

# The perception of waste management of hikers at Bulusaraung mountain area of Bantimurung Bulusaraung National Park

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Received 07 August 2024;  
Accepted 30 November 2024;  
Published online 06 December 2024

**Citation:** Heldayanti, A., Asrianny, & Maulany, R.I. 2024. The Perception of Waste management of hikers at Bulusaraung mountain area of Bantimurung Bulusaraung National Park. *JPK Wallacea*, Vol. 13 No. 2 pp. 75-88

**Abstract.** Waste management in tourist destinations is a serious problem because of its non-biodegradable nature and the volume of waste produced each year continues to increase along with the increasing number of visitors to the tourist area. The existence of climbing activities in the Bulusaraung Mountains area has an impact on the waste problem that arises due to hikers activities in the area. This study aims to examine the effectiveness of waste management in the Bulusaraung Mountains, Bantimurung-Bulusaraung National Park (South Sulawesi), Indonesia from the perspective of hikers, a survey was conducted on 100 hikers with a focus on their perceptions, attitudes and awareness using a set of questionnaires. Additionally, observations were made regarding the implementation of hiking procedures applied by the National Park on waste management in the area. A correlation analysis determined the relationship between socio-demographic factors and hikers' perspectives on waste management in the Bulusaraung Mountains. The results, which underscore the importance of this study, indicated that hikers held positive perceptions, attitudes, and awareness regarding the waste management efforts implemented by Bantimurung Bulusaraung National Park. Age and education positively influenced hikers perception, attitude, and awareness towards waste management. In addition, a significant correlation was found between age and awareness ( $p = 0.05$ ). Other variables, such as gender, occupation, and organization, were negative and insignificant in influencing hikers' perception, attitude, and awareness ( $p > 0.05$ ). Respondents' education is positively correlated with hikers' perceptions, attitudes and awareness towards waste management in the Bulusaraung Mountains.

**Keywords:** Tourism, Perception, Karst



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## INTRODUCTION

Tourism activities in protected areas have been widely known for bringing a multitude of benefits not only for local communities but also for conservation (Leung et al., 2018; Thapa et al., 2022). Employment opportunities, an increase in the community's economic levels, socioeconomics and cultural improvement of the locals, local product's development and commercialization, as well as the rise of people's awareness towards conservation are examples of how tourism has positively contributed to the people and environment (Belsoy et al., 2012). National parks as protected area have become an important concept in nature conservation and at present, are in high visitation demand by world travelers (Agyeman et al., 2019; Winter et al., 2020; Karhu et al., 2022; Mari et al., 2022). The increase in visitors to the national park

continues to increase every year, which can have an impact on the ecosystem (Anaka et al., 2024). Visitors repeatedly come with the main purpose of enjoying nature, taking a leisurely walk, hiking, or other activities conducted in nature (Pachrová et al., 2020; Baek et al., 2021).

However, the downsides of tourism are also inevitable if the activities are not well managed due to their negative impacts on the environment (Dunjić et al., 2017). One of the most highlighted issues in a decade is waste disposal in tourist destinations located in national parks. (Belsoy et al., 2012; Byers et al., 2024). Waste generated in tourist areas is often managed merely by collecting, transporting, and disposing of it without proper waste management practices (Yulia et al., 2021). Waste generated by visitors has been known to pose risks to the environment, not only leaving it as a pollutant but also having a wide range of impacts on wildlife, forest regeneration, and the environment. For example in Ujung Kulon National Park, rubbish left by visitors has been consumed by wildlife, indirectly altering animal behaviour and interactions with food preferences, and increasing the risk of disease transmission to animals and even humans. (Laurenson et al., 1998; Woodroffe et al., 1999; Newsome et al., 2013; Johnson et al., 2015; Lewis et al., 2015; Sekarningrum, 2020; Satyatama et al., 2023). The lack of waste management facilities and infrastructure in national park areas is ineffective because these areas are located in remote areas and are difficult to reach. Mobilisation to transport waste is also still limited, so the waste problem in the national park area is still not well resolved. In addition, inadequate field personnel hinder optimal supervision, education and inspection. Education is required to provide an understanding of performing and maintaining travel experiences, ethics, cleanliness, and comfort (Velmurugan et al., 2021). Awareness from visitors is also very influential in keeping the tourist areas of being clean (Abdullah et al., 2018; Alubel et al., 2021).

In Indonesia, Protected area, including national parks, are in different ecosystems, from terrestrial, covering low to high land and aquatic environments. The number of national parks, to the present, has become the highest among the other forms of conservation areas (Goh, 2019). The increasing public interest in traveling in nature greatly affects the management of natural tourism areas (Ferretti-Gallon et al., 2021; Telbisz et al., 2023). The increase in the number of visitors will be proportional to the increase in the volume of waste (Adewumi et al., 2019; Rauf et al., 2022). The behaviour of hikers who are aware of the impact of littering affects the sustainability of the area. The National Park management has many ongoing challenges to achieving the goals of protection and tourism (Lee et al., 2019). The behavior of visitors who ignore the rules in the tourist area has become a big problem. In recent decades, visitor behavior has become a major concern for national park management worldwide (Amin et al., 2022). The importance of obeying the rules that apply to tourist areas such as not littering and other rules related to the management of National Parks. Visitors responsible for preserving and complying with the rules have a major impact on the management of tourist areas (Pope et al., 2019) When tourists understand the importance of preserving and cleaning the environment, it will have a positive impact (Zheng et al., 2021; Ravikumar et al., 2022).

Bantimurung Bulusaraung National Park (TN Babul) is one of the national parks in Sulawesi. Mount Bulusaraung, which is a climbing area, is not a karst formation, but rather marine sedimentary rock interspersed with volcanic rock, volcanic rock composed of breccia, lava, conglomerate, tuff, as well as intrusive and alluvial rocks Hiking activities have led to an increase in visitors, particularly hikers, resulting in a rise in waste generated in the Bulusaraung Mountain area. Although waste management efforts exist in this area, they are not yet optimized. According to the Head of the Conservation Agency's Decision No. SK. 188/T.46/TU/KSA/10/2016 on the Standard Operating Procedures (SOPs) for Visitor Services and Bulusaraung Mountain Hiking Rules, these SOPs serve as guidelines for visitors on hiking mechanisms and rules, including the inspection of items that could become waste and the requirement to bring back waste to the Information Center where registration is conducted before the hike. The rules applied can guide hikers to understand the importance of maintaining conservation areas (Fernández-Llamazares et al., 2020). However, these SOPs might not have been fully applied effectively, causing waste issues along the Bulusaraung hiking trail to remain unresolved. This may lead to the accumulation of waste at several spots on Bulusaraung Mountain. Given the unresolved waste issue due to visitors' non-compliance with waste management regulations, this research, in general, was aimed at assessing hikers' perspectives toward waste management in the Bulusaraung Mountain area.



validity of the answers was further analyzed using Principal Component Analysis (PCA). The relationship between the three variables hikers' (perceptions, attitudes, and awareness) with the socio-demographic conditions of hikers was analyzed using Spearman's correlation to determine the relationship between variables with hikers' socio-demographics is significant if the p value <0.05. PCA analysis was used to validate each dimension tested without rotation to find the components of the hikers' perception, attitude, and awareness variables that were correlative and representative. From the variables tested, these dimensions formed several components that approached Eigenvalue <1. Using a linear graphic statistical approach, components will be formed to select the results of the hikers' perception, attitude, and awareness variables.

## RESULTS

### Characteristics of Respondents

Data on respondent characteristics were collected, focusing on age, gender, education, occupation, and organizational participation. Age is divided into three categories: under 20 years (28%), 20-30 years (67%) the highest percentage in the age group and 30-40 years (5%) with the lowest percentage. Male respondents dominated (80%), and the majority of hikers were college students (91%), indicating that their knowledge about waste was good. Occupation was divided into four categories: students (81%), private employees (11%), entrepreneurs (5%), and civil servants (3%). Lastly, participation in organizations was considered, with half of the respondents having no organizational background (50%), and the rest divided into categories: nature-loving students (MAPALA; 31%), scouts (8%), nature-loving students in schools (SISPALA; 6%), and active members of NGOs (5%)(Fig.2).

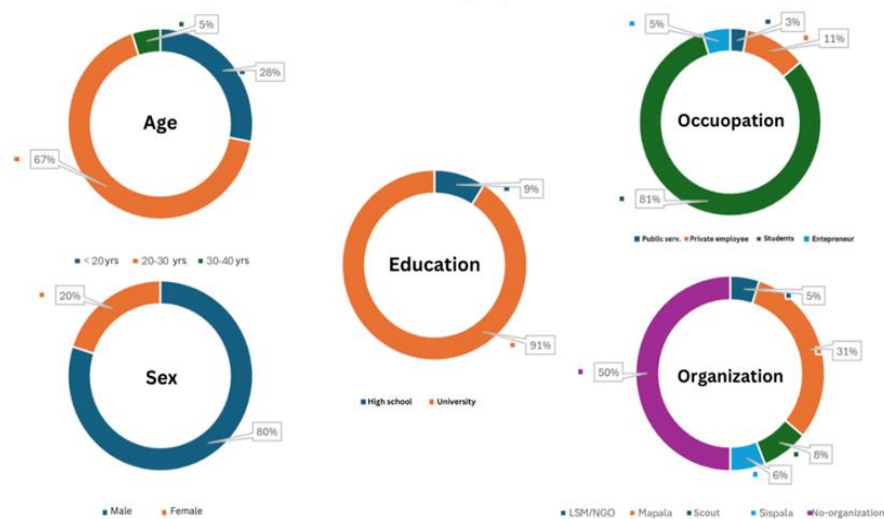


Figure 2. Socio-demographic descriptions of hikers in Bulusaraung Mountain (South Sulawesi)

### Waste Composition

Observations were made on the waste composition collected along the Bulusaraung Mountain hiking trail. Waste was divided into three categories: plastic, metal/glass, and paper. Plastic waste is the most common type of waste and can be processed into useful products (Nunoo et al., 2009; Pagdee & Morgan, 2021). Plastic waste, mainly plastic bags, and water bottles dominated (79%), followed by paper waste (16%), metal/glass waste (4%), and other materials (<1%) (Fig.3). The waste data collected from June to July 2023 showed an average of 0.40 kg per person (Table 1). This value represents the amount of waste successfully brought back by hikers, indicating that several kilograms were unaccounted for due to factors such as waste falling, being blown away by the wind, or other reasons leading to the waste not being brought back out of the hiking trail.

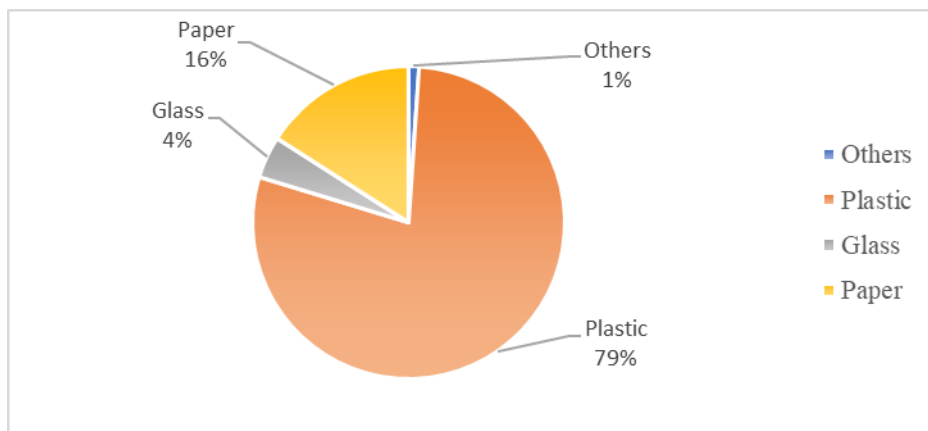


Figure 3. Waste Composition Generated by Hikers of Bulusaraung Mountain (South Sulawesi), Indonesia

Table 1. The average monthly waste generated by hikers in Bulusaraung Mountain (South Sulawesi), Indonesia

No	Month	Total waste collected (kg/month)	Number of Hikers (people/month)	Average hiker’s waste (kg)
1	June	168,72	444	0,38
2	July	203,39	473	0,43

Perceptions, Awareness, and Attitudes of Hikers

The majority of respondents (53%) strongly agree that waste management needs to be improved, and there are (39%) in the category of agree (Fig.4). This has indirectly indicated a strong consensus on the need for better waste management practices. Although (36%) of respondents agree that the current roles are adequate and (41%) remain neutral, there is still a space required for improvement, particularly related to stakeholder involvement. The adequacy of waste management personnel shows variability in perceptions, with (47%) neutral, (35%) agreeing, and (14%) disagreeing, reflecting uncertainty about the sufficiency of the personnel.

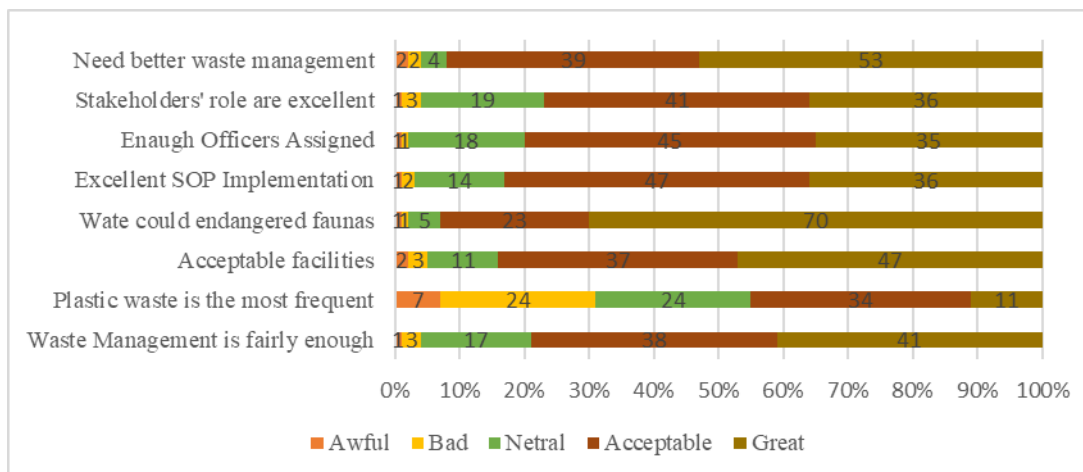
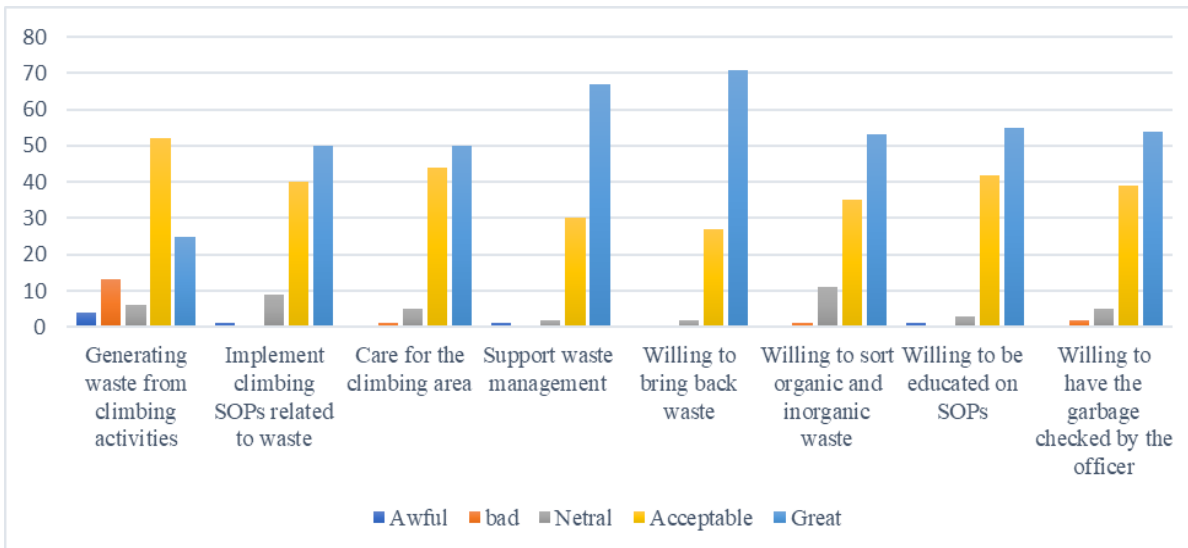


Figure 4. Perceptions of respondents towards the implementation of SOPs for waste management in Bulusaraung Mountain (South Sulawesi), Indonesia



Opinions on the implementation of standard operating procedures (SOPs) for hiking vary, with (46%) neutral, (47%) agree, and a small minority disagree, indicating diverse experiences with the current SOPs. Most respondents (70%) agree or strongly agree that waste can harm wildlife, showing awareness of the environmental impact of improper waste management. The adequacy of facilities received mixed reviews, with (47%) neutral and (37%) agreeing, suggesting that the existing facilities may not fully meet hikers' needs. The perception that plastic waste is the most common type is held by (36%) who agree and (24%) who strongly agree, highlighting the known issue of plastic pollution. Lastly, opinions on the overall good management of waste are divided, with (41%) agreeing and (38%) neutral, reflecting varying levels of satisfaction with current waste management efforts. Overall, the data show significant concern about the current waste management conditions, emphasizing the need for improvements, enhanced facilities, and more effective stakeholder engagement to address these issues.



**Figure 5.** Attitudes and awareness of respondents towards waste management in Bulusaraung Mountain (South Sulawesi), Indonesia

Attitudes and awareness of hikers in Fig. 5 show that respondents have high attitudes and awareness towards waste management in the Bulusaraung Mountains. Respondents agreed to produce waste from climbing activities by (77%) and those who disagreed to produce waste by 17%. In climbing, some SOPs must be implemented by hikers, and respondents are ready to comply with these SOPs (99%). Respondents' attitude of concern for a climbing area free from litter is shown by (95%) of respondents' answers care about this. Furthermore, (97%) of respondents argued in favor of waste management on the Bulusaraung mountain hiking trail. The hikers' awareness to bring their waste back after climbing activities amounted to (98%) and the next (88%) of hikers were willing to sort organic and inorganic waste. Only (12%) of respondents had a neutral opinion. While hikers are willing to be given education on climbing SOPs before climbing (96%), then climber respondents think they are willing to have their garbage rechecked by officers (93%). Further analysis was carried out using PCA analysis to see the relationship between perceptions, attitudes, and respondents' awareness.

**Relationship Between Socio-demographic Factors and Hiker’s Perspectives**

A correlation test was conducted between perceptions and socio-demographic conditions (Table 2). It was revealed that the relationships between age and perception, attitude, and awareness were insignificant ( $p>0.05$ ). This also occurred due to the relationship between attitude and socio-demographics. A positive and significant relationship was found between age and waste management awareness in Bulusaraung Mountain ( $p=0.05, r=0.197$ ).

**Table 2.** Relationship between sociodemographics towards perceptions, attitudes, and awareness of hikers in Bulusaraung Mountain (p<0.05)

Socio-demographic	Correlation		
	Perception (p-value; r-value)	Attitude (p-value; r-value)	Awareness (p-value; r-value)
Age	0.283; 0.108	0.118; 0.157	<b>0.05</b> ; 0.197
Sex	0.301; -0.105	0.268; -0.112	0.927; -0.009
Education	0.927; 0.022	0.707; 0.082	0.775; 0.105
Occupation	0.149; -0.146	0.337; -0.097	0.154; -0.144
Organization	0.111;-0.165	0.104; -0.183	0.175;-0.113

The analysis of hiker’s perspectives was analyzed using the principal component analysis or PCA method. The significance of the first principal component variable was assessed to determine how much each variable contributed to the first component (Poponi et al., 2020). This analysis is used to see the relationship between hikers' perspectives on waste management from perception, attitude, and awareness variables. Table 3 is a table of perception variables in which there are 20 items of hiker’s perception statements (PR). After PCA analysis without rotation collected in a linear graph, 5 (five) components were formed resulting from respondents' perceptions. The five components are formed which are close to the number Eigen < 1.

**Table 3.** Evaluation of perception variables

Perception statement	Component 1	Component 2	Component 3	Component 4	Component 5
PR19	0.795*	0.117	0.048	-0.248	-0.156
PR18	0.782*	-0.307	0.225	-0.068	0.056
PR16	0.773*	-0.352	0.122	-0.084	-0.091
PR14	0.767*	0.065	0.1	0.024	-0.011
PR20	0.757*	0.197	0.03	-0.344	-0.086
PR7	0.746*	0.42	-0.228	0.071	-0.021
PR8	0.728*	0.502	-0.095	0.202	0.051
PR10	0.722*	0.361	-0.082	0.153	-0.064
PR13	0.71*	-0.25	0.134	0.339	-0.125
PR12	0.682*	-0.374	-0.118	0.149	-0.046
PR17	0.632*	-0.522	0.041	0.065	-0.157
PR15	0.62*	-0.288	0.057	-0.071	-0.493
PR9	0.61*	0.454	-0.312	0.087	0.177
PR11	0.606*	0.485	-0.001	0.321	-0.047
PR4	0.594*	-0.118	-0.096	-0.443	0.365
PR6	0.581*	0.13	0.108	-0.368	0.404
PR1	0.438	-0.605	-0.129	0.07	0.203
PR5	0.257	-0.23	0.459*	0.457	0.55
PR3	-0.006	0.297	0.675*	-0.33	-0.059
PR2	-0.083	0.346	0.687*	0.165	-0.13

\*Correlation value close to Eigenvalue <1

The value shows that component 1 has the most dominant closeness value because it has a correlation value close to the value of 1 (one), while items PR1, PR5, PR3, and PR2 can be eliminated because they have different correlation values with most other items in the same construct. Of the 20 perception items, 16 perception items have a correlation value close to the Eigenvalue <1.

Furthermore, the same test was carried out for the attitude variable (AT). For the attitude variable, 2 components have closeness or correlation after evaluating the PCA method (Table 4).

**Table 4.** Evaluation of attitude variables

Attitude statement	Component 1	Component 2
AT1	0.296	0.833*
AT2	0.279	0.817*
AT3	0.088	0.719*
AT4	0.835*	-0.044
AT5	0.727*	-0.272
AT6	0.868*	-0.147
AT7	0.891*	-0.094
AT8	0.799*	-0.16
AT9	0.823*	0.039
AT10	0.571*	0.006

\*Correlation value close to Eigenvalue <1

The value shows that items AT1, AT2, and AT3 can be eliminated because they have different correlation values with most other items in the same construct, for other SK items are not eliminated because they have close correlation values. For the awareness variable (AW), after testing with the PCA method, only 1 component was found (Table 5).

**Table 5.** Evaluation of awareness variables

Awareness statement	Component
AW1	0.668
AW2	0.752
AW3	0.739
AW4	0.83
AW5	0.857
AW6	0.869
AW7	0.908
AW8	0.841

There are 8 statements and questions in the questionnaire submitted to hikers climbing the Bulusaraung Mountains. It can be concluded that the awareness variable has a high correlation and closeness of values, so all items can be taken as items for the variable.

**DISCUSSION**

Waste management in the Bantimurung Bulusaraung National Park hiking area poses a major challenge for environmental and biodiversity conservation. The Bulusaraung Mountains, which are famous for their stunning karst formations and an altitude of 1,353 meters above sea level, are easily accessible to novice hikers, thus attracting many visitors, especially students from surrounding areas, to come to this park. The influx of hikers and tourists has led to an increase in waste production that can damage the environment and pose urgent problems for the local ecosystem and the overall aesthetics of the park. Plastic waste is the type of waste that dominates the waste of hikers in the Bulusaraung mountains. For effective waste management in the hiking area, several important considerations are needed, including establishing stricter standard operating procedures (SOPs) (Syaputra, 2019). Respondents stated that the implementation of the Bulusaraung Mountains Climbing SOP was good, but this SOP must describe how hikers can bring back their waste and determine strategic locations for waste management facilities along the climbing route (Briswakarma et al., 2023).

Additionally, involving local communities in waste management programs is crucial for their success (Danese, 2021). Consequently, engaging the local community in the Bulusaraung Mountains' waste management efforts is essential. Furthermore, promoting environmental education among rs and residents can foster a deeper understanding of the importance of preserving natural landscapes. Workshops and



informational sessions should be organized to inform individuals about the environmental impact of improper waste disposal and the benefits of maintaining a clean climbing area. This increased awareness can motivate hikers to adopt responsible practices, such as utilizing biodegradable waste bags and adhering to the principle of "Leave No Trace" (Sharp et al., 2018).

Hikers in the Bulusaraung Mountains generally have quite good attitudes and awareness. Although respondents admitted that they produce waste during climbing activities, follow standard operating procedures for climbing related to waste, and advocate for a waste-free mountain area, some waste is still disposed of incorrectly. Evidence of litter was seen at post 9, where hikers rest or spend the night. Respondents showed a willingness to bring back their waste, separate organic and inorganic waste, and have their waste checked by the authorities as much as 65%. Although respondents expressed support for waste management in the Bulusaraung Mountains, actual practices in the field show that hikers still violate waste disposal norms. This indicates that hikers' attitudes and awareness still need to be improved through education and awareness programs (Rijal et al., 2020). The hikers' age impacts their views, perspectives, and awareness of waste management in the Bulusaraung Mountains. As hikers age, their concern for environmental conservation, including waste management, increases (Almulhim & Abubakar, 2021). Environmental awareness tends to align with age, reflecting knowledge and ingrained personal behaviors and norms (Farage et al., 2021). Hendra et al. (2015) stated that the perception of hikers and residents towards management affects environmental sustainability. Raising awareness of environmental quality is essential to maintaining sustainability (Ihsyaluddin & Mane, 2022). Thus, maintaining environmental quality in the Bulusaraung Mountains area is influenced by perceptions and local communities so that the area remains sustainable.

Educational initiatives and community engagement are essential in fostering environmental stewardship within the climbing community (Azeharie et al., 2022). Hikers education influences perceptions, attitudes and awareness of waste management, which has been statistically shown to be positively correlated. This collaborative endeavor is geared towards nurturing a sustainable hiking ethos, safeguarding pristine landscapes like the Bulusaraung Mountains for posterity. The diverse personal backgrounds of individuals can impact their environmental awareness, as suggested by Dean et al. (2019). Cohen's criteria for interpreting correlation coefficients indicate that coefficients under 0.3 are weak (Cohen & Kohn, 2011).

In addition, it is important to consider the role of education and access to information in shaping environmental awareness. Individuals who have the opportunity to engage in environmental education programs or access media that highlight ecological issues may demonstrate higher awareness and proactive behavior (Sunari & Nurhayati, 2023). For socio-demographics, gender, occupation and organization, the correlation to hikers' perceptions, attitudes and awareness is negatively correlated. This is because background, cultural values and social norms can influence a person's perspective. Conversely, in societies that highly value individualism, there may be less communal pressure to engage in environmentally friendly practices (Ballabh et al., 2022).

Future research should aim to dissect these multifaceted influences further, possibly employing mixed methods approaches to capture the nuanced interplay between personal background, education, cultural context, and environmental awareness. By doing so, we can develop more targeted and effective strategies for promoting environmental consciousness across diverse populations. Understanding these dynamics enriches academic discourse and equips policymakers and educators with the insights needed to craft interventions that resonate on a deeper, more personal level. This holistic approach is essential for fostering a global community that is informed, engaged, and committed to safeguarding our planet for future generations (Kyle, 2020).

## **CONCLUSION**

Waste management in the Bulusaraung Mountains is already underway, but there is no proper and good management. With the implementation of the visitor service SOP for hikers, the amount of rubbish scattered along the hiking trail has decreased from before the SOP was implemented. However, the SOP for visitor services has not completely solved the problem of waste that still accumulates at the Bantimurung Bulusaraung National Park information center. The provision of education and socialization related to waste

still needs to be improved, as well as the availability of waste management facilities and infrastructure and awareness about proper waste management through training or collaboration with related parties and stakeholders. This approach will help make climbing waste management useful and economically beneficial for managers and local communities around the Bulusaraung Mountains. The relationship between the perception, attitude, and awareness of hikers will affect the quality of the environmental area of the Bulusaraung Mountains. The age of hikers affects awareness of the environment and waste management in the Bulusaraung Mountains. The older one gets, the better one's awareness, as evidenced by significant statistics. However, gender, education, and occupation do not affect hikers' perception, attitude, and awareness, which is statistically insignificant. Most likely, the Bulusaraung Mountains' hikers are novice hikers whose knowledge and awareness of waste are still lacking. Of course, with better waste management in the Bulusaraung Mountains area, the karst landscape plays an important role for protected flora and fauna. It is also a source of water for life that must always be preserved so that it is not polluted by waste so that the beauty of nature can continue to be maintained.

## ACKNOWLEDGEMENT

Thanks to the Bantimurung Bulusaraung National Park Center for helping the author during the research, especially the Balocci resort. This paper is not perfect, but the author hopes that this paper can be helpful for waste management in Bantimurung Bulusaraung National Park.

## AUTHOR CONTRIBUTIONS

Alya Heldayanti: main contributors, research conceptualization, research implementer, data analysis, data interpretation, manuscript writing; Asrianny: member contributor, research coordinator, data analysis, data interpretation, manuscript writing; Risma Maulany: member contributor, data interpretation, manuscript writing”.

## CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest related to financial funding or the order of authorship for this article

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