Exploring predictors of donation willingness for urban public parks in Vietnam: Socio-demographic factors, motivations, and visitation frequency

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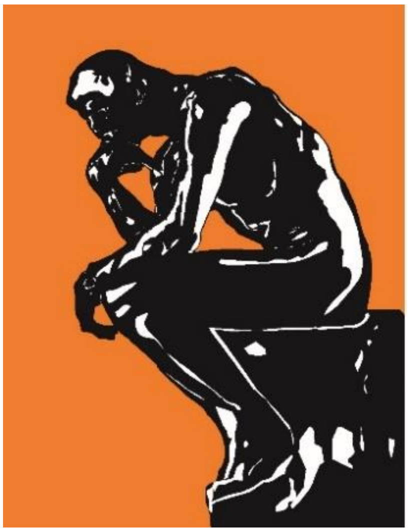

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"– My family's fishing legacy is the epitome of talent, to the point that we are revered as "king." Only today did I learn that, apparently, the whole family has been catching fish illegally."

—In "Family Legacy…"; *The Kingfisher Story Collection* (2022)

Abstract

Rapid urbanization in Vietnam significantly impacts the environment and human well-being. Public parks are crucial for enhancing social and environmental sustainability in urban areas, yet their establishment and expansion require substantial funding. This study investigates the factors influencing Vietnamese urban residents' willingness to donate to planting projects in public parks, utilizing the Bayesian Mindsponge Framework (BMF), which combines Mindsponge Theory's informational entropy-based notion of value with Bayesian analysis. Analyzing data from 535 residents in major Vietnamese cities, we found that while men visit public parks more frequently, they are less willing to donate to planting projects. Older residents visit parks more often and are more willing to donate, while higher-income individuals show greater willingness to donate. Most motivations—such as relaxation, physical activities, nature enjoyment, socializing, and family time—are positively linked to park visit frequency and indirectly to donation willingness. However, only relaxation and enjoyment of nature are directly associated with willingness to donate. Interestingly, higher education levels and visiting parks for children's educational activities are associated with lower donation willingness. These findings hint at the possible existence of the free-riding problem, gender inequality, ineffective environmental education, and lack of awareness of public parks' natural value, as well as opportunities to cultivate an eco-surplus culture through nature interactions in public parks.

Keywords: human-nature nexus; education; motivation; visit frequency; finance; granular interactions thinking; eco-surplus culture

1. Introduction

Rapid urbanization is one of the most intense human activities that has a profound impact on global biodiversity and human well-being. The expansion of urban areas has disrupted natural habitats, degraded ecosystems, altered ecological processes, and can lead to local and global extinctions (Li et al., 2022; McDonald et al., 2020; Seto et al., 2012). Rapid and unplanned urbanization also cause severe disparities in society and a range of public health risks, including air and water pollution, spreading of disease, increased risk of natural disasters, and potential shortages of water and other vital resources (Elmqvist et al., 2016; Trivedi et al., 2008).

As one of the fastest-urbanizing countries in Southeast Asia, Vietnam is facing many challenges (Ouyang et al., 2016). Spurred by economic reforms initiated in 1986 known as Doi Moi, the country's urban population has increased dramatically, from 19.2% in 1986 to 37.3% in 2020, and is anticipated to surpass 50% by 2040 (World Bank, 2021; Yeung, 2007). Ho Chi Minh City and Hanoi, with populations exceeding 9 million and 8 million, respectively, are key drivers of this trend (General Statistics Office of Vietnam, 2021). As a result of this rapid growth, problems in the infrastructure, social services, and environment have become more challenging (Fan et al., 2019). To address these issues, Vietnam has implemented several initiatives such as the "National Urban Development Program" and "National Green Growth Strategy," which emphasize the importance and necessary of public parks for its citizen's health and for the sustainable development of the cities (Government of Vietnam, 2022; World Bank, 2014).

Public parks provide important ecological, social, environmental, and cultural benefits. They act as refuges for diverse plant and animal species while providing various ecosystem services important to urban landscapes, such as air purification and temperature regulation (Mexia et al., 2018). Public parks also provide residents with opportunities for exercising, relaxation, social connection, education, and recreation, which improves residents' physical and mental well-being (Muhamad Nor et al., 2021). According to M.-H. Nguyen and T. E. Jones (2022) and Nguyen, Nguyen, et al. (2023), parks and green spaces play a vital role in fostering "eco-surplus culture," promoting a societal mindset valuing environmental conservation. When such a culture is formed, urban residents will be more conscious about environmental issues and willing to contribute to conservation programs (M.-H. Nguyen & T. E. Jones, 2022; Nguyen, Le, et al., 2023; Nguyen, Nguyen, et al., 2023).

Despite their importance, public parks in Vietnam still face many challenges, such as lack of enforcement of planning regulations, insufficient funding, inadequate maintenance, and increasing pressure from population growth. These issues resulted in a decrease in the quality and extent of public parks (Labbé, 2021; Leducq & Scarwell, 2018). For instance, in Hanoi, due to financial constraints and overcrowding in the existing parks, sidewalks become the only accessible public spaces for the citizens (Labbé, 2021). Similarly, due to poor maintenance, amenities, and lack of monitoring in Ho Chi Minh City, urban parks become breeding grounds for disease vectors through the transmission of mosquitos thriving among overgrown grass and litter. At night, these areas are also vulnerable to crime, drug use, and vandalism (Do et al., 2019; Leducq & Scarwell, 2018). In an urban environment where cities are continuing to grow and urbanize, maintaining and developing green spaces that allow people to reconnect with nature is more vital than ever. It is, therefore, imperative to understand urban citizens' motivations, frequency of visits, and willingness to donate to public parks (Mexia et al., 2018).

Previous studies have shown that motivations for park usage and the frequency of visitation vary across different cultures and populations (Chiesura, 2004; Lo & Jim, 2010). Influential factors included demographic information, socioeconomic status, accessibility, beliefs, and personal perspective (Fontán-Vela et al., 2021; Lin et al., 2014; Zhan et al., 2021). The willingness to donate to public parks was found to be associated with factors like income, education, park use frequency, and natural orientation (Hoyos et al., 2015; Lo & Jim, 2010). While previous studies have analyzed various factors affecting park visitation and willingness to donate, there is a growing recognition that traditional economic models are insufficient to determine respondents' behaviors (Cooper et al., 2004; Lo & Jim, 2010). The reason can be public goods like parks are often difficult to value monetarily since the public lacks experience or information on their value. Thus, when faced with the willingness to pay questions, people tend to make decisions based on intuitive feelings, personal values, and emotions rather than purely economic considerations (Ajzen & Driver, 1992).

Furthermore, there have been few empirical investigations of public park visiting motivation and donation willingness in developing countries, especially Vietnam (Khuc et al., 2024). To address this gap, in this study, we applied the Mindsponge theory (Vuong, 2023; Vuong & Nguyen, 2024c) to examine urban residents' socio-demographic characteristics in terms of their motivations, visitation frequency, and willingness to donate to public parks. Mindsponge theory can help explain a phenomenon by illustrating how psychological factors are integrated into an individual's decision-making process. This theory also allows us to explore how various factors are "absorbed" or "filtered out" in decision-making, potentially influencing human behaviors. It also potentially helps uncover unexplored barriers to park use and support.

In this study, we collected data from 535 urban residents across Vietnam (mainly from two urban centers, Hanoi and Ho Chi Minh) to answer the following research questions:

1. How are urban residents' socio-demographic factors associated with their frequency of visiting public parks?
2. How are urban residents' motivations for visiting public parks associated with their frequency of visiting public parks?
3. How are urban residents' socio-demographic factors associated with their willingness to donate to public parks?
4. How are urban residents' motivations for visiting public parks associated with their willingness to donate to public parks?

By identifying the key drivers influencing public park usage and donation behavior, we aim to inform targeted interventions to improve park usage, maintenance, and development. These findings also aim to support sustainable urban development and eco-surplus culture, aligning with UN Sustainable Development Goals (UN, 2015). While drawing lessons from Vietnam's context, our study has the potential to benefit other developing countries facing similar urbanization challenges.

2. Methodology

2.1. Theoretical foundation

2.1.1. Mindsponge theory and the informational entropy-based notion of value

The Mindsponge Theory (MT) played a pivotal role in the study's conception, providing the foundation for constructing parsimonious models and reinforcing the scientific reasoning behind the findings (Vuong, 2023). In studies of environmental and conservation psychology, MT has been applied to examine the psychological mechanism underlying the interactions between humans and nature (Asamoah et al., 2024; Huang et al., 2023; Jiang et al., 2022; Nguyen et al., 2024; M.-H. Nguyen & T. E. Jones, 2022; Nguyen, Le, et al., 2023; M. H. Nguyen & T. E. Jones, 2022). Thus, the theory is expected to effectively explain the associations between motivation to visit public parks, visiting frequency, and willingness to donate to planting projects.

MT considers the mind and the environment as two main spectrums (Vuong, 2023). The mind is viewed as an information collection-cum-processor, with the environment serving as a broader information-processing system. The mind's primary objective is to ensure the continued existence of the system, whether through survival, growth, or reproduction. The mindset, the comfort zone, and a complex multi-filtering system constitute the mind. The mindset comprises core values, while the comfort zone serves as a temporary holding area for information for later evaluation process. The multi-filtering system comprises the trust evaluation and subjective cost-benefit judgments (Mantello et al., 2023; Vuong & Napier, 2015), which help determine which information to absorb into the mindset, leave in the buffer zone, or discard out of mind. The mindset, or the set of core values, is the primary benchmark for the multi-filtering system to operate, which subsequently influences the perceptions, thinking, and behaviors of the individual.

Recently, Mindsponge Theory has been developed further by drawing on the granular worldview of quantum mechanics (Rovelli, 2018) and Shannon's information theory (Shannon, 1948). The upgraded theory suggests that the operation of the mind can be explained by the informational entropy-based notion of value (Vuong & Nguyen, 2024c). Specifically, values are formed through the granular interactions within the mind (Vuong & Nguyen, 2024a). During the interaction process, the mind spends energy on evaluating, distinguishing, comparing, and combining both pre-existing and newly absorbed information units to generate insights that are beneficial for prolonging the existence of the mind, that is, values. Values can be seen as units of information, but not the basic information units absorbed directly through sensory systems (e.g., smell, color, size, or shape, etc.). Instead, they are synthetic, formed through the interaction and integration of various types of information. It should be noted that information units are defined by Shannon as potential alternatives.

Shannon suggests that the entropy (uncertainty or missing information) will rise as the number of information units (i.e., grains of information) increases. Then, the entropy within the mind can be calculated following Shannon's (1948) formula:

$$H(X) = -\sum_{i=1}^{n} P(x_i) \log_2 P(x_i)$$

$H(X)$ is the informational entropy of a mind X with information units $\{x_1, x_2, \dots, x_n\}$ and corresponding probabilities $\{P(x_1), P(x_2), \dots, P(x_n)\}$. $P(x_i)$ is the probability that the information unit x_i would be stored and processed by the mind. i is the number of information units within the mind. When the quantity of information units grows without clear differentiation and prioritization, informational entropy increases rapidly. It peaks when all units of information are treated as equally important, specifically when $P(x_i) = \frac{1}{n}$. Quantum physics tells us that all physical systems have inherent limits, and humans are no exception. As the mind stores and processes more information, the chances of that information being lost or forgotten increase. Thus, the informational entropy-based notion of value suggests that values are formed through granular interactions thinking to assign higher probability to important information units and reduce the risk of information loss.

2.1.2. Proposed assumptions

In this study, we can consider visiting public parks and donating to planting projects in public parks as two information units. If these two information units are processed within the mind, the individual would be more likely to visit public parks and donate to planting projects. For these two information units to have a higher probability of being stored and processed, they need to be deemed valuable. In other words, their interactions with other existing or newly absorbed information in the mind need to generate potential alternatives, or perceived values, that can help the mind prolong its existence. Such perceived values can be deemed motives.

According to self-determination theory, one of the most prominent theories on motivations, there are three types of motivations: amotivation, extrinsic motivation, and intrinsic motivation (Cook & Artino Jr, 2016; Deci & Ryan, 2000). Amotivation refers to the condition in which either inaction or actions are taken without genuine intent or purpose, while intrinsic motivation arises entirely from within, driven by personal values, curiosity, or the sheer enjoyment of the task. For a person's amotivation to become intrinsic motivation, it needs to go through the cognitive regulation processes (i.e., external regulation, introjected regulation, identified regulation, and integrated regulation) (Cook & Artino Jr, 2016; Ryan & Deci, 2020). The regulation processes help internalize and integrate unmotivated things and turn them into extrinsic motivation and then intrinsic motivation. Extrinsic motivation refers to the condition in which the individual acts because of external reasons (e.g., social values) rather than their inherent satisfactions or values (Ryan & Deci, 2000, 2020).

This mechanism of motivation can be elaborated by the informational entropy-based notion of value (Vuong & Nguyen, 2024c). In particular, amotivation toward a thing can be seen as an outcome of the mind's information processing, in which the information units of the given thing do not interact or create insights after interacting with core values within the mind. Extrinsic motivations toward a thing emerge when newly absorbed interact with core values within the mind and create synthetic information units that are valuable to the mind (i.e., the "self" in the self-determination theory). Such synthetic information units have different levels of importance, depending on the core values with which the newly absorbed information interacts, the length of interaction, or the intensity of the interactions, etc. When an information unit becomes highly important to the mind, it will be deemed a core value and, subsequently, become an intrinsic motive.

In the context of public park visitation, there can be many types of reasons. They can range from the individual's perceived values provided by the parks (e.g., opportunities for exercising, relaxation, social connection, education, and recreation) to perceived values not related to the parks (e.g., compulsory school activities, social pressure to attend an activity in the park). A study on the urban Chinese population found that physical exercise and rest-relaxation motives were the most reported reasons behind the act of visiting a public park (Liu et al., 2017). In addition, contact with nature, meeting friends, relieving stress, previous positive experiences, and overall physical and mental benefits were also popular motives for public park visitation in China (Ma et al., 2022; Shan, 2014; Wang et al., 2021; Zhan et al., 2021). Individuals tend to have different motivations for going to public parks. When the individual's motivations derive more from perceived values provided by the parks than values not related to the parks, they would be more likely to visit the park (i.e., visit the park more frequently) and more willing to contribute to improving the park (i.e., donate to planting projects) to maximize their perceived values, and vice versa. Based on this reasoning, we expect that public park visitation motivations would generally be positively associated with their frequency of visiting public parks and donation willingness.

When visiting the public park, an individual will have a chance to directly interact with information provided by the park through experiences, which can lead to the emergence of values within their minds (e.g., improvement of mental and physical health). People visiting the park more frequently would have more opportunities to experience it, and thus, they are expected to perceive the intrinsic values (i.e., information provided by the parks and their constituents, like trees, animals, and biodiversity level) of the park. When such intrinsic values are processed within the individual's mind, they would be more likely to influence their subsequent thinking to maximize the benefit, i.e., planting more trees in public parks. Therefore, we expect that the frequency of visits to public parks can be a mediator between the motivation to visit the park and the willingness to donate.

2.2. Model Construction

2.2.1. Dataset and selected variables

This study utilized a dataset of 535 urban residents from 35 cities across Vietnam, with the majority residing in Ho Chi Minh City (n = 347, accounting for 64.86%) and Hanoi Capital City (n = 107, accounting for 20%) (Nguyen, 2021). The dataset, which was peer-reviewed by two referees before being published in *Data Intelligence*, captures urban residents' multifaceted perceptions of biodiversity–human interactions in Vietnam. It is structured into six major categories: 1) wildlife product consumption, 2) general biodiversity perceptions, 3) biodiversity in home and neighborhood settings, 4) public park visitation and motivations, 5) national park visitation and motivations, and 6) socio-demographic profiles (Nguyen, 2021). For the purpose of this study, 13 variables in the fourth and sixth categories were retrieved and used in the current study's data analysis.

Data collection was conducted using a questionnaire designed based on interviews with 38 urban residents in Hanoi Capital City and Ho Chi Minh City between November 15 and December 26, 2020. The sample selection criteria aimed to include diverse demographic backgrounds to ensure a broad range of inputs. Interviews were concluded when no new information was achieved (i.e. when the theoretical saturation was reached) (Cresswell & Poth, 2018).

After the questionnaire was designed, data collection was conducted online using Google Forms. The sample consisted of Vietnamese urban residents contacted through non-discriminative snowball sampling. This method began with participants from the researchers' personal networks, who were then asked to share the questionnaire with friends or relatives. These new participants were similarly encouraged to distribute the questionnaire further within urban areas. Despite the snowball sampling method, efforts were made to ensure diversity in origin, gender, age, and educational levels to minimize potential biases. Sampling was concluded when no new referrals were received.

Sample size standards were followed to determine the minimum benchmark for data collection. VanVoorhis and Morgan (2007) suggest that a reasonable sample size for regression analysis is around 50. Green (1991) recommends that the sample size should be calculated based on the formula $N > 50 + 8 \times m$ (where m is the number of independent/predictor variables) for multiple regression testing. For this study, which involves 12 predictor variables (four socio-demographic variables, seven reflecting public park visitation motives, and one reflecting visitation frequency), the minimum required sample size was 216. Given that the dataset's sample size is 535, it meets and exceeds these standards, making it adequate for data analysis.

Although no ethical review board examined the survey protocol (as this is not mandatory for social research), ethical standards were upheld. Respondents were encouraged to read an online consent form outlining the study's aims, required data, and confidentiality measures on the first page of the Google Forms survey. Only after consenting were they allowed to proceed to the questionnaire, where they provided personal information and perspectives on biodiversity–human interactions in urban Vietnam.

A total of 581 responses were collected between June 18 and August 8, 2021. To ensure high-quality data, a four-step quality check was conducted. First, responses were filtered to exclude those from non-urban residents (n = 27). Second, respondents under 18 years old were excluded (n = 13). Third, duplicate responses were removed by checking email addresses (n = 3). Fourth, responses exhibiting patterned answers on the Likert scale or selecting all options on checkbox questions were excluded (n = 3). Ultimately, 535 valid responses were encoded and saved in a comma-separated values (CSV) format in the published dataset. Table 1 below details the demographic characteristics of these 535 respondents.

Table 1: Socio-demographic characteristics of respondents (n = 535)

Characteristics	Frequency (F)	Percentage (%)
Gender:		
1) Females	312	57.08
2) Males	220	42.92
Age (y.o.):		
1) 18-22	120	13.95
2) 23-30	132	21.36
3) 31-40	140	25.75
4) 41-50	87	17.37
5) 51-60	36	7.58
6) >60		

	20	3.99
Education:		
1) Primary school	1	0.2
2) Secondary school	9	1.8
3) High school	70	13.77
4) Undergraduate	338	61.68
5) Post-graduate	117	22.55
Income (VND):		
1) No income	22	4.39
2) <5 million	53	10.58
3) 5-10 million	107	20.16
4) 10-15 million	99	15.37
5) 15-20 million	40	7.78
6) 20-30 million	44	9.38
7) >30 million	40	7.78

The sample had a relatively balanced gender distribution, with 57.08% female and 42.92% male respondents. Participants spanned various age ranges, with the highest proportion (64.48%) being between 23 and 50 years old. Most respondents had undergraduate (61.68%) or post-graduate (22.55%) education. Additionally, a significant portion of respondents (46.11%) reported a monthly income between 5-15 million VND (approximately $196-$589 at the current exchange rate).

A more thorough description of the interview's and survey collection's design and results are available in the following study (Nguyen, 2022).

In this study, we extracted 13 variables from the published dataset for the data analysis (see Table 2). To assess the socio-demographic factors of urban residents, we used the variables Sex, Age, $Education$, and $Income$, which represent socio-demographic characteristics. These variables are represented by variables $F1$, $F3$, $F5$, and $F7$ in the original dataset, respectively. To measure motivations for public park visitation, we employed the variables *Relaxation*, *PhysicalActivities*, *Friends*, *Family*, *EducationalActivities*, *EnjoyNature*, and *CommunityEvents*, which capture individual reasons for visiting nearby public parks. These variables were generated from variable $D3$ in the original dataset, which demonstrates the respondent's reasons for visiting the nearby public park. Respondents were provided with a range of options to select from. If an option is selected, it will be considered one of the respondent's motivations to visit public parks. This approach made all variables related to respondents' motivations binary variables.

The frequency of public park visits was measured using the variable *PublicParkFrequency*. In the original dataset, it was coded as variable $D2$. Lastly, the willingness to donate to public park projects was assessed using the variable *PublicParkDonation*, which was coded as variable $D4$ in the original dataset. Table 2 below provides a detailed explanation of the studied variables.

Table 2: Variable Description

Variable	Description	Data type	Value
PublicParkFrequen	The frequency of visiting nearby public parks	Numerical	1 = Never; 2 = Almost never; 3 = Sometimes; 4 = Almost every day; 5 = Everyday
Relaxation	Reasons for going to public park (motives): Relaxation	Binary	1 = Yes; 0 = No
PhysicalActivities	Reasons for going to public park (motives): Physical activities	Binary	1 = Yes; 0 = No
Friends	Reasons for going to public park (motives): Meeting with friends	Binary	1 = Yes; 0 = No
Family	Reasons for going to public park (motives): Spending time with family	Binary	1 = Yes; 0 = No
EducationalActivities	Reasons for going to a public park (motives): Educational activities for children	Binary	1 = Yes; 0 = No
EnjoyNature	Reasons for going to public park (motives): Enjoying nature	Binary	1 = Yes; 0 = No
CommunityEvents	Reasons for going to a public park (motives): Community events	Binary	1 = Yes; 0 = No

PublicParkDonation	The willingness to donate to planting project in the nearby public park	Numerical	1 = Not at all; 2 = Not really; 3 = Willing; 4 = Very/fully willing
Sex	Biological sex	Numerical	0 = Female; 1 = Male
Age	Age group	Numerical	1 = 18 - 22; 2 = 23 - 30; 3 = 31 - 40; 4 = 41 - 50; 5 = 51 - 60; 6 = More than 60
Education	The highest educational level	Numerical	1 = Primary school; 2 = Secondary school; 3 = Highschool; 4 = Undergraduate; 5 = Post-graduate
Income	Monthly income group	Numerical	1 = no income; 2 = less than 5 million VNĐ, 3 = 5 - 10 million VNĐ; 4 = 11 - 15 million VNĐ; 5 = 16 - 20 million VNĐ; 6 = 21 - 30 million VNĐ; 7 = More than 30 million VNĐ

2.2.2. Statistical Model

To test our hypotheses, we constructed three different analytical models. The first model was developed to analyze the relationships between residents' socio-demographic factors, motivations for visiting public parks, and the frequency of their visits. Model 1 is shown as follows:

$$PublicParkFrequen \sim normal(\mu, \sigma) \quad (1.1)$$

$$\mu_i = \beta_0 + \beta_1 * Sex_i + \beta_2 * Age_i + \beta_3 * Education_i + \beta_4 * Income_i + \beta_5 * Relaxation_i + \beta_6 * PhysicalActivities_i + \beta_7 * Friends_i + \beta_8 * Family_i + \beta_9 * EducationalActivities_i + \beta_{10} * EnjoyNature_i + \beta_{11} * CommunityEvents_i \quad (1.2)$$

$$\beta \sim normal(M, S) \quad (1.3)$$

The probability around μ is determined by the form of the normal distribution, whose width is specified by the standard deviation σ. μ_i represents resident i's frequency of visiting the nearby public park. The variables Sex_i, Age_i, $Education_i$, and $Income_i$ correspond to resident i's gender, age group, highest formal education level, and monthly income group in VND, respectively. Additionally, $Relaxation_i$ reflects whether resident i visits a public park for relaxation; $PhysicalActivities_i$ reflects whether resident i visits a public park for physical activities; $Friends_i$ reflects whether resident i visits a public park to meet friends; $Family_i$ reflects whether resident i visits a public park to spend time with family; $EducationalActivities_i$ reflects whether resident i visits a public park to engage children with educational activities; $EnjoyNature_i$ reflects whether resident i visits a public park to enjoy nature; and $CommunityEvents_i$ reflects whether resident i visit a public park to participate in community events. The model has an intercept of β_0, coefficients of β_1-β_{11}, and the standard deviation of the "noise", σ (i.e., uncertainty or variability in the observed data that is not explained by the model). The coefficient values follow a normal distribution with a mean denoted by M and a standard deviation denoted by S.

The second model was developed to analyze the relationships between residents' socio-demographic factors, motivations for visiting public parks, and the willingness to donate to planting projects in the nearby public park. Model 2 is shown as follows:

$$PublicParkDonation \sim normal(\mu, \sigma) \quad (2.1)$$

$$\mu_i = \beta_0 + \beta_1 * Sex_i + \beta_2 * Age_i + \beta_3 * Education_i + \beta_4 * Income_i + \beta_5 * Relaxation_i + \beta_6 * PhysicalActivities_i + \beta_7 * Friends_i + \beta_8 * Family_i + \beta_9 * EducationalActivities_i + \beta_{10} * EnjoyNature_i + \beta_{11} * CommunityEvents_i \quad (2.2)$$

$$\beta \sim normal(M, S) \quad (2.3)$$

In Model 2, μ_i represents resident i's willingness to donate to a planting project in the nearby public park, while the predictor variables remain similar to Model 1.

The third model was constructed to examine whether there is a direct relationship between residents' frequency of visiting public parks and their donation willingness, as well as indirect relationships involving socio-demographic factors, motivations for visiting public parks, and donation willingness. Thus, the predictor variable $PublicParkFrequen_i$ was added to Model 2 to create Model 3. Model 3 is demonstrated as follows:

$$PublicParkDonation \sim normal(\mu, \sigma) \quad (3.1)$$

$$\mu_i = \beta_0 + \beta_1 * Sex_i + \beta_2 * Age_i + \beta_3 * Education_i + \beta_4 * Income_i + \beta_5 * Relaxation_i + \beta_6 * PhysicalActivities_i + \beta_7 * Friends_i + \beta_8 * Family_i + \beta_9 * EducationalActivities_i + \beta_{10} * EnjoyNature_i + \beta_{11} * CommunityEvents_i + \beta_{12} * PublicParkFrequen_i \quad (3.2)$$

$$\beta \sim normal(M, S) \quad (3.3)$$

If the coefficient of $PublicParkFrequen_i$ in this model is significant and reliable, it is plausible to say that any socio-demographic factors and motivations for visiting public parks that have a direct relationship with the frequency of visiting public parks will also have an indirect relationship with the donation willingness.

2.3. Analysis and Validation

The Bayesian Mindsponge Framework (BMF) analytics was employed in this study for several key reasons (Nguyen et al., 2022; Vuong et al., 2022). First, the method integrates the logical reasoning capabilities of Mindsponge Theory with the inferential strengths of Bayesian analysis, as these two approaches are highly compatible in exploring socio-psychological issues (Nguyen et al., 2022). Second, Bayesian inference treats all properties, both known and unknown, probabilistically (Csilléry et al., 2010; Gill, 2014), enabling the reliable prediction of parsimonious models with small data at hand. Despite its simplicity, the Markov chain Monte Carlo (MCMC) technique can also allow Bayesian analysis to handle complex models, including multilevel and nonlinear regression frameworks (Dunson, 2001). Third, Bayesian inference offers several advantages over the frequentist approach, particularly the ability to use credible intervals for result interpretation rather than relying solely on dichotomous decisions based on *p*-values (Halsey et al., 2015; Wagenmakers et al., 2018).

In Bayesian analysis, selecting an appropriate prior is essential during model construction. Given the exploratory nature of this study, uninformative priors or a flat prior distribution were used to minimize the influence of prior information on model estimation (Diaconis & Ylvisaker, 1985). However, we still performed prior-tweaking to check whether the estimated posteriors were sensitive to changing prior information using prior distribution reflecting our disbelief in the associations, that is, normal distribution with a mean equal to 0 and standard deviation equal to 0.5. If the estimated results using informative prior reflecting our disbelief are not different from the results estimated using uninformative priors, the posteriors can be deemed insensitive to priors (Vuong et al., 2022).

After fitting the model, we employed Pareto-smoothed importance sampling leave-one-out (PSIS-LOO) diagnostics to assess the model's goodness of fit (Vehtari & Gabry, 2019; Vehtari et al., 2017). The LOO is computed as follows:

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

$p_{post(-i)}(\theta)$ is the posterior distribution based on the data minus data point i. The *k*-Pareto values are used in the PSIS method for computing leave-one-out cross-validation, which helps identify observations with a high degree of influence on the PSIS estimate. Observations with *k*-Pareto values greater than 0.7 are often considered influential and may be problematic for accurately estimating leave-one-out cross-validation. Commonly, a model is considered fit when the *k* values are below 0.5.

If the model fits the data well, we proceeded with convergence diagnostics and result interpretation. In this study, we assessed the convergence of Markov chains using both statistical measures and visualizations. Statistically, we used the effective sample size (*n_eff*) and the Gelman–Rubin shrink factor (*Rhat*) to evaluate convergence. The *n_eff* value indicates the number of independent samples obtained during stochastic simulation, while the *Rhat* value, also known as the potential scale reduction factor, assesses convergence across multiple chains (Brooks & Gelman, 1998). A *n_eff* value greater than 1000 typically suggests that the Markov chains have converged and the samples are sufficient for reliable inference (McElreath, 2018). For *Rhat*, a value above 1.1 indicates non-convergence, while a value of 1 generally suggests convergence. Additionally, convergence was visually inspected using trace plots.

Bayesian analysis was conducted in R using the bayesvl open-access package, which offers eye-catching visualization capabilities (La & Vuong, 2019). To address data transparency and reproducibility, all data and code snippets from this study were deposited on a preprint server (Vuong, 2018): https://zenodo.org/records/10589237

3. Results

3.1. Model 1

Model 1 was fitted to investigate the associations between residents' socio-demographic factors, motivations for visiting public parks, and the frequency of their visits. The model fitting process utilized four Markov chains, each comprising 5,000 iterations, with 2,000 iterations allocated for warmup.

The PSIS-LOO test was first conducted to evaluate the fit of Model 1 with the collected data. As shown in Figure 1, all *k*-values are below the 0.5 threshold, indicating that the model fits the data well.

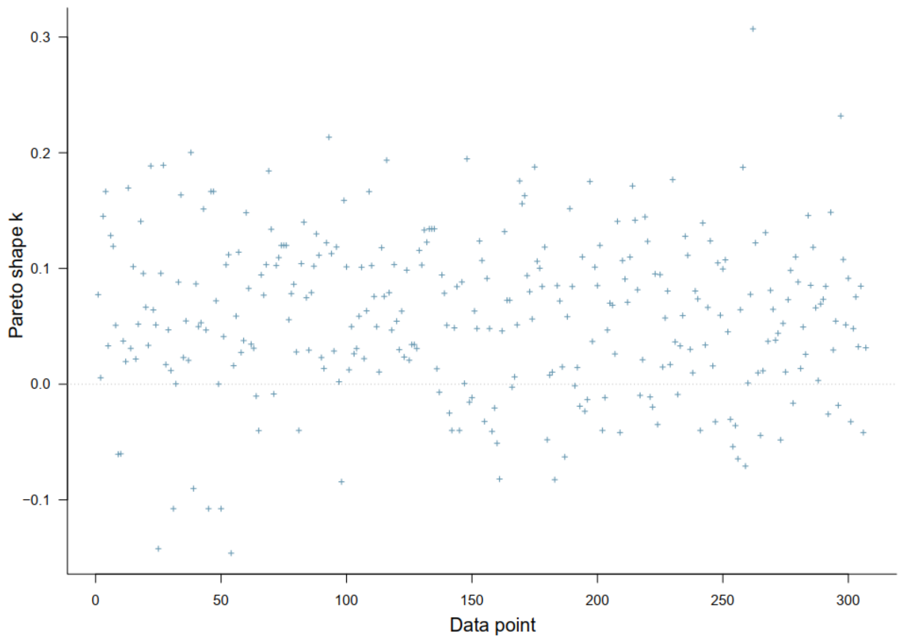

Figure 1: Model 1's PSIS-LOO diagnosis using uninformative priors

Next, the convergence of the model must be assessed using two diagnostic metrics: effective sample size (*n_eff*) and the Gelman–Rubin shrink factor (*Rhat*). With all parameters showing *n_eff* values greater than 6,000 and *Rhat* values equal to 1, Model 1 appears to converge well (see Table 3).

Table 3: Model 1's simulated posterior results

Parameter	**Uninformative prior Normal (0,10)**				**Priors reflecting disbelief Normal (0,0.5)**			
	M	**S**	**n_eff**	**Rhat**	**M**	**S**	**n_eff**	**Rhat**
Constant	2.04	0.24	6862	1	2.05	0.24	7004	1
Sex	0.11	0.08	11763	1	0.11	0.08	10662	1
Age	0.15	0.03	10396	1	0.015	0.03	11455	1
Education	-0.01	0.06	7130	1	-0.01	0.06	7133	1
Income	0.02	0.03	9531	1	0.02	0.03	10447	1
Relaxation	0.22	0.09	10436	1	0.22	0.08	10678	1
PhysicalActivities	0.39	0.08	11633	1	0.38	0.08	10932	1
Friends	0.15	0.09	11399	1	0.15	0.09	12060	1
Family	0.11	0.10	10150	1	0.11	0.09	10654	1
EducationalActivities	0.06	0.10	10327	1	0.07	0.10	10455	1
EnjoyNature	0.13	0.08	11833	1	0.13	0.08	10276	1
CommunityEvents	0.04	0.11	11000	1	0.05	0.10	11796	1

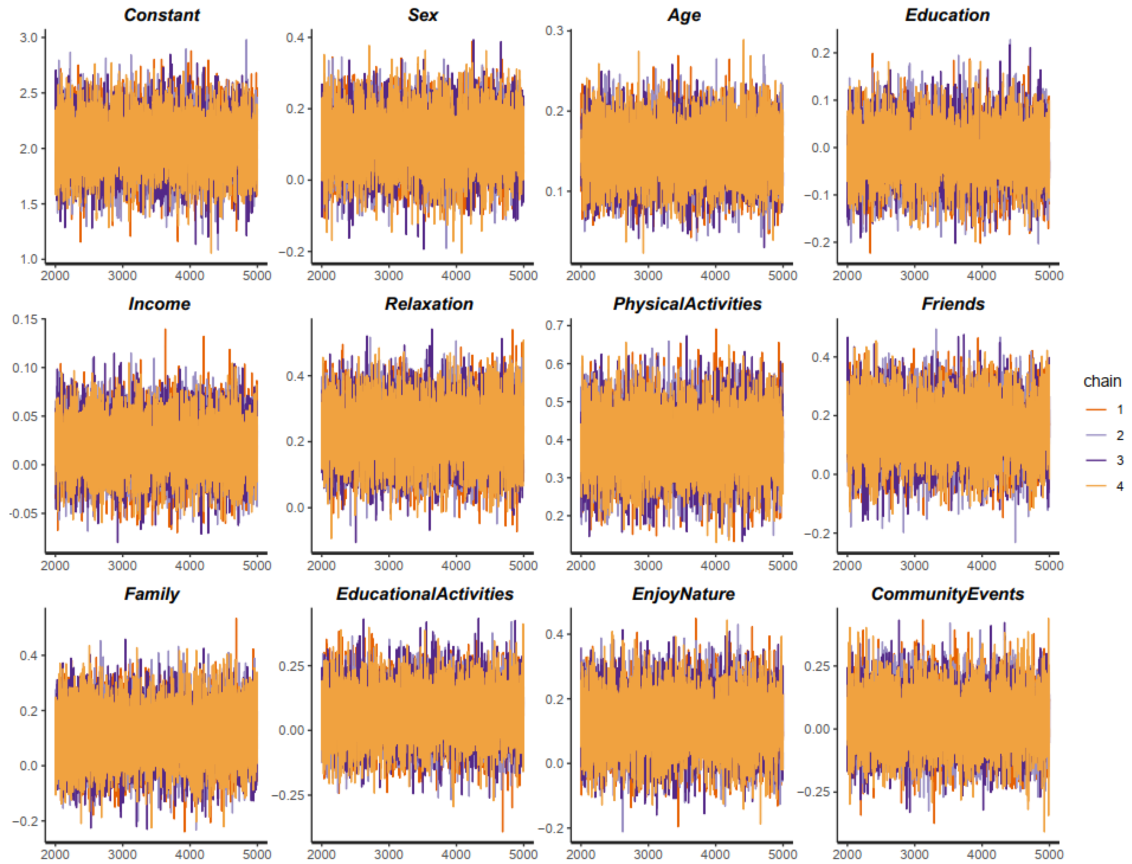

Figure 2: Model 1's trace plots using uninformative priors

Additionally, the trace plots further confirm this convergence. Specifically, they display MCMC sample values for each successive iteration along the chain. The *y*-axis represents the coefficient's value, while the *x*-axis shows the number of iterations in the Markov process. Convergence is indicated if the chains exhibit good mixing (evidenced by rapid zig-zag movement) and remain stationary around an equilibrium (i.e., staying within the posterior distribution) (McElreath, 2018). Figure 2 illustrates the trace plots for Model 1, showing that the Markov chains are convergent. Note that all iterations before the 2,000th are excluded in Figure 2, as these warmup iterations are not used for inference.

The simulated posteriors employing uninformative priors imply some significant relationships between socio-demographic factors and the frequency of visiting public parks. Male and older residents are found to visit public parks more frequently (M_{Sex}=0.11 and S_{Sex}=0.03; M_{Age}=0.15 and S_{Age}=0.03), while educational level and income are found to have ambiguous relationships with the frequency of visiting public parks. Sex's and Age's 90% of the Highest Posterior Density Intervals (HPDI), represented by the thick black line in Figure 3, are located almost entirely on the positive side of the x-axis, suggesting that their associations with $PublicParkFrequen$ highly reliable.

For the motivations, almost all motivations (i.e., $Relaxation$, $PhysicalActivities$, $Friends$, $Family$, $EnjoyNature$) have positive associations with $PublicParkFrequen$, except for $EducationalActivities$ and $CommunityEvents$. 90% HPDI of $Relaxation$,

$PhysicalActivities$, $Friends$, and $EnjoyNature$ are located entirely on the positive side, indicating the high reliability of their positive associations with $PublicParkFrequen$ (see Figure 3). A portion of $Family$'s HPDI still lies on the negative side, so its positive association with $PublicParkFrequen$ can only be deemed moderately reliable.

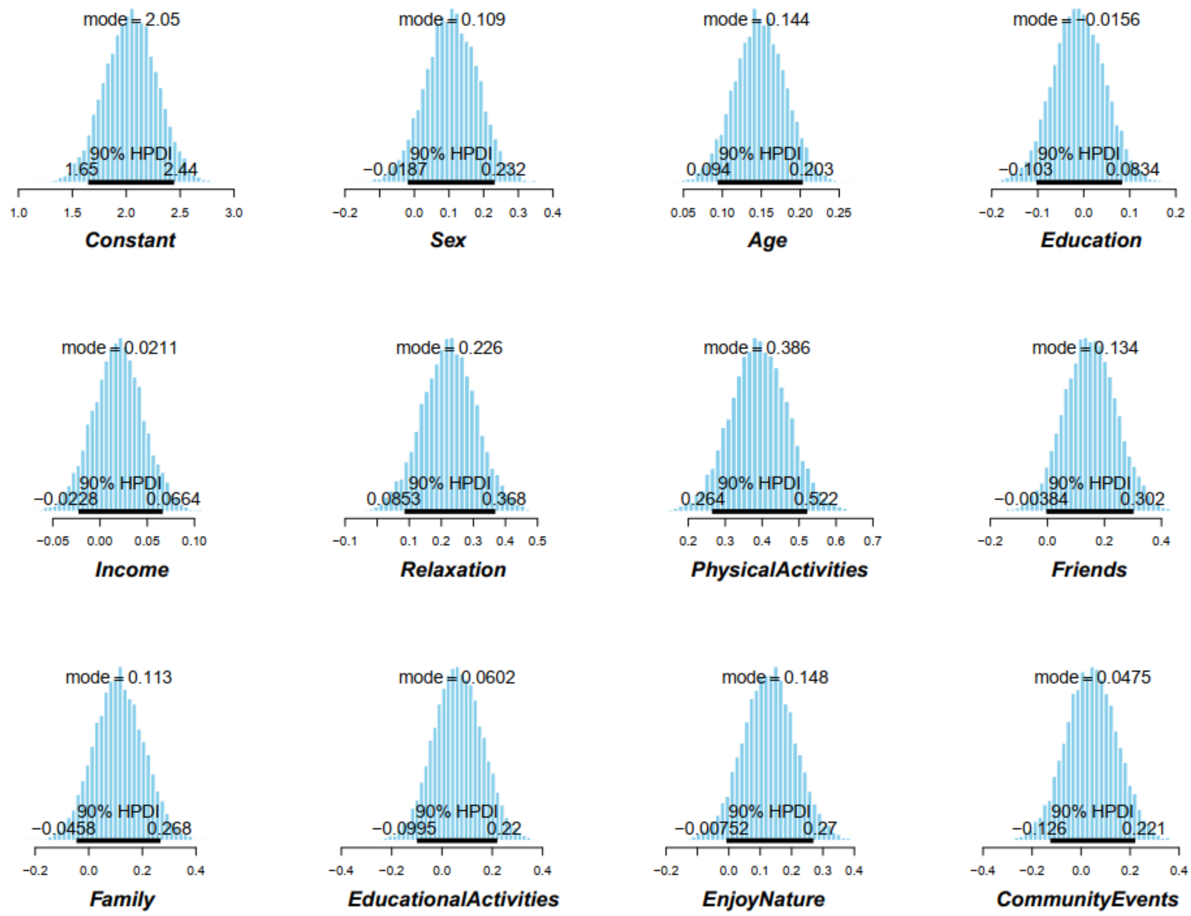

Figure 3: Model 1's estimated posteriors using uninformative priors

Even after fitting Model 1 again using informative priors reflecting our disbelief in the associations, the estimated posteriors remain almost identical to those fitted using uninformative priors. Thus, we can consider the estimated results insensitive toward priors.

3.2. Model 2

Model 2 was fitted to examine the associations between residents' socio-demographic factors, motivations for visiting public parks, and the willingness to donate to planting projects in the nearby public park. Figure 4 presents the visual PSIS-LOO diagnostics for Model 2. Since the k-values in the figure are below the 0.5 threshold, it indicates that Model 2 also fits the data well.

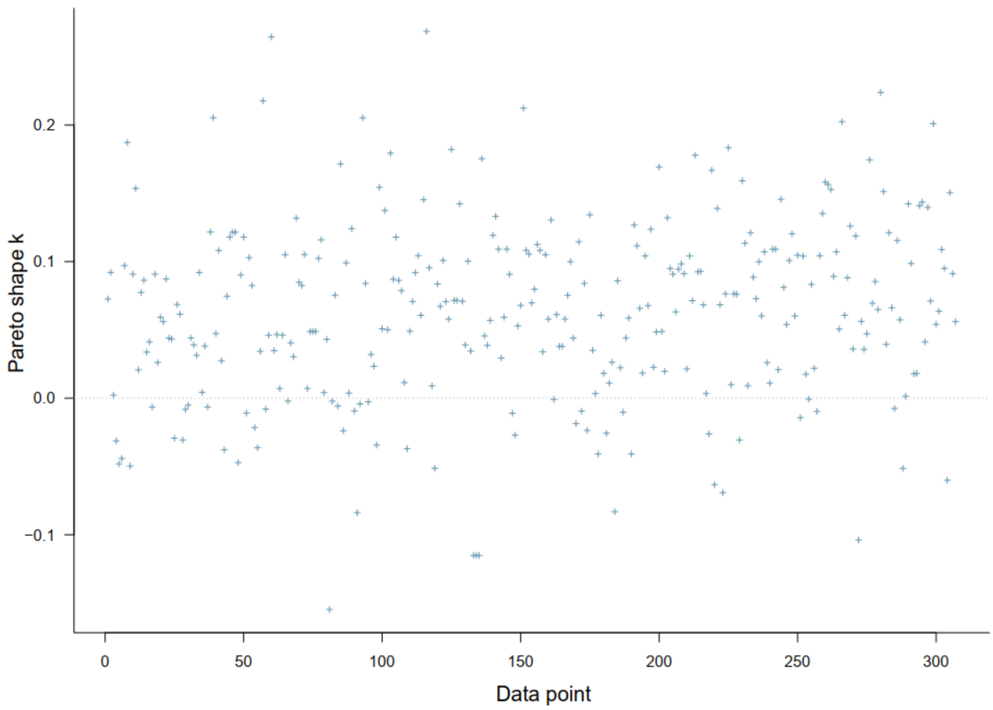

Figure 4: Model 2's PSIS-LOO diagnosis using uninformative priors

Both convergence diagnostic values (*n_eff* and *Rhat*) of the model imply that its Markov chains have converged (see Table 4). Additionally, the trace plots in Figure 5 also validate the convergence.

Table 4: Model 2's simulated posterior results

Parameter	Uninformative prior Normal (0,10)				Priors reflecting disbelief Normal (0,0.5)			
	M	S	n_eff	Rhat	M	S	n_eff	Rhat
Constant	2.71	0.24	7770	1	2.71	0.24	6334	1
Sex	-0.15	0.08	11890	1	-0.15	0.07	11702	1
Age	0.04	0.03	9178	1	0.04	0.03	10480	1
Education	-0.06	0.06	7912	1	-0.06	0.06	6411	1
Income	0.07	0.03	9008	1	0.07	0.03	8893	1
Relaxation	0.24	0.09	10802	1	0.23	0.08	10608	1
PhysicalActivities	0.05	0.08	12154	1	0.05	0.08	10460	1
Friends	0.02	0.09	12023	1	0.01	0.09	10587	1
Family	0.08	0.10	10520	1	0.07	0.09	10497	1
EducationalActivities	-0.22	0.10	10234	1	-0.21	0.10	10408	1
EnjoyNature	0.20	0.08	10541	1	0.20	0.08	9819	1
CommunityEvents	-0.05	0.11	11198	1	-0.05	0.11	10729	1

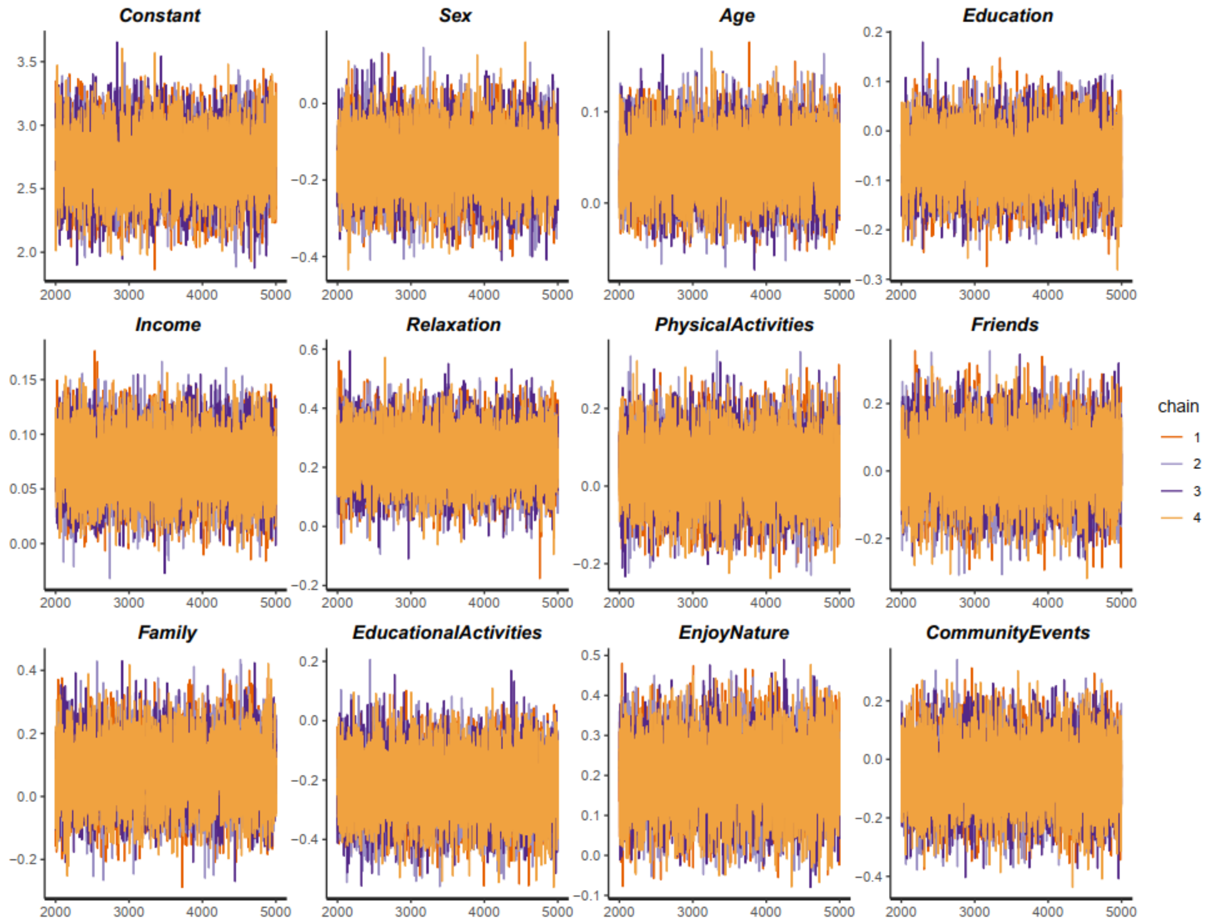

Figure 5: Model 2's trace plots using uninformative priors

Based on the estimated results of Model 2 in Table 4, it can be seen that while age and income have positive associations with donation willingness (M_{Age}=0.04 and S_{Age}=0.03; M_{Income}=0.07 and S_{Income}=0.03), males and those with higher education levels are less willing to donate to planting projects (M_{Sex}=-0.15 and S_{Sex}=0.08; $M_{Education}$=-0.06 and $S_{Education}$=0.06). The HPDIs of Sex and $Education$ in Figure 6 demonstrate that the negative association between Sex and $PublicParkDonation$ is highly reliable, while that between $Education$ and $PublicParkDonation$ is moderately reliable. Meanwhile, HPDIs of Age and Income suggest their positive associations are moderately and highly reliable, respectively (see Figure 6).

As for motivations to visit public parks, only $Relaxation$ and $EnjoyNature$ are found to have positive associations with $PublicParkDonation$ ($M_{Relaxation}$=0.24 and $S_{EnjoyNature}$=0.09; $M_{EnjoyNature}$=0.20 and $S_{EnjoyNature}$=0.08), while other motivational factors have ambiguous associations. The HPDIs of $Relaxation$ and $EnjoyNature$ lie entirely on the positive sides of the *x*-axis, so their positive associations with $PublicParkDonation$ can be deemed highly reliable. In contrast, *EducationalActivities* is found to have a negative association with $PublicParkDonation$ ($M_{EducationalActivities}$=-

0.22 and $S_{EducationalActivities}$=0.10), and the association is highly reliable as illustrated by its HPDI in Figure 6.

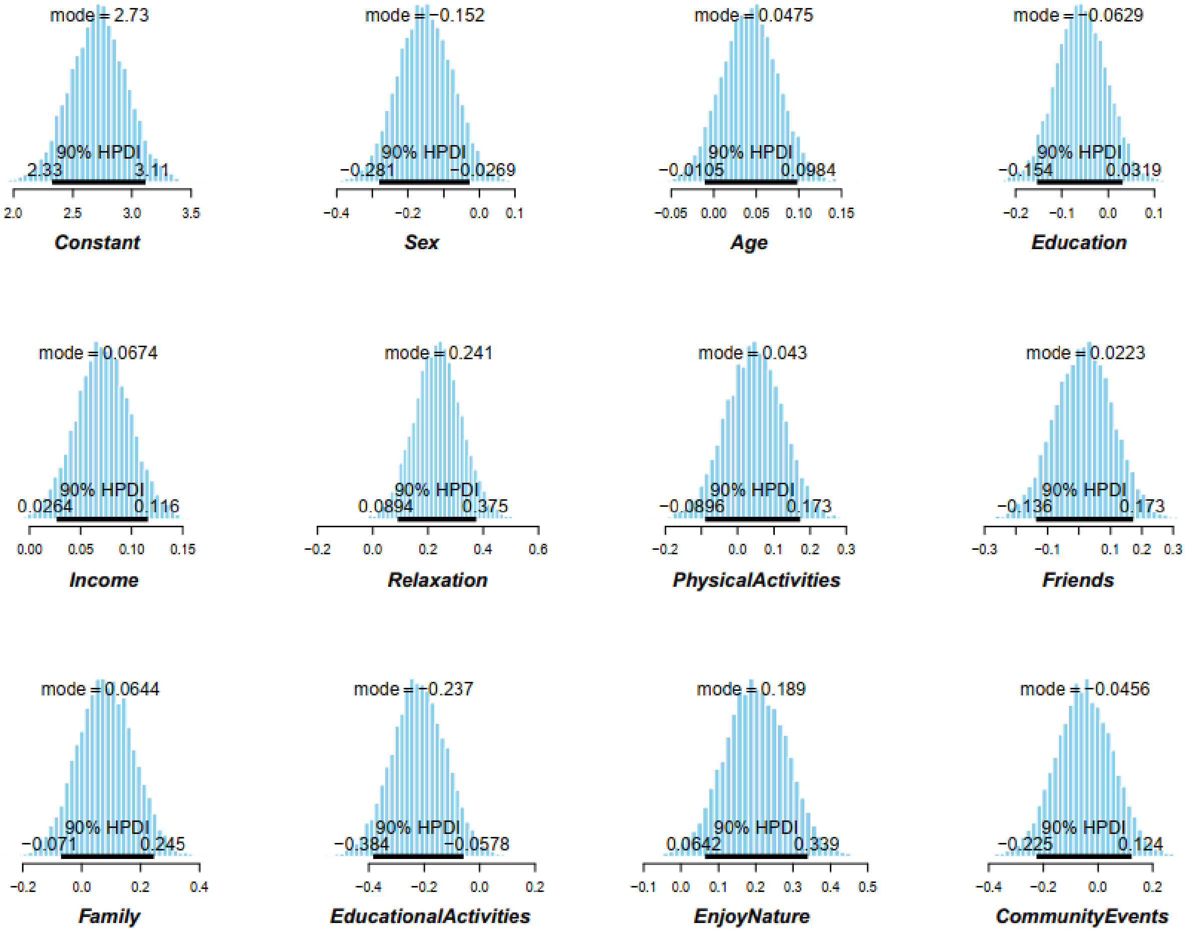

Figure 6: Model 2's estimated posteriors using uninformative priors

When we refitted Model 2 using informative priors that reflected our disbelief in the associations, the estimated posteriors remained nearly identical to those obtained with uninformative priors. This suggests that the estimated results are insensitive to the choice of priors.

3.3. Model 3

For Model 3, our goal was to assess whether the respondent's frequency of visiting public parks is associated with their donation willingness, as well as whether socio-demographic factors and motivations for visiting public parks are indirectly associated with donation willingness through the frequency of visiting public parks. The procedure for fitting and validating Model 3 were consistent with those used for Models 1 and 2. Initially, we performed a PSIS-LOO diagnosis for both models. The visualizations of *k*-values in Figure 7, where all *k*-values are below 0.5, indicate that Models 3 are neither underfitted nor overfitted with the data.

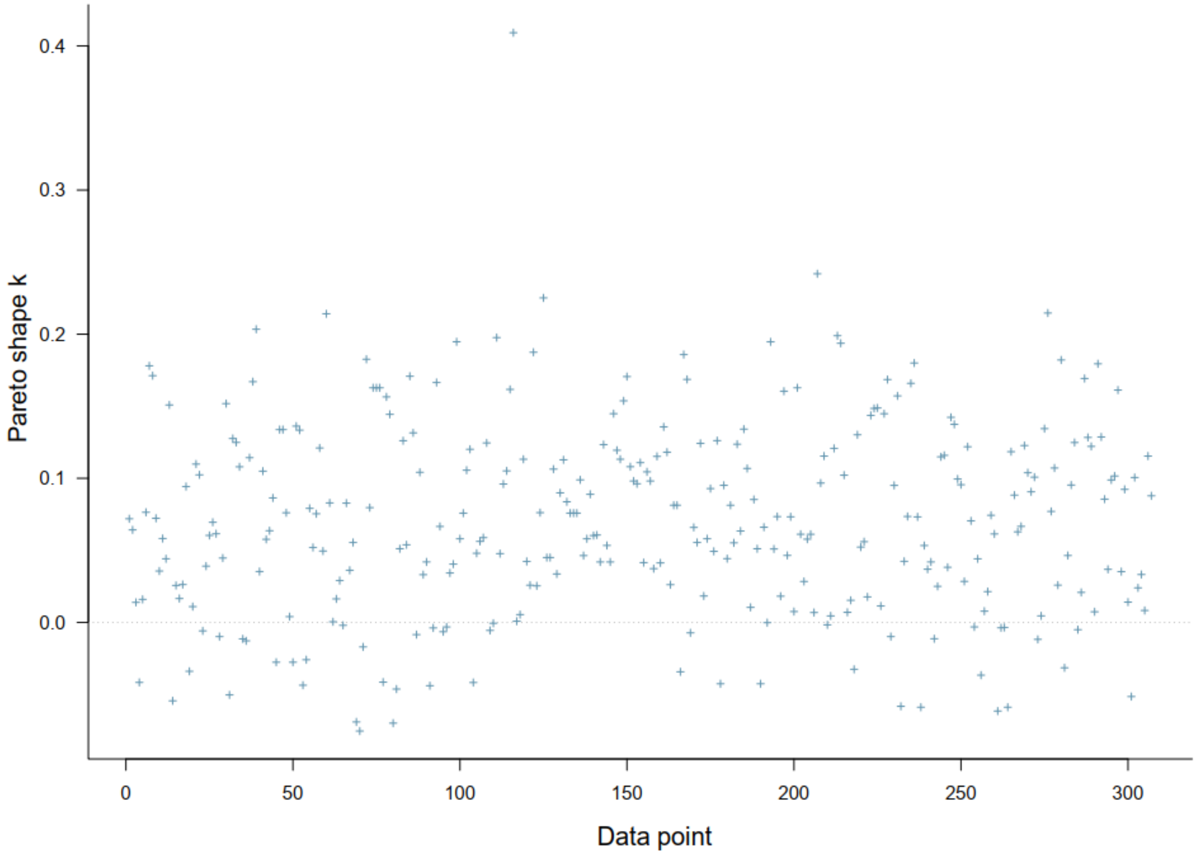

Figure 7: Model 3's PSIS-LOO diagnosis using uninformative priors

Table 5 shows that the *n_eff* and *Rhat* values confirm the convergence of Models 3 (with *n_eff* > 8,000 and *Rhat* = 1). Additionally, the convergence is supported by visual diagnostics from the trace plots illustrated in Figure 8.

Table 5: Model 3's simulated posterior results

Parameter	**Uninformative prior Normal (0,10)**				**Priors reflecting disbelief Normal (0,0.5)**			
	M	**S**	**n_eff**	**Rhat**	**M**	**S**	**n_eff**	**Rhat**
Constant	2.43	0.27	8922	1	2.43	0.26	8175	1
Sex	-0.16	0.08	13597	1	-0.16	0.07	13686	1
Age	0.02	0.03	12657	1	0.02	0.03	12998	1
Education	-0.06	0.06	9212	1	-0.05	0.06	8505	1
Income	0.07	0.03	11014	1	0.07	0.03	11737	1
Relaxation	0.21	0.09	11973	1	0.20	0.08	12172	1
PhysicalActivities	-0.01	0.08	11561	1	-0.01	0.08	13617	1
Friends	0.00	0.09	12162	1	0.00	0.09	13367	1
Family	0.06	0.10	11745	1	0.06	0.09	12017	1
EducationalActivities	-0.23	0.10	11731	1	-0.22	0.10	11569	1
EnjoyNature	0.18	0.09	12052	1	0.18	0.08	13537	1

CommunityEvents	-0.05	0.11	11893	1	-0.05	0.10	14534	1
PublicParkFrequen	0.14	0.06	10840	1	0.14	0.06	11321	1

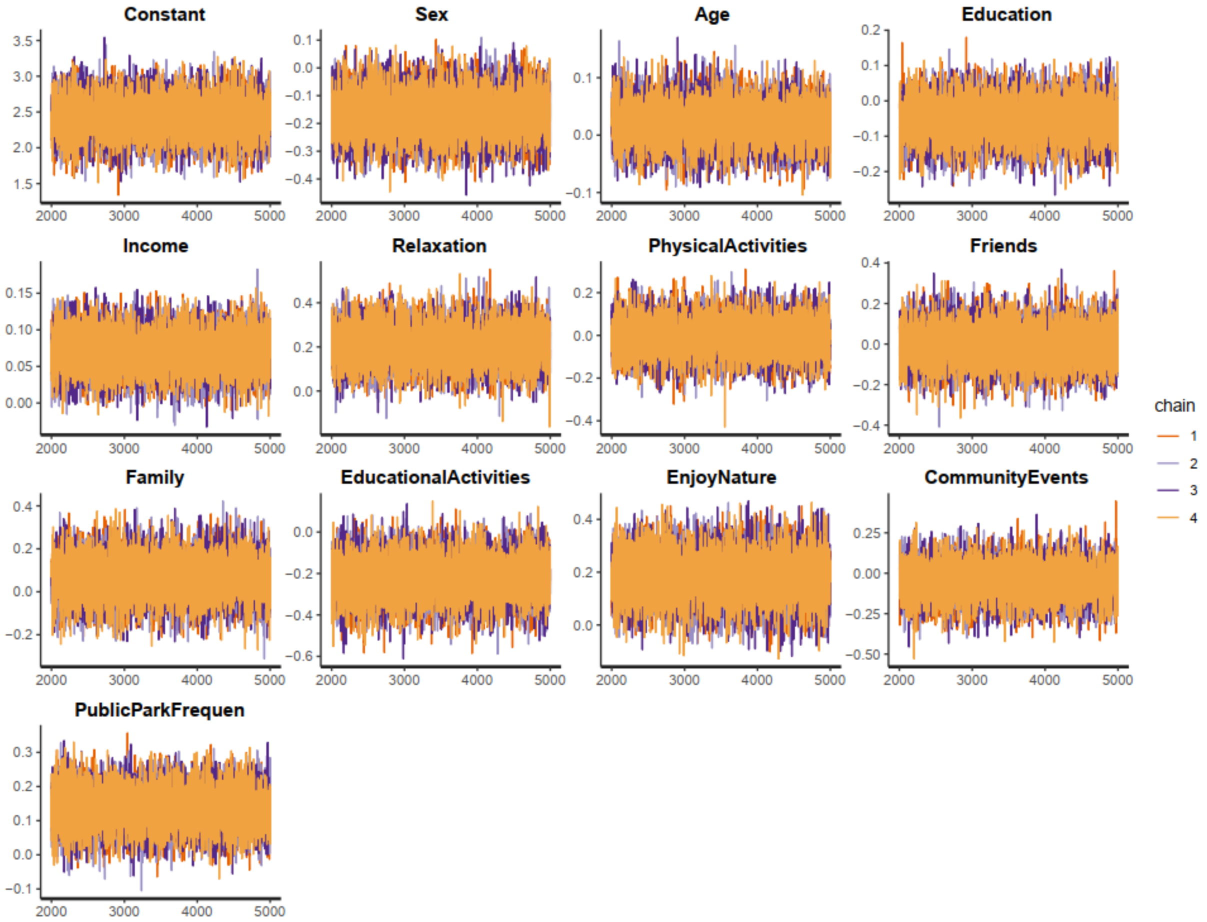

Figure 8: Model 3's trace plots using uninformative priors

As can be seen from Table 5, $PublicParkFrequen$ has a positive association with $PublicParkDonation$ ($M_{PublicParkFrequen}$ =0.14 and $S_{PublicParkFrequen}$ =0.06). 90% HPDI of $PublicParkFrequen$ is also entirely located on the positive side, so its positive association can be deemed highly reliable (see Figure 9). Even after adding *PublicParkFrequen* into the model, coefficients of other variables in Model 3 are relatively similar to those in Model 2. Refitting the model using information priors did not change the estimated posteriors, so the results are robust against priors (see Table 5).

Figure 9:

4. Discussion

Under rapid urbanization, public parks are crucial for protecting biodiversity and enhancing human well-being. In this study, we examined the relationships between urban residents' socio-demographic characteristics, park visitation motivation, visit frequency, and donation willingness in major cities in Vietnam. Based on the results of Models 1-3, we discovered several major findings.

First, respondents' socio-demographic factors have varying relationships with their frequency of visiting public parks and donation willingness. From these relationships, two points are noteworthy. In particular, male residents tend to visit public parks more frequently, but they are less willing to donate to planting projects in the public parks. The finding highlights the discrepancies between male and female residents in park usage frequency and donation willingness. Concerning the association between sex and donation willingness, our study's finding is aligned with that of López-Mosquera (2016), which also indicates women have more willingness to pay for the conservation of the national park. López-Mosquera (2016) explained that woman may feel more empowered to effect change through their actions and are more susceptible to subjective and moral norms, potentially increasing their tendency to donate to causes they value. However, when male residents visit the public parks more frequently, as indicated in our study, it might lead to serious free-riding and gender inequality problems (Gomez-Ruiz & Sánchez-Expósito, 2020), where females are more likely to pay for utilities that would be utilized more frequently by males. With the current study's design, it is not feasible to delve into this problem. Exploring whether the free-riding and gender inequality problem really exist and its underlying mechanism can be valuable research direction for future studies.

Another point is that people with higher education are less willing to donate to planting projects in public parks. Although the association is moderately reliable, it is remarkable since it contrasts with Peters and Hawkins (2009) and Majumdar et al. (2011), who reported higher donation willingness to public parks among more educated visitors. These discrepancies might stem from cultural or contextual differences between Vietnam and previously studied urban environments, highlighting the importance of context-specific research in urban park management. Besides the two notable points, we also found that older residents do not only visit public parks more frequently but are also more willing to donate than younger residents, and people with higher income are more willing to donate.

Second, it was discovered that almost all examined motivations—relaxation, physical activities, nature enjoyment, meeting friends, and family time—are positively associated with visiting frequency. Regarding the direct relationship between motivation and willingness to donate, only relaxation and enjoying nature show reliable positive associations. These results validate our presumption made based on the Mindsponge Theory and the informational entropy-based notion of value: people with motivations deriving more from the intrinsic values of the park tend to visit the park frequently and be more willing to donate. Besides providing a place where urban people can interact with nature (e.g., plants and animals), public parks also serve as a place for urban people to do physical exercise, social gatherings, and educational and recreational activities, which do not necessarily require interactions with plants and animals in the park. People motivated by physical activity, socializing, and family time tend to visit public parks more frequently. However, their willingness to donate to park planting projects is often uncertain, as they might not see such donations as valuable for them. In contrast, those visiting public parks for activities that partly or wholly require interactions with nature, like relaxation and nature enjoyment, are more willing to donate because they might consider doing so to maximize their benefits.

The result above seems to suggest that the Vietnamese urban people's awareness of the natural values of public parks is relatively low, and the eco-surplus cultural values might not have existed within the Vietnamese urban communities (M.-H. Nguyen & T. E. Jones, 2022; Vuong, 2021). Although physical exercise, social gatherings, and educational and recreational activities do not require public park visitors to interact with surrounding plants or animals, the visitors still benefit from the natural experiences through their sensory systems, like sight (e.g., colorful landscape), smell (e.g., the odor of wood, flowers, and grass), hearing (e.g., sounds of bird), etc. The negative associations between educational level, educational activities, and donation willingness also further corroborate this interpretation. This implies that environmental education in Vietnam may be lacking or ineffective, potentially due to its perception that it is a formal obligation rather than an engaging experience. Through the lens of Mindsponge theory, if educational programs are perceived as not beneficial or even costly, relevant information provided by such programs would be less likely to be absorbed into individuals' mindsets (Vuong et al., 2021). Sometimes, it might also lead to rejection or denial of the value of such information. These findings question conventional assumptions about the role of education in environmental engagement (Aiman et al., 2022), and call for further investigation into the effectiveness of environmental education and how it can be associated with urban park management in the contexts of rapidly developing countries, like Vietnam.

Third, although physical activities, meeting friends, and family time motivations are not directly associated with donation willingness, they are found to be indirectly positively associated with donation willingness through the mediation of public park visiting frequency. This result, again, confirms our presumption that people with more experience (or interactions) with public parks would be more willing to donate. Through the mediation of park visiting frequency, although people initially visit the parks not because of the natural values of the parks, they would gradually recognize such values if the visiting frequency is high. Subsequently, they would be more willing to donate for planting projects. The result also hints at the potential of building an eco-surplus culture among Vietnamese urban residents by increasing their frequency of visiting public parks.

Our study offers several implications for urban planning, park management, and sustainable urban development in rapidly urbanizing contexts. Firstly, given that relaxation and nature enjoyment are primary drivers of both visitation and donation willingness, park designers and managers should prioritize spaces and programs that facilitate these experiences in their planning and fundraising efforts (Vuong & Nguyen, 2023). This aligns with Wolch et al. (2014)'s concept of creating high-quality green spaces that meet community needs. Secondly, our results suggest a need to reevaluate public education and outreach efforts related to environmental values and public parks. While educational activities remain crucial, they should be redesigned to be more engaging and emotionally resonant, fostering connections that could translate into eco-surplus cultural values and greater support for public park projects (López-Mosquera et al., 2014; Vuong & Nguyen, 2024b). This approach is corroborated by Soga and Gaston's (2016) work on the importance of nature engagement opportunities, especially for children in increasingly urbanized environments.

Thirdly, to foster a more comprehensive eco-surplus culture, policymakers and park managers should prioritize more spaces for public parks in urban planning to provide urban residents with more nature connection opportunities. In this way, residents' awareness of the intrinsic value of nature and the broader ecological benefits of urban green spaces would also be improved. Finally, park managers could benefit from tailoring their donation campaigns around personal nature experiences and personal benefits rather than relying solely on abstract environmental concerns. This strategy is supported by Park and Cho's (2020) study, which identified personal experience and emotional sympathy as the most significant factors influencing donation intention for both experienced and inexperienced donors. Given the positive association between income and donation tendency, conservation and park-related campaigns should also be designed to engage and garner support from higher-income groups.

While our study provides insights into public park visitation frequency and donation willingness in urban cities of Vietnam, several limitations need to be considered (Vuong, 2020). Firstly, our data collection occurred during the COVID-19 pandemic in 2021, potentially influencing findings, particularly regarding park visitation frequency, community events, and educational activities. Secondly, the cross-sectional nature of the data limits our ability to infer causal relationships or temporal analysis, which may not directly translate to actual donation behavior. Thirdly, the absence of spatial analysis, which could have elucidated the influence of park accessibility on visitation patterns and attitudes, represents another limitation. To address these constraints, future research could incorporate GIS data on park locations and urban forms, providing a more comprehensive understanding of spatial dynamics. Longitudinal studies could deliver temporal changes to attitudes and behaviors, while experimental designs could more robustly assess causal relationships. Future studies could also explore strategies to bridge the gap between personal benefits and broader ecological awareness, fostering the growth of an eco-surplus culture in urban Vietnam. Additionally, comparative studies with other rapidly urbanizing countries could offer valuable insights into how cultural and economic factors influence attitudes toward urban green spaces and conservation efforts.

In conclusion, as cities continue to grow, the creation and maintenance of public green spaces should be viewed as inseparable from the fostering of resident's eco-surplus culture. This approach not only enhances the quality of urban life and maintains the human-nature connection but also contributes to the long-term sustainability of rapidly urbanizing countries.

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