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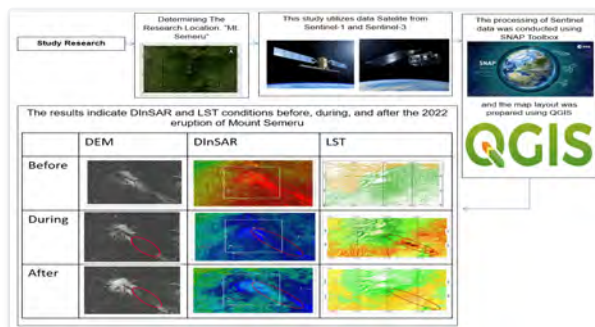
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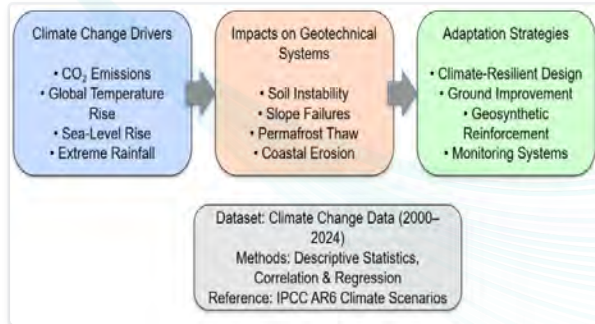
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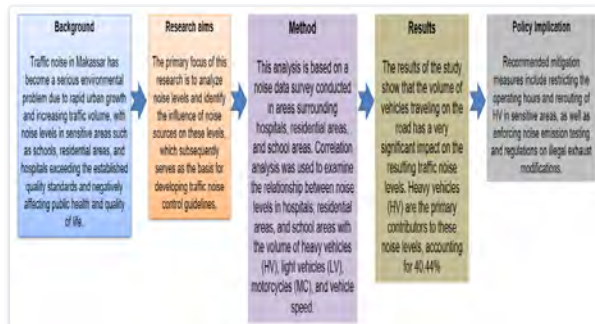
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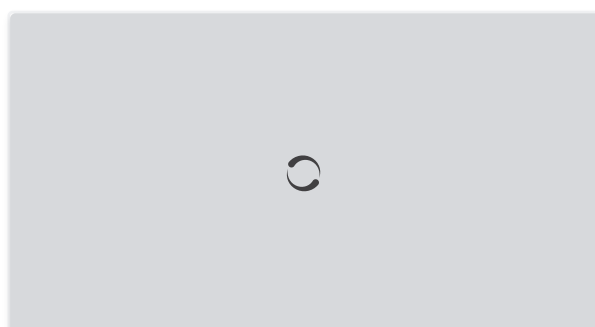
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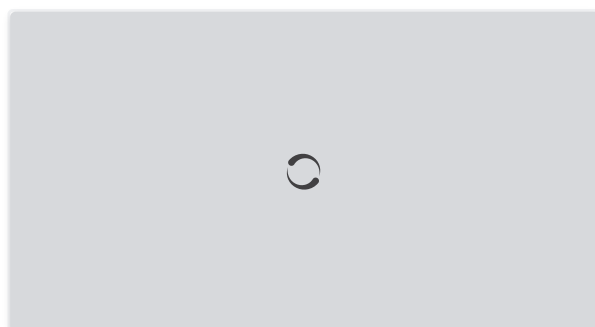
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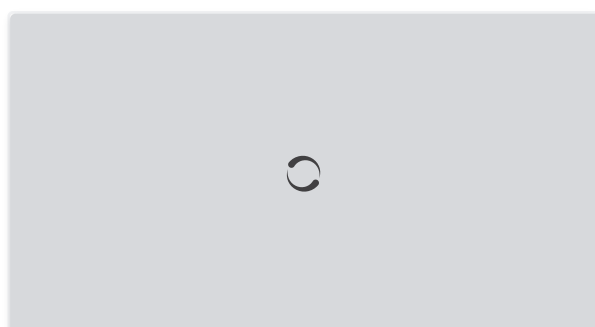
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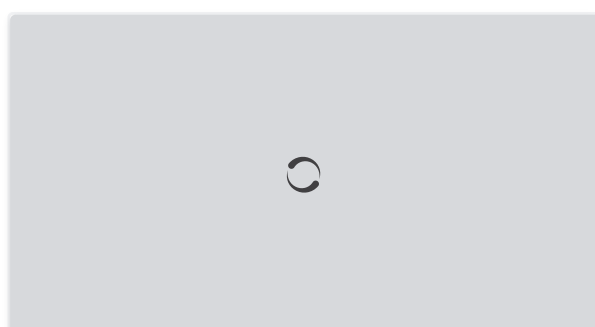
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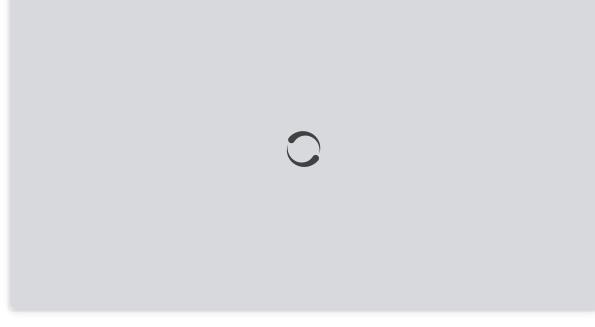
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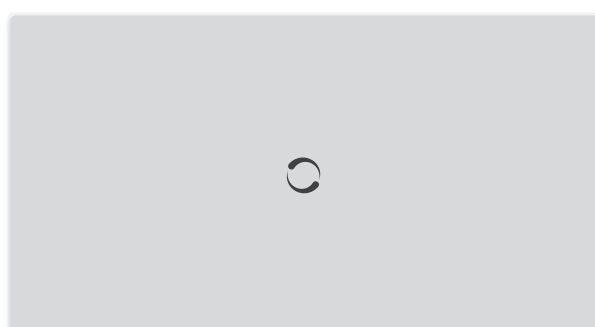
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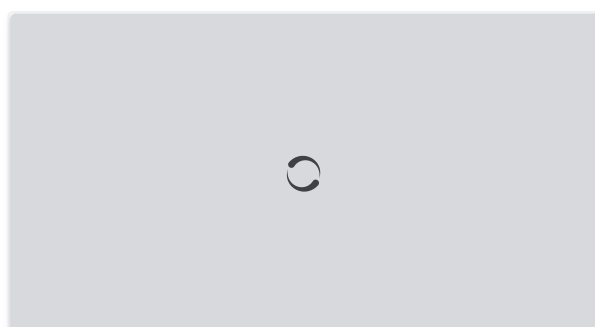
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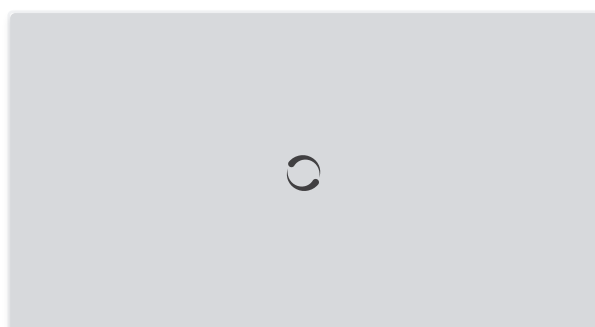
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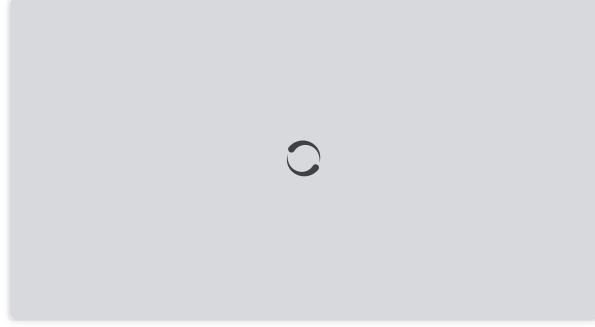
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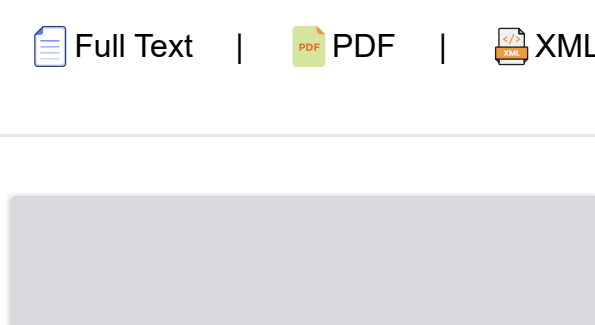
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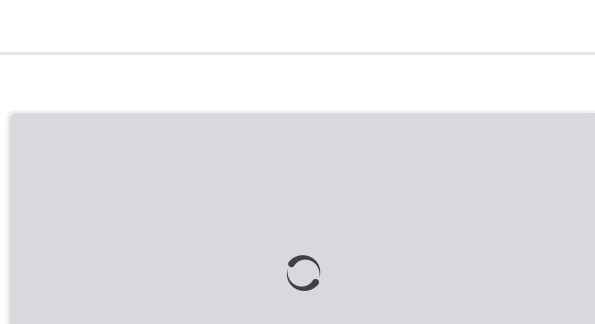
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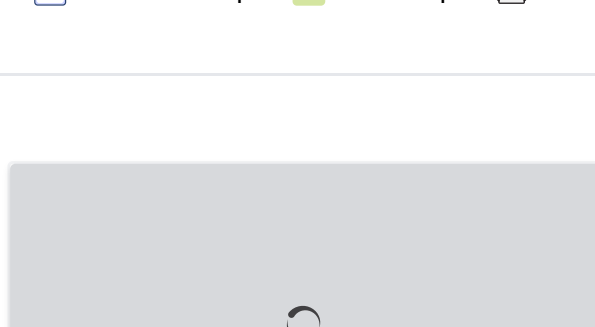
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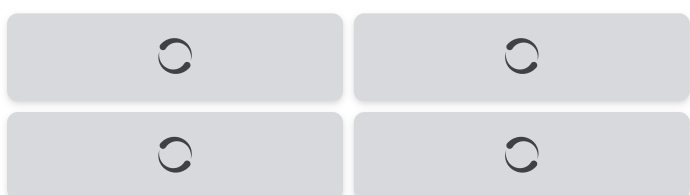
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Sustainable Coastal Tourism and Waste Management: Evidence from Willingness to Pay and Spatial Analysis in Southern Yogyakarta

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Abstract: Tourism provides considerable economic advantages; however, it also imposes environmental challenges, especially in coastal regions where unmanaged waste poses a threat to long-term sustainability. This research seeks to examine the behavioral and spatial elements that affect tourists’ willingness to pay (WTP) for circular waste management in eight coastal destinations in Southern Yogyakarta, Indonesia. Employing the Contingent Valuation Method (CVM), primary survey data were gathered from 984 visitors and analyzed using Ordinary Least Squares (OLS) regression, K-Means clustering, and spatial mapping techniques with geomap orange data mining. The analysis investigates how socio-economic factors such as age, income, gender, education level, and travel costs influence WTP, with behavioral theory serving as the interpretive framework. The findings indicate that younger and more educated tourists demonstrate a higher WTP, while age and travel costs negatively and significantly impact their WTP. The estimated average WTP of IDR 13,840 surpasses the official waste retribution fee, reflecting a considerable level of environmental concern among visitors. Additionally, spatial and cluster analyses uncover diversity in visitor segments across coastal areas, implying that standardized waste management policies may not be effective. In summary, the results underscore the necessity of merging economic valuation with spatially informed and behaviorally conscious policy tools, illustrating the potential of WTP as a funding mechanism for sustainable and circular waste management in coastal tourism regions.

Keywords: Willingness to pay; Coastal waste management; Sustainable tourism, Ordinary Least Square; K-Means clustering; Geo-Map orange data mining, Marine debris

1 Introduction

Marine debris is one of the most pressing global environmental challenges. It is the main focus in achieving the Sustainable Development Goals (SDGs), especially Goal 12 (responsible consumption and production), Goal 13 (climate change management), and Goal 14 (marine ecosystems) [1]. The Organization for Economic Cooperation and Development OECD estimated that more than 11 million tons of plastic waste enter the oceans each year in 2022, and this figure could triple by 2040 if there is no serious intervention. This issue has a significant impact on the sustainability of marine ecosystems, coastal balance, and economic sectors that depend on the ocean, such as fisheries and tourism [2–4]. Indonesia, as an archipelagic country with the second-longest coastline in the world, faces major challenges related to the problem of marine debris. According to the Ministry of Environment and Forestry (MoEF), Indonesia produces more than 3.2 million tons of plastic waste every year, and around 0.27–0.59 million tons of it is estimated to pollute the sea through river flows, coastal settlement activities, and tourism activities [5]. Data from the 2023 National Waste Management Information System (NWMIS) shows that several provinces with high levels of tourism also produce significant volumes of waste, one of which is the Special Region of Yogyakarta. Despite having a relatively small area, the Special Region of Yogyakarta has the characteristics of being highly urbanized and tourism characteristics, making it one of the provinces with the highest per capita waste generation in Indonesia [6]. Despite the increasing prevalence of marine debris and its accumulation in coastal tourism areas, the current waste management policies in Indonesia face two significant limitations. Firstly, the existing fee or retribution frameworks are mainly administrative and seldom based on empirical environmental valuation or an understanding of tourists’

behavioral responses to environmental conservation. Consequently, policy instruments frequently do not capture the true economic value that visitors attribute to the quality of coastal environments or utilize pro-environmental behavior as a means of sustainable financing. Secondly, coastal environmental policies are often formulated and executed without adequate spatial integration, employing uniform strategies across various destinations despite considerable spatial diversity in tourism intensity, sources of waste generation, and environmental vulnerability. This absence of spatial differentiation restricts the effectiveness of policies, especially in tourism-centric areas where environmental pressures differ markedly from one location to another.

One of the most influential areas in the Special Region of Yogyakarta is the coastal area of Bantul Regency, which is known as the center of marine tourism in the southern part of the province. The eight main beaches that tourists focus on are Parangtritis, Parangkusumo, Depok, Goa Cemara, Kuwaru, Pandansimo, Samas, and Baru Beaches, as seen in the number of tourists in Figure 1 [7]. During the 2020–2024 period, Parangtritis Beach was recorded as the destination with the highest number of visits, which was 4.23 million people, followed by Parangkusumo Beach with 2.15 million visits, and Depok Beach with 1.95 million visits [8]. The waste problem that occurs in the eight coastal areas has five main characteristics, the most prominent of which can be seen in Figure 2. First, the high proportion of single-use plastic waste, such as bottles, straws, and food packaging, dominates the composition of daily waste generation [9]. Second, there is a lack of waste management facilities at tourist sites, both in terms of sorted waste bins, collection systems, and transportation systems to the Final Disposal Site. Third, the low awareness and behavior of tourists towards environmental cleanliness are shown by their habit of littering and not bringing back garbage. Fourth, the contribution of waste from local traders who do not have a commercial waste management system, and use packaging materials that are not environmentally friendly. Finally, marine debris from upstream that is carried by river currents, especially during the rainy season, accumulates on the coastline and adds to the burden of local management [10].



Figure 1. Map of the number of visitors on eight beaches

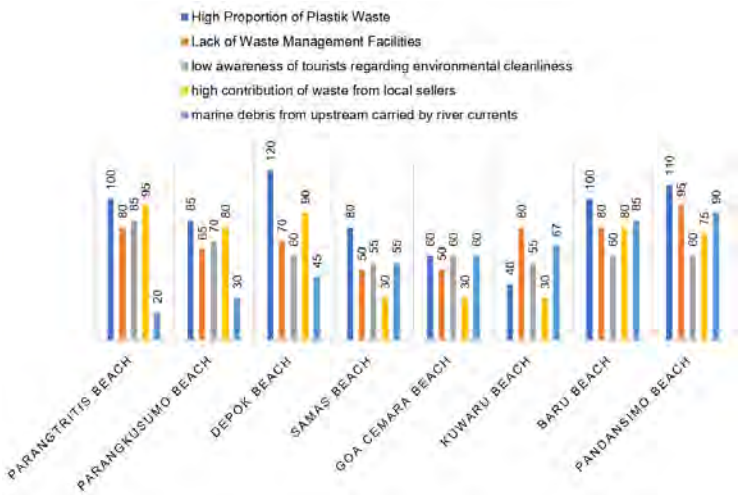


Figure 2. The level of waste problems on eight beaches

The eight beaches in Bantul Regency have diverse characteristics of waste generation sources, depending on the level of tourist visits and their proximity to large rivers [8]. Beaches with high levels of tourist visits, such as Parangtritis Beach, Parangkusumo Beach, and Depok Beach, tend to experience an increase in the volume of waste generation from tourist and trader activities [11]. The waste generally consists of single-use plastics, food scraps, and commercial waste such as packaging and tableware that are not environmentally friendly, which are produced directly during tourism activities. However, beaches located around the downstream of the Progo River and the Opak River, such as Samas Beach, Pantai Baru, and Pandansimo Beach, show a higher vulnerability to marine debris pollution originating from the upstream, which is carried by river flows and empties into coastal areas. This pattern indicates that the waste problem in coastal areas is not only sourced from local activities, but is also influenced by waste management systems in upstream areas, so it requires an integrated approach across regions and sectors, as shown in Figure 3.

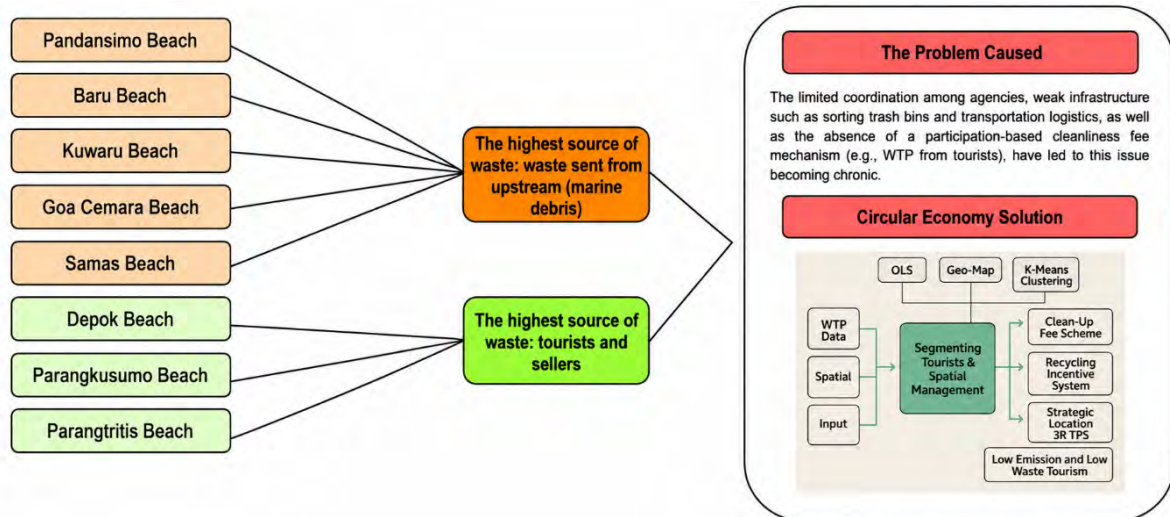


Figure 3. Characteristics of waste generation sources

In addition to being based on field conditions and policy urgency, the issue of waste management in tourist areas is also reflected in the development of ongoing scientific research trends. These relevant topics have been highlighted in studies related to marine pollution over the past five years, including marine debris, waste management, tourism, and Willingness to Pay (WTP) [12]. The visualization of the keyword network reflects that socio-economic dimensions such as income and gender are increasingly being explored in the context of tourists' environmental behavior (Figure 4). While previous research in Indonesia has extensively employed WTP analysis and cluster segmentation to examine coastal tourism sustainability, most of these studies have remained descriptive in nature and lack a behavioral-theoretical grounding [13]. To address this gap, the present study advances the framework by integrating the Theory of Planned Behavior (TPB) to explain the underlying cognitive and attitudinal mechanisms shaping tourists' payment intentions. This theoretical extension transforms WTP analysis from a purely econometric exercise into a behavioral model that links demographic, attitudinal, and control factors to pro-environmental actions. Hence, the research not only replicates established empirical relationships but also contributes theoretically by contextualizing WTP as a measurable manifestation of pro-environmental behavioral intention. This integration is particularly relevant to support evidence-based and spatially informed policy formulation for circular waste management in coastal destinations [14].

VosViewer served a significant diagnostic function by visualizing the co-occurrence of keywords and emphasizing prevailing themes (such as marine debris, WTP, and waste management) along with emerging connections between socio-economic factors and waste issues related to tourism. However, a mere map of keywords does not represent conceptual innovation; it simply identifies clusters of existing research that require further theoretical or methodological integration. A more detailed examination of the literature reveals three distinct patterns: (1) numerous studies from Indonesia and the surrounding region utilize contingent valuation or descriptive WTP methods without situating those estimates within a clear behavioral framework or spatial policy design (i.e., they are predominantly descriptive valuation studies); (2) a smaller group of studies incorporates behavioral models like the TPB alongside valuation techniques, yet these often measure TPB constructs directly or are confined to individual sites, failing to merge valuation with spatial segmentation; and (3) spatial or GIS-based investigations of coastal pollution frequently concentrate on distribution and hotspots without correlating those spatial trends with visitors' economic valuation or grouped behavioral segments. The novelty of the current research lies not in the application of VosViewer itself, but

in the transition from a bibliometric diagnosis to an empirical synthesis: it integrates CVM-elicited continuous WTP, OLS analysis of socio-economic factors, K-Means clustering of visitor categories, and Geo-Map spatialization to link behavioral interpretation (using TPB as a conceptual framework) with location-specific policy tools thus addressing the gaps that keyword mapping merely indicated.

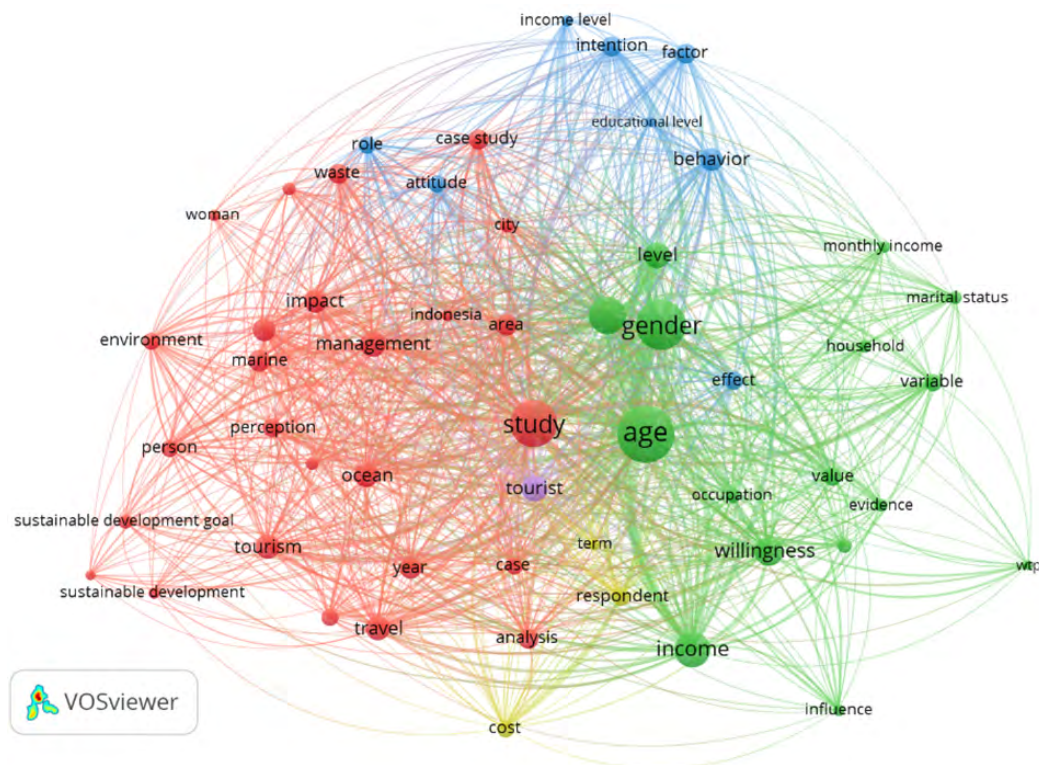


Figure 4. Relevant issues regarding waste pollution on the beach in the last years

To analyze the environmental awareness of tourists and design a data-driven management strategy, this study applied a quantitative approach with three main analytical tools involving 984 visitors on eight beaches in the location. First, the Ordinary Least Squares (OLS) regression was used to identify factors that affect tourists' WTP towards waste management retributions [15]. Second, the Geo-Map approach is applied to map the spatial distribution of visitor characteristics as well as the distribution of WTP values on each beach. Third, K-Means clustering is used to group the characteristics of tourists' environmental awareness based on demographic patterns, behavior, and regional origin [16]. This comprehensive approach is expected to provide participatory-based waste management policy recommendations in accordance with local characteristics and support the achievement of concrete SDG targets. This study aims to examine the socio-economic and demographic factors influencing tourists' WTP for coastal waste management using an OLS approach. It also seeks to analyze the spatial distribution of tourists' characteristics and WTP values across eight coastal destinations through Geo-Map analysis. In addition, this study aims to identify distinct behavioral segments of tourists based on environmental awareness, demographic patterns, and regional origin using K-Means clustering to support spatially differentiated and data-driven waste management policies. The novelty of this study lies in its integrated framework that combines CVM-based continuous WTP estimation, socio-economic regression, spatial clustering, and behavioral interpretation using TPB as a conceptual lens, enabling location-specific and behaviorally informed coastal waste management policies.

2 Methodology

This study adopts a quantitative approach with the aim of analyzing the impact of socio-economic characteristics on the WTP value of 984 visitors in supporting a circular economy-based waste management system in coastal tourism areas. This method was chosen for its ability to objectively uncover the relationships between variables and allow the analysis of specific patterns through statistical data processing and spatial visualization. The analysis process is carried out through systematic stages, starting from primary data collection, OLS regression, cluster analysis using K-Means, and Geo-Maps-based spatial mapping through the orange data mining application. This approach provides a solid foundation for understanding the conditions on the ground while developing evidence-based policy recommendations outlined as follows.

2.1 Data, Indicators, and Data Sources

This study utilizes primary data obtained through field surveys of visitors in the beach area. The data collection technique was carried out by distributing questionnaires containing information about socio-economic characteristics and WTP values related to the circular economy-based waste management system [17]. The sampling technique applied is purposive sampling, taking into account the location and characteristics of waste on each beach [18]. Table 1 is an operational definition of the variables used in this study as follows.

Table 1. Variables and operational definitions of variables

No.	Variable	Variable Type	Indicators	Data Sources
1	Willingness to pay visitors for environmental concern (<i>WTP</i>)	Dependent	Maximum amount willing to be paid by visitors (Rupiah)	Primary data (survey)
2	Total travel cost (<i>Cost</i>)	Independent	Total cost spent by visitors to visit tourist attractions (Rupiah)	
3	Age (<i>Age</i>)	Independent	Age of the visitor (year)	
4	Gender (<i>Gender</i>)	Independent	Dummy variables (0 for males and 1 for females)	
5	Education level (<i>Education</i>)	Independent	Based on the length of the school year	
6	Income (<i>Income</i>)	Independent	Average monthly revenue	

2.2 Quota Valuation Method

The Contingent Valuation Method (CVM) was utilized to assess visitors' WTP for coastal waste management services. CVM is a stated-preference approach that directly gathers individuals' valuations of non-market goods by presenting them with a hypothetical situation and inquiring how much they are prepared to pay for its enhancement or conservation [19]. This technique is extensively employed in environmental economics as it encompasses both use and non-use values of environmental assets. In this research, participants were requested to indicate the maximum amount (IDR) they were willing to contribute as a retribution fee or environmental retribution to facilitate waste management in coastal tourism regions. The WTP responses were subsequently compiled to derive the average and total economic value of environmental services in each area.

The general functional form of the WTP estimation can be expressed as:

$$WTP_i = f(X_i, \varepsilon_i) \quad (1)$$

where, WTP_i is individual willingness to pay of respondent i , X_i is vector of socio-economic characteristics, and ε_i is random error term.

$$E(WTP) = \frac{1}{n} \sum_{i=1}^n WTP_i \quad (2)$$

To maintain internal consistency and reduce potential bias, this study employed a double-bounded dichotomous choice format within the CVM to elicit respondents' WTP. In this approach, respondents were first asked whether they were willing to pay an initial bid amount, followed by a higher or lower bid depending on their initial response. The responses from this bidding process were subsequently converted into a continuous WTP measure by estimating the respondents' maximum stated WTP, which was then used as the dependent variable in the OLS regression analysis. This approach allows the double-bounded format to improve the efficiency of WTP elicitation, while the use of OLS facilitates the examination of socio-economic and demographic factors influencing payment willingness. In addition, clustering and spatial analyses were conducted to identify behavioral patterns and geographic heterogeneity among visitors. In this study, the TPB is not empirically tested through its latent constructs; rather, it is employed as a conceptual framework to interpret WTP as a manifestation of pro-environmental behavioral intention.

2.3 Ordinary Least Square

The primary analytical technique utilized to assess the impact of visitors' socio-economic attributes on their WTP is OLS regression. OLS is chosen due to the fact that the WTP variable is regarded as a continuous measure obtained from the contingent valuation elicitation process, which facilitates a clear estimation of both the magnitude and direction of the relationship between WTP and significant explanatory factors such as age, income, education

level, gender, and travel cost [20]. This method serves to estimate the linear relationship between dependent and independent variables and evaluate their significance.

The OLS model is mathematically written as follows:

$$WTP_i = \beta_0 + \beta_1 Cost_i + \beta_2 Age_i + \beta_3 Gender_i + \beta_4 Education_i + \beta_5 Income_i + e_i \quad (3)$$

Prior to estimating the regression coefficients, classical assumption tests were performed to confirm the model's validity and reliability. These tests encompass the normality test to ascertain whether the residuals follow a normal distribution, the multicollinearity test to investigate possible correlations among independent variables, the heteroscedasticity test to assess the presence of unequal variance in the residuals, and the autocorrelation test to identify correlations among residuals across different observations. Adhering to these assumptions guarantees that the OLS estimators remain unbiased, consistent, and efficient.

2.4 K-Means Clustering Analysis

In order to delve deeper into the patterns and segmentation of visitor preferences concerning waste management, the K-Means clustering method was utilized. This unsupervised machine learning approach is designed to divide the dataset into k separate groups (clusters) based on the similarities in chosen attributes specifically, the socio-economic characteristics of visitors and their WTP for sustainable waste management initiatives. From a mathematical perspective, the K-Means algorithm aims to reduce the total within-cluster variance (commonly referred to as the Sum of Squared Errors, SSE). The objective of optimization can be expressed in the following manner:

$$\min_C \sum_{i=1}^k \sum_{x_j \in C_i} \|x_j - \mu_i\|^2 \quad (4)$$

where, k means number of clusters, C_i is the i -th cluster, x_j is data point j (vector of respondent's attributes), μ_i is centroid (mean vector) of cluster i , and $\|x_j - \mu_i\|$ is Euclidean distance between a data point and its cluster centroid. The Euclidean distance between two points x and y is defined as:

$$d(x, y) = \sqrt{\sum_{p=1}^n (x_p - y_p)^2} \quad (5)$$

The clustering process is iterative, involving the following steps: (1) Randomly initialize k centroids, (2) assign each observation to the nearest centroid based on Euclidean distance, (3) recalculate the centroids as the mean of all points assigned to each cluster, (4) repeat steps (2) and (3) until the centroids no longer change significantly or the objective function converges. The ideal number of clusters (k) was established through the Elbow Method, which graphs the SSE for different k values to pinpoint the point of diminishing returns, or alternatively, the Silhouette Score Method, which assesses the cohesion and separation of clusters.

$$(i) = \frac{b(i) - a(i)}{\max\{a(i), b(i)\}} \quad (6)$$

where, $a(i)$ is average distance between point i and all other points in the same cluster (cohesion) and $b(i)$ is average distance between point i and all points in the nearest neighboring cluster (separation). The results of the clustering analysis demonstrate the diversity among respondents and assist in pinpointing particular behavioral segments. For example, certain clusters may signify local merchants who exhibit a strong environmental consciousness (high WTP despite limited income), whereas other clusters could include casual visitors who show a low WTP irrespective of their income level. Grasping these trends enables policymakers and site managers to formulate tailored intervention strategies, including varied pricing, awareness initiatives, or incentive programs [21–23].

2.5 Spatial Analysis Using Geo-Map Orange Data Mining

After the clustering process is complete, the results are then mapped spatially using the Geo-Maps feature contained in the orange data mining software [16]. Each visitor location point is mapped based on the geographic coordinates obtained during the survey, and then colored according to the respective cluster. This spatial visualization provides a comprehensive picture of the distribution of WTP and the geographic preference clusters of traders in the coastal areas studied. Thus, priority zones for the implementation of circular economy-based waste management policies or programs can be identified [24].

3 Results

Tourist visitors have a very important role in shaping the dynamics of waste generation in coastal destinations [25]. Eight beaches in Bantul Regency become the center of tourist visits every year, with Parangtritis, Parangkusumo, and Depok Beaches recorded as the beaches with the highest number of visits during the 2020–2024 period. This large number of visits not only provides economic benefits for the region but also poses serious environmental challenges, especially in the form of increased marine debris and coastal litter [26]. Tourist activities such as food consumption, recreational activities, and inappropriate disposal of single-use plastics have been identified as one of the main contributors to waste generation in the region [27]. A descriptive analysis of survey data collected from 984 respondents reveals significant diversity in the demographic profiles of visitors, encompassing factors such as age, gender, education level, income, and overall travel expenses. The selection of respondents was conducted through purposive sampling, adhering to specific inclusion criteria: individuals aged 17 years and older, visitors present at one of the eight coastal tourism sites during the survey period, and those who were willing and able to provide comprehensive information regarding their socio-economic characteristics and WTP. The sample size of 984 respondents was established to ensure sufficient representation across all study locations, facilitating robust estimations in regression, clustering, and spatial analyses, rather than aiming for population-level statistical representativeness. In the realm of behavioral valuation and exploratory spatial analysis, this sample size is deemed adequate to capture the diversity in visitor characteristics and payment preferences across various coastal destinations. These characteristics play an important role in understanding the variation in environmental awareness and the amount of their WTP to waste management retributions as seen in Table 2.

Table 2. Socio-demography indicator of tourist

Socio-Demographic Indicators	Number of Visitors	Socio-Demographic Indicators	Number of Visitors
Total Travel Cost (Rupiah)		Education	
<1,040,000	942	Elementary school	84
1,040,001–2,080,000	25	Junior high school	112
2,080,001–6,120,000	14	Senior high school	276
6,120,001–7,160,000	1	Diploma	132
>7,160,000	1	Bachelor's degree	280
Gender		Master degree	100
Male	401	Income (Rupiah)	
Female	582	<1,000,000	60
Age (Years)		1,000,000–2,999,999	708
<17	44	3,000,000–4,999,999	129
18–25	293	5,000,000–7,999,999	56
26–35	206	8,000,000–9,999,999	2
36–45	145	>10,000,000	28
46–55	115		
56–65	65		
>66	6		

The research utilizes purposive sampling to choose on-site visitors who fulfill specific inclusion criteria, irrespective of their educational background. Visitors with elementary and middle school education are deemed valid respondents for the estimation of WTP since the valuation relies on actual travel expenses and expressed payment preferences, rather than on formal educational qualifications. This approach renders them suitable sources for the calculation of tourism-related costs. Descriptive analysis of survey data of 984 respondents showed that visitors have a diversity of demographic profiles, including age, gender, education level, income, and total travel expenses [28]. These characteristics play an important role in understanding the variation in environmental awareness and their WTP for waste management retributions. In terms of income, most of the respondents were in the range of IDR 1,000,000–2,999,999 (708 people), followed by IDR 3,000,000–4,999,999 (129 people), and IDR 5,000,000–7,999,999 (56 people). Only a few respondents had a high income above IDR 8,000,000 (4 people). This condition confirms that more tourists come from the lower middle group. Meanwhile, in terms of total travel costs, the majority of respondents (942 people) spent less than IDR 1,040,000. This number is very dominant compared to other categories, such as the range of IDR 1,040,001–2,080,000 (25 people), IDR 2,080,001–6,120,000 (14 people), and IDR 6,120,001–7,160,000 (2 people). In fact, only one respondent was recorded to spend more than IDR 7,160,000. Based on these characteristics, there are various proposals for WTP for visitor waste retribution in the eight beach areas which are calculated on average in Table 3.

Table 3. Amount and average willingness to pay (WTP)

Willingness to Pay (IDR)	Frequency	WTP × Frequency (IDR)
0	187	0
1,000	1	1,000
2,000	26	52,000
2,500	2	5,000
3,000	1	3,000
5,000	15	75,000
10,000	15	150,000
13,000	1	13,000
15,000	660	9,900,000
20,000	24	480,000
25,000	6	150,000
30,000	41	1,230,000
35,000	5	210,000
Total		13,619,000
Average		13,840

According to the results of the calculations, the average waste retribution amount that visitors were prepared to pay was IDR 13,840 which significantly exceeds the official tariff set forth in Bantul Regency Regulation No. 23 of 2024 regarding service fees for recreational, tourism, and sports facilities. This regulation raised the general entrance fee from IDR 10,000 to IDR 15,000, which already encompasses an insurance and sanitation fee of IDR 500. The findings carry considerable significance for the governance of sustainable coastal tourism. First, local authorities might utilize the estimated WTP values as a factual foundation for adjusting waste retribution tariffs, thereby ensuring that the pricing framework more accurately reflects the environmental valuation held by visitors [19]. As a result, the retribution policy can transition from being merely an administrative measure to functioning as an economic tool for internalizing environmental externalities. Second, a portion of the fees collected should be allocated in a transparent manner to support environmental and educational initiatives, such as the provision of segregated waste bins, the organization of regular beach-cleaning events, or the offering of incentives to tourism vendors who implement circular waste management practices. Transparent allocation of funds can enhance public trust and promote ongoing participation. Third, the results indicate a significant opportunity for the introduction of green retributions or eco-fees in other tourist locations throughout Indonesia. Such initiatives could act as sustainable financing solutions for environmental infrastructure and conservation efforts, thereby decreasing reliance on local government budgets. Indeed, the elevated WTP reflects a growing collective environmental consciousness among tourists. When effectively managed through robust fiscal and governance frameworks, this behavioral shift not only aids in preserving coastal cleanliness but also bolsters Yogyakarta's reputation as a sustainable tourism destination one that harmonizes economic, social, and ecological aspects within a circular economy model [29].

This comparison suggests that visitors demonstrate a relatively high degree of environmental awareness, as they are inclined to contribute more than the required fee to aid in the cleanliness and sustainability of coastal tourism areas. Such actions not only indicate an economic willingness but also represent a voluntary form of environmental engagement, where tourists acknowledge their responsibility for preserving the quality of the destination. Within the context of the TPB, this observation can be interpreted as reflecting favorable attitudes toward environmental cleanliness, perceived social expectations to act responsibly, and a perceived capacity to contribute financially. However, these TPB components are not measured directly in this study and are therefore used as a conceptual framework to interpret tourists' WTP, rather than as empirically tested behavioral variables [30]. Overall, these findings show that the majority of tourists who come are young, productive women with a secondary to higher education background and lower middle incomes, and they tend to choose low expenses for both travel and environmental contributions through WTP. These descriptive findings are an important basis for further testing of the factors that affect the WTP value of tourists through linear regression analysis (OLS). Utilizing the OLS model, this study will analyze the extent to which socio-economic variables such as age, gender, education level, income, and total travel expenses have a significant influence on the WTP value, as shown in Table 4 and Eq. (7).

With the following equation:

$$WTP_i = 5.47 + 0.18Cost_i - 0.19Age_i - 0.05Gender_i + 0.12Education_i + 0.08Income_i + e_i \quad (7)$$

Based on Table 4, the majority of variables have a significance probability value of <0.05, which indicates that the WTP value of visitors at eight beach destinations is influenced by these variables, namely: age, total travel cost, income, and education level. According to Table 4, most variables exhibit a significance probability value of <0.05,

suggesting that the WTP of visitors at eight beach destinations is affected by these factors, specifically age, total travel cost, income, and education level. Moreover, classical OLS assumption tests were performed to verify the robustness of the regression findings. The normality test of the residuals, utilizing the Jarque–Bera statistic, results in a probability value of 0.21, which indicates that the residuals follow a normal distribution. The examination of multicollinearity was carried out using the Variance Inflation Factor (VIF), where all independent variables displayed VIF values between 1.12 and 1.84, significantly lower than the critical threshold of 10, implying that there are no serious multicollinearity concerns. Additionally, the heteroskedasticity test, conducted via the Breusch–Pagan method, reveals a probability value of 0.37, indicating that there is no heteroskedasticity present in the error terms, thereby confirming that the OLS estimators are both unbiased and reliable.

Table 4. Ordinary Least Squares (OLS) regression result

Variable	Coefficient	Probability
Constant (<i>C</i>)	5.47	0.00
<i>Age</i>	-0.19	0.00
<i>Cost</i>	-0.18	0.00
<i>Income</i>	0.08	0.05
<i>Gender</i>	-0.05	0.30
<i>Education</i>	0.12	0.03
R^2	0.23	
Prob (<i>F</i> -Statistic)	0.00	

Visitors younger than 1 year have a higher WTP rate on waste management of 0.19%. This can be explained from a psychological and demographic perspective. The age distribution map is shown in Figure 5. It can be seen that the majority of visitors are from the young age group, especially in the range of 18–25 years and 26–35 years. This distribution is quite even in almost all locations, such as Parangtritis Beach, Parangkusumo, Depok, and Goa Cemara. In terms of age, younger groups of visitors generally show a higher level of concern for environmental issues, especially those related to waste management, because they are more exposed to environmental education and campaigns in schools, social media, and communities. The younger generation is also known to be more responsive to sustainability discourse and has a stronger preference for environmentally friendly tourism. In terms of demographics, the majority of young visitors are still at the stage of early productive age (e.g., 18–25 years) with a relatively smaller burden of family dependents than older age groups. This condition makes them more flexible in allocating income for non-essential purposes, including voluntary contributions to environmental management in tourist destinations [31]. In addition, young age groups are often more active in social activities and tend to have high ideals, making it easier to support conservation initiatives and sustainable programs. In contrast, in older age groups, WTP's propensity for waste management tends to be lower. This can be influenced by several factors [32].



Figure 5. Map of distribution of visitor age range on eight beaches in the south of Bantul Regency

First, different financial priorities: older age groups typically have larger family dependents, complex household needs, and a more cautious spending orientation, so additional contributions to waste management are not considered a top priority. Second, in terms of perception, the older generation is generally not used to the massive sustainability

narrative, because exposure to environmental issues is stronger in the younger generation through digital media and the latest formal education. Thus, this age-based difference in WTP shows a significant demographic dimension [33–35]. The younger generation tends to be more adaptive, idealistic, and have an emotional attachment to environmental issues, so their WTP is higher. Older generations are more pragmatic and cautious in spending, so their contributions tend to be lower. This is in line with global trends that emphasize that consumer preferences for environmental issues are heavily influenced by generational factors and demographic patterns [36].

The second factor that has a significant influence on WTP is the total cost of travel. The estimated results show that every 1% increase in total travel costs actually reduces the WTP value by 0.18%. This can be explained through the theory of tourism economics, where travel costs are often considered a proxy of the tourist's implicit prices. The greater the travel costs incurred, the higher the financial burden borne by tourists [37]. As a result, their ability and willingness to increase their financial contribution through WTP for waste management is lower. If related to the distribution map in Figure 6, it can be seen that Parangtritis, Parangkusumo, and Depok Beach are destinations with a relatively high concentration of travel costs (shown by the yellow to dark green color gradation). This is logical because the location is more popular, has more commercial infrastructure, and attracts visitors from more distant areas. Hence, the accumulation of transportation, tickets, and consumption costs also increases. Meanwhile, beaches such as Pandansimo and Kuwaru show lower intensity of travel costs (blue-green areas), indicating that visitors tend to come from nearby areas, so the burden of travel is lighter. This is in line with the regression results. In destinations with high travel costs, visitors are more cautious about spending extra on non-essential aspects such as waste management, although they still acknowledge the importance of environmental issues. In contrast, in destinations with low travel costs, tourists are relatively more financially free to contribute to sustainability [38, 39].



Figure 6. Distribution of total travel cost for visitors on eight beaches in the south of Bantul Regency

The WTP waste retribution in coastal tourism areas is one of the important indicators to assess the extent to which tourists and local communities care about the cleanliness and sustainability of the environment [40]. An increase in revenue of 1% which has an impact on the increase in WTP of 0.08% also applies in the context of waste retributions, because tourists with higher incomes tend to have greater awareness and ability to pay additional fees to maintain the cleanliness of tourist destinations. This retribution is not only considered a cost burden but also an investment in maintaining the quality of the travel experience [41]. If it is related to the map of the distribution of beaches in Bantul, the Parangtritis, Parangkusumo, and Depok Beach areas, which have a high rate of visits, certainly produce a larger volume of waste than other beaches. With many tourists coming from various groups, including those with higher incomes, as seen in Figure 7, the potential for revenue from the waste retribution in this area is also greater. Tourists in popular destinations are generally willing to pay more to keep the tourist area clean, safe, and comfortable.

Meanwhile, beaches such as Samas, Goa Cemara, Kuwaru, and Pandansimo, which are still relatively quiet, also require the implementation of a garbage retribution. However, the WTP value tends to be lower because the number of visits is not as large as at the main beach. The policy of implementing the waste retribution can be managed with the principle of fairness, for example, through an integrated entrance ticket system that covers cleaning fees, so as not to burden tourists with layered retributions. The revenue from this waste retribution can then be allocated for integrated waste management, such as the provision of sorted waste bins, routine transportation, and visitor education about the importance of maintaining beach cleanliness. In this way, increasing tourist WTP to waste retribution will have a direct impact on the quality of the tourist environment, improve the image of destinations, and encourage tourism sustainability [42].

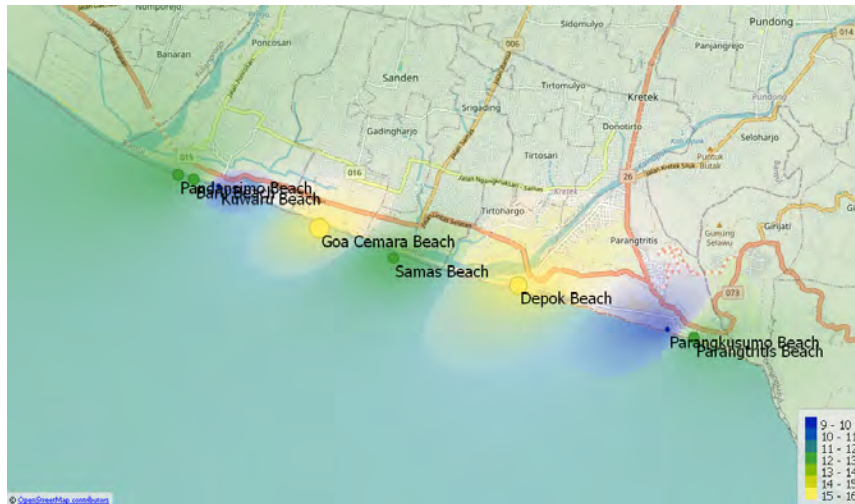


Figure 7. Distribution of tourist income on eight beaches in the south of Bantul Regency

The level of education has an impact on tourists' WTP. Based on the analysis carried out, every 1% increase in the length of the education year will contribute to an increase in WTP by 0.03%. This is understandable because education is closely related to individual awareness, mindset, and behavior. Tourists who have a higher level of education are generally more aware of the importance of maintaining environmental quality, supporting tourism sustainability, and appreciating the facilities and services provided in tourist areas [43, 44]. Therefore, they tend to be willing to spend additional costs, either in the form of entrance tickets, cleaning fees, or other contributions, to get a better comfort and travel experience. If we look at the distribution of the educational years of visitors in the eight beaches on the map in Figure 8, there is a variation in the concentration of visits. Parangtritis and Parangkusumo beaches, which are located on the main route and become tourist icons of Yogyakarta, tend to be visited by various levels of education, including those with secondary to higher education [7]. Thus, the potential for an increase in WTP influenced by educational factors on the beach is quite significant, especially with the existence of relatively complete facilities. Depok Beach, which is famous for its seafood culinary, also attracts visitors with higher educational backgrounds, as they generally have diverse culinary tourism preferences.



Figure 8. Distribution of visitor's education on eight beaches in the south of Bantul Regency

On the other hand, beaches such as Samas, Goa Cemara, Kuwaru, and Pandansimo are more visited by local tourists with varying levels of education as mentioned in Figure 8. However, with the increase in the number of more educated visitors, the potential for increased WTP on these beaches can also grow, especially if they are well managed and equipped with educational facilities such as conservation tourism or ecotourism. For example, Goa Cemara, which is known as an evergreen forest, can be promoted as an environmental education tourism destination, so that it can attract visitors with a longer educational background [45]. Overall, the distribution of visitors with varied educational backgrounds in the eight beaches shows that the higher the average level of education of tourists,

the greater the WTP score that can be obtained [46]. Therefore, the policy of managing beach tourism in Bantul needs to accommodate educational tourism and environmental sustainability so that tourists with higher education feel that their contribution is comparable. This will ultimately strengthen the potential for regional revenue from the retribution and entrance ticket sectors.

Based on the results of a survey conducted on 984 visitors, an average WTP of IDR 5,000 per person was obtained. This value shows that, in general, tourists are willing to incur relatively affordable additional costs to support the cleanliness, comfort, and sustainability of beach management. When viewed from the distribution on the map, there are variations in WTP values between coasts that reflect differences in preferences, attractions, and socio-economic characteristics of visitors. Beaches with high visitor rates, such as Parangtritis, Parangkusumo, and Depok, tend to show a higher WTP distribution (in the range of IDR 6,000–7,500), as seen in Figure 9. This is natural because these beaches are the main destinations in Bantul with more complete facilities, easy road access, and popular tourist attractions both among locals and outside the region. Tourists who visit these beaches generally have more diverse incomes and educational backgrounds, including those of the upper middle class, so their WTP to maintain the comfort and quality of the environment is also greater [40]. Meanwhile, other beaches such as Goa Cemara, Samas, Kuwaru, and Pandansimo showed lower WTP values (in the range of IDR 2,500–5,000). These beaches are generally visited by local tourists who have relatively lower economic ability and educational backgrounds compared to visitors to Parangtritis or Depok [2, 7, 47]. In addition, limited facilities, minimal promotion, and access that is not as good as the main beach also affect the low value of WTP. Tourists on this beach usually only allocate fees for basic tourist needs, such as standard entrance tickets or parking fees. These findings give an idea that although the average tourist WTP is IDR 13,840, there is greater management potential on popular beaches with a high concentration of visits. With transparent and service-based retribution management (e.g., beach cleanliness, sanitation facilities, and waste management), the value of this WTP has the potential to increase, especially among visitors with higher educational and income backgrounds. Conversely, on beaches with low WTP, improvement strategies should be focused on environmental education and improvement of basic facilities so that tourists feel that their contribution is commensurate with the benefits received.



Figure 9. Distribution of willingness to pay (WTP) tourist waste retribution on eight beaches in the south of Bantul Regency

The results of the OLS regression show that the age factor and total travel cost are important determinants that affect visitors' WTP for waste management programs in coastal areas. Each one-year increase in age contributes to an increase in WTP by 0.19%, which suggests that younger age groups tend to have greater concern in supporting environmental sustainability. In contrast, a 1% increase in total travel costs will reduce WTP by 0.18%. This suggests that the higher the cost of visitors to reach the tourist site, the lower their level of willingness to make additional contributions to waste management [27]. This regression finding is strengthened by the results of the K-Means clustering analysis, which groups the characteristics of visitors into four main clusters in Table 5. In Cluster 1 (Kuwaru Beach), visitors are dominated by young people with low income and education, and the lowest WTP. This condition suggests that although young age has the potential to increase WTP, limited purchasing power remains a determining factor that decreases the actual contribution. On the other hand, Cluster 2 (Depok Beach) features a visitor profile with high incomes, large travel costs, and the highest WTP. These results are in line with the regression, where the negative impact of travel costs can be offset by strong purchasing power. Furthermore, Cluster 3 (Baru, Goa Cemara, Pandansimo, Samas) shows the productive age group (30–36 years) with medium income and moderate WTP. This

reflects a fairly stable segment of local-regional travelers, where relatively low to medium travel costs maintain their contribution. Meanwhile, Cluster 4 (Parangkusumo and Parangtritis) represents high-income tourists with a high level of education and a large WTP. These beaches are popular destinations that attract tourists with a higher environmental awareness, so despite the relatively large cost of travel, the WTP remains high.

Table 5. K-Means clustering results

Cluster 1	Cluster 2
Beach: Kuwaru Visitor age is relatively young (25 years old), lowest income ($\pm$ IDR 1.68 million), low education (9 years), and lowest WTP (IDR 2,940)	Beach: Depok Characteristics: Medium visitor age (34 years), fairly high income (IDR 2.15 million), relatively high education (12 years), high total travel costs (IDR 455,000) and the highest WTP (IDR 7,613).
Cluster 3	Cluster 4
Beaches: New, Goa Cemara, Pandansimo, Samas Characteristics: Visitor's age: 30–36 years, median income (IDR 1.9–3 million), education varies (9–12 years), medium WTP (IDR 3,400 – IDR 4,600).	Beaches: Parangkusumo and Partangtritis Characteristics: Medium visitor age (31–33 years), high income (IDR 2.9–3.3 million), very high education (16 years), WTP quite high (IDR 5,200–IDR 6,400).

Based on the results of K-Means clustering, waste management strategies on eight beaches can be adjusted to the socio-economic characteristics of their visitors as shown in Table 5. In Cluster 1 (Kuwaru Beach), visitors are dominated by young people with low income and education and low WTP. Therefore, proper waste management is based on community participation, for example, through the provision of easy-to-understand sorted waste bins, a simple “take your garbage home” campaign, and involving local youth organizations in maintaining cleanliness. This approach is inexpensive and in accordance with the purchasing power of visitors. It is different from Cluster 2 (Depok Beach), where visitors have a fairly high income, relatively high education, and the highest WTP. Strategies that can be applied are a modern management system based on financial contributions, such as the implementation of eco-fees, the integration of digital waste banks with seafood traders, and the provision of organic and plastic shredding machines in culinary centers. With high purchasing power, this segment is relatively ready to pay more for environmental cleanliness [48]. Meanwhile, Cluster 3 (Pantai Baru, Goa Cemara, Pandansimo, and Samas) has the character of visitors between 30 and 36 years old, with medium income, and moderate WTP. Therefore, the right approach in waste management is one based on family education and environmental tourism. Examples include family waste bank facilities, mini workshops on compost and ecobricks, and educational photo spots with the theme “Waste-Free Beach,” which can be an additional attraction [49]. Finally, Cluster 4 (Parangkusumo and Parangtritis Beaches) attracts tourists with high incomes, very high levels of education, and fairly high WTP. Appropriate strategies are the implementation of premium systems, such as green tickets, some of which are allocated for cleanliness, the provision of zero-waste stations with organic and non-organic processing technology, and beach adoption programs involving universities or communities as a form of corporate social responsibility (CSR) and sustainability research [50, 51]. Thus, the integration of regression and clustering results confirms that the variables of age and travel costs cannot be separated, but rather need to be analyzed simultaneously with other demographic factors such as income and education. This cluster-based segmentation provides practical implications for the management of beach tourism, especially in designing a fairer visitor contribution scheme, and in accordance with the characteristics of each segment.

Notwithstanding its contributions, this study presents several limitations that warrant acknowledgment. Firstly, the application of purposive sampling indicates that the findings may not be statistically representative of the entire population of coastal tourists. Although the sample size is adequate for exploratory regression, clustering, and spatial analysis, one must exercise caution when extrapolating the results beyond the context of the study. Secondly, while the TPB is utilized as a conceptual framework to analyze WTP, its fundamental constructs—attitude, subjective norm, and perceived behavioral control—are not measured directly. Consequently, TPB functions as an interpretive framework rather than a rigorously tested behavioral model. Thirdly, the cross-sectional nature of the data captures visitors’ preferences at a singular moment in time and fails to consider temporal shifts in behavior, seasonal fluctuations, or policy changes. Future research could mitigate these limitations by adopting probabilistic sampling methods, integrating direct behavioral measurements, and employing longitudinal designs to more effectively capture the evolution of tourists’ environmental preferences over time.

4 Conclusions

This research investigated the willingness of tourists to pay for sustainable waste management in coastal tourism regions by employing a combination of the CVM, OLS regression, clustering, and spatial analysis. The results

demonstrate that the willingness to financially contribute to waste management is primarily influenced by demographic and economic factors, especially age and travel expenses. Younger tourists generally show a higher WTP, indicating a greater responsiveness to sustainability efforts, whereas increased travel costs diminish the ability to make further environmental contributions, emphasizing the impact of budget limitations on pro-environmental actions. In addition to individual-level factors, the combination of regression, clustering, and spatial analysis uncovers significant variability across coastal locations. Different visitor segments with diverse socio-economic profiles and WTP amounts imply that standardized waste management policies may not be effective. Rather, tailored and spatially aware strategies, ranging from low-cost, community-driven initiatives to premium eco-fee systems, are more appropriate for tackling various environmental challenges and visitor demographics. These findings highlight the necessity of aligning waste management strategies with both behavioral and spatial attributes of tourism destinations. From a policy standpoint, this research illustrates that WTP can act as a viable economic metric to bolster sustainable financing frameworks in coastal tourism, as long as considerations of affordability and equity are upheld. By capitalizing on the increased environmental consciousness among younger tourists while addressing the financial limitations encountered by other demographics, policymakers can formulate inclusive and flexible waste management approaches. In summary, this study adds to the existing literature by connecting economic valuation with spatial and behavioral viewpoints, providing evidence-based insights to enhance the governance of coastal tourism in a more effective and sustainable manner.

Author Contributions

Conceptualization, N.W. and A.R.; methodology, A.R.; software, A.R.; formal analysis, A.R.; investigation, A.S. and A.R.; resources, N.W.; data curation, A.S.; writing original draft preparation, A.R.; writing review and editing, L.A. and N.W.; supervision, N.W.; project administration, N.W. All authors have read and agreed to the published version of the manuscript.

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Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

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Conflicts of Interest

The authors declare no conflict of interest.

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