Jurnal Manajemen Hutan Tropika, *28*(3), 232–240, December 2022
EISSN: 2089-2063
DOI: 10.7226/jtfm.28.3.232

Scientific Article
ISSN: 2087-0469

Clustering Residents' Intention and Behavior Toward Forest Rehabilitation Initiative: A Case Study in the Upstream of Central Java, Indonesia

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Received June 1, 2022/Accepted October 24, 2022

Abstract

The success of forest rehabilitation initiatives depends on community engagement; thus, it is important to understand community opinions toward forest rehabilitation initiatives. However, the available literature is sparse, as most research focuses on forest rehabilitation research, frequently only on planting performance. We scrutinized residents' opinions of the forest rehabilitation initiative using the extended Theory of Planned Behavior framework variables, i.e., behavior (*B*)*, behavioral intention* (*BI*)*, attitude toward behavior* (*ATB*)*, perceived behavioral control* (*PBC*)*, subjective norm* (*SN*)*, moral norm* (*MN*)*, perceived risk* (*PR*)*, and self-identity* (*SI*)*. Those factors were used to cluster residents into various groups using the k-means clustering method. 307 completed questionnaires were obtained. We found that residents were clustered into two distinctive groups: active supporters* (*AS*) *and passive supporters* (*PS*)*. PS was dominant in the community* (*61.9%*)*. They were characterized by less agreement in perceiving the adverse impacts of forest degradation, less intent and engagement in forest rehabilitation programs. In contrast, AS was more receptive to forest rehabilitation initiatives. These results confirm that residents are heterogeneous in opinions and interest in forest rehabilitation initiatives. Therefore, forest managers should design effective policies and alternative approaches to ensure the success of forest rehabilitation programs based on those distinctive groups.*

Keywords: *theory of planned behavior, clustering analysis, Bengawan Solo, upstream Java*

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Introduction

Tropical forest degradation is a major global concern. Indonesia's forest cover has degraded during the last few decades (Margono et al., 2014; Tsujino et al., 2016; Gaveau et al., 2021). Specifically, a significant forest cover in the upstream of Java island is deteriorating in various ways (Lukas, 2014; Higginbottom et al., 2019). Indeed, upstream areas provide essential services. However, upstream Java reflects a region where communities rely on forest areas and agricultural activities for their livelihoods (Cahyono & Wijaya, 2014; Muhamad et al., 2014; Nijman & Nekaris, 2014). Forest degradation has resulted in a decline in forest-based ecosystem services (Marhaento et al., 2018) and economic practices reliant on forests (Lukas, 2014; Nugroho et al., 2020). As a result, the Indonesian government's primary objective has been to restore forest cover in upstream areas through forest rehabilitation projects.

Indonesian forest rehabilitation practices have long transitioned toward a more participatory approach, focusing on community concerns (de Jong, 2010). Residents' active participation is definitely encouraged at this point. This is supported by the premise that comprehensive approaches, including technical and social components, will ensure the succes of forest rehabilitation strategies (Nawir et al., 2008). More importantly, scholars argue that it is critical to establish a link between forest recovery and local livelihoods (Adams et al., 2016; Nugroho et al., 2020). Numerous studies have explained Indonesian forest rehabilitation strategies; however, most focus on policy, technical, and physical activities. Marliana and Rühe (2014), for example, describe how forest regeneration in the Dieng Mountains was organized utilizing indigenous species. This is expected to cover the bare land and increase vegetation diversity, resulting in numerous ecosystem services provided by forests.

Additionally, previous research has focused on forest cover changes on water availability (Nugroho et al., 2013; Kusumandari & Nugroho, 2015; Suryatmojo, 2015; Marhaento et al., 2018). While those earlier physical-based studies were critical for forest rehabilitation implementation, it is now widely acknowledged that connecting social dimension (e.g., residents' opinions) to forest rehabilitation strategies is indispensable (Nawir et al., 2008; Nugroho et al., 2021b). It could be because residents are key stakeholders directly impacted by a range of socioeconomic and environmental changes. As a result, obtaining their

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perspectives on forest rehabilitation strategies would greatly assist forest rehabilitation evaluation and improvement. More importantly, a better understanding of the psychological mechanisms underlying residents' support for forest rehabilitation initiatives would help policymakers encourage more conservation behavior and increase the success of forest rehabilitation strategies.

However, it is commonly believed that communities are made up of individuals who have varying perspectives and interests regarding specific circumstances. Subsequently, their intentions and behaviors regarding forest rehabilitation are likely to be varied and complex. Following the theory of planned behavior (TPB) (Ajzen, 1991), people's intentions to engage in specific behaviors (Behavioral Intention/BI) can be influenced by their attitude toward behavior (ATB), perceived behavioral control (PBC), and subjective norms (SN). The current research defined behavior (B) as residents' involvement in forest rehabilitation initiatives in their villages. ATB considers a person's positive or negative feelings toward a particular behavior. SN is defined as an individual's assessment of the extent to which others take an interest in and support specific behaviors. PBC reflects an individual's belief in his or her ability to control his or her behavior. It entails assessing the degree to which a particular behavior would be difficult or simple to perform. Indeed, those Ajzen's basic tenets of TPB (Ajzen, 1991) have been extensively used in understanding people's behavior in research-related conservation programs (Yazdanpanah et al., 2014; 2016; Valizadeh et al., 2020; Nugroho et al., 2021a).

Yazdanpanah et al. (2014), on the other hand, extend basic TPB (Ajzen, 1991) in their study by incorporating normative dimensions, which have been shown to have a significant effect on residents' intentions and behavior. They indicate that moral norms (MN), self-identity (SI), and perceived risks (PR) have been shown to have a significant effect on residents' intentions and behavior. SI represents how an individual perceives hie or herself. Indeed, forest resources support local communities' livelihoods (Muhamad et al., 2014; Nugroho et al., 2020; Jiang et al., 2021; Nugroho et al., 2021a), and changes in forest ecosystem composition and structure may eventually jeopardize their livelihoods. More importantly, Whitmarsh and O'Neill (2010) emphasize the importance of people's self-identity in determining their willingness to engage in pro-environmental behavior. As such, the more significant forest rehabilitation is to a local's self-identity, the more likely they will participate in forest rehabilitation initiatives. Additionally, scholars have placed a greater emphasis on understanding human behavior through the lens of individual risk perception. It includes the mental processing of risk information and the coping mechanisms that people use when faced with uncertain outcomes (Datta & Sarkar, 2012), and it may also play a role in increased willingness to conserve forest areas. Also, studies contended that risk attitude could predict willingness to change behavior (O'Connor et al., 1999; Yazdanpanah et al., 2014). Furthermore, MN is self-administered moral rules or values that are motivated by anticipated self-administered rewards or penalties (Chang, 2010; Commerçon et al., 2021; Marini Govigli et al., 2021). Individuals who identify as typical conservationists are more likely to conserve resources than individuals who do not (Chang, 2010; Valizadeh et al., 2020). In summary, those earlier studies indicated that grasping individual psychology within a larger society is exceptionally challenging. Given this scenario, identifying groups of individuals who share similar patterns of intention and behavior and then clustering them would benefit in explaining the community's response to specific challenges. Finally, while there are numerous studies on clustering residents' opinions (del Chiappa et al., 2018; Skallerud & Armbrecht, 2020; Nugroho et al., 2021a), the study employs clustering analysis to examine residents' intentions regarding forest rehabilitation initiatives in the upstream area is underexplored.

The current study uses Wonorejo village in Karanganyar Regency, Indonesia, as a case study to understand the variability of residents' intentions and behavior regarding forest rehabilitation initiatives. Wonorejo is primarily found upstream of the Bengawan Solo Hulu sub-Watershed. Bengawan Solo Hulu subwatershed is the upper part of the Bengawan Solo watershed, which is regarded as one of Indonesia's most degraded watersheds (Mechram et al., 2012; Sudarsono et al., 2018). The current research attempts to cluster residents of Wonorejo village according to the factors driving their intention to engage in forest rehabilitation initiatives. The primary objective of cluster analysis is to identify individuals who hold similar opinions and eventually classify them into distinct groups (Sinclair-Maragh et al., 2015; Lopes et al., 2019; Nugroho et al., 2021a). We hypothesized that residents were clustered according to their distinct attitudes toward behavior (ATB), subjective norms (SN), perceived behavioral control (PBC), behavioral intention (BI), behavior (B), moral norms (MN), self-identity (SI), and perceived risks (PR). To clarify this, our research employs an extended Theory of Planned Behavior (TPB) by Yazdanpanah et al. (2014) and generates cluster analysis using their discovered determinants. While TPB is a well-known cognitive theory model for explaining volitional behavior variability through the use of interrelated variables (Ajzen, 1991), researchers have indicated that adding additional constructs increases the model's utility and predictive power (Fielding et al., 2008; Whitmarsh & O'Neill, 2010; Yazdanpanah et al., 2014; Nugroho et al., 2021a). Finally, the outcomes of the current study will provide a more realistic picture of the community structure in the field, allowing for greater insight into how to improve strategies and policies that enable upstream areas to deal with forest degradation challenges.

Methods

Study site The survey was intended to be a cross-sectional manner. The study site is in the Bengawan Solo watershed's upstream section, well-known as one of Indonesia's most degraded watersheds (Mechram et al., 2012; Sudarsono et al., 2018). Figure 1. demonstrates the study site and the upstream of the Bengawan Solo Hulu Subwatershed. Residents of Wonorejo village in Karanganyar Regency, Indonesia, comprised the population of interest. The village has a total population of 6,560 residents. The majority of households reported that their primary source of income is from farming activities on their land, while a small percentage of residents work as government officials, entrepreneurs, or laborers (BPS Kabupaten Karanganyar,

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Scientific Article
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2021). Our field study noticed that a series of forest rehabilitation initiatives had been run to counter forest degradation in recent years. In this scenario, the Ministry of the Environment and Forestry (MoEF) funded forest rehabilitation programs via Bengawan Solo watershed management agencies. These objectives were primarily attained by encouraging residents to establish a nursery that produced multi-purpose tree species. Once the seedlings mature, they will be planted in forest areas and private gardens.

Questionnaire design and survey procedure A structured questionnaire is divided into two sections based on the study of Manto (2021) which follows earlier studies conducted by Yazdanpanah et al. (2014; 2016). The first section included seven latent variables adapted from Yazdanpanah's extended Theory of Planned Behavior (TPB) framework (Yazdanpanah et al., 2014). Those latent variables were behavior (B), behavioral intention (BI), attitude toward behavior (ATB), perceived behavioral control (PBC), subjective norm (SN), moral norm (MN), perceived risk (PR), and self-identity (SI). In total, 30 question items from earlier studies (Yazdanpanah et al., 2014; 2016) were adopted and adapted. The responses were given on a five-point Likert scale, with 1 being "strongly disagree" and 5 being "strongly agree." Finally, the second section of the questionnaire asked explicitly about the demographic characteristics of the residents.

The questionnaires were distributed face to face to ensure a high response rate (Heerwegh & Loosveldt, 2008). Two interviewers were trained to collect data, conduct interviews, and distribute the questionnaire. In total, 6,560 people were lived in Wonorejo village. Randomization, as well as testing the entire population, are practically almost impossible due to the limitation of resources (e.g., time, human resources, financial). Given this circumstance, a convenience sampling method was used to assign respondents to the survey based on their availability, accessibility, and willingness to participate (Wu Suen et al., 2014; Etikan et al., 2016). Slovin formula was used to propose minimum number of respondents required for data analysis. By taking confidence interval of 94% and e = 0.06, we proposed minimum 267 respondents which represents 6% sampling error. The survey was restricted to residents aged 18 and over. Residents who were intercepted were asked if they would participate in the survey. Once the resident was intercepted and agreed, he or she was asked to complete the question items on-site. In total,

Data analysis Prior to performing the cluster analysis, data were screened to ensure their suitability and applicability. Subsequent analyses were conducted using completed questionnaires. *Second*, Cronbach's alpha (α) coefficient analysis was used to determine internal consistency or the degree to which a group of question items is related to one another under a designated latent variable. The coefficient is greater than 0.6, indicating a high degree of reliability (Taber, 2018), and the average value of the latent construct's question items was eventually used in the clustering analysis. *Third*, The clusters were generated using a non-hierarchical clustering technique (i.e., k-means). This was used to group residents' opinions using the extended TPB framework's factors (Yazdanpanah et al., 2014). The k-means algorithm is widely used because it enables users to determine the

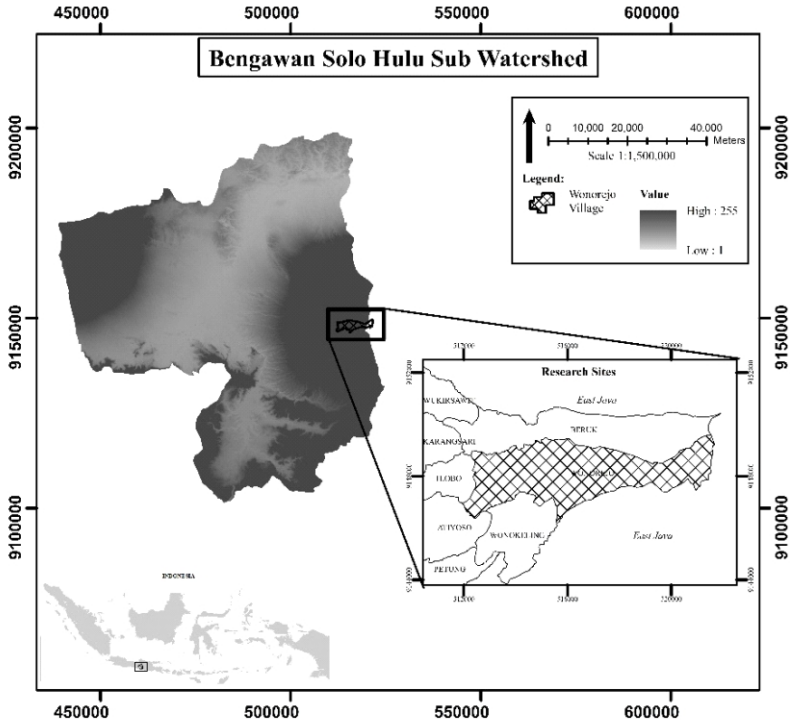

Figure 1 Study site and the upstream of the Bengawan Solo Hulu subwatershed.

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optimal number of central clusters (k) (Sinclair-Maragh et al., 2015; del Chiappa et al., 2018; Nugroho et al., 2021a). We used the silhouette method to determine the optimal value of k in this study. Within the predetermined data set, this procedure looks for k-centers that minimize the total sum of the squared distances between each sample and its nearest center. The k-means analysis was performed once the optimal number of clusters had been determined. Next, an independent sample t-test was used to validate the identified clusters generated by the k-means analysis. To compare the different groups, the t-test was used to look for statistically significant differences between them. Finally, descriptive statistics and cross-tabulation were used to outline the demographic characteristics of respondents in each of the generated clusters.

Results and Discussion

Respondent characteristics We collected 307 completed questionnaires in total. Our samples represented 94 confidence interval and 0.06 sampling error of the study samples. Furthermore, the demographic characteristics of respondents are shown in Table 1. The majority of respondents (74.59%) were male, and the majority were between 25 and 50 years old (62.21%). Of the respondents, 78.5% had attained secondary education (i.e., junior and high school), and 3.58% were enrolled in university. Finally, those with personal monthly incomes of IDR1,000,000 (USD69.61) or IDR1,000,000–2,000,000 (USD69.61–USD139.21) constituted for 46.26% and 46.6%, respectively (USD1 = IDR14,366 as of April 16, 2022).

Cluster analysis The value of the study's latent variables is summarized in Table 2. Cronbach alpha values were greater than 0.6 for all latent variables, indicating reliability (Taber, 2018). The cluster analysis was then performed using the average values of the question items classified as latent variables. The mean score (*M*) and standard deviation (*SD*) for each factor was ATB (*M* = 4.7, *SD* = 0.6); SN (*M* = 4.6, *SD* = 0.7); PBC (*M* = 4.3, *SD* = 0.7); BI (*M* = 4.3, *SD* = 0.6); B (*M* = 4.1, *SD* = 1.0); PR (*M* = 3.9, *SD* = 1.1); MN (*M* = 45, *SD* = 0.6); SI (*M* = 4.1, *SD* = 0.6). The current study used a non-hierarchical analysis with the k-means method to finalize the number of clusters examined by the silhouette method based on an a priori optimum number of clusters. As illustrated in Figure 2, the optimal number of clusters was two. Thus, two clusters were derived from the non-hierarchical procedure involving 307 observations.

The cluster plot in Figure 3 depicts residents' intentions and behaviors using the extended TPB framework. Cluster 2 (*N* = 190), being the largest, represented 61.9 % of respondents. On the other hand, cluster 1 (*N* = 117) accounted for 38.1% of respondents. Furthermore, each of the eight latent variables to justify the clusters was statistically significant (Table 3). The cluster centers and significant differences between the cluster centers of all latent variables are shown in Table 3.

Attitudes toward behavior were significantly different between Clusters 1 (4.73) and 2 (4.6) (t_{value} = 3.16, *p*-value < 0.01). Subjective norms were significantly different between Clusters 1 (4.4) and 2 (3.8) (t_{value} = 9.56, *p*-value < 0.001). Perceived behavioral control was significantly different between AS (4.5) and PS (4.2) (t_{value} = 4.33, *p*-value < 0.001). Behavioral intention was significantly different between AS (4.4) and PS (4.2) (t_{value} = 5.2, *p*-value < 0.001).

Behavior was significantly different between AS (4.6) and PS (3.7) (t_{value} = 12.7, *p*-value < 0.001). Perceived risks was significantly different between AS (4.6) and PS (3.4) (t_{value} = 22.1, *p*-value < 0.001). Social norm was significantly different between AS (4.6) and PS (4.4) (t_{value} = 4.3, *p*-value < 0.001). Self identity was significantly different between AS (4.5) and PS (3.9) (t_{value} = 11.4, *p*-value < 0.001).

Those aforementioned results confirmed that the two clusters generated in the study had statistically distinct. The derived clusters were subsequently named based on their agreement with the question items to represent the two clusters that were established distinctively.
Table 3

As shown in Table 3, residents of Cluster 1 are more receptive to forest rehabilitation initiatives. This can be seen in their greater agreement on ATB, SN, PCB, BI, B, MN, and SI. Additionally, they are concerned about the adverse effects of forest degradation on water availability and natural disasters. As a result, Cluster-1 was named as a "active supporters (AS)" of forest rehabilitation initiatives. However, Cluster 2 is primarily defined by the fact that, while they have a favorable attitude toward forest rehabilitation (ATB), PBC, BI, and MN, they are less engaged in forest rehabilitation programs (Behavior/B). Additionally, they maintain a lesser degree of agreement on PR, SN, and SI. This cluster was subsequently labelled "passive supporters (PS)."

The current study reveals that passive supporters (PS) dominate the community (61.9%). They are primarily characterized by those who have less intent (BI) and engage in forest rehabilitation programs (B), as well as hold less agreement in their self-identity (SI). Interestingly, while they are relatively positive toward forest rehabilitation initiatives, they do not identify as responsible for their surrounding environment. Those PS members were also less aware of the risk of forest degradation. Subsequently, they manage to less engage in forest rehabilitation activities. Our findings were

Table 1 Respondents' demographic characteristics

Characteristics	Frequency	Proportion (%)
Gender		
Male	229	74.59
Female	78	25.41
Age (years)		
≤ 25	10	3.26
> 25 – 50	191	62.21
> 50	106	34.53
Formal education attainment		
No formal education	2	0.65
Elementary school	53	17.26
Junior high school	145	47.23
High school	96	31.27
University	11	3.58
Personal monthly income (IDR)		
≤ 1,000,000	136	46.26
> 1,000,000 – ≤ 2,000,000	137	46.60
> 2,000,000 – ≤ 3,000,000	18	6.12
> 3,000,000	3	1.02

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

Latent and observed variables	α	Mean	SD
Attitude toward behavior/ATB	0.65	4.7	0.6
I am enthusiastic about forest rehabilitation initiatives			
I believe that participating in forest rehabilitation initiatives is beneficial.			
I believe that engaging in forest rehabilitation initiatives is prudent.			
I believe that engaging in forest rehabilitation initiatives is favorable			
I believe that forest rehabilitation would effectively prevent natural disasters.			
Perceived behavioral control/PBC	0.85	4.3	0.7
It's pleasant for me to become involved in forest rehabilitation initiatives.			
If I wanted to, I could easily engage in forest rehabilitation initiatives			
I have sufficient resources (time and money) to engage in forest rehabilitation.			
It is primarily up to me whether or not to participate in forest rehabilitation initiatives.			
I exert greater control over my engagement in forest rehabilitation initiatives.			
Subjective norm/SN	0.7	4.0	0.7
The majority of people who matter to me believe that I should be involved in forest rehabilitation initiatives.			
The majority of people who matter to me believe that forest rehabilitation initiatives are worthwhile.			
Moral norm/SN	0.61	4.5	0.6
I feel I am obligated to be actively involved in forest rehabilitation.			
If I can rehabilitate extensive forest areas, I'll feel better.			
If I rehabilitate additional forest areas, I feel I am contributing to something greater.			
Perceived risks/PR	0.74	3.9	1.1
I'm highly concerned about the impending water crisis in my (and my family's) lives due to a lack of water.			
I'm highly concerned about the impact of the water crisis on my life.			
I'm highly concerned about the future of my farm and job due to a lack of water.			
I'm highly concerned that forest degradation in this village will result in erosion and landslides.			
Self identity/SI	0.74	4.1	0.6
I consider myself to be a forest rehabilitation practitioner.			
Enrolling in forest rehabilitation activities is an integral part of my identity.			
Behavioral intention/BI	0.72	4.3	0.6
I intend to engage in forest rehabilitation activities			
I am willing to invest my resources (both time and money) in forest rehabilitation initiatives.			
I will speak positively about initiatives aimed at forest rehabilitation.			
I intend to be involved in future forest rehabilitation initiatives.			
I intend to encourage others to become involved in forest rehabilitation.			
Behavior/B	0.79	4.1	1.0
I have been involved in forest rehabilitation initiatives			
I planted trees on my land			
I kept plants that had been planted in proper condition.			
I defended the forest rehabilitation area's security.			

Note: α = Cronbach's alpha; SD = standard deviation

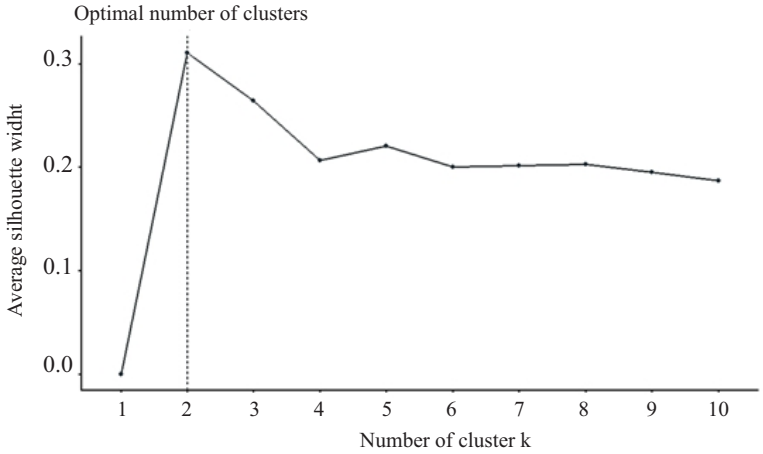

Figure 2 The optimal number of clusters is generated by the Silhouette method.

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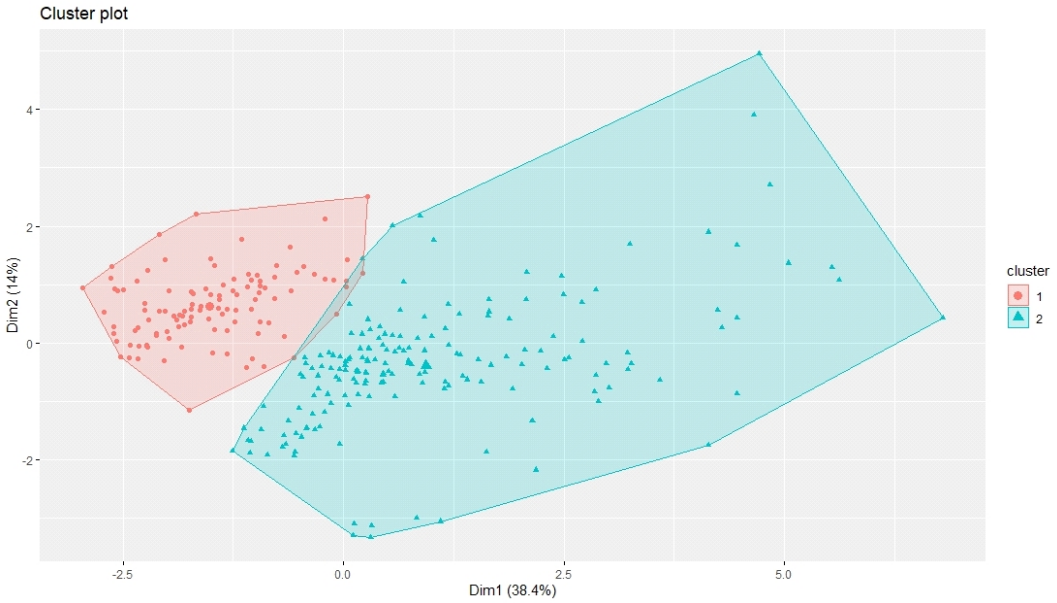

Figure 3 Cluster plot for resident intention and behavior toward forest rehabilitation initiative based on extended the TPB framework (Yazdanpanah et al., 2014). 1 and 2 indicates Cluster 1 and Cluster 2, respectively.

Table 3 Characteristics of clusters

Latent variables	Cluster center		*t* value	*p*-value	Sig
	Active supporters (AS)	Passive supporters (PS)			
Attitude toward behavior (ATB)	4.7	4.6	3.2	0.002	**
Subjective norm (SN)	4.4	3.8	9.6	0.000	***
Perceived behavioral control (PBC)	4.5	4.2	4.3	0.000	***
Behavioral intention (BI)	4.4	4.2	5.2	0.000	***
Behavior (B)	4.6	3.7	12.7	0.000	***
Perceived risks (PR)	4.6	3.4	22.1	0.000	***
Moral norms (MN)	4.6	4.4	4.3	0.000	***
Self identity (SI)	4.5	3.9	11.4	0.000	***

Table 4 Cluster members' demographic characteristics.

Demographic characteristics	Active supporters (AS)		Passive supporters (PS)	
	Frequency	Proportion (%)	Frequency	Proportion (%)
Gender				
Male	112	95.7	117	61.6
Female	5	4.3	73	38.4
Age (years)				
≤ 25	0	0.0	12	6.3
> 25 – 50	82	70.1	123	64.7
> 50	35	29.9	55	28.9
Formal education				
Illiterate	0	0.0	2	1.1
Primary education	15	12.8	38	20.0
Secondary education	63	53.8	82	43.2
Tertiary education	30	25.6	66	34.7
University	9	7.7	2	1.1
Personal monthly income (IDR)				
≤ 1,500,000	87	74.4	165	86.8
> 1,500,000 – ≤ 3,000,000	27	23.1	25	13.2
> 3,000,000	3	2.6	0	0.0

corroborated by earlier studies that concurred that self-identity is a relatively stable individual factor that plays a significant role in determining specific behavior, i.e., environmental activism (Fielding et al., 2008; Whitmarsh & O'Neill, 2010; Gatersleben et al., 2014; Yazdanpanah et al., 2014). However, active supporters (AS) residents are more receptive to forest rehabilitation initiatives. They identify themselves as forest rehabilitation activists. This can be seen in their more remarkable agreement on ATB, SN, PCB, BI, B, MN, and SI. That high agreement in factors to support forest rehabilitation activities may indicate their intense awareness of the importance of forest rehabilitation activities in their area. Additionally, they are concerned about the adverse effects of forest degradation on water availability and natural disasters.

Clusters' profile The demographic characteristics of cluster members are summarized in Table 4. Our study noted that most respondents in AS and PS were male, with 95.7% and 61.58%, respectively. AS was dominated by individuals aged between 25 and 50 (70.09 %), with secondary education (70.1%), and earning less than IDR1,500,000 (74.4%). Additionally, the majority of PS members were between the ages of 25 and 50 (64.7%), had completed secondary education (43.2%), and had a monthly personal income of less than IDR1,500,000 (86.8%).

Conclusion

The current study contributes to the growing body of knowledge on residents' opinions of forest rehabilitation initiatives by providing insights from the upstream region of Java, Indonesia. Also, this response to recent calls for comprehensive studies on expanding behavioral research focused on the extended theory of planned behavior (TPB). Following that, our study analysis revealed that communities are not homogeneous in response to forest rehabilitation programs. We identified two distinct clusters of supporters ('active' and 'passive' supporters), implying that residents' opinions toward forest rehabilitation initiatives are not homogeneous in the study area, thereby validating the study hypothesis. Residents hold distinctive attitudes, perceived behavioral control, subjective norms, behavioral intention, moral norms, self-identity, perceived risks, and behavior on forest rehabilitation initiatives in their villages. These findings generally demonstrate the robustness of the TPB tenets and their expanded version in explaining behavioral phenomena.

Recommendation

While providing empirically proven findings, the current study proposes managerial implications for forest managers. It is substantial to note that forest managers should be aware that those residents adjacent to the forest areas are clustered based on their own opinion and interest in forest rehabilitation initiatives. Those characteristics of distinct groups should be considered in designing policies and strategies for forest rehabilitation. Subsequently, forest managers should provide alternative approaches to ensure the success of forest rehabilitation programs.

Acknowledgment

The current study is a part of the first author's diploma thesis. The authors are thankful to Mr. Wiyono and Mr. Bowo Dwi Siswoko for their constructive and meaningful advice. We would like to thank the residents of Wonorejo village for their assistance during the field study.

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