

Willingness to Pay for Smartphone-Based Plant Care Advisory Services: Evidence from Dang Xa Urban Area, Hanoi, Vietnam

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ABSTRACT

In the context of digital transformation and urban agricultural development, smartphone applications providing plant care advice are becoming increasingly popular and are expected to bring many benefits to urban residents. However, the level of acceptance and willingness to pay for these services has not been fully studied. This study aims to analyze the willingness to pay (WTP) of urban residents for smartphone-based plant care advice services in the Dang Xa urban area, Hanoi. Data was collected from 115 households through direct surveys. The analysis methods included descriptive statistics, exploratory factor analysis (EFA) based on the Technology Acceptance Model (TAM), and multiple linear regression. The results indicate that the average WTP is estimated at 37,826 VND (approximately USD 1.46), with substantial variation across respondents. Regression results show that perceptions of the application's usefulness, income, and gender have a positive, statistically significant impact on residents' willingness to pay. Meanwhile, perceptions of ease of use and other demographic characteristics have not yet shown a significant impact. Based on this, the study proposes several policy and management implications to promote the development and expansion of digital plant care advisory services in urban contexts.

Keywords: *Smartphone-based advisory services, Willingness to pay, Plant Care Advisory Services, Digital agricultural services, TAM*

1 Introduction

Urban gardening has expanded rapidly in Vietnam, particularly among middle-income households seeking safer, higher-quality food (Pham et al. 2023). In large cities such as Hanoi, residents increasingly cultivate vegetables and ornamental plants in limited spaces, including balconies, rooftops, and small yards. Despite its potential to enhance household food security and urban sustainability, urban gardening often faces constraints, including limited technical knowledge, inappropriate plant varieties, soil management problems, and pest control issues, which reduce plant productivity and survival (Trung & Loan 2025). At the same time, conventional agricultural extension services in Vietnam have traditionally

prioritized rural areas, leaving urban gardeners with insufficient access to professional plant care guidance (Faltmann 2023, Pham & Turner 2020, Trung & Loan 2025).

Advances in digital technology, especially the widespread use of smartphones, create new opportunities to address this gap through smartphone-based plant care advisory services (Bonke et al. 2018, Emeana et al. 2020, Fox et al. 2021, Mangole et al. 2024, Michels et al. 2020). These services typically provide real-time information on planting techniques, weather conditions, pest management, and access to expert consultations, making them particularly suitable for urban residents with limited time and space (Emeana et al. 2020, Fox et al. 2021). In line with Vietnam's national digital transformation and digital agriculture initiatives,

such services are increasingly recognized as policy-relevant tools for modernizing agricultural extension and improving service inclusiveness. However, despite their potential benefits, the adoption of smartphone-based advisory services remains limited, partly due to concerns about cost, data security, service reliability, and varying levels of digital literacy among users (Michels et al. 2020).

Existing literature has examined the role of digital advisory services in agriculture, mainly focusing on rural farmers and productivity outcomes, while evidence from urban contexts—especially in developing countries—remains scarce (Bonke et al. 2018, Emeana et al. 2020, Fox et al. 2021, Michels et al. 2020). In particular, there is limited empirical research on urban residents' willingness to pay (WTP) for smartphone-based plant care advisory services in Vietnam. To further explain how urban residents accept and evaluate smartphone-based plant care advisory services, this study incorporates the Technology Acceptance Model (TAM). The TAM posits that an individual's acceptance of a new technology is primarily determined by two main perceptions: perceived usefulness and perceived ease of use (Davis, 1989). In the context of urban gardening, perceived usefulness (PU) reflects the extent to which users believe smartphone-based advisory services can improve plant health, while perceived ease of use (PE) reflects the extent to which the application is perceived as user-friendly and compatible with users' digital skills. These perceptions shape users' attitudes toward the technology, thereby influencing their behavioral intentions to accept and pay for the service. By incorporating TAM into an economic pricing framework, this study links the WTP of urban residents not only to socioeconomic characteristics but also to behavioral and cognitive factors related to technology adoption. This integrated approach allows for a better understanding of service adoption decisions. It helps explain why potential users may or may not be willing to financially support smartphone-based plant care advisory services in the Vietnamese urban context.

Against this backdrop, this study aims to assess residents' WTP for smartphone-based plant care advisory services in Dang Xa Urban Area, Hanoi. By identifying the level of WTP and its key socioeconomic and behavioral determinants, the study contributes empirical evidence to the limited literature on digital agricultural services

in urban Vietnam. The findings also provide policy-relevant insights for service providers and policymakers seeking to design effective pricing strategies, enhance service adoption, and promote the sustainable development of digital advisory services for urban agriculture.

2 Theoretical Basis and Research Model

2.1 *Technology Acceptance Model (TAM)*

The Technology Acceptance Model (TAM), proposed by Davis (1989), suggests that consumers' behavior in accepting and using technology is primarily influenced by two factors: perceived usefulness (PU) and perceived ease of use (PE). Perceived usefulness reflects the extent to which users believe that using technology will improve their work efficiency or quality of life, while perceived ease of use reflects the ease of learning and using that technology. In the context of smartphone-based plant care consulting services, PU can be understood as the extent to which users believe the application helps them care for their plants more effectively, reduce pest and disease risks, and save time and costs. PE reflects the user-friendliness of the interface, ease of operation, and accessibility.

2.2 *Willingness to Pay for Digital Services*

Willingness to Pay (WTP) is a measure reflecting the economic value that consumers are willing to pay for a particular product or service. In research on digital services, WTP is influenced not only by perceived benefits and costs, but also by socioeconomic factors such as income, gender, Age, education level, and household characteristics (Bonke et al. 2018). For urban residents, the decision to pay for plant care consulting services may also be influenced by factors such as family care responsibilities, household size, and the presence of children or elderly family members.

2.3 *Research Model*

Based on theoretical foundations and research overview, this study proposes a model to analyze the relationship between willingness to pay for smartphone-based plant care consultation services and the following groups of factors: (i) perceived usefulness; (ii) perceived ease of use; and (iii) socio-demographic characteristics of urban residents.

3 Methodology

3.1 Data Collection Method

Primary data were collected through face-to-face interviews with 115 residents in Dang Xa Urban Area, Hanoi. This approach was chosen to ensure a high response rate, clarify survey questions, and improve respondents' understanding of the hypothetical market scenario, which is essential to the reliability of contingent valuation studies.

The survey was designed following an open-ended contingent valuation method (CVM). Before eliciting WTP, respondents were provided with a standardized, detailed description of the smartphone-based plant care advisory service. The description outlined a hypothetical market scenario and clearly explained the service's main features and assumed benefits, including improved plant health and quality, time savings in daily plant care, and enhanced quality of life for urban residents. Instead of using dichotomous-choice questions with predetermined bid levels, respondents were directly asked to state the maximum amount they would be willing to pay for the service. This open-ended elicitation approach allowed respondents to freely express their valuation without being constrained by predefined bid amounts, thereby reducing potential starting-point and anchoring biases commonly associated with closed-ended CVM formats.

To support respondents in providing realistic and thoughtful responses, the questionnaire included clarifying statements regarding the payment context, such as the assumed payment vehicle (e.g., monthly subscription fee) and the conditions under which the service would be provided. In addition, respondents were reminded to consider their household budget constraints and alternative expenditures when stating their maximum WTP.

Given the importance of interviewer performance in face-to-face valuation surveys, all interviewers received intensive training prior to data collection. The training focused on ensuring a consistent presentation of the valuation scenario, a clear explanation of the service attributes, and proper administration of the open-ended WTP question. Interviewers were instructed to avoid suggesting any price levels, refrain from prompting respondents toward specific answers, and maintain a neutral and professional tone throughout the interview. Pilot surveys and role-playing exercises were conducted to help interviewers

handle respondents' questions, address potential misunderstandings, and appropriately identify protest or zero WTP responses.

To enhance data quality, face-to-face interviews were conducted at times and locations convenient for respondents, such as their homes or common residential areas. Interviewers ensured privacy during the interview process and verified that respondents fully understood the valuation question before recording their responses. Respondents were informed that participation was voluntary and that all responses would be kept confidential. These measures contributed to improved response accuracy, reduced measurement error, and enhanced the overall reliability of the collected data.

3.2 Description of Research Variables

Dependent variable

The dependent variable in this study is the WTP of urban residents for a smartphone-based plant care consultation service. WTP is elicited using an open-ended contingent valuation question, in which respondents are asked to state the maximum amount of money they are WTP per month for access to the service under the specified hypothetical market scenario. The WTP variable is treated as continuous and non-negative. Zero values are allowed and interpreted as either genuine zero WTP or protest responses, which are further examined during data cleaning and robustness checks.

Independent variable

The independent variables are divided into two main groups: technology acceptance factors based on the TAM, and socio-demographic characteristics.

(i) TAM variables

Following the TAM framework, the model includes two latent cognitive constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PE).

Each construct is measured using multiple observed indicators rated on a five-point Likert scale, ranging from 1 ("*strongly disagree*") to 5 ("*strongly agree*"). After validating the measurement scales through exploratory factor analysis, composite scores for PU and PE are computed as factor scores. These factor scores are continuous variables capturing respondents' cognitive evaluation of the service.

(ii) Socio-demographic variables

A set of socio-demographic variables is included to control for individual and household

characteristics that may influence WTP. These variables include: Gender: binary variable ($1=$ male, $0=$ female), Age: categorical group of respondent's Age ($1=18-25$ years, $2=26-35$ years, $3=36-45$ years, $4=46-55$ years, $5=$ above 55 years); Education level (Edu) is also measured as an ordinal variable, indicating the highest level of education attained by respondents: $1=$ below high school, $2=$ high school, $3=$ vocational college and $4=$ university degree or postgraduate education; Occupation status: dummy variable capturing $1=$ retirement or non-working status; $0=$ Others; Income (Income per month): ordinal variable measured in income group: $1=<3$ millions, $2=3-5$ millions, $3=5-10$ millions, $4=10-20$ millions, $5=>20$ millions; Marital status (Marriage): binary variable ($1=$ married, $0=$ single); Household size (Hhsize): total number of household members; Number of children (Kid): number of children in the household; Number of elderly members (Elder): number of household members aged 60 years or older.

These variables are included to account for heterogeneity in economic capacity, household responsibilities, and preferences.

3.3 Data Analysis Methods

Descriptive statistics

Descriptive statistical analysis is first conducted to summarize the characteristics of the survey sample and provide an overview of respondents' socio-demographic profiles and WTP distribution. Measures such as means, standard deviations, frequencies, and percentages are reported for key variables.

Reliability analysis of measurement scales

The reliability of the PU and PE scales was assessed using Cronbach's alpha. All constructs exceeded the recommended threshold of 0.7, indicating satisfactory internal consistency.

Exploratory factor analysis (EFA)

Exploratory factor analysis is applied to validate and reduce the observed indicators of PU and PE into underlying latent constructs. Prior to EFA, data suitability is assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. The KMO measure was 0.82, and Bartlett's test of sphericity was statistically significant ($p<0.001$), confirming the suitability of the data for factor analysis (Hair et al., 2010). Factors with

eigenvalues greater than one are retained, and items with factor loadings below a predefined threshold are excluded to ensure construct validity and internal consistency. Based on the EFA results, the two latent factors corresponding to PU and PE are clearly grouped, with no substantial cross-loadings, thereby confirming the discriminant validity of the measurement scales (Table 1). After EFA, the PU and PE were retained, and factor scores were computed for use in the regression analysis.

Econometric model

To analyze the determinants of WTP, a multiple linear regression model is employed. Given that WTP is observed as a continuous variable through an open-ended CVM, the baseline econometric specification is expressed as:

$$WTP_i = \beta_0 + \beta_1 PU_i + \beta_2 PE_i + \sum_{k=1}^K \gamma_k Z_{ik} + \varepsilon_i$$

Where:

WTP_i is the stated monthly willingness to pay of respondent i ;

PU_i and PE_i are the factor scores representing perceived usefulness and perceived ease of use;

Z_{ik} is a vector of socio-demographic control variables;

β_0 is the intercept;

$\beta_1, \beta_2,$ and γ_k are parameters to be estimated;

ε_i is the error term, assumed to be independently and identically distributed with zero mean and constant variance.

Ordinary Least Squares (OLS) is the primary estimation method. Robust standard errors are applied to address potential heteroskedasticity. The SPSS 22.0 package was used for this analysis.

4 Results and Discussion

4.1. Descriptive statistics of the sample

The descriptive statistics (Table 2) indicate that the sample is relatively balanced by gender, with 59.1% male and 40.9% female respondents. Regarding age distribution, the majority of respondents fall within the economically active age groups, particularly 46-55 years (28.7%), followed by 26-35 years (24.3%) and 36-45 years (22.6%). Respondents aged 55+ account for 19.1%, while the youngest group (18-25 years) represents only 5.2% of the sample.

In terms of educational attainment, the sample is characterized by a high level of education. More than 60% (61.7%) of respondents hold a university

Table 1. Rotated factor loadings of PU and PE items

Item code	Measurement items	Perceived Usefulness (PU)	Perceived Ease of Use (PE)
PU1	Using a smartphone-based plant care advisory service can improve the effectiveness of my plant cultivation.	0.871	
PU2	The service helps me save time and effort in taking care of my plants.	0.870	
PU3	Receiving plant care guidance through a smartphone is convenient for me.	0.814	
PU4	I am less concerned about the accuracy of the information provided by the service.	0.808	
PU5	I am less concerned about the security and privacy of my persona information when using the service.	0.831	
PE1	I believe that the interface of the plant care advisory application would be user-friendly and easy to use.		0.619
PE2	I think that using the smartphone-based plant care advisory service would be easy and would not require advanced technical skills.		0.923
PE3	I expect that it would be easy for me to learn how to use the smartphone-based plant care advisory service.		0.922

Table 2. Socio-demographic characteristics of respondents

Characteristics	Categories	Percentage
Gender	Male	59.1
	Female	40.9
Age group	18-25 years	5.2
	26-35 years	24.3
	36-45 years	22.6
	46-55 years	28.7
	Above 55 years	19.1
Education Level	Below High School	3.5
	High School	7.0
	Vocational College	27.8
	University Degree or Postgraduate Education	61.7
Occupation Status	Retired or non-working	21.0
	Others	79.0
Income per month	<3 millions	7.8
	3-5 millions	8.7
	5-10 millions	27.0
	10-20 millions	51.3
	>20 millions	5.2
Marital Status	Married	89.6
	Single/divorce	10.4
Household Size Number of household members in the family	1 person	4.3
	2 persons	14.8
	3 persons	27.8
	3 persons	40.9
	4 persons	11.3
	5 persons	0.9
Number of children Number of children less than 16 years old in the family	0 person	61.7
	1 person	30.4
	2 persons	7.8
Number of elderly members Number of household members aged 60 years or older	0 person	72.2
	1 person	22.6
	2 persons	5.2

degree or postgraduate qualification, while 27.8% have completed vocational college education. The proportions of respondents with a high school education (7.0%) or below high school level (3.5%) are relatively small.

Regarding occupational status, 79.0% of respondents are currently employed or engaged in other active occupations, whereas 21.0% are retired or not working at the time of the survey. Regarding monthly income, over half of the respondents (51.3%) report an income level of 10-20 million VND, followed by those earning 5-10 million VND (27.0%). Lower-income groups earning below 5 million VND account for 16.5%, while only 5.2% report a monthly income exceeding 20 million VND.

In terms of marital status, the sample is predominantly married (89.6%), while 10.4% are single or divorced. Household size varies across the sample, with most households consisting of three or four members, accounting for 27.8% and 40.9%, respectively. Smaller households with one or two members account for 19.1%, while larger households of five or more members constitute a relatively small proportion.

Regarding household composition, 61.7% of respondents report having no children under 16 years old, while 30.4% have one child, and 7.8% have two children. In addition, most households (72.2%) do not include elderly members aged 50 years or older, whereas 22.6% report having one elderly member, and only 5.2% have two elderly members.

Overall, the descriptive statistics suggest that the sample consists mainly of middle-aged, well-educated, married individuals with moderate to high incomes, living in medium-sized households, which is consistent with the characteristics of the urban households targeted in this study.

4.2. Willingness to pay for the smartphone-based plant care advisory service

Based on 115 valid responses (Table 3), the estimated mean WTP is 37,826 VND (approximately USD 1.46), with considerable variation across respondents (SD = 17,309 VND, equivalent to USD 0.67). Individual WTP values range between 10,000 VND (USD 0.38) and 95,000 VND (USD 3.65), using an exchange rate of 26,000 VND per USD.

4.3. Econometric Results

Table 4 presents the results of the multiple

linear regression model examining the determinants of urban residents' WTP for the smartphone-based plant care advisory service. The dependent variable is the stated monthly WTP, while the independent variables include socio-demographic characteristics and factor scores derived from the exploratory factor analysis. The regression model explains 41.9% of the variation in WTP, with an adjusted R² of 0.357, and the F-statistic of 6.747 is statistically significant at the 1% level ($p < 0.001$), indicating that the model has good overall explanatory power and is statistically reliable.

Socio-demographic factors

Among the socio-demographic variables, gender and income are statistically significant predictors of WTP. The coefficient for gender is positive and significant at the 1% level, indicating that male respondents are WTP, on average, approximately 9,053 monetary units (9,053 VND) per month than female respondents, holding other factors constant.

Income also has a positive, statistically significant effect on WTP, suggesting that respondents with higher incomes are more willing to pay for the service. This result is consistent with economic theory, as individuals with greater purchasing power tend to exhibit higher WTP for value-added digital services.

Other socio-demographic variables, including Age, education level, occupation status, marital status, household size, number of elderly household members, and number of children, do not show statistically significant effects at conventional levels. However, the coefficient for the number of children in the household is negative and marginally significant at the 10% level, implying that households with more children may face tighter budget constraints, which could reduce discretionary spending on digital advisory services.

Technology Acceptance Model (TAM) factors

The regression results highlight the dominant role of technology acceptance factors in explaining WTP. Perceived Usefulness (PU) has a strong positive and highly significant effect on WTP. Specifically, a one-unit increase in perceived usefulness is associated with an increase of approximately 7,451 monetary units in monthly WTP (7,451 VND).

In contrast, Perceived Ease of Use (PE) has a positive but statistically insignificant effect on

Table 3. Estimated mean willingness to pay for the smartphone-based plant care advisory service

Statistic	Value (VND) *
Mean WTP	37,826
Standard deviation	17,309
Minimum	10,000
Maximum	95,000
Observations	115

Note: * 1 USD = 26,000 VND (June 2025)

Table 4. Determinants of willingness to pay for the smartphone-based plant care advisory service

Variables	Coefficient (B)	Std. Error	Standardized β	t-statistic	VIF
Constant	17,106.147	10,741.205	-	1.593	
Gender	9,053.312***	2,733.319	0.258	3.312	1.077
Age	1,013.283	1,545.098	0.070	0.656	1.995
Education	-2,580.965	2,182.214	-0.116	-1.183	1.697
Occupation	5,588.182	4,041.118	0.132	1.383	1.609
Income	4,849.436***	1,721.753	0.279	2.817	1.737
Marriage	8,013.294	5,429.024	0.142	1.476	1.644
Household size	-694.553	1,529.595	-0.042	-0.455	1.501
Number of children	-4,147.950*	2,383.738	-0.153	-1.740	1.373
Number of elderly	1,708.119	2,864.325	0.057	0.596	1.594
Perceived Usefulness (PU)	7,451.279***	1,374.954	0.430	5.419	1.118
Perceived Ease of Use (PE)	1,961.442	1,360.920	0.113	1.441	1.095
Number of observations (N)	115				
R ²	0.419				
Adjusted R ²	0.357				
F static	6.747				
Sig.	0.000				

Notes: The dependent variable is monthly WTP. PU and PE are factor scores derived from EFA. Robust standard errors are reported. *** p<0.01, denotes significance at the 1% level; ** p<0.05, at the 5% level; * p<0.10, at the 10% level. All variance inflation factor (VIF) values are below 2, indicating no multicollinearity concerns.

WTP, which suggests that while ease of use may contribute to favorable perceptions of the service, it does not directly translate into higher WTP once perceived usefulness and socio-demographic factors are controlled for.

4.4. Discussion

The findings provide several important insights into how urban residents value smartphone-based plant care advisory services. First, the substantial effect of perceived usefulness confirms the central proposition of the TAM: users' valuation of a digital service is primarily driven by the extent to which they believe the service delivers tangible benefits, such as improved plant care efficiency, time savings, convenience, and reliable information. This finding aligns with previous literature, including that of

Bonke et al. (2018).

The insignificant effect of perceived ease of use suggests that, in the context of a hypothetical digital service, ease of use may be viewed as a basic or expected feature rather than a differentiating factor that warrants a higher price. This result is consistent with previous studies on digital and mobile services, which often find that ease of use influences adoption intention indirectly through perceived usefulness rather than directly affecting WTP (Bonke et al. 2018, Emeana et al. 2020, Fox et al. 2021, Mangole et al. 2024, Michels et al. 2020, Widiyanto 2022).

From a socio-demographic perspective, the positive effects of gender and income indicate heterogeneity in valuation across population groups. The higher WTP among male respondents

may reflect differences in technology engagement or spending preferences, while the income effect underscores the importance of affordability considerations in pricing digital advisory services. The negative (through marginal) effect of having children highlights potential budget trade-offs within households, suggesting that family-related financial obligations may limit discretionary spending on non-essential services.

Overall, the results imply that policy makers and service providers aiming to promote smartphone-based plant care advisory services should prioritize enhancing and clearly communicating the practical benefits of the service rather than focusing solely on interface simplicity. Emphasizing measurable outcomes – such as improved plant health, reduced time commitment, and reliable guidance – may be more effective at increasing users' WTP, particularly among higher-income and technology-oriented user segments.

5 CONCLUSIONS

The study examines urban residents' WTP for smartphone-based plant care advisory services using a framework that integrates socio-demographic characteristics and the TAM. Based on survey data from 115 households in the Dang Xa urban area of Hanoi, the findings provide empirical evidence on the key determinants shaping users' valuation of digital plant care services in an urban context.

The results indicate that technology acceptance factors, particularly perceived usefulness, play a more decisive role in explaining WTP than most socio-demographic characteristics. The substantial and statistically significant effect of perceived usefulness confirms that users' valuation of the service is primarily driven by the extent to which they expect tangible and practical benefits, such as improved plant care outcomes, time saving, and access to reliable guidance. In contrast, perceived ease of use may be regarded as a basic requirement rather than a value-enhancing attribute in the context of digital advisory services.

Among socio-demographic factors, income and gender are found to influence WTP, highlighting heterogeneity in users' valuation significantly. Higher-income respondents demonstrate a greater WTP, reflecting affordability constraints and differences in purchasing power. The higher WTP observed among male respondents may be associated with variations in technology engagement

or spending preferences. Additionally, the marginally negative effect of having children suggests that household budget constraints may limit discretionary spending on non-essential digital services.

From a policy and managerial perspective, these findings imply that efforts to promote smartphone-based plant care advisory services should prioritize enhancing and clearly communicating the service's functional benefits, rather than focusing exclusively on interface simplicity. Service providers should emphasize measurable, outcome-oriented benefits, such as improved plant health, reduced maintenance time, and reliable, expert-backed recommendations, to increase perceived usefulness and, consequently, users' WTP.

In terms of pricing and market segmentation, differentiated pricing strategies may be considered to improve accessibility across income groups, for example, through tiered service packages or introductory pricing for lower-income households. Policymakers and urban agricultural planners may also support the adoption of such digital services by integrating them into broader urban greening or smart-city initiatives, thereby enhancing their perceived value and social relevance.

Despite its contributions, this study is subject to certain limitations. The analysis is based on a relatively small sample and a single urban area, which may limit the generalizability of the findings. Future research could expand the sample size and incorporate multiple urban contexts. Additionally, future studies may investigate the role of trust, information quality, and long-term usage experience in shaping users' WTP for digital plant care advisory services.

6 Statement of Conflict of Interest

Le Thi Thanh Loan, who serves on the JESEG Editorial Board, had no involvement in the review of this manuscript to preserve objectivity in the evaluation process. Furthermore, the authors affirm that there are no financial or personal relationships that could be perceived as potential conflicts of interest in relation to this work

7 Author Contribution

Le Thi Thanh Loan was involved in the conception and design of the study, data analysis

and interpretation, drafting and revision of the manuscript for significant intellectual content, served as the lead and corresponding author, and gave final approval for the version to be published. Bui Phuong Nhung contributed to the study conception, data collection, and approved the final version for publication.

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