

Residents' Willingness to Pay for Green Infrastructure – A Case Study of Hanoi City

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Abstract: This study investigates the factors affecting residents' willingness to pay for green infrastructure in Hanoi by combining the Theory of Planned Behavior and environmental behavior theory. A cross-sectional survey of 1,092 residents in Hanoi City was carried out using a non-probability sampling method. The results show that perceived environmental benefits, trust in government, and personal environmental responsibility are the most important factors influencing residents' willingness to pay for green infrastructure. The results indicate that improving public awareness, building trust, and encouraging environmental responsibility are essential for increasing residents' willingness to support green infrastructure.

Keywords: Green infrastructure, willingness to pay, theory of planned behavior, Hanoi

1. INTRODUCTION

Amid rapid urbanization, major cities worldwide face serious issues like environmental pollution, loss of green spaces, urban flooding, and the growing effects of climate change. According to the Intergovernmental Panel on Climate Change (2022), urban areas are heavily impacted by climate change and also produce a large share of emissions. In Hanoi, fast-paced urban growth combined with population increases has put more pressure on infrastructure and the quality of life, leading to air pollution, fewer green spaces, and higher flood risks (World Bank, 2020).

In this context, green infrastructure is viewed as an effective way to improve environmental quality and boost urban resilience. Green infrastructure not only helps reduce the impacts of climate change but also provides many ecological, economic, and social benefits (Kim and Song, 2019; Jansson, 2014). At the same time, according to the Millennium Ecosystem Assessment (2005), urban ecosystems and green spaces are essential for enhancing human well-being and promoting sustainable development.

However, implementing green infrastructure projects often requires substantial financial resources, but state budgets are limited, especially in developing countries. Therefore, mobilizing citizen participation through Willingness to Pay (WTP) becomes a key strategy in sustainable urban management and development (Hanley et al., 2001). Research on WTP enables the quantification of the value citizens assign to environmental benefits and aids the policy decision-making process.

Although the concept of WTP has been widely studied, existing research mainly focuses on valuing environmental resources or green spaces in general, while specific research on urban green infrastructure is relatively limited, especially in the context of developing countries. Some recent studies in Vietnam show that people tend to be willing to pay for urban environmental services; however, the extent and influencing factors have not been analyzed in depth (Nguyen et al., 2021). Similarly, international studies indicate significant differences in WTP across regions and a dependence on many socio-economic factors (Xu et al., 2020).

Recent research highlights a gap in integrated analytical frameworks that combine major behavioral theories, such as the Theory of Planned Behavior and Stern's (2000) environmental behavior theory, specifically in the context of urban green infrastructure. Most previous studies have relied on applying each theory separately, which limits their ability to explain residents' willingness to pay fully. Notably, the interactive effects of factors like environmental benefit awareness, social norms, trust in government, and personal responsibility have not been systematically examined. Additionally, the distinctive features of

green infrastructure, including efficiency, accessibility, and fairness in benefit distribution, have not been sufficiently incorporated into existing models, resulting in limitations when explaining people's behavior toward this type of infrastructure.

In this context, in Hanoi, where rapid urbanization, high population density, and varying levels of environmental awareness among social groups are common, relevant empirical evidence remains quite limited. Although green infrastructure development initiatives have been promoted, they are mostly top-down and lack extensive research on willingness to pay and the factors that influence resident behavior. This lack of practical data hampers policy feasibility assessments and limits the ability to design suitable financing mechanisms and encourage community participation. Therefore, it is necessary to supplement empirical studies in the local context, as recommended by the Organisation for Economic Co-operation and Development (2018), to provide a solid scientific basis for planning and implementing green infrastructure development policies.

2. LITERATURE REVIEW

2.1. Related concepts

2.1.1. Green Infrastructure

Green infrastructure is defined as a network of natural and semi-natural elements designed and managed to provide ecosystem services and deliver various environmental, economic, and social benefits (European Commission, 2013). According to Kim and Song (2019), green infrastructure includes components such as parks, urban greenery, green roofs, sustainable drainage systems, and nature-based solutions.

In urban areas, green infrastructure is vital for improving air quality, decreasing the urban heat island effect, and boosting resilience to climate change (Jansson, 2014). For Hanoi, developing green infrastructure also helps address urgent environmental challenges like urban pollution and flooding.

2.1.2. Willingness to Pay

Willingness to pay (WTP) is the highest amount an individual is prepared to pay to gain a benefit or avoid a loss, especially in cases where market prices for goods and services are unclear (Hanley et al., 2001). WTP is a key idea in environmental economics and is frequently used to value ecosystem services and public resources.

In this study, WTP indicates how willing residents are to financially support the development and upkeep of urban green infrastructure. Therefore, WTP not only has economic importance but also reflects people's attitudes and awareness of environmental issues.

2.2. Analytical framework

The study's analytical framework combines behavioral theories and environmental economics to explain willingness to pay (WTP) for green infrastructure. This integrated approach clarifies the cognitive, social, and institutional factors that influence individual behavior in urban settings.

First, the Theory of Planned Behavior (Ajzen, 1991) is used as the main foundation for analyzing behavioral intentions. Accordingly, the intention to pay is influenced by attitudes (formed from perceived environmental benefits), subjective norms, and perceived behavioral control (financial ability, ease of contribution).

Additionally, Stern's (2000) environmental behavior theory is incorporated to enhance the aspect of values and ethical norms. This theory highlights the importance of awareness of environmental impacts and personal responsibility in encouraging environmentally friendly actions, which in turn affects payment decisions.

Furthermore, the theory of environmental economic valuation offers a foundation for measuring WTP as an indicator of the value individuals assign to green infrastructure (Hanley et al., 2001). This method enables the quantification of behavior from an economic perspective and aids in developing suitable financial mechanisms.

Finally, institutional factors, especially trust in the government, are included to reflect the practical context. According to the Organisation for Economic Co-operation and Development (2018), trust greatly affects the level of citizen participation in public programs, including financial contributions to green infrastructure.

The proposed analysis framework is as shown in Figure 1:

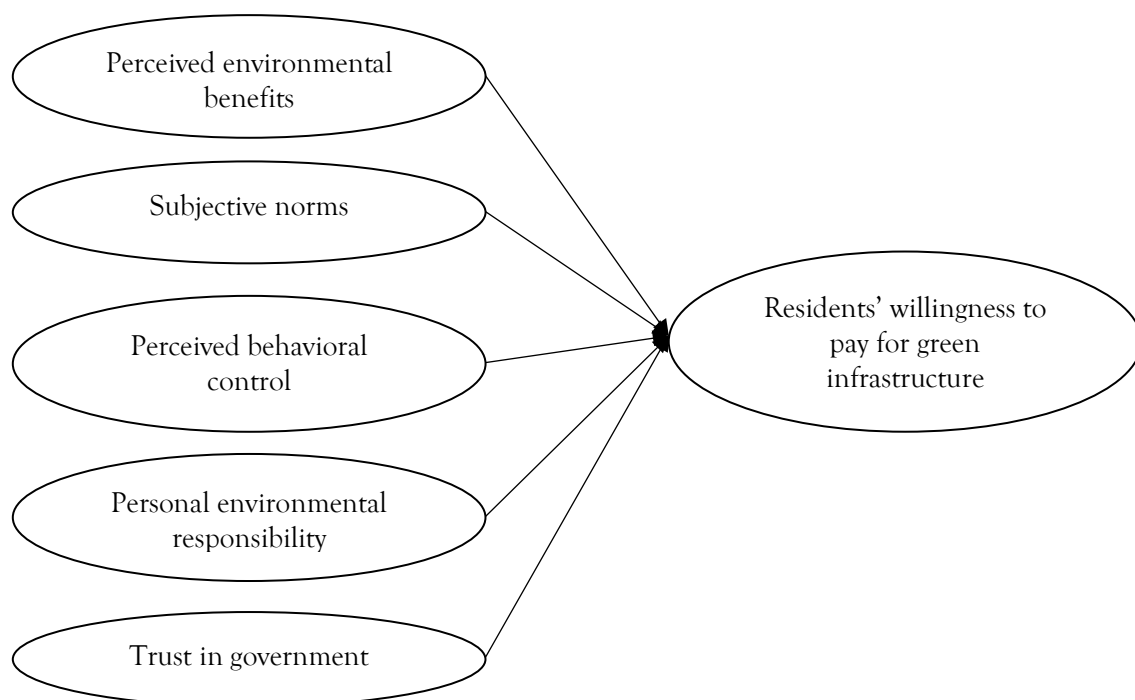


Figure 1. Analytical Framework

Source: Author's compilation

2.3. Hypothesis development

Perceived environmental benefits play a key role in shaping people's attitudes toward pro-environmental actions. According to TPB, having a positive attitude toward a behavior increases the chance of developing a strong behavioral intention (Ajzen, 1991). When residents see that green infrastructure improves air quality, lowers urban heat, enhances aesthetics, and promotes public health, they are more likely to appreciate these projects and support them financially. Past research also confirms that perceived environmental and social benefits greatly influence individuals' WTP for environmental goods (Kim and Song, 2019; Jansson, 2014). Based on the above arguments, the research hypothesis is proposed as follows:

H1: Perceived environmental benefits positively affect residents' willingness to pay for green infrastructure.

Subjective norms refer to the perceived social pressure to perform or not perform a behavior. Within the TPB framework, individuals are more likely to engage in a behavior if they believe that important others (e.g., family, friends, community) expect or support such actions (Ajzen, 1991). In the context of environmental behavior, social norms can promote collective responsibility and motivate

individuals to contribute to public goods like green infrastructure. Empirical studies have demonstrated that social influence plays a significant role in shaping pro-environmental intentions and financial contributions (Hanley et al., 2001). Based on the above arguments, the research hypothesis is proposed as follows:

H2: Subjective norms positively affect residents' willingness to pay for green infrastructure.

Perceived behavioral control reflects individuals' perception of their ability to perform a behavior, including financial capacity, access to payment mechanisms, and perceived ease of participation. According to TPB, higher perceived control leads to stronger behavioral intention (Ajzen, 1991). In the context of WTP, individuals who believe they have sufficient financial resources and find the contribution process convenient are more likely to express willingness to pay. Prior research also highlights that income level and perceived affordability are key factors influencing WTP for environmental services (Hanley et al., 2001; Xu et al., 2020).

H3: Perceived behavioral control positively affects residents' willingness to pay for green infrastructure.

Personal environmental responsibility stems from Stern's (2000) environmental behavior theory, which highlights the importance of personal norms and moral obligation in motivating pro-environmental actions. People who feel a strong sense of responsibility for protecting the environment are more likely to engage in behaviors that promote sustainability, including providing financial support for environmental initiatives. The Value-Belief-Norm (VBN) theory indicates that awareness of environmental impacts and the attribution of responsibility activate personal norms, which then influence behavior (Stern, 2000). Based on the above arguments, the research hypothesis is proposed as follows:

H4: Personal environmental responsibility positively affects residents' willingness to pay for green infrastructure.

Trust in government is an important institutional factor influencing public participation in environmental programs. In many cases, green infrastructure projects are funded and managed by public authorities; therefore, individuals' willingness to contribute depends on their trust in the government's ability to allocate and use resources effectively and transparently. According to Organisation for Economic Co-operation and Development (2018), higher levels of public trust enhance citizens' willingness to cooperate and participate in public initiatives. Empirical evidence also indicates that trust significantly influences WTP for public environmental goods, especially in developing countries (Xu et al., 2020). Based on the above arguments, the research hypothesis is proposed as follows:

H5: Trust in government positively affects residents' willingness to pay for green infrastructure.

3. METHODOLOGY

3.1. Measurement scales

This study employs a structured questionnaire to measure the constructs in the proposed model. All variables are operationalized using multi-item scales, adapted from prior studies to ensure content validity. Responses are measured using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Perceived environmental benefits are individuals' evaluations of the positive environmental and social outcomes of green infrastructure. This construct is adapted from previous studies on environmental perception and green space valuation (Kim and Song, 2019; Jansson, 2014).

Subjective norms reflect perceived social pressure from significant others about participating in environmental efforts. The scale is adapted from the Theory of Planned Behavior (Ajzen, 1991).

Perceived behavioral control reflects individuals' perception of their ability to financially contribute to green infrastructure. This construct is also based on TPB (Ajzen, 1991).

Personal environmental responsibility is an individual's moral duty to protect the environment. The scale is adapted from Stern's (2000) environmental behavior theory.

Trust in government shows how much people believe public authorities can handle environmental projects in a clear and effective way. This scale is based on research about institutional trust (Organisation for Economic Co-operation and Development, 2018).

Willingness to pay is the dependent variable that indicates residents' intention to financially support green infrastructure. This idea is based on environmental valuation research (Hanley et al., 2001; Xu et al., 2020).

3.2. Data collection

Based on Slovin's formula (1960) and an estimated urban population of 4,138,500 in Hanoi by late 2024, a minimum sample size of 400 was established. A non-probability sampling approach was employed in the investigation. To ensure methodological rigor, consultations with specialists and interested parties were undertaken, leading to improvements. Household representatives aged 18 years or above were included. The survey was administered between January and March 2025. A total of 1,500 questionnaires were gathered, and out of those, 1,092 were deemed acceptable, thus guaranteeing a substantial sample size appropriate for data analysis.

An outline of the sample's attributes is presented in Table 1. A male majority was observed, exceeding 69% of those surveyed. Regarding age, the largest segment, comprising 63.10% of the sample, fell within the 25 to 40-year range; subsequently, 25.91% were over 40. The remaining portion was younger than 25. Educational attainment revealed that bachelor's degrees were held by over 81% of the participants. A monthly household income exceeding 20 million VND was reported by more than 80%.

Table 1: Sample characteristics

Characteristics	Frequency	Ratio
Gender		
Male	764	69.96
Female	328	30.04
Age		
Under 25	120	10.99
25-40	689	63.10
Above 40	283	25.91
Education		
Below university	75	6.87
University	890	81.50
Postgraduate	127	11.63
Monthly household income		
Under 20 millions VND	210	19.23
Above 20 millions VND	882	80.77

Source: Analysis results from SPSS 26

3.3. Data analysis

The author uses SPSS 26 software to analyze the data collected. The analysis methods include descriptive statistics, scale reliability testing (Cronbach's Alpha), exploratory factor analysis (EFA), correlation analysis, and multivariate linear regression.

4. RESULTS

Table 2 presents the Cronbach’s Alpha values for the scales. The results show that the scales’ reliability, as measured by Cronbach’s Alpha, surpasses the 0.7 threshold recommended by Hair et al. (2010).

Table 2: The results of Cronbach’s Alpha

Scales	Sign	Items	Cronbach’s Alpha	Loadings
Perceived environmental benefits (PEB)	PEB1	Green infrastructure improves air quality.	0.821	0.867
	PEB2	Green infrastructure helps reduce urban heat.		0.878
	PEB3	Green infrastructure enhances urban aesthetics.		0.806
	PEB4	Green infrastructure contributes to public health.		0.812
Subjective norms (SN)	SN1	People important to me think I should support green infrastructure.	0.812	0.820
	SN2	My family and friends encourage me to contribute to environmental protection.		0.868
	SN3	I feel social pressure to support green infrastructure initiatives.		0.812
Perceived behavioral control (PBC)	PBC1	I have sufficient financial resources to contribute to green infrastructure.	0.799	0.834
	PBC2	It would be easy for me to make a financial contribution.		0.849
	PBC3	I can provide financial support for green infrastructure.		0.859
Personal environmental responsibility (PER)	PER1	I feel personally responsible for protecting the environment.	0.800	0.816
	PER2	I believe it is my duty to contribute to environmental improvement.		0.830
	PER3	I feel guilty if I do not take action to protect the environment.		0.822
Trust in government (TG)	TG1	I trust the government to manage green infrastructure projects effectively.	0.811	0.847
	TG2	I believe funds for green infrastructure will be used transparently.		0.832
	TG3	I have confidence in government environmental policies.		0.829
Residents’ willingness to	WTP1	I am willing to pay for the development of green infrastructure.	0.825	0.836

Scales	Sign	Items	Cronbach's Alpha	Loadings
pay for green infrastructure (WTP)	WTP2	I am willing to contribute regularly to maintain green infrastructure.		0.844
	WTP3	I would support a policy that requires financial contributions for green infrastructure.		0.824

Source: Analysis results from SPSS 26

The results of the EFA for the independent variable show a KMO of 0.833 (above 0.5), a significance level of 0.000 (below 0.05), an Eigenvalue greater than 1, and factor loadings for the 16 items exceeding 0.5 (see Table 2). These variables were grouped into five factors as initially proposed by the model. Additionally, the total variance explained reached 69.21%, which is above 50%, indicating that these three factors accounted for 69.21% of the variation in the data from the 16 items participating in the EFA.

The EFA results for the dependent variable show a KMO value of 0.814, which is above 0.5, and Bartlett's Test significance is 0.000, less than 0.05, indicating that factor analysis is suitable. One factor was extracted with an Eigenvalue of 2.018, greater than 1, and the cumulative explained variance is 66.37%, exceeding 50%. This factor accounts for 66.37% of the variance in the three items involved in the EFA.

The results of the correlation analysis indicated that the Pearson correlation between the independent and dependent variables was less than 0.05, suggesting a significant linear relationship. Trust in government showed the strongest correlation with residents' willingness to pay for green infrastructure, with an r of 0.587. Conversely, subjective norms displayed the weakest correlation, with an r of 0.511.

The regression results in Table 3 show an adjusted R² of 0.694, indicating that the independent variables explain 69.4% of the variance in residents' willingness to pay for green infrastructure. The analysis also shows that the VIF is less than 5, suggesting the data does not violate the multicollinearity assumption. Additionally, the Durbin-Watson value of 1.937 falls within the 1.5 to 2.5 range, indicating no violation of the error independence assumption. Furthermore, the t-values for the independent variables are less than 0.05, demonstrating statistical significance.

Table 3: The results of regression model

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity Statistics		
	B	Std. Error	Beta			Tolerance	VIF	
1	Constant	0.837	0.065		12.877	0.0002		
	PEB	0.325	0.062	0.407	5.241	0.0001	0.778	1.829
	SN	0.256	0.063	0.289	4.063	0.0004	0.800	1.911
	PEC	0.276	0.067	0.302	4.119	0.0003	0.802	1.901
	PER	0.314	0.061	0.387	5.147	0.0005	0.849	1.937
	TG	0.318	0.064	0.395	4.969	0.0007	0.878	1.947
Adjusted R ² = 0.694, Sig. F = 0.000, Durbin-Watson = 1.937								
<i>Notes:</i> PEB = Perceived environmental benefits, SN = Subjective norms, PEC = Perceived behavioral control, PER = Personal environmental responsibility, TG = Trust in government								
Dependent variable: Residents' willingness to pay for green infrastructure								

Source: Analysis results from SPSS 26

A regression equation with a standardized coefficient is expressed as follows:

$$WTP = 0.407PEB + 0.289SN + 0.302PEC + 0.387PER + 0.395TG$$

As shown in the regression output, the independent variables are statistically significant at the 0.05 level. Therefore, hypotheses from H1 to H5 are accepted.

5. DISCUSSION AND IMPLICATIONS

5.1. Discussion

First, perceived environmental benefits (PEB) have the strongest positive effect on WTP ($\beta = 0.407$, $p < 0.001$). This finding shows that residents are more willing to pay when they clearly understand the environmental and social advantages of green infrastructure. This result matches previous studies (Kim and Song, 2019; Jansson, 2014) and supports the Theory of Planned Behavior, where attitude is a key factor in shaping behavioral intention. It implies that raising public awareness of environmental benefits is essential for increasing financial support for green initiatives.

Second, trust in government (TG) is also a strong predictor ($\beta = 0.395$, $p < 0.001$), ranking among the most influential factors. This emphasizes the importance of institutional trust in shaping residents' willingness to pay. When individuals believe that the government will handle funds transparently and efficiently, they are more likely to contribute. This finding aligns with Organisation for Economic Co-operation and Development (2018), highlighting that trust is a key driver of public participation in environmental programs, especially in developing urban areas.

Third, personal environmental responsibility (PER) significantly influences WTP ($\beta = 0.387$, $p < 0.001$), confirming the importance of moral and normative factors. This finding supports Stern's (2000) theory, which emphasizes that individuals with a stronger sense of responsibility toward environmental protection are more likely to participate in pro-environmental behaviors, including providing financial support.

Fourth, perceived behavioral control (PEC) also has a positive and significant effect ($\beta = 0.302$, $p < 0.001$). This indicates that residents' financial ability and perceived ease of participation influence their willingness to pay. Even when individuals recognize environmental benefits and feel responsible, their actual intention depends on whether they see the contribution as doable. This finding aligns with previous research in environmental valuation (Hanley et al., 2001; Xu et al., 2020).

Finally, subjective norms (SN) positively influence WTP ($\beta = 0.289$, $p < 0.001$), although their effect size is smaller compared to other factors. This shows that social influence still matters, but it is less dominant than individual perceptions and institutional trust. The result suggests that while social pressure can encourage participation, personal beliefs and trust factors are more decisive in this situation.

5.2. Implications

This study adds to the existing literature by expanding the application of the Theory of Planned Behavior in the areas of green infrastructure and environmental financing. Although TPB has been commonly used to explain pro-environmental actions, this research shows that its explanatory power can be improved by including moral and institutional factors. Specifically, adding personal environmental responsibility, based on the theory of Stern (2000), offers a more complete understanding of internal motivations beyond rational assessment.

Furthermore, the study emphasizes the important role of trust in government as a key factor influencing willingness to pay, which is often overlooked in traditional behavioral models. This finding indicates that behavioral theories should be expanded to include contextual and governance-related factors, especially in developing countries. Combining cognitive (perceived benefits), social (subjective norms), moral (responsibility), and institutional (trust) aspects provides a more comprehensive framework for understanding environmental behavior.

Additionally, by applying environmental valuation concepts (Hanley et al., 2001) to the specific case of green infrastructure, the study bridges the gap between behavioral theory and economic valuation. It shows that WTP is not just an economic decision but also a behavioral outcome influenced by psychological and social factors. Therefore, this research adds to the interdisciplinary literature by integrating insights from environmental economics and behavioral science.

The findings offer several key implications for policymakers and urban planners in Hà Nội and comparable urban settings.

First, since perceived environmental benefits have the strongest influence on WTP, public authorities should focus on awareness campaigns to improve residents' understanding of the benefits of green infrastructure. Educational programs, media outreach, and community involvement initiatives can help boost positive attitudes and gain public support.

Second, the important role of trust in government highlights that transparency and accountability are essential for encouraging financial contributions. Authorities should ensure clear communication about how funds are collected, managed, and spent. Implementing participatory governance practices and providing regular public reports can build trust and increase willingness to contribute.

Third, the influence of personal environmental responsibility highlights the need to cultivate environmental values among citizens. Policies should not only prioritize infrastructure development but also foster environmental ethics through education, community programs, and social campaigns.

Fourth, because of the impact of perceived behavioral control, policymakers should develop flexible and affordable ways for contributions. For example, adding tiered payment options, voluntary contributions, or including payments in existing public service fees can help make participation easier.

Finally, while subjective norms have a smaller impact, they still play a meaningful role in shaping behavior. Using social influence through community leaders, social networks, and public campaigns can help foster a culture of collective responsibility for environmental protection.

6. CONCLUSION

This study investigates the factors influencing residents' willingness to pay (WTP) for green infrastructure in Hanoi by combining the Theory of Planned Behavior and Stern's environmental behavior theory (2000). The results indicate that perceived environmental benefits, trust in government, and personal environmental responsibility are the most significant factors, followed by perceived behavioral control and subjective norms. These findings emphasize that WTP is influenced by a mix of cognitive, social, subjective, and institutional factors.

This study contributes by providing an integrated framework that links behavioral and economic perspectives; however, several limitations should be acknowledged. The use of cross-sectional and self-reported data may limit causal inference and introduce potential bias, while focusing on a single city might restrict the generalizability of the findings. Future research should consider longitudinal designs, wider geographic areas, and additional variables to increase robustness.

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