advantages of Bayesian analysis. The Mindsponge Theory is focused on the fundamental aspects of human psychology and behavior, using information-processing principles to elucidate and integrate concepts across different psychological and social frameworks. BMF has been particularly useful in investigating psychological processes and mechanisms in fields including mental health, psychological adaptation, and environmental psychology [32].

There are several advantages to employing BMF analytics in the current study. First, the Bayesian approach probabilistically considers all properties, including unknown parameters, enabling accurate prediction using parsimonious models [49,50]. Second, the Markov chain Monte Carlo technique allows for fitting complex models, such as polynomial, non-linear, and hierarchical regression structures [51]. Here, we employed hierarchical Bayesian regression (or Bayesian multilevel modeling) with *CountryIncomeLevel* being the varying intercepts for several reasons. Multilevel modeling helps improve the estimate of a dataset with unbalanced samples; few respondents are from low-income countries (5 observations,

accounting for approximately 1%) and lower-middle-income countries (14 observations, accounting for approximately 2%) [52]. Multilevel modeling also explicitly provides estimates of variation among groups. Thus, this method is highly suitable for survey data, which are often non-random and limited [53]. Third, compared to the frequentist approach, Bayesian inference offers several advantages, such as the use of credible intervals and the highest probability of parameters instead of the dichotomous decision-making of accepting or rejecting a hypothesis based on p -values [54].

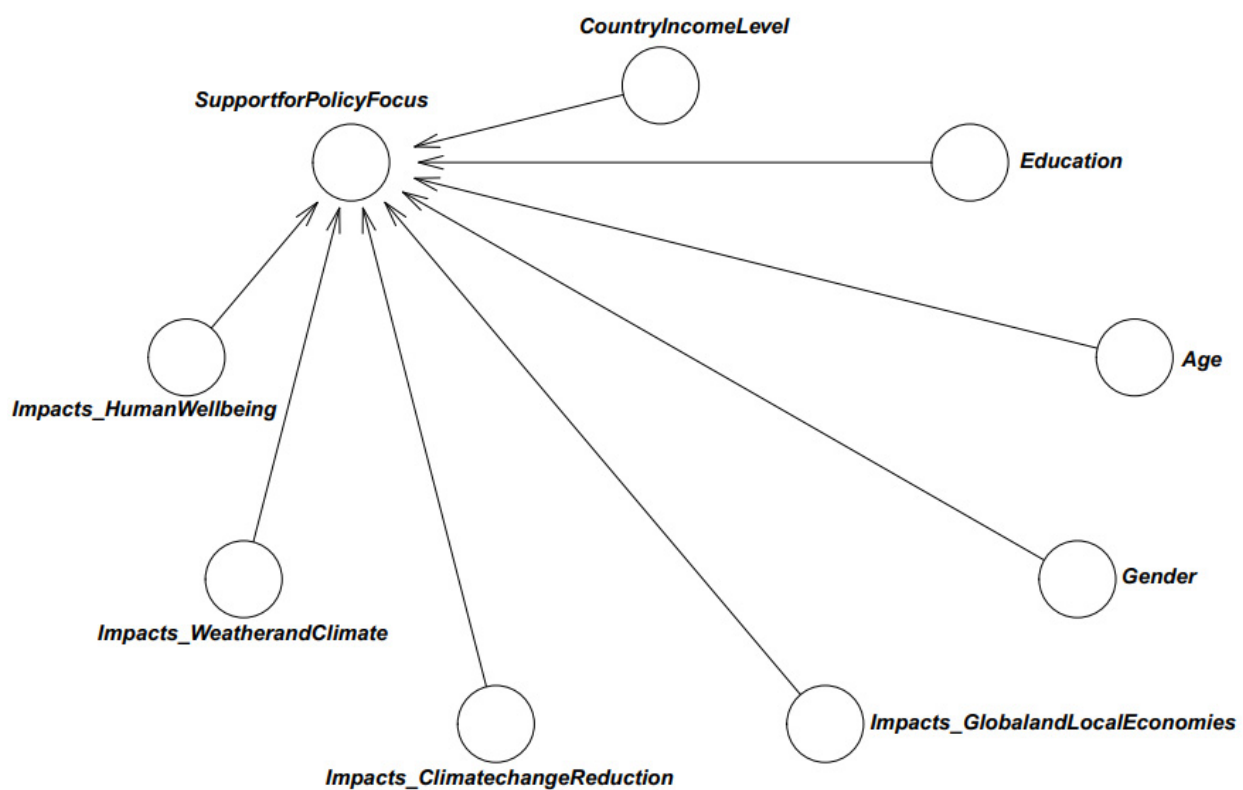


Figure 1. Logical network of Model 1.

Compared to SmartPLS and other psychology-oriented analyses, typically used for narrower contexts and psychology-oriented scenarios [55], the study's broad scope and varied objectives made BMF a better fit for handling complex models with a wide range of variables.

To account for the exploratory nature of this study, models were constructed with uninformative priors or a flat prior distribution, providing minimal prior information for model estimations [56]. As detailed below and in the previous literature, Pareto-smoothed importance sampling leave-one-out (PSIS-LOO) diagnostics were used to test the models' goodness-of-fit with the data. [57,58]:

$$LOO = -2LPPD_{loo} = -2 \sum_{i=1}^n \log \int p(y_i|\theta) p_{post(-i)}(\theta) d\theta$$

The posterior distribution, denoted as $p_{post(-i)}(\theta)$, is calculated through the data minus data point i . The PSIS method was employed to compute leave-one-out cross-validation k -Pareto values (using the R **loo** package). Observations with k -Pareto values greater than 0.7 are normally regarded as influential for checking the model's goodness-of-fit. It is typically regarded as being fit when a model's k values are less than 0.5.

The R **loo** package employs the PSIS technique to conduct leave-one-out cross-validation, incorporating k -Pareto values to identify influential observations. Accurately computing leave-one-out cross-validation can be challenging for observations with k -Pareto values

exceeding 0.7, which are generally considered significant. A widely accepted criterion for assessing model goodness-of-fit is k values below 0.5.

Before interpreting the posterior distributions of the model's coefficients, checking whether the Markov chains are convergent is mandatory. The Markov chain central limit theorem holds if convergent, and the estimated results become reliable and qualified for interpretation. Statistical values, such as the effective sample size (n_{eff}) and Gelman–Rubin shrink factor ($Rhat$), can be utilized to check the convergence of Markov chains. The n_{eff} value represents the number of iterative samples that are not autocorrelated during stochastic simulation. A value of n_{eff} greater than 1000 is generally considered sufficient for inference and convergence [52]. The $Rhat$ value, alternatively referred to as the potential scale reduction factor, should not exceed 1.1 for convergence to be achieved. If $Rhat$ equals 1, the model can be considered convergent [59]. In addition, graphical tools, including trace plots, Gelman–Rubin–Brooks plots, and autocorrelation plots, can aid in this determination.

The **bayesvl** R package and the **ggplot2** package were utilized to perform Bayesian analysis and generate eye-catching graphics [60]. The entire code and dataset utilized for this analysis are deposited with the Open Science Framework for transparency, future reproducibility, and scientific cost reduction (see the Data Availability Statement) [46].

3. Results

Model fitting was performed on R version 4.2.0 (“Vigorous Calisthenics”) using four Markov chains, each consisting of 7000 iterations, with 3000 used for the warmup period. The simulation took 322.5 s to be completed. The simulated results are displayed in Table 2.

Table 2. Estimated results.

Parameters	Mean	Standard Deviation	n_{eff}	$Rhat$
<i>Impacts_HumanWellbeing</i>	0.16	0.04	11,286	1
<i>Impacts_WeatherandClimate</i>	0.14	0.04	11,385	1
<i>Impacts_ClimatechangeReduction</i>	0.21	0.04	11,741	1
<i>Impacts_GlobalandLocalEconomies</i>	0.01	0.04	12,752	1
<i>Gender</i>	−0.08	0.05	12,412	1
<i>Age</i>	0.01	0.02	11,954	1
<i>Education</i>	−0.01	0.03	11,125	1
<i>CountryIncomeLevel[Low income]</i>	2.20	0.30	12,523	1
<i>CountryIncomeLevel[Lower-middle income]</i>	2.17	0.29	12,742	1
<i>CountryIncomeLevel[Upper-middle income]</i>	2.04	0.29	8545	1
<i>CountryIncomeLevel[High income]</i>	2.16	0.27	11,052	1
<i>Constant</i>	2.14	0.31	5635	1

First, we check the goodness-of-fit between the constructed model and the dataset using the PSIS-LOO test. The test's k -values are shown in Figure 2, which shows that most of the k -values are below 0.5, while only two k -values (0.3% of total k -values) are within the 0.5–0.7 range. These k -estimates suggest that the model fits the data reasonably well.

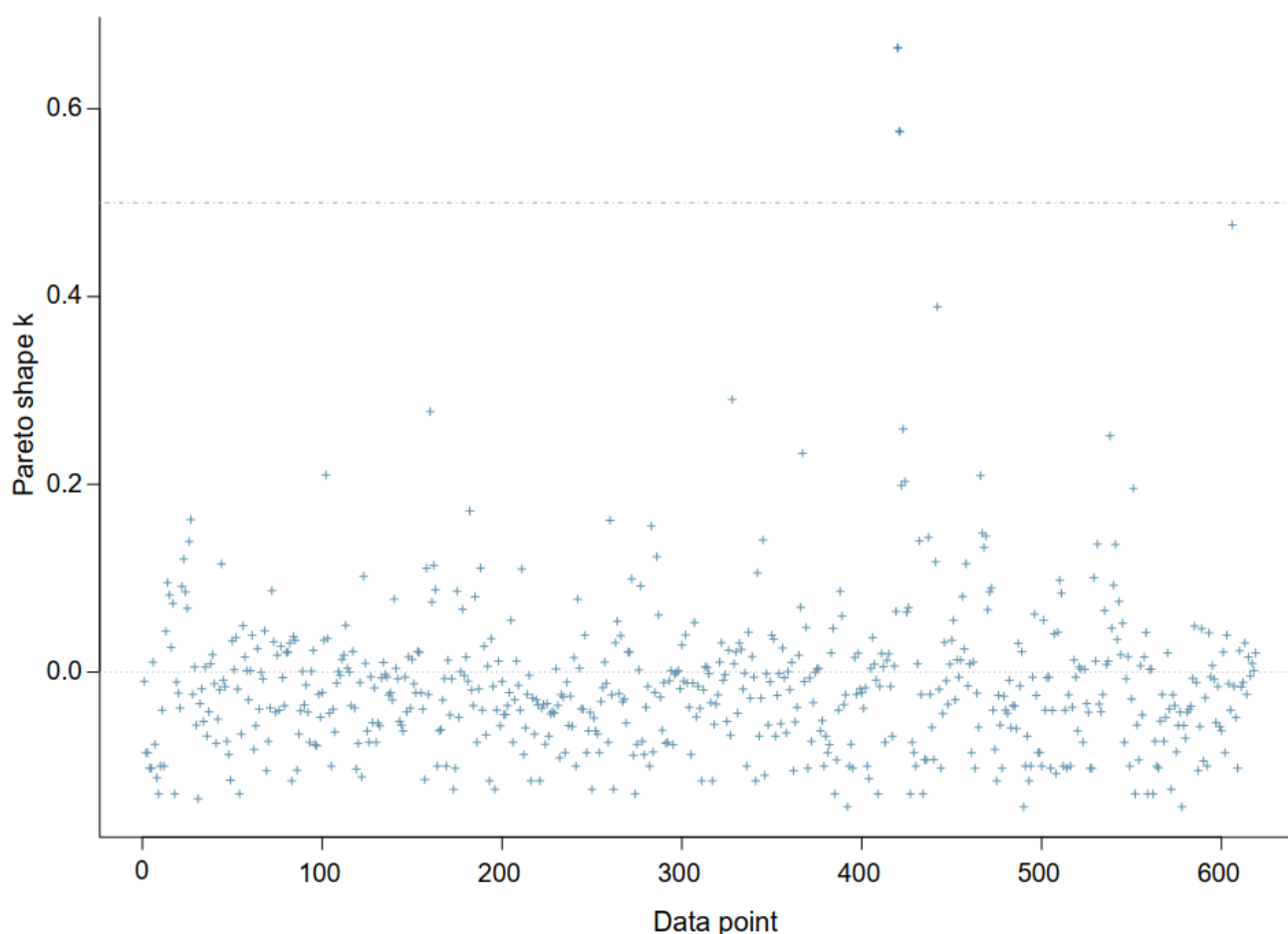


Figure 2. Model 1's PSIS plot.

Then, we proceed with diagnosing the Markov chain convergence. All the coefficients' n_{eff} values are greater than 1000, and the $Rhat$ values are equal to 1, implying that the model's Markov chains have converged well.

We also visualized the trace, Gelman–Rubin–Brooks, and autocorrelation plots to confirm the Markov chain's convergence (or the Markov chain central limit theorem). Figure 3 illustrates the healthy mixing of all coefficients' Markov chains around an equilibrium, which is a good signal of convergence.

In Figure A1, the shrink factors in all Gelman–Rubin–Brooks plots show a rapid decline to 1 within the warmup period (prior to the 3000th iteration). Meanwhile, in Figure A2, the autocorrelation levels of all coefficients' iterations also decline to 0 quickly after a certain number of lags. Both outcomes hint at the good convergence of Markov chains. Therefore, the simulated results are qualified for interpretation.

The simulated results manifest the positive associations between *Impacts_HumanWellbeing*, *Impacts_WeatherandClimate*, *Impacts_ClimatechangeReduction*, and *SupportforPolicyFocus*. Meanwhile, *Impacts_GlobalandLocalEconomies* has an ambiguous effect on *SupportforPolicyFocus* ($M_{Impacts_GlobalandLocalEconomies} = 0.01$ and $S_{Impacts_GlobalandLocalEconomies} = 0.04$). Regarding the socio-demographic factors, only gender is found to affect stakeholders' support for the policy centered on marine and coastal ecosystem enhancement and preservation ($M_{Gender} = -0.08$ and $S_{Gender} = 0.05$). Specifically, female stakeholders tended to obtain higher support than their male counterparts. The effects of age and education on policy support are ambiguous ($M_{Age} = 0.01$ and $S_{Age} = 0.02$; $M_{Education} = -0.01$ and $S_{Education} = 0.03$). The effects of *Impacts_HumanWellbeing*, *Impacts_WeatherandClimate*, *Impacts_ClimatechangeReduction*, and *Gender* are reliable as their posterior distributions are located entirely on the positive and negative sides of the x-axis (see Figure 4).

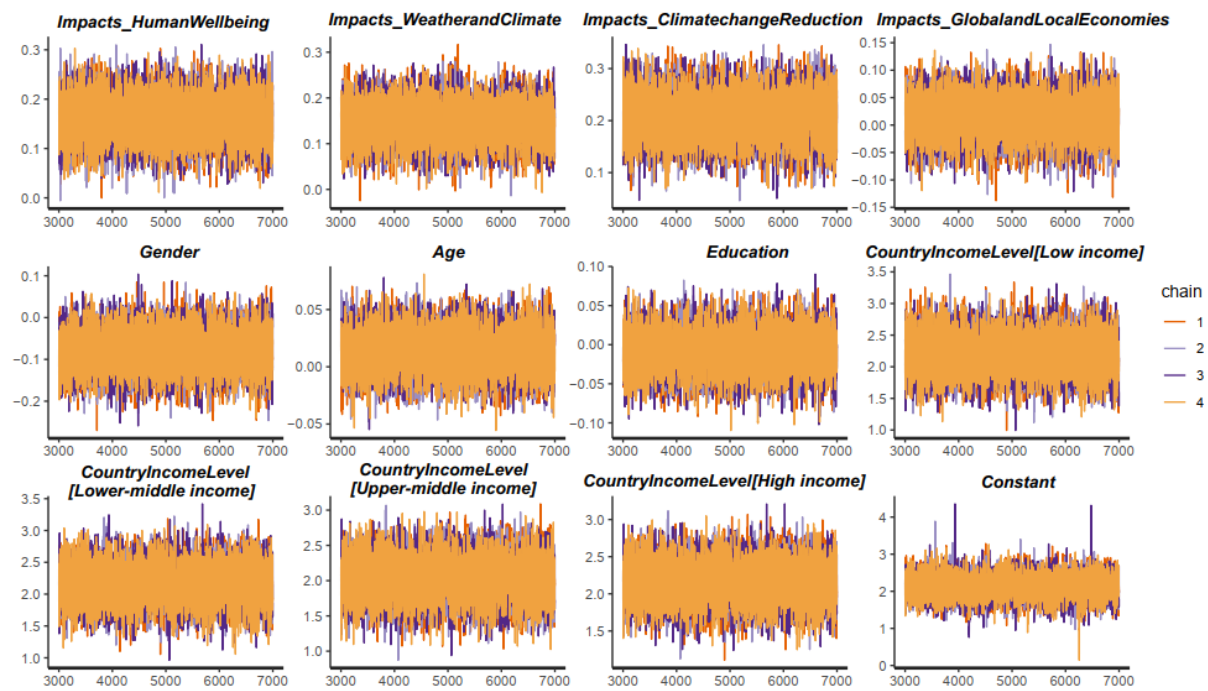


Figure 3. Model 1's trace plots.

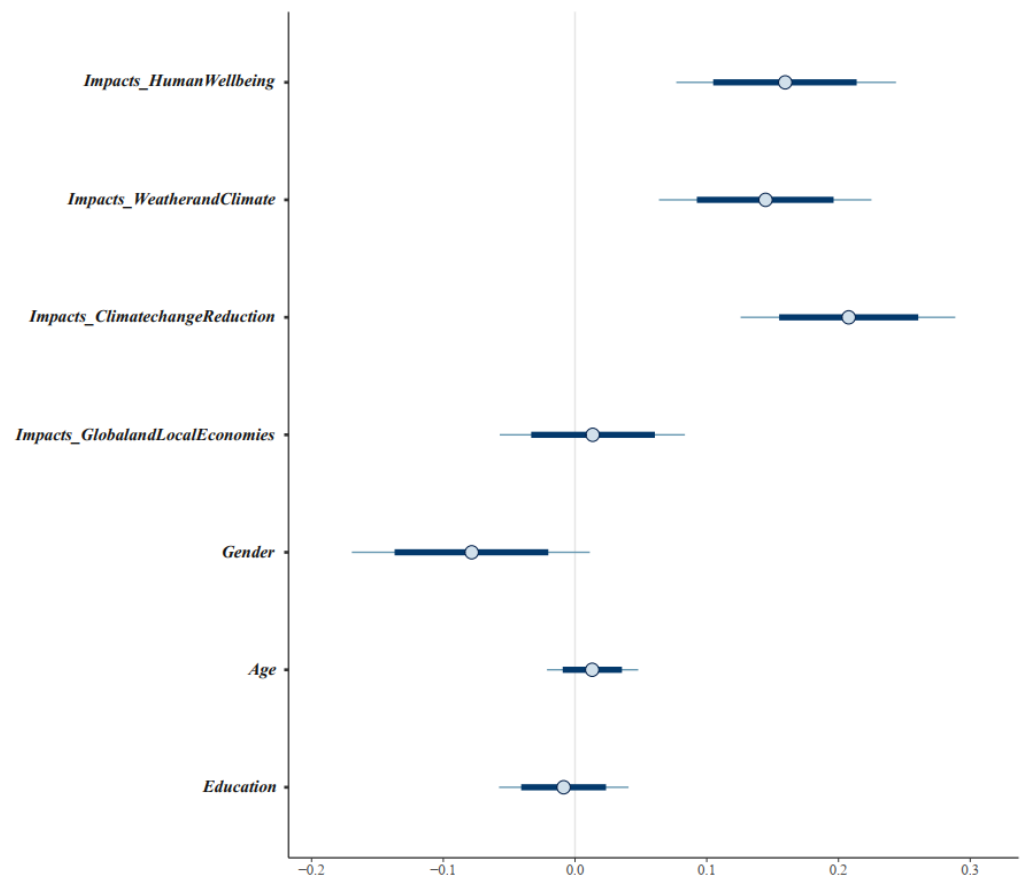


Figure 4. Posterior distributions of Model 1's coefficients.

The varying intercepts also suggest that stakeholders with different income levels in different countries did not significantly differ in their support for the policy. The

posterior distributions of varying intercepts also illustrate no distinction among groups of stakeholders (see Figure 5).

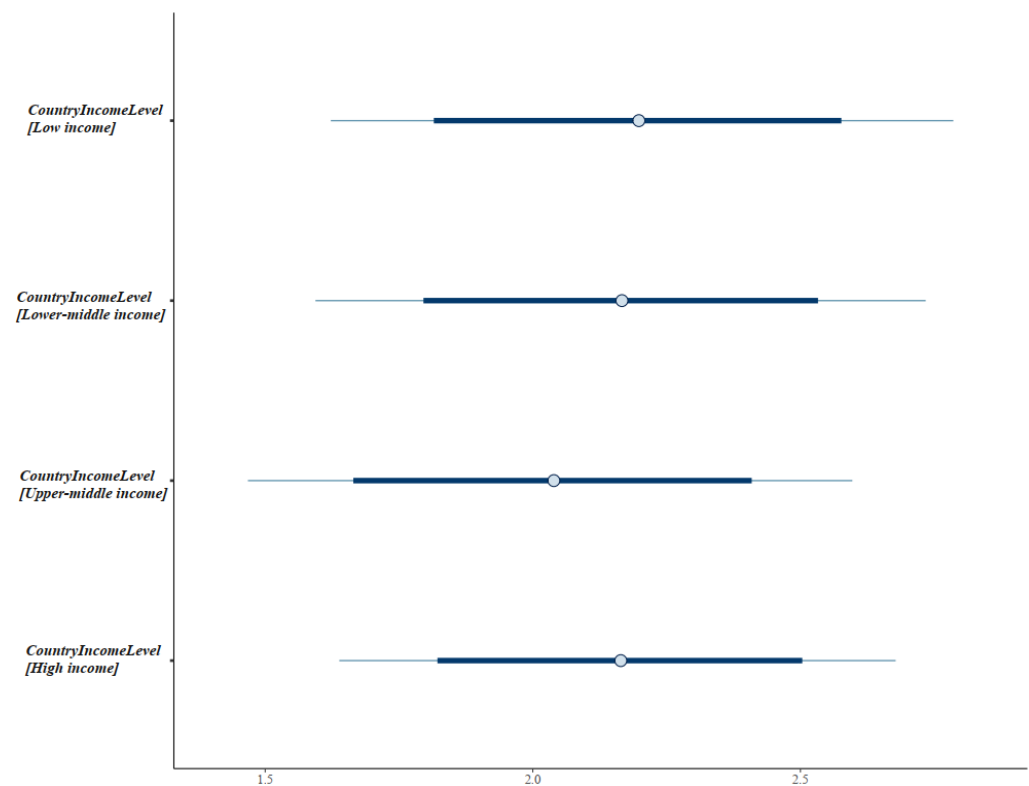


Figure 5. Posterior distributions of Model 1's intercepts.

4. Discussion

Based on the statistical analysis above, the study found no different level of policy support among stakeholders with different socio-demographic characteristics or from countries with different income levels, except for gender. In particular, female stakeholders across countries tended to support marine and coastal preservation policies more than their male counterparts. The factors underlying this gender disparity in the endorsement of ocean protection are likely complex. They may encompass differences in environmental attitudes, perceptions of the natural environment, or cultural and societal influences.

This result is aligned with the study of Xiao and McCright [61], which found that women slightly expressed higher levels of concern about health-related environmental problems compared to men, even while accounting for key social role variables. Xiao and McCright [61] contended that the higher concern level of females than males is attributed to risk perception, which largely mediates the effect of gender on environmental concern. The finding of gendered differences in support for ocean preservation policies can help inform policymakers in designing management policies and choosing appropriate targets for public communication campaigns and programs. Policymakers could consider a gender-specific approach to policy development to ensure inclusivity and address gender discrepancies in policy support. This strategy will result in more balanced and equitable conservation strategies that resonate with all stakeholders, regardless of gender [62].

The study's findings partially confirm our assumption that stakeholders will prioritize seeking, absorbing, and integrating information that can preserve the values of the ocean and coastal ecosystems to maximize their perceived benefits or minimize their perceived costs if they acknowledge the importance of the ocean and coastal ecosystems. Particularly, we found that stakeholders who perceived the impacts of marine and coastal ecosystem preservation on human wellbeing, climate and weather, and climate change reduction tended to support the policy more strongly. Nevertheless, the perceived impact of marine

and coastal ecosystems on global and local economies has an ambiguous effect on the stakeholders' policy support.

These results can be explained through the information-processing lens of Mindsponge Theory. According to the theory, humans are likely to maximize their perceived benefits and minimize their perceived costs to prolong their existence (i.e., survival, growth, and reproduction) [31]. The perceived benefits and costs are based on the information in their mindset. Wellbeing is one of the fundamental goals humans aim to achieve, so when stakeholders perceive marine and coastal ecosystems as critical to human wellbeing, they are likely to support policies promoting the preservation of marine and coastal ecosystems.

Climate and weather can affect multifaceted aspects of human society on a large scale. The consequences of climate change (i.e., natural disasters and extreme climate and weather) can cause substantial damage to the whole human society, but not only to those that have direct involvement with the marine and coastal environment environmentally, socially, culturally, and economically [63,64]. Thus, people who understand the importance of marine and coastal ecosystems in reducing climate change and affecting the climate and weather (e.g., carbon sequestration and moderating extreme events) tend to support policies centered on marine and coastal ecosystem preservation [65,66]. It should be noted that the samples in this study are mostly stakeholders that have direct or indirect connections with marine and coastal ecosystems (i.e., people from conservation, recreation, and fishing/seafood sectors), so they might be aware of climate change's consequences. However, people who do not believe in climate change (i.e., climate change denialists) or understand climate change impacts [67,68] might not weigh climate change reduction important, and their policy support tendency might not be affected by perceiving the impacts of marine and coastal ecosystem preservation. Thus, studying factors contributing to climate change denialists' policy support can be a potential research direction.

Unlike other perceptions, the perceived impacts of marine and coastal ecosystems preservation on global and local economies have an ambiguous effect on policy endorsement. It might be because of the divergent livelihoods of stakeholders [7,69,70]. For example, preserving marine and coastal ecosystems requires establishing marine protected areas, which can cause collateral negative impacts on the livelihoods of some stakeholders (i.e., commercial fishing) [71]. Thus, based on the Mindsponge Theory's principle of perceived benefit maximization, it is plausible that when the benefits are unclear, perceived impacts of marine and coastal ecosystem preservation on global and local economies have ambiguous effects on stakeholders' policy support. To clarify this ambiguity, future studies should examine how economic factors associated with marine and coastal ecosystem preservation might influence their policy support.

Our findings suggest that policymakers can promote stakeholders' support for ocean and coastal preservation policies by raising their awareness and knowledge of the stakeholders. Specifically, the accessibility of stakeholders to information regarding climate change, ocean and coastal ecosystems, and the essential roles of the ocean and coast should be improved [72]. Educational campaigns, public outreach programs, and even pro-environmental entertaining platforms are possible means to increase the touchpoints toward the information, improve information dissemination (or knowledge diffusion) efficiency, and influence stakeholders' subjective environmental paradigms [4,6,13,73–76].

Also, the information content should emphasize the importance of ocean and coastal ecosystems to stimulate the absorption of information endorsing policies centered on preserving ocean and coastal ecosystems. In particular, the ocean and coastal ecosystems' roles in regulating the climate and weather, reducing climate change, and improving human wellbeing should be addressed rather than the economic-relevant content. If the stakeholders absorb and integrate sufficient information regarding the importance of environmental conservation into their mindset, they will gradually develop an eco-surplus culture [77]. Such culture will subsequently influence stakeholders' thinking, decision-making, and behaviors to create more positive values "to reduce negative anthropogenic impacts on the environment and conserve and restore nature" [43]. This cultural change

will greatly aid the protection and restoration of marine and coastal ecosystems, as it will promote sustainability and a more responsible approach to environmental conservation [78]. In addition, successfully cultivating an eco-surplus culture inspires stakeholders to go beyond mere sustainability and actively contribute to creating environmental surplus impacts, enhancing the effectiveness and sustainability of long-term marine conservation efforts [73,79].

Practically, the current study's findings suggest that informing the public about the effects of marine and coastal ecosystems on human wellbeing, climate and weather, and climate change reduction can also contribute to the EU's accomplishment of carbon neutrality (e.g., the European Green Deal) [80]. If the policies prioritizing marine and coastal preservation are supported, they will also help improve the blue carbon potential, which helps sequester carbon and reduce emissions [81]. Although the findings can inform the EU's policymaking to combat climate change, they might not be effective for policymaking aimed at helping vulnerable countries, as agreed at the United Nations climate conference in Glasgow (COP26) in 2021 [80]. More than 95% of the samples in this study were from high- and upper-middle-income countries, where social welfare is high and people are less likely to be vulnerable to basic survival needs (e.g., food, water, shelter, clothing, and sleep). Meanwhile, many vulnerable countries to climate change are also the least developed countries, landlocked developing countries, and small island developing states [82]. Thus, stakeholders' value systems (influenced by mindsets) in those countries might differ drastically from the samples of this study, leading to distinctions in perceived benefits and costs.

According to the principle of perceived benefits maximization explained above, ensuring the stakeholders' livelihood in vulnerable countries should be focused on along with marine and coastal preservation and climate change prevention initiatives because their needs to improve wellbeing or reduce the collateral damages of climate change are less significant than their desire to survive. However, these reasonings require further studies using data in vulnerable countries for validation.

5. Conclusions

The present study utilized BMF analytics to analyze a dataset from the MaCoBioS research project involving 709 stakeholders from 42 countries. The primary objective was to investigate factors (e.g., socio-demographic factors, country income level, and perceived impacts of marine and coastal ecosystems) influencing people's endorsement of a policy that prioritizes the preservation of marine and coastal ecosystems.

The study found no difference in the level of policy support among stakeholders with different socio-demographic characteristics or from countries with different income levels, except for gender. In particular, female stakeholders tended to support marine and coastal preservation policies more than their male counterparts. The study also found that stakeholders who perceived the impacts of marine and coastal ecosystem preservation on human wellbeing, climate and weather, and climate change reduction tended to support the policy more strongly. Meanwhile, the perceived impact of marine and coastal ecosystems on global and local economies has no impact on the stakeholders' policy support. Exploring this ambiguous impact can be an interesting and valuable research direction for later studies.

Through the study, employing Mindsponge Theory and BMF analytics can be deemed an effective way to examine the environmental psychology of stakeholders in coastal and marine ecosystems. Based on the research findings, we suggest that policymakers can promote stakeholders' support for ocean and coastal preservation policies by promoting their awareness and knowledge of the stakeholders. Moreover, we also suggest that for receiving policy support from stakeholders, the content of the disseminated environmental information should highlight the importance of marine and coastal ecosystems in improving human wellbeing, regulating climate and weather, and reducing climate change. The

suggestion can also contribute to the EU's accomplishment of carbon neutrality (e.g., the European Green Deal).

The current study has some limitations, so we report them here for transparency [83]. First, although the dataset consists of people from 42 nations, most are from Europe, particularly France and Italy. As a result, this dataset does not represent people from non-European areas. However, it might be considered a tentative attempt to include non-European perspectives in a global approach. Second, participants' mindsets may be skewed due to the data-gathering technique (i.e., snowball sampling). Those who opted to respond to the survey may have specific biases regarding environmental concerns.

Author Contributions: M.-H.N.: Conceptualization, Writing—original draft, Writing—review and editing; M.-P.T.D.: Methodology, Software, Writing—original draft; M.-C.N.: Software, Validation; N.M.: Data curation, Formal analysis; R.J.: Writing—review and editing; P.-T.N.: Investigation; T.-T.L.: Methodology, Writing—review and editing; Q.-H.V.: Conceptualization, Writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The current study employed secondary data, which were validated and approved by Data in Brief (Elsevier Journal) on April 2023 (<https://www.sciencedirect.com/science/article/pii/S2352340923000422> (accessed on 15 March 2023)). The dataset has been made open for reusability under the CC BY 4.0 license. Due to the nature of the data, the IRB and informed consent are automatically exempted.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: All the code and data used to perform this analysis are deposited with the Open Science Framework for transparency, future reproducibility, and scientific cost reduction: <https://osf.io/etm7p/> (DOI: 10.17605/OSF.IO/ETM7P)).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

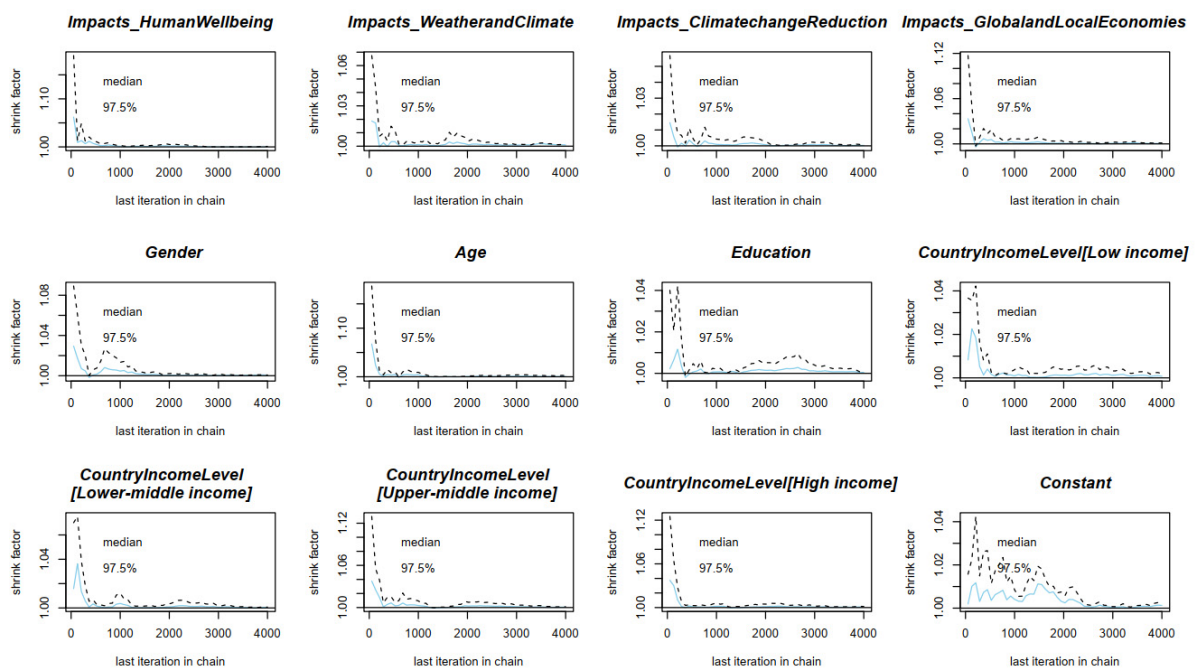


Figure A1. Model 1's Gelman–Rubin –Brooks plots.

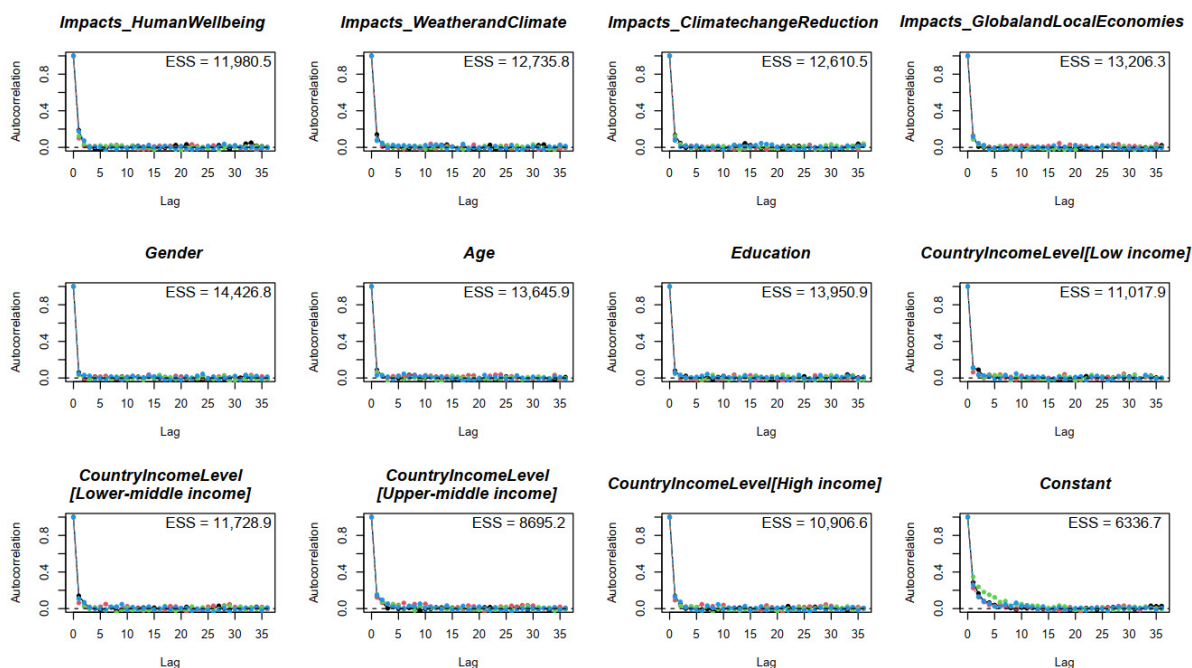


Figure A2. Model 1's autocorrelation plots.

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