FACTORS AFFECTING DECISION AND WILLINGNESS TO PAY TO CONNECT TO PIPE WATER OF HOUSEHOLDS: A CASE STUDY IN VIETNAM

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ABSTRACT

Gia Lam district is an urban district, but 13 out of the 22 communes of Gia Lam district, representing 71% of the district's population, have no access to piped water services. This study was conducted to analyze the factors affecting households' decision and willingness to pay to connect to piped water. Primary data was collected by interviewing 200 randomly household heads. The contingent valuation method was used as well as data analysis by descriptive statistics and econometric models. The results showed about 78% of households in study sites were willing to shift to using piped water. The significant factors affecting the decision to connect to piped water system include households' income, education level, number of children in household, household's perception on quality of well water and monthly water expenditure. The willingness to pay for piped water services averages 4,314 VND/m3 or 152.95 thousand VND per month, accounting for 2.56% of the household's income. However, households cannot afford the full cost of installing piped water networks, so the government may subsidize the installation.

Keywords: Contingent Valuation Method, Piped Water, Willingness to Pay, Logit Model, Marginal Effect.

INTRODUCTION

Drinking water is necessary to sustain human life. The World Health Organization defined drinking water as water safe for drinking and cooking. In the cities, there are more households using water from deep wells instead of piped water (World Health Organization). However, well water might be contaminated with bacteria, parasites and viruses (microorganisms) (World Health Organization). This is the present situation in the Red River Delta in Vietnam, where groundwater is extensively pumped from high arsenic aquifers (Winkel, 2011). Groundwater is obtained primarily from wells with high concentrations of pollutants such as As, Fe, Mn, and NH_4^+, increasing over time and distributed over a large area (Le Luu, 2019). In the context in which water sources are getting more and more polluted, traditional technologies do not remove all pollutants such as persistent organic substances, heavy metals, and dissolved hazardous ions (Sharma, 2017). Therefore, it is required that water source protection and upgrade of water treatment plants and reform of water supply system management be carried out.

In Gia Lam district, groundwater quality has been declining (Gia Lam economic department, 2013). This is the reason why households wanted to shift from using deep wells to piped water. However, there are still 13 communes (in 22 communes totally) without piped water service, or about 71% of the district's population, which indicates that a large part of the population needs piped water. Therefore, this study analyzed what factors affect households' decisions and determined the level of willingness to pay by households for a piped water connection.

LITERATURE REVIEW

Having access to clean water is a necessity. However, many countries experience a scarcity of clean water with a low coverage rate for the population (Hazrat, 2020; Alfonso, 2019; Shemelis Kebede, 2016). In addition, unsanitary water causes various diseases (Alexandra, 2019; Meginnis, 2020). Previous studies have analyzed people's perceptions of water quality improvement and willingness to pay for piped water to avoid health risks related to water (Naz Abdulkareem, 2020). There are many methodologies to estimate the level of willingness to pay for piped water, such as the hedonic price method, travel cost method, contingent valuation method (Kuenzang,2015; Anthony, 2017). Willingness to pay for clean water ranges from 2% to 8% of household monthly expenditure (Ngawang, 2013). Or the average monthly payment for clean water, equivalent to 3% to 8% of household income (Anderson, 2010). Specifically, urban households are willing to pay up to 6% of monthly expenses; rural households are willing to spend about 2% of monthly costs for piped drinking water. Households concerned about water quality and are informed about parasites have higher WTP levels. Also, low-income households were also more willing to use when new clean water sources were available (Meginnis, 2020; Anderson, 2010). Both contingent valuation method (CVM), a stated preference technique, and averting expenditures, which is a revealed preference method, can measure willingness to pay for improved drinking water. Likewise, both methods depend on respondents' perceptions (Orgill-Meyer, 2018; Ghimire, 2015; Jones, 1984; Lyman, 1992). Some studies have used the Becker-DeGroot-Marschak (BDM) mechanism to estimate the willingness to pay value. However, there was a difference between BDM and CVM. Therefore, the BDM was recommended for field studies with experiments instead of the collection of cross-sectional data (James, 2020). In addition, to estimate willingness to pay value using choice experiments, some studies suggest that choice experiments give better results than the hedonic pricing method (Tidwell, 2019). Research using choice experiment (Meginnis, 2020), with conditional logit, latent class logit and mixed logit, has shown the relationship between willingness to pay level and variables as knowledge or social-economic characteristics (Houessionon, 2018).

In addition, improvement in water systems depends on variables such as location, self-provision factors, in which poverty and cost were the main determinants of willingness to pay (Pattanayak, 2006). As the current dissatisfaction with water quality led to an increase in willingness to pay, factors such as income, household size, water source, age, number of children, bid value and socio-economic characteristics have an impact on the willingness to pay level (Bukenya, 2006; Venkatachalam, 2006; Witt, 2019; Vásquez, 2009; Shemelis Kebede, 2016). A higher income level leads to an increasing desire for better water quality (Hazrat, 2020; Basani, 2008; Ahmad, 2010; Ogunniyi, 2011). In areas with a high poverty rate, connection cost subsidies might increase demand for piped water, but it could not estimate whether the benefits outweigh connection costs (Pattanayak, 2006). However, urban residents were less interested in improving clean water when they already had piped drinking water available (Hazrat, 2020). Areas constrained by clean water supply and facing problems of increased water demand have 17 or 18% higher WTP for improved water supply than current water costs. Such was valuable information for water demand management (Hasan, 2021). Furthermore, as WTP increases, clean water companies earn higher income to cover maintenance, investment and operating costs (Ngawang, 2018). Studies also called for curbing population growth and saving water in urban areas (Hazrat, 2020). In addition, governments provide credit to households, helping them increase their ability to connect to piped water to improve welfare (Florencia, 2012) and enhance the role of vendors (Georg, 2020). Hence, studies on the WTP level can be a source of information and baseline for private firms (Kuenzang, 2015). This study, therefore, applies the contingent valuation method to elicit the factors to estimate the households' decision and the level of willingness to pay by households for connecting piped water.

METHODOLOGY

Study Sites

The study was conducted in Gia Lam District, one of the districts located in the Hanoi capital. Gia Lam district was not included in the targeted areas of the Hanoi city water supply program for the development of urban water supply since it is located between two rivers, the Red River and Duong River (Schoebitz, 2014; Hoang, 2020; Economics Research, 2014). The Hanoi water supply number 2 joint stock company has provided water services to only 15% of its population ever since 1993. Since 2013, of the 22 communes in the Gia Lam district, nine communes already have piped water service, which translates to only 29% of the district's population using piped water. The three communes selected as study sites were Le Chi, Van Duc and Trung Mau. These communes were selected for the following reasons: (i) The communes are situated between two polluted rivers – the Red River and Duong River; (ii) The communes are located areas without piped water and (iii) these communes are located in areas defined by the local government as belonging to the agricultural production area.

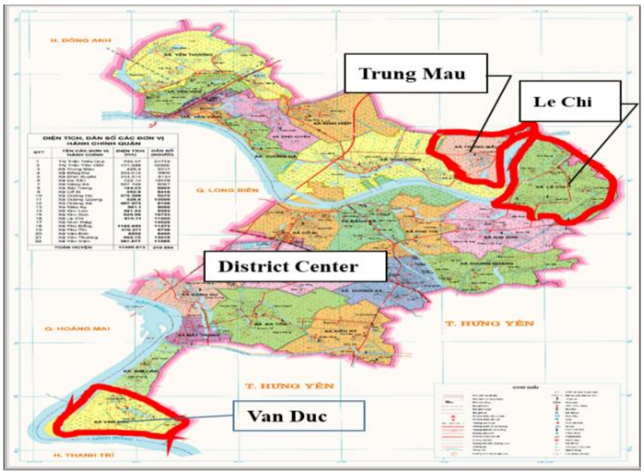

FIGURE 1
THE MAP OF THE STUDY SITES

This study used cross-section data from the household level for willingness to pay of use piped water. A contingent valuation method was used to ask respondents about their current well water and as well as about the socio-economic characteristics including education level, age, income, household size, number of children, perception of quality of well water, current water expenditure. Secondary data were obtained from sources such as the internet, unpublished materials, statistical abstracts, and report of regional officers. This study was based on cross-sectional household survey data from three representative communes in the Gia Lam district between December 2014 and January 2015. Yamane (1967) provides a simplified formula to calculate sample sizes.

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, and e is the level of precision with a value of 7%. Finally, 200 respondents were selected using simple random sampling based on probability proportional to size. Primary data were collected from three communes of Le Chi (75 respondents), Van Duc (65 respondents), and Trung Mau (60 respondents), using a detailed household survey questionnaire. These communes were selected because they are situated between the two polluted rivers of the Red River and Duong River without piped water system and are defined by the local government as an agricultural production area.

Table 1
NUMBER OF RESPONDENTS FROM THE SURVEY IN GIA LAM DISTRICT, HANOI, VIETNAM

Commune	Population		Sample	
	Person	Portion (%)	Number of respondents (person)	Portion (%)
Le Chi	8,598	39.8	75	37.5
Van Duc	6,729	31.15	65	32.5
Trung Mau	6,276	29.05	60	30
Total	21,603	100	200	100

Data Analysis

a. Logit model for factors affecting the decision for using piped water

The random utility model is the basic model for analyzing dichotomous responses. Hanemann (Hanemann, 1984) constructed the basic model utilizing the random utility framework developed by McFadden. He rationalized responses to dichotomous contingent valuation questions, putting them in a framework that allows parameters to be estimated and interpreted. In the contingent valuation case, there are two choices or alternatives i (i=0: the status quo; i=1: the piped water scenario), so that utility for respondent jth can be written as:

$$U_{ij} = U_i(X_j, \varepsilon_{ij})$$

The indirect linear utility function was used when the preference function is linear in income and variables following the formula:

$$V_{ij} = \beta X + \varepsilon_{ij}$$

Where V is indirect utility, X is the variables related to individual characteristic j^{th}, and β is the vector of parameter, and $X = \sum_{k=1}^{m} \beta_k X_k$. A contingent valuation question induces the respondent to choose between the piped water and the current state (status quo).

Respondents use the piped water when their utility is greater than zero.

$$V_{1j} = \beta X + \varepsilon_{1j} > 0$$

Let respondent's answer was yes, denote the connection to piped water,

$$\Pr(\mathrm{Yes_j}) = \Pr(\beta X + \varepsilon_{1j} > 0) \text{ or } \Pr(\beta X + \varepsilon_{1j} > 0) = \Pr(\varepsilon_{1j} < \beta X)$$

If ε_j is assumed to be distributed logistically, then the probability of a yes response becomes

$$\Pr(\mathrm{yes}) = \frac{1}{1+e^{-(\beta X)}} \text{ or } 1 - \Pr(\mathrm{yes}) = \frac{e^{-(\beta X)}}{1+e^{-(\beta X)}}$$

These expressions can be reduced to:

$$\frac{\Pr(\mathrm{yes})}{1-\Pr(\mathrm{yes})} = e^{\beta X}$$

Then, this expression by taking the natural logs right and left side:

$$\ln[\frac{\Pr(\mathrm{yes})}{1-\Pr(\mathrm{yes})}] = \beta X$$

One of the traditional appeals of the logistic distribution is the closed-form solution for the cumulative distribution. The logit model used this to determine the probability of a "yes" connection of piped water.

$$\mathrm{logit}(\Pr(\mathrm{yes})) = \ln\left[\frac{\Pr(\mathrm{yes})}{1-\Pr(\mathrm{yes})}\right] = \beta_0 + \beta_1 X_1 + \cdots + \beta_n X_n$$

Understanding the factors that affect household water demand provides essential information for connecting to piped water. The logit model is extraordinarily similar in its formulation and results, relying on a "link" function using cumulative distribution functions (CDFs) logistically distributed. As is well-known, these CDFs present a sigmoid (S-shaped) distribution, which more closely resembles the observed distribution of dichotomous data. In addition, these models do not use ordinary least squares methodology but instead, rely upon maximum likelihood estimation.

The factors influencing the decision of households to connect to piped water systems were analyzed using the logit model. The binary logit model used was:

$$\mathrm{DECISION} = \mathrm{Ln}[\frac{\mathrm{Pr_{yes}}}{1-\mathrm{Pr}_{yes}}] = \beta_0 + \beta_1\mathrm{HHINC} + \beta_2\mathrm{WATEXP} + \beta_3\mathrm{EDU} + \beta_4\mathrm{NCHILD} + \beta_5\mathrm{QUALWW} + \beta_6\mathrm{BOTWAT}$$

The variables are defined as follows:

Table 2
DESCRIPTION, MEASURE, AND EXPECTED SIGNS OF THE VARIABLES OF THE BINARY LOGIT MODEL FOR RESPONDENTS' DECISION TO USE PIPED WATER IN GIA LAM DISTRICT, HANOI, VIETNAM

Variables	Description	Measure	Expected Sign
Dependent Variable			
DECISION	Decision of respondents	1 = respondent who want piped water connection	
		0 = respondent who does not want piped	

			water connection	
Independent Variables				
HHINC Household income	Monthly household income	Million VND per month	+	Households with higher income have a higher probability of deciding to connect to piped water
WATEXP Water expenditure per month of the household	Thousand VND per month	Thousand VND per month	-	It depends currently on the level cost of investment on the filtration system in the household. Thus, households with high water expenditure may be likely or unlikely to connect to piped water at that time.
EDU Educational level	The household head's formal education	Years in school	+	It was hypothesized that respondents with a higher level of education have a better understanding of the important role of piped water for health. Hence, those with higher education would want to connect to piped water.
NCHILD Number of children	Number of children in the household. Children are those who are below 12 years of age.	Number	+ or -	Piped water is preferred as it is safer for children.
QUALWW Perception on quality of well water	Satisfaction with the quality of well water.	Dummy variable (1=satisfaction with well water quality, 0=dissatisfaction with well water quality)	+ or -	Households would likely use piped water if the deterioration of well water quality.
BOTWAT Bottled water	Household use of bottled water	1 = Yes 0 = No	+	Bottled water was expensive in the study site. Thus, households currently buying bottled water will tend to connect to piped water.

The marginal effect was used to analyze the change in the probability of connecting to piped water. A positive sign of the marginal effect $\left(\frac{d_y}{d_x}\right)$ means that an increase in the independent variable increases the probability of a "yes" answer to connect piped water, while a negative coefficient yields the opposite.

Econometric model for factors affecting the level of willingness to pay

To calculate the average level of WTP, the weighted average formula was applied.

$$\overline{\mathrm{WTP}} = \frac{\sum_{k=1}^{m} \mathrm{WTP_k}.\,\mathrm{n_k}}{\sum_{k=1}^{m} \mathrm{n_k}}$$

Factors that affect the level of willingness to pay of households for connection to piped water services were determined using the following variables:

$$\mathrm{WTP} = \beta_0 + \beta_1\mathrm{Edu} + \beta_2\mathrm{Gen} + \beta_3\mathrm{HHInc} + \beta_4\mathrm{NChild} + \beta_5\mathrm{QualWW} + \beta_6\mathrm{BotWat}$$

Linear form regression is a simple model that examines the relative explanatory variables to the level of willingness to pay. The model used OLS estimators. The β_j is interpreted for the dependent variable.

Table 3 DESCRIPTION, MEASURE, AND EXPECTED SIGNS OF THE VARIABLES OF THE LINEAR REGRESSION MODEL FOR RESPONDENTS WHO WANT TO CONNECT TO PIPED WATER SERVICES, IN GIA LAM				
Variables Label	**Variable Name**	**Description**	**Measure**	**Expected Sign**
Dependent Variable				
WTP	Willingness to pay	Level of willingness to pay of the respondent	VND thousand/1 cubic meter of piped water	
Independent Variables				
EDU	Educational level	The household head's formal education	Years in school	+
GEN	Gender	Gender of household head	1 = Male	+ or -
			0 = Femal	
HHINC	Household income	Monthly income of household	VND	+
NCHILD	Number of children	Chilren's number in household	Number	+ or -
QUALWW	Perception on quality of well water	Are you satisfied with the quality of well water?	Dummy variable (1=satisfaction with well water quality,	+ or -
			0=dissatisfaction with well water quality)	
BOTWAT	Bottled water	Household is using bottled water?	1 = Yes	+
			0 = No	

RESULTS AND DISCUSSION

General Characteristics of Respondents

Wells are the primary water source of all households in the study sites. Water from wells serves mainly the needs for drinking, eating, and washing. Moreover, many households bought bottled water (20 to 30 liters) from local dealers for drinking. In addition, households using rainwater invested in building tanks to collect and save rainwater. However, given the limited rainfall in recent years, the amount of rainwater collected was not enough to meet the daily water requirements of households. Therefore, all households are using filtration tanks or filtration machines to purify water for their family use. While a filtration machine is expensive, it guarantees water quality. Filter tanks with low cost include yellow sand and active coal. Although providing piped water to people is essential, the scenario assumes that, soon, water quality will improve in the communes by piped water.

Table 4 and 5 shows the characteristics of respondents who want to connect to piped water (respondents who accepted the scenario to connect to a piped water system) and those who do not want to connect to piped water (respondents who rejected the scenario to connect to a piped water system).

Table 4 DESCRIPTIVE STATISTICS OF THE HOUSEHOLD SURVEY DATA IN GIA LAM					
Variables	**Measure**	**Mean**	**Std. Dev.**	**Min**	**Max**
Decision					
Dummy variable	Proportion (%)	0.78	0.42	0	1
1 = respondent who want piped water connection					
0 = respondent who do not want piped					

water connection					
HHINC Monthly household income	Million VND/month	5.67	0.98	3.5	8
WATEXP Water expenditure per month of the household	Thousand VND per month	153	7.46	50	460
EDU The household head's formal education	Years in school	9.5	2.05	3	15
NCHILD Number of children in the household. children are those who are below 12 years of age.	Number (Average number of children per household)	0.53	0.72	0	2
QUALWW Perception on quality of well water. Dummy variable 0=dissatisfaction with well water quality) (1=satisfaction with well water quality,	Percentage (%)	0.42	0.49	0	1
BOTWAT Bottled water Dummy variable 1 = Yes 0 = No	Percentage (%)	0.45	0.5	0	1
AGE	Years old	47.57	8.14	30	65
Number of observations	200				

From Table 4, the percentage of households that want to connect to piped water accounts for 78%. The average age of respondents is 47.57 years old. The average income of households is 5.67 million VND/month. The average monthly water expenditure of households is 159.7 thousand VND/month, which includes the cost of electricity, filter replacement, depreciation of water filters. Of the surveyed households, 105 have children (people under 12, equivalent to primary school children). As many as 42% of households perceived satisfactory well water quality, and 45% of households used bottled water for drinking.

Table 5: Characteristics between respondents wanting and not wanting to connect to piped water in Gia Lam

Variable	Unit	Respondent Who Do Not Want to Connect to Piped Water	Respondent Who Want to Connect to Piped Water	T-Stat	Mean Diff	Significance
HHINC Monthly household income	Million VND/month	4.69	5.95	-8.9	- 1.26***	0
WATEXP Water expenditure per month of the household	Thousand VND per month	129.1	159.6	-2.43	3.06**	0.016
EDU The household head's formal education	Years of schooling	7.77	9.99	-7.08	- 2.21***	0
NCHILD	Proportion of household having children (%)	11.36	48.08	-4.52	- 0.53***	0
QUALWW Perception on the good quality of well water	Proportion of household having a satisfied perception of the quality of well water (%)	45.45	40.38	0.6	0.05*	0.55
BOTTLEW Bottled	Proportion of household	15.91	52.56	-4.52	-	0

water	using bottled water (%)				0.37***	
AGE	Year old	54.61	45.58	7.3	9.03	0
Number of Observation		44	156			

Furthermore, it can be inferred that households with higher monthly incomes wanted to connect to piped water. These households' average monthly income was around 5.95 million VND, while those who did not want to connect was about 4.69 million VND. It varies between households in terms of monthly water expenditure, with high-cost households at 159.6 thousand VND/month for water filtration machines for drinking and cooking. Furthermore, households who want to connect to piped water have more years of schooling. In addition, the proportion of households having children (48.08%) who wanted to connect to the piped water system was higher than the proportion of households without children (11.36%). Moreover, those who want to connect to piped water perceive well water quality as not good, accounting for about 60% of households.

Factor Affecting Household's Decision to Connect to Pipe Water

Factors that influenced the household's decision to connect to piped water were determined using the logit regression model. Results show that five factors are affecting the decision to connect to a piped water system. These were household income, monthly water expenditure, level of education, number of children in the household, perception of the current quality of well water, and household's use of bottled water. The likelihood ratio (LR) chi-square tests indicate the overall significance of the model. The resulting LR chi-square of 124.10 and p-value of 0.0000 can reject the null hypothesis that all independent variables in the logit model are zero. There was an overall significant relationship between independent variables and the decision to connect to a piped water system. A pseudo-R-square of 0.5888 means that the model could explain 58.88% of the change in probability in the respondents' decision.

Table 6
ESTIMATED COEFFICIENTS OF LOGIT MODEL FOR DECISION OF RESPONDENTS TO CONNECT TO PIPED WATER SYSTEM IN GIA LAM

Variable	Coefficient	Marginal effect (dy/dx)	Standard Error	Z	P>z
HHINC	2.64062***	0.06031***	0.5731	4.61	0
WATEXP	-0.11454*	-0.00262*	0.0597	-1.92	0.055
EDU	0.73131***	0.01670***	0.1898	3.85	0
NCHILD	2.21281***	0.05054***	0.7147	3.1	0.002
QUALWW	-1.08642*	-0.02823*	0.5935	-1.83	0.067
BOTWAT	2.24396***	0.05419***	0.7243	3.1	0.002
CONSTANT	-18.15191		3.4639	-5.24	0
Number of obs	200	Pseudo R2	0.5888		
LR chi2(6)	124.1	Log likelihood	-43.333873		
Prob > chi2	0				

Note: ***, ** and * are statistically significant at 1%, 5% and 10%, respectively, ns is non-significance. HH, households.

Several diagnostic tests can help detect multicollinearity. This study used VIF (variance inflation factor). The average VIF is less than 2, so serious multicollinearity is not an issue. In addition, the VIF and correlation among variables were low in most of the variables. Therefore, multicollinearity among the independent variables is not a problem. The household income variable (HHINC) is statistically significant at 1%. When monthly household income increases by 1 million VND (or 43.3 USD), the probability of connecting to piped water increases by 6.03%. This suggests that households will likely shift to using piped water if their household income increases. The average income of households that would want to connect to piped water was 6.0 million VND/month (equivalent 259.74 USD per month), which is higher than households who think otherwise with an average income of 4.7 million VND/month (or 203.46 USD per month). Thus, the income variable had critical influence on the demand of piped drinking water. The finding was consistent with the result of previous studies (Parveen, 2016; Olagunju, 2015; Hartono, 2007; Dlamini, 2015).

Furthermore, results of the logit analysis also showed that when the monthly water expenditure increases by 10 thousand VND (0.43 USD), the probability of connecting to piped water decreases by 0.26%. This is because households having higher water expenditure invested much in water purification. Therefore, during the survey period, these households still did not want to connect to the piped water system. However, households still hesitated to connect to the piped drinking water system due to higher water filtration cost. This result was contrast with those of previous research which suggested that the high water filtration cost increased the likelihood of households to connect to the piped water system (Parveen, 2016; Odwori, 2020). The household head's level of education (EDU) is positively related to the decision to use piped water. The average number of years of schooling of household heads wanting to connect to piped water was higher compared to those not desiring to connect to piped water (Table 2). Furthermore, an additional year of schooling of household heads increases the probability of connecting to piped water by 1.67%. As explained earlier, education is associated with knowledge and understanding of the vital role of clean piped water in health. Education was also determinants of the decision to connect piped drinking water. Households with higher educational level had higher willingness level to connect to piped water system. The study’s finding further supports what found in previous studies (Olagunju, 2015; Makwinja, 2019; Twerefou, 2015; Chatterjee, 2017).

Furthermore, the number of children (NCHILD) is positively related to the decision to connect to piped water. Results showed that 48.08% of the households with children want to connect to piped water, while only 11.36% did not want to. Also, the addition of one more child in a household increases the probability of connection to piped water by 5.054%. These families would also be willing to shoulder the costs related to connection with piped water to protect their children's health and prevent diseases associated with using poor quality water. Only few studies argue that the number of children should not be neglected in examining human capital effects in decision of using piped drinking water (Entele, 2020). Other study just focused on household size and the number of family member under 18 years old were the most common factors to represent decision of using piped drinking water (Hartono, 2007; Dlamini, 2015; Sarker, 2011; Odusina, 2012).

The perception of respondents regarding the quality of well water (QUALWW) has a negative relationship with the decision to connect to piped water. The results of the analysis show that when household heads perceive that their well water is good or satisfactory quality, the probability of wanting to connect to pipe water decreases by -0.02823or 2.823%. These results show that household heads tend to use piped water instead of low-quality well water. A rich body of research have examined how household perceive the quality of current water system (Hartono, 2007, Twerefou, 2015; Entele, 2020; Dlamini, 2016; Mbata, 2006; Ndedzu, 2012). The use of bottled water (BOTWAT) is also a significant factor at 1%, affecting the household's decision to connect to piped water. Many households would buy bottled water because of the belief that bottled water is safe for their families. As mentioned, the use of bottled water for drinking is expensive in the study site. Thus, households using bottled water would likely shift to piped water, having a higher probability of connecting to piped water at 0.05419 or 5.419%. However, how the incidence of using bottle water affects the decision to use piped drinking water is still overlooked in previous studies. The predicted probability of the logit model is 97.66%, higher than the actual value at 78%. This shows that when piped water is available in the study site, the percentage of households who want to connect piped water can reach 97.66%.

Level of Willingness to Pay for Piped Water Connection and Factor Affecting It

The respondents' level of willingness to pay was categorized into six different pricing scales ranging from 3,000 to 8,000 VND per cubic meter of piped water. The price level of 4,000 VND/m3 (0.173 USD) was preferred by 30.50% of the total respondents, followed by 3,000 VND/m3 (22%). Respondents who are farmers would likely be willing to pay a minimum of 3,000 VND/m3 because they can still combine well water with piped water for household use.

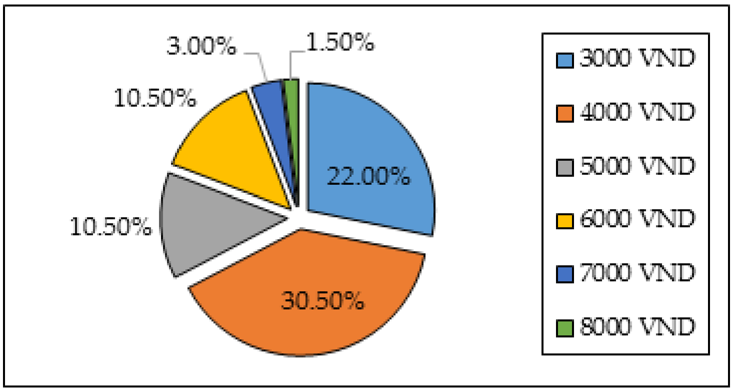

FIGURE 2
PERCENTAGE OF DIFFERENT WTP LEVELS ACCORDING TO HOUSEHOLDS, IN GIA LAM

In the study sites, 22% of households can afford this price level (3,000 VND/m3) because they are medium-income and can still use well water.

Table 7
LEVEL OF WILLINGNESS TO PAY (WTP) FOR CONNECTION TO PIPED WATER IN GIA LAM

WTP (VND/m3)	Total	
	No. of HH	Portion (%)
3,000	44	22
4,000	61	30.5
5,000	21	10.5
6,000	21	10.5
7,000	6	3
8,000	3	1.5
Total	156	

Results showed that the average willingness to pay for one cubic meter of water for respondents wanting pipe water connection was 4,314 VND/m3 (or 0.187USD/m3). Therefore, it was estimated that a household pays a monthly average of 152.95 thousand VND (6.621 USD) for water use of 35.45m3 for general household activities (drinking, cooking, bathing). This expenditure is equivalent to 2.68% of monthly household income. Thus, households may use a combination of well water and piped water to reduce the cost of using piped water. The study found that the WTP for connection to the piped water accounted about 2 – 6 % of average monthly household income. Previous studies (Behailu, 2012; Dey, 2018) also had similar findings.

Factors Affecting the Level of Willingness to Pay

The factors affecting the respondents' level of WTP for piped water connection were determined and analyzed using linear regression. In the linear model, five variables were significant. The model is statistically significant at (Prob>F=0.0000). The correlation matrix of paired independent variables in the multiple linear regression model for the WTP level of respondents to connect to piped water service is weak, with most absolute values below 0.3. This indicates that the multicollinearity problem among the independent variables is not critical. Respondents with higher educational levels have a greater understanding of the importance of using piped water. The statistically significant variables that influenced WTP at 5% statistical significance. Specifically, as the number of schooling years increased by one year, the WTP level increases by about 95.77 VND.

Furthermore, households with higher income have higher WTP to use piped water. An increase of one million VND (43.29 USD) in monthly income increases the WTP level by 710.94 VND/m3 (0.031 USD/m3). These households prefer having a piped water connection to protect their family's health and staining their clothing and furniture from using well water. As the number of children in the household increases, the WTP for using piped water also increases. Specifically, an addition of one child in the household increases the WTP level for piped water connection by 239.49 VND/m3 (about 0.011 USD) since households want to use safe water for their children.

Table 8
ESTIMATED COEFFICIENTS OF LINEAR REGRESSION MODEL FOR WILLINGNESS TO PAY LEVEL OF RESPONDENTS IN GIA LAM

Variable	Coefficient	Std. Err.	T	P>T
EDU	95.7682**	40.5253	2.36	0.019
GENDER	120.6656ns	157.8582	0.76	0.446
HHINC	710.9362*	92.1399	7.72	0
NCHILD	239.4878**	101.0376	2.37	0.019
QUALWW	310.6090**	153.3067	2.03	0.045
BOTWAT	412.6773*	156.99	2.63	0.009
CONS	-1423.0790**	621.8005	-2.29	0.024

Note: ***, ** and * are statistically significant at 1%, 5% and 10%, ns is non-significance

Households that perceive that current well water was not good are willing to pay 310.61 VND/m3 more for piped water. Lastly, using bottled water tends to increase the WTP level by 412.67 VND/m3, at 10% of statistical significance.

CONCLUSIONS

Results of the study show that about 78% of households in the study site are willing to connect to piped water. The significant considerations affecting their decision include household income, which is the most crucial factor since it reflects their financial capacity to replace well water with piped water. Another is the level of education that provides households with a better appreciation of the importance of clean water for their health. The next is the number of children because of the importance attached by parents to their children's health. Finally, another factor is the household's perception of the quality of well water. Factors also were determined and analyzed using regression analysis with WTP level of the respondents. Results show that respondents have an average willingness to pay of 4,314 VND/m3 or 152.95 thousand VND per month for piped water use. This amount constitutes 3% of the household's monthly income, which is reasonable for households using piped water. However, households cannot afford the costs of installation of piped water networks. Thus, installing the piped water system can be subsidized by the government and the water company. Moreover, orientation programs should be organized to increase the knowledge and understanding of people, household heads in particular, about the importance of using piped water. Such can be initiated and carried out by the water company.

Author Contributions

Tran Thi Hoang Mai: Conceptualization, writing – original draft; Le Phuong Nam: writing – original draft and methodology; Nguyen Van Song: Supervision; methodology, software; Nguyen Van Huong: visualization, editing; Nguyen Dang Que: formal analysis, investigation; Thai Van Ha: data curation, analysis, visualization; Louie Marie T. Eluriaga: project administration, editing. All authors have read and agreed to the published version of the manuscript.

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