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Clustering Residents' Attitudes Toward Human-Wildlife Conflict: A Case Study of Neighboring Communities in Paliyan Wildlife Sanctuary, Indonesia

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ABSTRACT

Understanding the heterogeneity of community opinions on human-wildlife conflict is crucial for developing effective mitigation strategies. This research investigates the attitudes and behaviors of residents surrounding Paliyan Wildlife Sanctuary in Indonesia, with a focus on their interactions with the long-tailed macaque (*Macaca fascicularis*) and the resulting human-wildlife conflict (HWC). By employing the attitude-behavior-context (ABC) framework, the research aims to identify and cluster different community groups by using K-means clustering analysis based on their perceptions of macaques, conservation initiatives, and the management of human-wildlife conflict. We identified distinct clusters of residents, classified by their positive and negative attitudes, degree of support for wildlife conservation initiatives, their perceptions of the sanctuary's management, and the intensity of conflicts they experience with macaques. The "Conditional Conservation Supporters" exhibit less trust in wildlife managers and comparatively greater support for conservation, while underscoring the necessity for successful conflict resolution. In contrast, the "Disillusioned Critics" display less faith in conservation authorities, limited endorsement of existing management practices, and a pronounced inclination to regulate macaque populations. This research highlights the intricate interaction between human communities and wildlife conservation, highlighting the necessity of understanding local attitudes and behaviors in shaping conservation outcomes. The study provides policymakers and conservation practitioners with essential information for designing more customized and effective interventions that meet both the ecological requirements of wildlife and the social dynamics of local communities.

1. Introduction

Human-wildlife conflict (HWC) constitutes a substantial global concern, particularly in areas where human populations are closely linked to conservation areas (Göttert and Starik 2022; Li et al. 2024; Ma et al. 2024; Novriyanti et al. 2025; Ravenelle and Nyhus 2017; Xin et al. 2024). In these areas, human populations often coexist near wildlife habitats, resulting in frequent interactions that can negatively impact agricultural livelihoods. The long-tailed macaque (*Macaca fascicularis*) is a species that often causes economic harm by foraging on crops, thereby

exacerbating conflicts between wildlife and local communities (Rifaie et al. 2024; Xin et al. 2024). Jayarathne et al. (2025) indicate that in India's Kurunegala District, macaque invasions result in a monthly economic loss of USD 7.66–46.64 per household, highlighting a considerable financial burden on local farmers. Studies on the long-tailed macaque consistently demonstrate that negative attitudes toward wildlife are frequently associated with economic hardship, particularly in communities situated near conservation areas that experience significant wildlife-induced losses (Fitria et al. 2020; Metananda et al. 2024; Nasri et al. 2023; Rifaie et al. 2024; Xin et al. 2024). Consequently, understanding residents' attitudes, behaviors, and the contextual elements that influence their interactions with wildlife is essential for formulating effective conflict mitigation strategies.

Attitudes, defined as individuals' assessments of wildlife species or wildlife-related issues, play a crucial role in shaping specific behaviors (Nilsson et al. 2016; Qiu et al. 2024). Studies conducted throughout Indonesia have consistently demonstrated that long-tailed macaque is generally viewed with a negative attitude (Fitria et al. 2020; Metananda et al. 2024; Rifaie et al. 2024). This is primarily due to the potential hazards these animals pose to local safety and livelihoods, as well as the damage they cause to crops. Metananda et al. (2024) reported that long-tailed macaque disturbances in Riau manifest as aggression toward children, destruction of lighting fixtures and roofs, damage to fruit trees and vegetable plots, and frequent large troop movements through residential areas. Similar to this, a study conducted by Fitria et al. (2020) in Central Java and the surrounding regions revealed that long-tailed macaque troops (ranging from a dozen individuals to over 400) frequently infiltrate farms and villages, damaging food crops (cassava, corn, vegetables, fruit trees), infrastructure, and tourist sites, and have even inflicted bite injuries on residents and visitors. Retaliatory actions, such as the use of traps or poison, may result from such negative attitudes, which can exacerbate conflicts and impede conservation efforts.

However, studies also emphasize that attitudes toward wildlife are not fixed and can evolve, especially when communities perceive tangible benefits from conservation efforts or are engaged in decision-making processes (Madden and McQuinn 2014; Pudyatmoko et al. 2018). Effective and culturally appropriate wildlife management solutions that integrate both livelihood interests and conservation goals can significantly influence local attitudes (Dong et al. 2024; Pudyatmoko et al. 2018). These approaches may cultivate increased tolerance toward wildlife and bolster community support for conservation initiatives. Furthermore, the correlation between attitudes and behaviors is mediated by the degree of trust in conservation authorities and wildlife managers (Song et al. 2019; Stern and Baird 2015).

A lack of trust in these institutions can foster resentment and opposition to conservation programs, as residents may perceive their concerns as inadequately addressed, thereby affecting their willingness to support wildlife conservation activities. Insufficient participation in decision-making processes can lead to feelings of disenfranchisement, which can exacerbate unfavorable perceptions of wildlife and increase the likelihood of actions detrimental to conservation objectives. Notably, many locals residing near protected areas often develop a profound affinity for these locations. This attachment has a significant impact on community support for conservation initiatives, fostering a deep emotional bond with the area and motivating individuals to safeguard its natural and cultural heritage. Studies indicate that individuals with a strong sense of place attachment view conservation initiatives as congruent with their identity and livelihood, adhering to regulations and participating in pro-conservation behaviors (McGinlay et al. 2023). Place attachment, in conjunction with perceived social consequences and trust in park

management, constitutes a vital element in cultivating and sustaining local support for conservation initiatives (McGinlay et al. 2023; Xie and Wang 2024). The situations above underscore the importance of understanding both individual attitudes and behaviors, as well as the broader institutional and governance frameworks in which these dynamics occur.

This study examines four villages adjacent to the Paliyan Wildlife Sanctuary (PWS), which are increasingly affected by human-wildlife conflicts—a growing issue in Java, Indonesia. These villages serve as significant case studies, illustrating the overarching issues faced by communities at the intersection of human activities and wildlife habitats. The research highlights the increasing prevalence and urgency of such conflicts in recent years (Rifaie et al. 2024), thereby enhancing our comprehension of the underlying social and ecological dynamics. The goal of this research is to analyze the attitudes, behaviors, and contextual conditions inside PWS, yielding significant insights into the dynamics of human-wildlife relationships in the region and generating more effective, context-sensitive conservation measures. The findings will elucidate essential factors contributing to conflict and underscore the necessity for customized, participatory approaches that consider local context and promote collaboration between wildlife managers and local communities. Mitigating human-wildlife conflicts requires a comprehensive strategy that prioritizes wildlife conservation while simultaneously addressing the livelihoods and welfare of local communities, thereby assuring the efficacy and sustainability of conservation initiatives. This research aims to identify nuanced patterns of support and resistance by categorizing residents based on their attitudes and behaviors within a specific context, thereby providing insights into effectively engaging diverse community groups in conservation initiatives. Ultimately, this study enriches the existing literature on HWC by providing a more thorough knowledge of the factors influencing residents' responses to wildlife conflicts.

2. Materials and Methods

2.1. Study Site

This study identifies the central coordinates of the villages of Karangduwet (-8.005512° S and 110.503794° E), Karangasem (-8.009057° S and 110.532012° E), Kepek (-8.057370° S and 110.513572° E), and Jetis (-8.037931° S and 110.489201° E), which are situated along the periphery of the Paliyan Wildlife Sanctuary in Gunungkidul, Yogyakarta, Indonesia (**Fig. 1**). These villages are primarily populated by agricultural populations that depend significantly on land-based activities for their livelihoods. The predominant activities of residents in Karangduwet are rice farming, vegetable and fruit farming, and small-scale livestock husbandry, including goats and chickens. Karangasem is an agricultural village where rice cultivation and cattle rearing are pivotal to the local economy, with some households also growing crops such as cassava and maize. Kepek integrates rice cultivation with the collection of forest resources, as several residents depend on the adjacent forest for fuelwood, timber, and other materials alongside their agricultural activities. Goat farming is notably common in Kepek Village. In Jetis Village, rice cultivation predominates, accompanied by vegetable and fruit crops, while livestock, particularly goats, constitutes another important source of income. The four villages have a significant reliance on agriculture and natural resources, making them susceptible to the effects of human-wildlife conflicts. Wildlife, including the long-tailed macaque, frequently encroaches upon agricultural and livestock areas, resulting in crop destruction in the Gunungkidul area (Rifaie et al. 2024). These

confrontations have intensified and proliferated in recent years, presenting a significant challenge to the villagers' capacity to sustain their agricultural-based livelihoods. As a result, the communities in these villages are increasingly confronted with the dual problem of maintaining their land-based activities while managing the adverse effects of wildlife interactions.

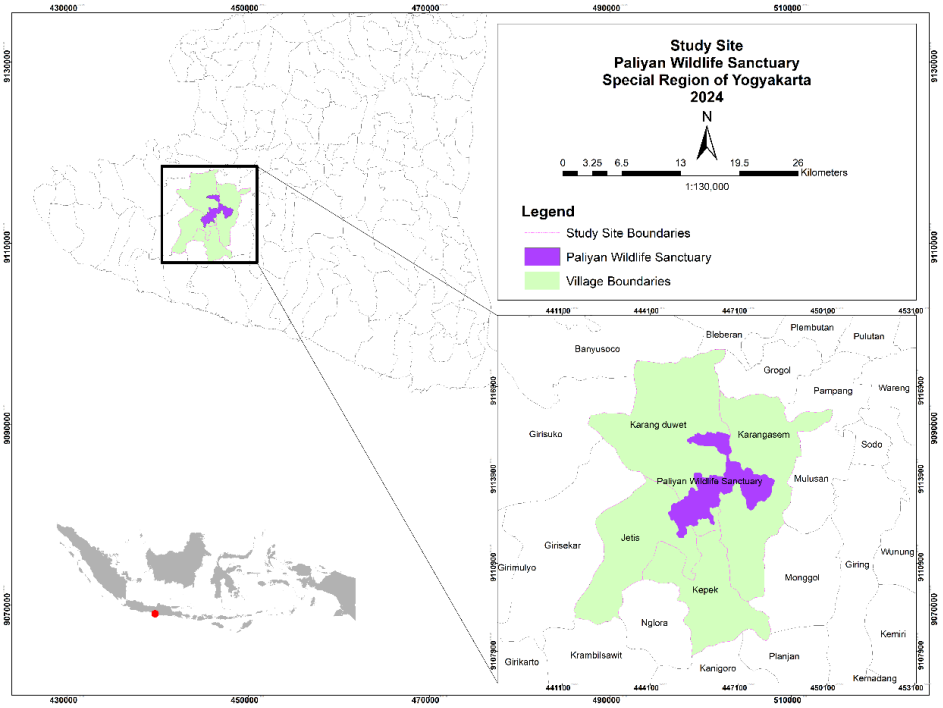

Fig. 1. Research site location.

2.2. Questionnaire Design

The attitude-behavior-context (ABC) framework is employed in this study. This robust theoretical framework examines the interplay between individuals' attitudes toward wildlife, their behaviors related to conflict, and the socio-environmental context in which these interactions occur. The ABC framework posits that human behaviors related to wildlife conservation are influenced not only by personal beliefs but also by contextual factors, including socio-economic conditions, cultural values, and resource availability (Cuadrado et al. 2023; Perry et al. 2022).

A structured questionnaire was developed comprising two sections. The initial part defines the seven latent variables, incorporating items intended to capture both cognitive beliefs and emotional responses. Questions were formulated to assess residents' opinions of the expansion of long-tailed macaque populations in the PWS, focusing on normative attitudes about population size. Local attachment items assess emotional ties to the PWS and its environment, examining how these elements influence residents' personal identity and daily life. Perceived negative and positive perceptions are assessed with measures that evaluate both the benefits and costs related to the long-tailed macaque. The assessment of trust in PWS managers is conducted through inquiries that gauge residents' confidence in PWS management's ability to safeguard wildlife and local interests. To assess the urge to control wildlife populations, the questionnaire includes items that explore residents' attitudes toward various wildlife population management strategies. Support for PWS conservation initiatives is assessed by questions regarding residents' willingness to endorse and participate in conservation actions and policies. A total of 35 question items were adopted and adapted from earlier studies (Metcalf et al. 2024; Nesbitt et al. 2023). Responses were recorded on

a five-point Likert scale, with 1 representing "strongly disagree" and 5 representing "strongly agree." The second section of the questionnaire collects demographic data from the respondents.

2.3. Survey Procedure

The questionnaires were administered in person to ensure a high response rate (Cheung et al. 2024; dos Santos and Cirillo 2023). Ten trained interviewers with a forestry background were responsible for data collection, conducting interviews, and distributing the questionnaires. The combined population of the four selected villages comprised 26,752 individuals. By applying Cochran's formula (Bartlett et al. 2001) for an infinite population—with a 95 % confidence level (Z = 1.96), an assumed variance of p = 0.5, and a 3.5 % margin of error (e = 0.05)—the required sample size was estimated at approximately 762. Due to resource limitations, such as time, human resources, and finances, random sampling or testing the entire population was not feasible. In light of this, a convenience sampling method was employed, selecting respondents based on their availability, accessibility, and willingness to participate (Etikan et al. 2016; Suen et al. 2014). The survey was restricted to residents in four targeted villages aged 18 and older. Individuals were approached and asked if they would be willing to participate in the survey. Once consent was obtained, participants completed the questionnaire on-site.

2.4. Data Analysis

Before conducting the cluster analysis, the data were carefully screened to ensure their suitability and relevance. The analysis was then performed using completed questionnaires. Initially, Cronbach's alpha (α) coefficient was used to evaluate the internal consistency of latent variables, measuring the degree of interrelationship among a set of items under a specific latent variable. A coefficient exceeding 0.6 signifies a robust level of reliability (Taber 2018), and the mean score of the latent construct's items was subsequently included in the clustering procedure. Subsequently, clusters were established utilizing a non-hierarchical clustering technique, specifically the k-means algorithm. This technique categorized residents' opinions according to the elements taken from the Attitude–Behavior–Context theory. The k-means algorithm is frequently utilized as it facilitates the determination of the optimal number of central clusters (*k*). To determine the optimal value of *k*, the silhouette method was utilized in this study. This method identifies k-centers that minimize the total sum of squared distances between each data point and its nearest center within the dataset. Once the optimal number of clusters was determined, k-means analysis was performed. To validate the clusters generated, an independent sample t-test was conducted. This test was used to compare the groups and identify any statistically significant differences between them. Finally, descriptive statistics and cross-tabulation were employed to describe the demographic characteristics of respondents within each of the identified clusters. The data analyses were conducted using RStudio, with the following packages: PSYCH (Version 2.4.6.24) and GGPLOT2 (Version 3.5.1).

3. Results and Discussion

3.1. Respondent Demographic Characteristics

The demographic profile of the respondents is presented in **Table 1**. Regarding the distribution by village, respondents were fairly evenly represented across the four surveyed areas,

with Kepek having the highest proportion (25.70%), followed closely by Karangduwet (25.21%), Karangasem (25.46%), and Jetis (23.62%). In terms of gender, males constituted a majority of the respondents (59.49%). In comparison, females made up 40.51%, reflecting a gender distribution that may influence perceptions and attitudes toward conservation and human-macaque interactions.

Table 1. Respondent demographic characteristics

No	Demographic characteristics	Frequency	Percentage (%)
1	**Village**		
	Karangduwet	206	25.21
	Kepek	210	25.70
	Karangasem	208	25.46
	Jetis	193	23.62
2	**Gender**		
	Male	486	59.49
	Female	331	40.51
3	**Age (years old)**		
	17 – 25	7	0.86
	> 25 – 35	56	6.85
	> 35 – 45	138	16.89
	> 45 – 55	240	29.38
	> 55	376	46.02
4	**Formal educational attachment**		
	No formal education	85	10.40
	Elementary school	311	38.07
	Junior high school	239	29.25
	Senior high school	171	20.93
	University	11	1.35

The age profile indicates that the majority of respondents were older, with 46.02% aged 55 years or older, followed by 29.38% aged 45–55 years. Only 16.89% of respondents were between 35–45 years, 6.85% between 25–35 years, and a small minority (0.86%) aged 17–25 years. This indicates that the surveyed population primarily consisted of older individuals, likely reflecting a cohort with established local ties and experiences related to human-macaque conflicts. Educational attainment highlights a predominance of respondents with limited formal education. A significant proportion (38.07%) had completed only elementary school, and 29.25% had attended junior high school. Meanwhile, 20.93% completed senior high school, 10.40% had no formal education, and a mere 1.35% attained university-level education. This demographic profile suggests that most respondents belong to a rural, older population with relatively low levels of formal education, which may shape their perspectives on wildlife management and conservation efforts. Understanding these demographic factors is crucial for tailoring conservation strategies that resonate with the local community.

3.2. Cluster Analysis

The value of the study's latent variables is summarized in **Table 2**. The reliability and descriptive analyses of the latent and measured variables reveal important insights into community perceptions regarding long-tailed macaques and conservation management. The reliability analysis, measured using Cronbach's alpha (α), demonstrates varying levels of internal consistency across constructs. A positive attitude toward long-tailed macaques has low reliability (α = 0.6),

Table 2. Latent and observed items, reliability coefficient, mean, and standard deviation

	Latent and measured variables	α	Mean	SD
	Positive attitude toward long-tailed macaque	0.6	2.03	1.35
1	Long-tailed macaque is a magnificent animal			
2	Long-tailed macaque plays a crucial role in maintaining environmental balance			
3	I am pleased to know that MEP inhabits the SM Paliyan forest area			
4	I am pleased to know that MEP is present in this village			
5	Long-tailed macaque can significantly contribute to improving the economic conditions of local residents			
6	Long-tailed macaque has the right to live in the SM Paliyan forest area			
7	In my opinion, MEP has the right to live in this village			
8	MEP has great potential to become a tourist attraction			
	Negative attitude toward long-tailed macaque	0.75	4.43	0.90
1	MEP consumes a significant amount of my time because I must constantly monitor them to prevent damage			
2	The presence of MEP is a burden, and I do not want to deal with them.			
3	MEP has the potential to target individuals, including myself.			
4	I am concerned that MEP might damage items that are important to me (e.g., buildings, farming tools, or crops in fields and yards)			
5	MEP negatively impacts and poses a detriment to the well-being of local residents			
	Normative Population expansion belief naturally	-	4.65	0.64
1	The MEP population naturally grows very quickly			
	Local attachment	0.92	4.66	0.70
1	I am a resident of this village			
2	I feel that I am an integral part of this village			
3	My opinions are well-respected in this village			
4	I am willing to contribute my time and effort to this village			
5	I consider the events and developments in this village to be important to me			
6	I feel a strong sense of responsibility for this village			
	Trust to wildlife sanctuary managers	0.97	2.83	1.38
1	I believe the managers of SM Paliyan possess effective strategies to manage and control the MEP population			
2	I trust that the managers of SM Paliyan share my perspective regarding ME			
3	I believe the managers of SM Paliyan are knowledgeable about resolving conflicts between the community and MEP			
4	I trust the managers of SM Paliyan to provide the community with the best information to minimize conflicts involving MEP			
5	I am confident that the managers of SM Paliyan communicate honestly about MEP and the current size of the MEP population			
6	I believe the managers of SM Paliyan would take similar steps to mine in addressing MEP-related issues			
	Control of long-tailed macaque	0.93	4.59	0.62
1	The MEP population should be controlled when it threatens the populations of other animals in SM Paliyan			
2	The MEP population should be controlled when it is observed near residential areas			
3	The MEP population should be controlled when it poses a threat to livestock			
4	The MEP population should be controlled when it damages agricultural or forestry crops			
5	The MEP population should be controlled when it damages residents' property			
6	The MEP population should be controlled when it endangers people or the community			
	Support for wildlife sanctuary conservation initiatives	0.84	3.31	1.48
1	I support all efforts to conserve various plant and animal species in SM Paliyan			
2	I fully support initiatives aimed at protecting MEP in SM Paliyan			
3	I am willing to participate in MEP protection activities by maintaining a village environment that is conducive to MEP			
4	I support MEP protection efforts by advocating for the continued existence of SM Paliyan			

suggesting variability in respondents' favorable views of these macaques. In contrast, negative attitude toward macaques (α = 0.75), local attachment (α = 0.92), trust in wildlife sanctuary managers (α = 0.97), control of macaque populations (α = 0.93), and support for conservation initiatives (α = 0.84) all exhibit acceptable to high reliability, indicating consistent responses within these constructs. Descriptive statistics further highlight prevailing attitudes and beliefs within the community. The mean score for positive attitudes toward macaques (mean = 2.03, SD = 1.35) is notably low, suggesting minimal favorability toward the species. In contrast, negative attitudes are significantly higher (mean = 4.43, SD = 0.90), indicating strong frustrations or concerns about macaques. Respondents express a near-unanimous belief in the importance of natural population regulation (mean = 4.65, SD = 0.64) and demonstrate strong local attachment (mean = 4.66, SD = 0.70), signifying deep ties to their environment and community. Trust in wildlife sanctuary managers is moderate (mean = 2.83, SD = 1.38), reflecting mixed opinions, while support for conservation initiatives is also moderate (mean = 3.31, SD = 1.48) but more variable across respondents. The need to control macaque populations receives strong agreement (mean = 4.59, SD = 0.62), highlighting the community's priority for management actions to mitigate human-macaque conflicts. These findings underscore a complex dynamic in which strong local attachment and shared beliefs in natural population regulation coexist with negative attitudes toward macaques, moderate trust in management, and mixed support for conservation efforts. Building trust and addressing human-macaque conflicts could improve community support for conservation initiatives.

The cluster analysis based on the attitude, behavior, and context (ABC) framework reveals two distinct groups, conditional conservation supporters (CCS) and disillusioned critics (DC), that represent differing perceptions and responses to human-macaque conflicts in the Paliyan Wildlife Sanctuary. These clusters illustrate the interplay between attitudes toward wildlife, conservation behaviors, and the contextual factors that influence these responses, as supported by the existing literature on community conservation and human-wildlife conflict management. Using the silhouette method, this study determined that the optimal number of clusters is two. **Fig. 2** illustrates the optimal cluster number identified through the silhouette method.

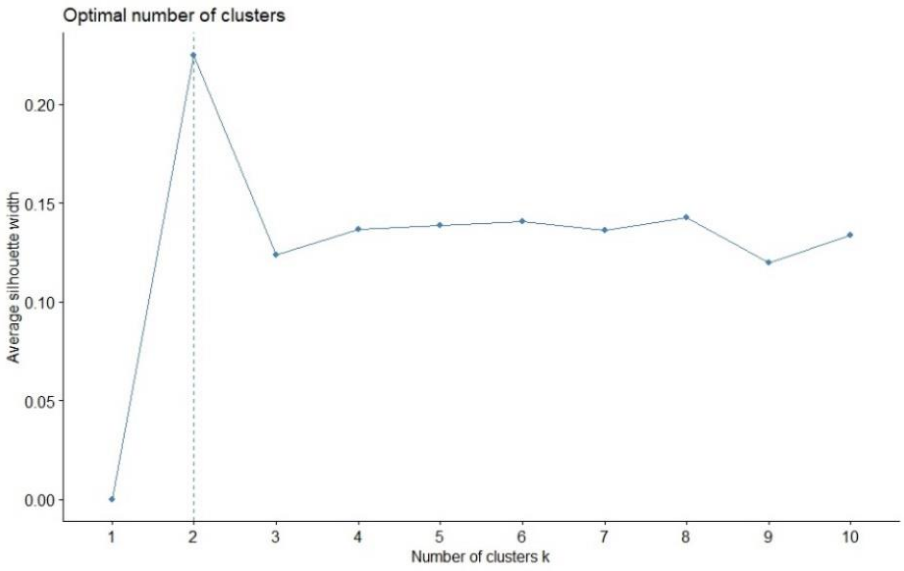

Fig. 2. The optimal number of clusters is generated by the Silhouette method.

The cluster plot depicting residents' attitudes based on the A-B-C framework is presented in **Fig. 3**. This figure provides a visual representation of the clustering results, highlighting the distinct groupings formed within the dataset. **Fig. 3** appears to show an overlap between clusters; however, this convergence is primarily a consequence of reducing a high-dimensional dataset, comprising seven latent variables, to two principal axes for visualization. Dim1 (accounting for 24.9% of the variance) is primarily influenced by negative attitudes toward long-tailed macaque, normative beliefs regarding population expansion, local attachment, and perceived control. In contrast, Dim2 (10.1% of the variance) reflects trust in wildlife sanctuary managers and endorsement of conservation initiatives. Respondents with moderate scores on these dimensions—neither strongly critical nor emphatically supportive—reside near the midpoint between cluster centroids. However, k-means assigns each borderline case to its nearest centroid; their composite positions inevitably fall within the convex hull of the opposite cluster in a two-dimensional projection. Substantively, such overlapping points denote individuals exhibiting ambivalent attitudes who may benefit from targeted engagement strategies that both address their concerns about long-tailed macaque impacts and cultivate their emerging willingness to collaborate with sanctuary authorities. Importantly, this interpretation is corroborated by the latent-variable means presented in **Table 3**, despite pronounced mean differences between CCS and DC respondents with intermediate scores, which diminish inter-centroid separation and thus manifest as overlap in the visual representation.

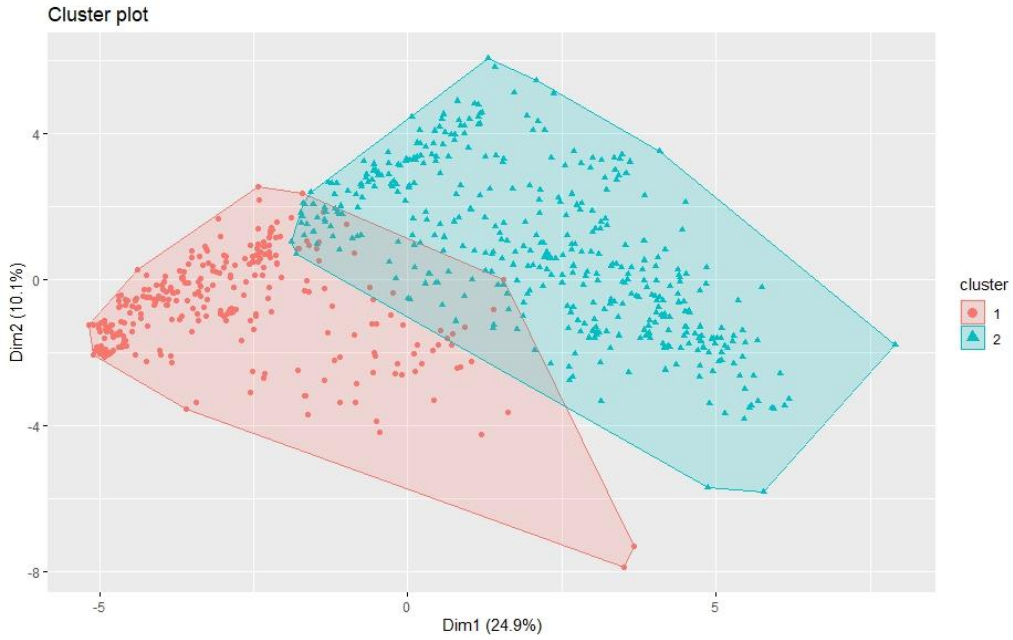

Fig. 3. Cluster plot for resident attitudes based on the A-B-C framework.

Interestingly, the absence of a significant difference in "positive attitude toward long-tailed macaque" between CCS and DC (**Table 3**) likely reflects a uniformly low degree of favorable sentiment toward macaques across all respondents, regardless of their overall conservation stance. In our study context, where repeated crop raids and property damage by macaques have engendered widespread concern, any residual "positive" sentiment (e.g., appreciation for macaque ecological roles) is overshadowed by conflict experiences, producing minimal variance on this latent dimension. In other words, both clusters share a baseline of negative affect that diminishes the discriminative power of the positive-attitude items. This circumstance indicates that standard

positive-attitude items may lack sufficient sensitivity to detect subtle variations in sentiment when negative encounters dominate community perceptions. Future studies could therefore refine the scale by incorporating items on cultural, aesthetic, or ecosystem-service values of macaques—approaches shown to reveal latent pro-wildlife affinities in other conflict landscapes (Messmer 2000; White and Ward 2010).

Table 3. Characteristics of clusters

Latent and measured variables	Cluster center		t-value	p-value	sig
	Conditional conservation supporters	Disillusioned critics			
Positive attitude toward long-tailed macaque	2.04	2.03	0.18	0.856	ns
Negative attitude toward long-tailed macaque	4.22	4.70	-11.88	0.000	***
Normative population expansion belief naturally	4.46	4.89	-10.11	0.000	***
Local attachment	4.44	4.94	-13.50	0.000	***
Trust to wildlife sanctuary managers	3.79	1.60	45.54	0.000	***
Control of long-tailed macaque	4.44	4.79	-10.40	0.000	***
Support for wildlife sanctuary conservation initiatives	3.95	2.50	18.90	0.000	***

Notes: ns (non-significant); $p > 0.1$, ***; $p < 0.001$.

The CCS demonstrates a balanced perspective toward conservation. They exhibit moderate trust in sanctuary managers (3.79), higher support for conservation initiatives (3.53), and a high level of local attachment (4.44). However, their negative attitudes toward macaques (4.22) and a strong desire for population control (4.44) reveal significant concerns about the impacts of human-macaque conflicts. This cluster aligns with the concept of conditional conservationism, where residents are willing to support initiatives if management addresses their practical concerns. Studies by Stern and Baird (2015) emphasize that trust in conservation authorities and perceived benefits are pivotal in fostering community support for conservation. CCS exhibits this dynamic; their willingness to collaborate hinges on their trust in sanctuary managers and the authorities' ability to mitigate conflicts effectively. Therefore, conservation managers should focus on building and maintaining trust by demonstrating effective management of human-wildlife conflicts, particularly those involving macaques. They should also harness the moderate trust and conditional willingness of CCS by implementing adaptive, community-responsive interventions. First, they should co-develop and install practical conflict-mitigation measures (e.g., reinforced crop barriers, strategic deterrent plantings, or early-warning systems) with CCS representatives to visibly address their concerns. Second, a streamlined compensation mechanism, featuring a transparent claims process and rapid disbursement, will reinforce perceptions of fairness and bolster procedural trust. Finally, establishing an inclusive governance forum, comprising PWS managers and selected CCS members, will enable the co-design of monitoring schedules, patrol routes, and educational outreach, thereby institutionalizing CCS engagement and sustaining their support for long-term conservation initiatives.

In contrast, DC represents a more oppositional stance, characterized by low trust in sanctuary managers (1.60) and minimal support for conservation initiatives (2.33). Their very high negative attitude toward macaques (4.70) and strong desire to control populations (4.79) reflect acute frustration with the conflicts, likely driven by repeated negative experiences. Their higher local attachment (4.94) and strong belief in natural population expansion management (4.89) indicate a deeply rooted connection to their community and land, but with a perception that macaques are a direct threat to their livelihood and environment. The strong local attachment to this cluster indicates a significant emotional and cultural connection to their land, which can amplify resistance when conservation measures disrupt their socio-economic stability (Sapiains et al. 2025; Zélie and Hunziker 2025). Their opposition to existing conservation strategies suggests that traditional top-down approaches may not be effective. Madden and McQuinn (2014) emphasize the importance of conflict transformation over mere conflict resolution in such contexts, advocating for processes that address underlying tensions and rebuild trust. For DC, characterized by high local attachment but deep mistrust, managers must prioritize conflict transformation and empowerment. They should convene mediated co-management committees that grant DC participants genuine authority over population-control protocols and sanctuary regulations, integrating their traditional ecological knowledge into decision-making. Simultaneously, the development of equitable benefit-sharing schemes (e.g., community-led ecotourism ventures or collaborative wildlife monitoring and conflict mitigation teams in which DC members receive real revenue shares) will align conservation outcomes with local livelihoods. Regular restorative dialogue sessions, focused on acknowledging past grievances and co-creating future land-use agreements, will further rebuild cultural trust and foster a sense of shared ownership in sanctuary governance.

3.3. Cluster Characteristics

Table 4 summarizes demographic characteristics of each cluster. The demographic characteristics of the conditional conservation supporters and disillusioned critics show notable differences. Among the CCS, the majority are male (65.07%) with a smaller proportion of female members (34.93%). This cluster is most represented in Karangduwet (31.00%) and Kepek (29.91%), with fewer members from Jetis (15.72%) and Karangasem (23.36%). The age distribution is skewed toward older individuals, with 43.01% being over 55 years old and 32.75% between 45 and 55 years old, while younger members are relatively few in number. Educationally, 27.95% have no formal education, 32.31% have completed junior high school, and 8.95% have completed senior high school.

In contrast, the DC group has a more balanced gender distribution, with 52.37% male and 47.63% female. This group is most concentrated in Jetis (33.70%) and Karangasem (28.13%), with fewer members from Karangduwet (17.83%) and Kepek (20.33%). Similar to the Conditional Conservation Supporters, the Disillusioned Critics are predominantly older, with 49.86% being over 55 years old and 25.07% between 45 and 55 years old. In terms of education, this group shows a higher percentage without formal education (50.97%) and fewer with junior high school (25.35%) or senior high school (12.26%) education. Both clusters are largely composed of older, less formally educated individuals, with differences in gender and village representation.

Table 4. Demographic characteristics of clusters

No	Demographic characteristics	Conditional conservation supporters (CCS)		Disillusioned critics (DC)	
		Frequency	Percentage (%)	Frequency	Percentage (%)
1	**Village**				
	Jetis	72	15.72	121	33.70
	Karangasem	107	23.36	101	28.13
	Karangduwet	142	31.00	64	17.83
	Kepek	137	29.91	73	20.33
2	**Gender**				
	Male	298	65.07	188	52.37
	Female	160	34.93	171	47.63
3	**Age (years old)**				
	17 – 25	3	0.66	4	1.11
	>25 – 35	34	7.42	22	6.13
	>35 – 45	74	16.16	64	17.83
	> 45 – 55	150	32.75	90	25.07
	>55	197	43.01	179	49.86
4	**Formal educational attachment**				
	No formal education	128	27.95	183	50.97
	Elementary school	132	28.82	39	10.86
	Junior high school	148	32.31	91	25.35
	Senior high school	41	8.95	44	12.26
	University	9	1.97	2	0.56

4. Conclusions

The results of this study offer several distinct contributions to the development and application of the attitude–behavior–context (ABC) framework, particularly within the context of human–wildlife conflict management. A significant theoretical contribution arises from the finding that the "positive attitude toward long-tailed macaques" does not differentiate between clusters, suggesting that standard measures of positive attitudes may lack sensitivity in contexts characterized by negative wildlife interactions. Hence, refining the ABC model by incorporating culturally relevant, ecosystem-service-oriented items is recommended for future studies. Additionally, the analysis empirically identifies two clusters—conditional conservation supporters (CCS) and disillusioned critics (DC)—which display distinct profiles in terms of attitudes, trust, and support for conservation, thereby enhancing the practical applicability of the ABC framework. From a policy perspective, CCS members, characterized by moderate trust and conditional support, should be actively engaged through co-designed conflict mitigation measures (e.g., reinforced crop barriers, strategic deterrent plantings) and rapid, transparent compensation processes. For the DC group, which exhibits high local attachment but intense mistrust and opposition, transformative approaches such as mediated co-management committees that empower local decision-making and equitable benefit-sharing schemes (e.g., community-led ecotourism, collaborative wildlife monitoring and conflict mitigation teams, community-based buffer zone restoration programs) are strongly recommended. These targeted interventions, guided by empirical cluster characteristics, can effectively reconcile community concerns with conservation objectives.

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Author Contributions

P.N.: Conceptualization, Methodology, Software, Validation, Formal Analysis, Resources, Data Curation, Writing – Review and Editing, Supervision, Funding Acquisition; L.R.W.F.: Conceptualization, Methodology, Writing – Review and Editing; W: Conceptualization, Methodology, Writing – Review and Editing; E.M.Y.: Investigation, Data Curation, Software, Validation, Spatial data analysis; G.R.A.: Investigation, Data Curation; M.F.N.H.: Investigation, Data Curation.

Conflict of Interest

The authors declare no conflict of interest.

Declaration of Generative AI And AI-Assisted Technologies in the Manuscript Preparation

During the preparation of this work, the authors utilized ChatGPT (OpenAI) to assist with paraphrasing passages and enhance the overall clarity of the manuscript. After using this tool, the author(s) carefully reviewed and edited all content as needed and take full responsibility for the accuracy and integrity of the publication.

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