Global Journal of Environmental Science and Management
(GJESM)

Homepage: https://www.gjesm.net/

Podcasts

ORIGINAL RESEARCH PAPER

Evaluation of willingness to pay and challenges to community empowerment in urban drinkable water

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ARTICLE INFO

Article History:
Received 31 July 2023
Revised 03 October 2023
Accepted 08 November 2023

Keywords:
Behavior
Empowerment
Public–partnership
Urban water
Water company
Water crisis

DOI: 10.22034/gjesm.2024.02.09

ABSTRACT

BACKGROUND AND OBJECTIVES: Environmental degradation, especially that related to water, has the potential to result in an unhealthy life. Humans drinkable water for basic needs, but poor water quality can cause disease. One of the solutions of households to obtain drinkable water is to subscribe to water companies. This study presents the notion of community engagement related to urban drinkable water supply, specifically by examining the willingness of community members to pay for such services in response to environmental pressures.
METHODS: This study used purposive sampling methods to determine the value of willingness to pay, identified challenges in the community through a questionnaire on drinkable water in Jakarta, Indonesia, and conducted estimation using ordinary least squares. This research used a sample of 503 households in Jakarta.
FINDINGS: The coefficient values of the control variables, namely, daily income (0.448), education level (4.344), and age (628.1), exhibited a positive correlation and statistically significant impact. Results indicate a positive and statistically significant association between the coefficient values of the variables of interest, namely, water quality (8.663) and water source (21.248), in willingness to pay for drinkable water. A one-unit increase in the coefficient score impacts the willingness to pay value, measured in Indonesian rupiahs. Findings indicate that the majority of the respondents expressed readiness to pay for drinkable water valued below 100,000 Indonesian rupiah per month, which is equivalent to under 6.30 United States Dollars. The suggested strategies for addressing the diverse issues encompass the necessity of implementing structural reforms involving the engagement of local leaders to enhance empowerment. This approach holds promise for effectively resolving the drinkable water crisis. Technical effort in shaping the behavior of urban communities in using and appreciating water is also essential to sustain the environment.
CONCLUSION: Environmental contamination issues have become a reason for households to subscribe to water companies. Customers are willing to pay to obtain clean and potable water. This study is essential as a basis for formulating policies that can be used by drinkable water companies regarding community members' ability to pay for water, preferences, and participation in protecting the environment.

NUMBER OF REFERENCES
61

NUMBER OF FIGURES
7

NUMBER OF TABLES
3

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Note: Discussion period for this manuscript open until July 1, 2024 on GJESM website at the "Show Article".

INTRODUCTION

Water is the most basic need for all living things on earth, including humans (Samimi *et al.,* 2023). Previous research shows that humans are indifferent to water use efficiency. Human activities have also been found to cause an increase in the burden of water pollution (Abidin, 2023; Kasim *et al.,* 2023; Samimi and Shahriari-Moghadam, 2023). Approximately 95 percent (%) of deadly illnesses are due to poor water quality (Olalekan *et al.,* 2019). Declining water quality in urban áreas, such as Jakarta, Indonesia, is affected by environmental factors because of decreased ecological functions and a lack of green open spaces (Mbarep and Herdiansyah, 2019). Jakarta is known as a metropolitan city because it has extremely diverse functions and roles. Households in Jakarta source clean water through tap water (8%), groundwater pumps (12%), and drinkable water companies (80%) (BPS, 2021a). Increased usage of water resources results in environmental concerns (Moghadam and Samimi, 2022). The 2019 Jakarta Resilience Secretariat Report indicates that 97.5% of reservoir water in Jakarta is polluted, 88% of river water is contaminated, and 68% of groundwater is polluted. The northern section of Jakarta is the worst-affected area because of the declining environmental condition, so water contaminated iron, sodium, chloride, and total dissolved solids (Fadly *et al.,* 2017). The groundwater quality evaluation in Jakarta in 2021 shows five dominant pollutant parameters, namely, potential hydrogen (pH), manganese, detergent, total coliform, and *Escherichia coli* (Dinas LH DKI Jakarta, 2021), which significantly affect the quality of life and the environment. Hence, healthy water means a healthy life. Improved standards must be developed to protect the environment. Several institutions, such as the Geology Agency, Jaya Regional Public Company for Drinkable Water/Perusahaan Umum Daerah Air Minum Jaya (PAM Jaya), and the Regional Government of Jakarta, collaborate to solve the related problems. Environmental and natural resource transformations entail an open-ended willingness to pay (WTP). PAM Jaya is a government public company supplying drinkable water to all areas in Jakarta with pay methods (Ismowati, 2018). The current study examines WTP of people in Jakarta for drinkable water sources by company. WTP is the amount of money people are prepared to pay in exchange for environmental resources (Tyllianakis and Skuras, 2016). WTP is a value reflecting consumers' assessment. Research on WTP for clean water in Jakarta by the government water company is fundamental in determining the best value for water. When WTP is known, it can be used as a benchmark by the regional and central governments to formulate policies related to the payment for clean water. The average WTP fee for improved drinkable water is about US Dollar (USD) 3.1 or 4.7% for two months or 0.22% per family in Mexico City (Rodríguez-Tapia, 2017), Indonesian Rupiah (IDR) 444,123.38 (USD 30) per month in Aceh Besar, Indonesia (Muazzinah *et al.,* 2020), 105,494.6 IDR (6.65 USD) in Katulampa Village, Indonesia (Syaukat and Maryani, 2020), and IDR 59,002 (USD 4.06) to IDR 132,652 (USD 9.13) per month in Cimahi, Indonesia (Prayoga *et al.,* 2021). The current research is slightly similar to previous research on WTP in Mexico, which used contingency valuation. However, the former was conducted in Jakarta using the ordinary least squares (OLS) method. Although research on WTP has been conducted in several regions in Indonesia, they differ from Jakarta. The current research focuses on drinkable water in urban areas because the environmental burden on capital cities reduces water quality. Hence, people tend to subscribe to drinkable water companies. No research has been comprehensively conducted involving household capacity for WTP and community engagement. Previous studies conducted in Vietnam have shown several major elements influencing water payment behavior, including gender, age, income, water usage patterns, payment methods, and maintenance practices (Bui *et al.,* 2022). Psychological variables have been observed to possibly play a role in shaping individuals' water payment behavior (Zolfagharipoor and Ahmadi, 2021). The determining factors used in previous research were age, education, income, family size, and gender in Aceh Besar, Indonesia (Muazzinah *et al.,* 2020) and Katulampa Village, Indonesia (Syaukat and Maryani, 2020). Some worldwide studies have focused on improving water quality (Lapworth *et al.,* 2020). In previous research on water pollution caused by oil spills, reaction readiness requires collaboration between corporations and communities, as well as increased understanding through community involvement (Soesilo *et al.,* 2020). Although several studies have been conducted on WTP factors related to drinkable water, there are still some unsolved issues, especially in capital cities. Geographical variances, demographic factors, and degrees of environmental pollution in urban water require specific research. The settlement concept proposed in this study involves urban community empowerment. Urban communities tend to have highly individualistic and socially restrained characteristics (Weckroth *et al.,* 2022). This study aims to obtain various WTP allocations from respondents regarding drinkable water use, analyze challenges in implementing WTP, and empower urban communities to make wise decisions regarding drinkable water use. Participation is in terms of community empowerment to satisfy them, manage water competently, and control the quality and quantity of water received from drinkable water companies. According to previous research, analyzing the development and distribution of water resources only through economic issues is not viable because economic and social goals may be discussed in a more complex manner (Hatamkhani and Moridi, 2021). The hypothesis proposes that daily income and water quality significantly impact the people of Jakarta's willingness to pay for drinkable water. Given that income is one of the essential factors in determining WTP in China, educational background has the most significant influence on WTP (Peng *et al.,* 2022). China used 419.2 cubic meters (m^3)/person/year in 2021 (National Bureau of Statistics of China, 2019). Resident of Jakarta used 31.11 m^3/household/month in 2021, obtained from the total volume of water sold divided by the number of household customers of PAM Jaya (BPS RI, 2023). These data show the difference in the amount of water each person uses in China and Jakarta. People seek the appropriate environmental services, and a higher service level objective will become more necessary. The most crucial aspects are finding solutions to obtain the best WTP for drinkable water and empowering communities for good water management behavior. Previous research has identified the relationship of WTP with environmental preferences (Hynes *et al.,* 2021), implementation of environment-friendly pharmaceutical policies (Alajärvi *et al.,* 2022), prevention of traffic-related air pollution (Istamto *et al.*, 2014), improvement of air quality (Rafique *et al.*, 2022), environment-friendly lifestyle behaviors (e.g., clothing, travel, housing, and waste recycling) (Geng *et al.,* 2023), and the desire to supply clean drinkable water (Cameron *et al.,* 2023). Previous research has also used sociodemographic characteristics on WTP. However, other factors, such as interest perspectives, should also be identified. The current research uses sociodemographic characteristics combined with an perspective on WTP. This study uses control variables (for sociodemographic characteristics) and variables of interest (perspectives on drinkable water). The present research is essential because it serves as a foundation for measures that drinkable water corporations may take regarding the community's willingness to pay for water, preferences, and community engagement in environmental protection. This research will also motivate the government to implement drinkable water policies. This study aims to evaluate WTP and the challenges of empowerment to address environmental issues for sustainable drinkable water in Jakarta from 2021 to 2022.

MATERIALS AND METHODS

The study was conducted through surveys using questionnaires and interviews with respondents as primary data. Secondary data were from PAM Jaya. This research uses a questionnaire combining open, closed, and Likert scale answers (Table 1). Variables using open answers are daily income (in IDR/day), education level (in years), respondents' age (in years), and total water consumption expenditure (in IDR/month). Closed questions were on marital status (e.g., married), gender (e.g., male or female), and primary water source (e.g., regional companies or groundwater). The Likert question is on the primary water source quality variable with the following point range: 5 (very good), 4 (good), 3 (neutral), 2 (por), and 1 (very por). The satisfaction level variable also uses a Likert scale with the following point range: 5 (very satisfied), 4 (satisfied), 3 (neutral), 2 (dissatisfied), and 1 (very dissatisfied). The survey was conducted in Jakarta (Fig. 1), with the overall theme of Jakarta Clean Water Survey in 2021. Consideration for choosing a location is based on the complexity of the environmental problems in Jakarta, including the clean water crisis. BPS RI (2021b) indicates that the number of households in Jakarta is 2,770,729. The study sample size is 503 households. Jakarta is between 6 degrees (°) 8 minutes (') South (S) and 106°48' East (E). Jakarta borders Banten Province to the west, West Java Province to the south, and

Table 1: The Questionnaire

List of Questions	Answer
Variables of control	
Income per day	IDR / day
Education Level	Elementary; Junior high school; senior high school; university; none
Age	In year
Marital Status	1 = Married; 0 = else
Gender	1 = Male; 0 = Female
Variable of interests	
What do you think about the quality of water?	1 = very poor; 2 = poor; 3 = neutral; 4 = good; 5 = very good
How much is the total expenditure on water consumption? (in IDR/month)	(respondents will answer the cost of water expenditures)
Where do you get your main water source?	1 = local government company; 0 = ground water
What is the satisfaction level of the water source?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied

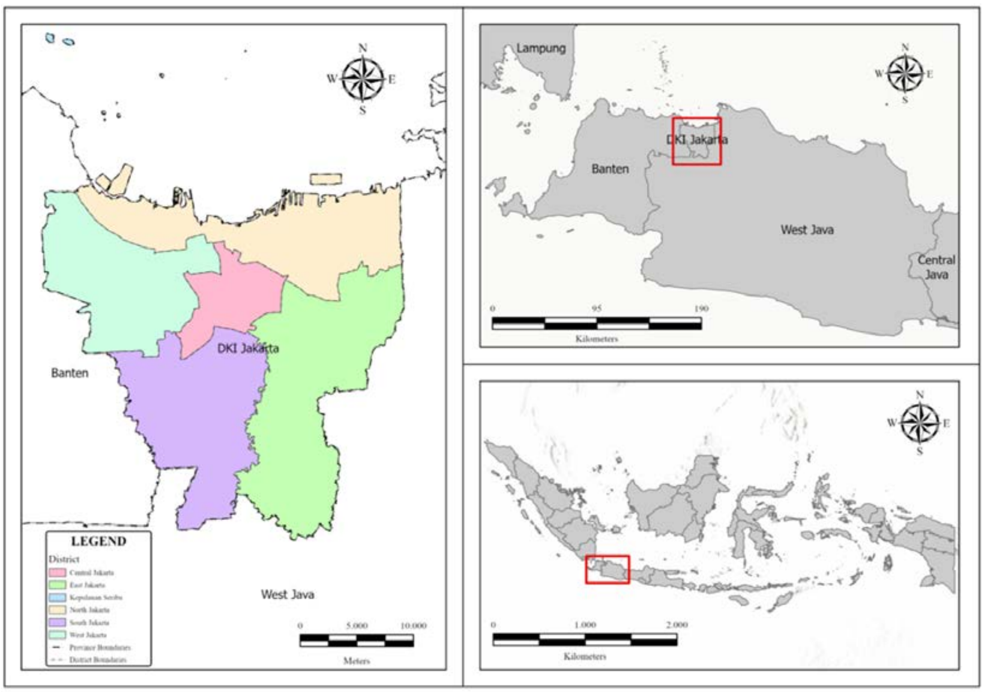

Fig. 1: Geographic location of the study area in Jakarta, Indonesia

Java Sea to the north (BPK RI., 2023). Jakarta has a total administrative area of 662.3 square kilometers (km^2). Jakarta has an average air temperature of 28.5 degrees Celcius (°C), with a maximum air temperature during the day ranging from 33.8 °C to 35.2 °C. Jakarta's minimum air temperature at night is from 23 °C to 24.6 °C. Lastly, Jakarta has an average rainfall throughout the year of 237.96 millimeters (mm) (DISKOMINFOTIK Pemprov. DKI Jakarta., 2023).

This study investigates the willingness of people to pay for drinkable water because of environmental preferences. This study uses the OLS approach to determine how socioeconomic and water-related variables influence respondents' WTP for drinkable water. OLS is a linear regression approach to estimate unknown parameters in a model with a fixed effect of a collection of explanatory variables. Normality, multicollinearity, heteroscedasticity, and autocorrelation tests determine if the predicted coefficients are correct. Gujarati and Porter (2009) stated that estimated coefficients in the OLS model must meet three criteria. First, the coefficient estimate must be linear, which means that the OLS estimate is a linear function of a random variable (e.g., independent variable in a regression model). Second, the estimated coefficient is unbiased, which means that the average value or prediction of the estimator is as close as possible to the actual value. Lastly, the estimated coefficients must be efficient, which means that the OLS estimator has a low variance to guarantee efficiency. OLS is one of the simplest methods to determine the significant variable affecting WTP through linear regression (Kavosi *et al.,* 2018). The OLS method seeks to accurately approximate a mathematical function to a given data set. This method achieves this objective by minimizing the sum of squared errors derived from the data set. The dependent variable is WTP for drinkable water. The control factors comprise income, education, age, marital status, and gender. The variables under consideration are the quality of the primary water source, total water consumption expenditure, a binary variable indicating the type of water source, and level of satisfaction with the primary water source, as shown in Eq. 1 (Gujarati and Porter, 2009).

$$\text{WTP of drinkable water} = \beta_0 + \beta_1 X1 + \beta_2 X2 + \beta_3 X3 + \beta_4 X4 + \beta_5 X5 + \beta_6 X6 + \beta_7 X7 + \beta_8 X8 + \beta_9 X9 \quad (1)$$

Where;

β_0 = Intercept

$\beta_1 - \beta_9$ = Coefficient parameter of the independent variable

$X1$ = Income per day

$X2$ = Education Level

$X3$ = Respondents' age

$X4$ = Dummy variable of marital status

$X5$ = Dummy variable of gender

$X6$ = Quality of main water source (scores of 1 until (–) 5)

$X7$ = Total water consumption expenditure

$X8$ = Dummy of the main water source (1 = local government company; 0 = ground water)

$X9$ = Satisfaction level on current primary water source (scores of 1–5)

WTP of the drinkable water variable is the respondents' material valuation from a specific total budget. The conversion of IDR to USD on October 30, 2023 at 09:00 Universal Time Coordinated (UTC) is USD 1 USD = IDR 15,878.75. In this survey, respondents were asked to spend IDR 1 million (USD 63) on several clean water aspects (the WTP variable is in IDR). Likert scale and quantitative analysis were conducted to assess the respondents' perspectives on the effect of WTP in drinkable water. A quantitative study was conducted to determine the expenditure allocation of respondents who buy drinkable water. Data analysis was performed using Microsoft Excel 2010 and Statistical Package for the Social Science (SPSS) 25.0.

RESULTS AND DISCUSSION

This study has five control variables, reflecting the respondents' socioeconomic factors, and four variables of interest in Jakarta. Owing to population density in metropolitan areas, there is a detrimental environmental impact on the surrounding region. The five control variables can determine WTP for clean water in Jakarta. Data analysis output has five estimation models (est), as shown in Eqs. 2 to 6 (Gujarati and Porter, 2009).

$$\textbf{Model}1: -35,723 + 0.453\textbf{X}1 + 3,366\textbf{X}2 + 620.6\textbf{X}3 + 14,626\textbf{X}4 - 5,808\textbf{X}5 \quad (2)$$

$$\text{Model2}: -76,414 + 0.459X1 + 3,812X2 + 628.1X3 + 14,293X4 - 4,271X5 + 7,164X6 \quad (3)$$

$$\text{Model3}: -76,354 + 0.457X1 + 3,807X2 + 628.1X3 + 14,282X5 - 4,306X5 + 7,171X6 + 0.00193X7 \quad (4)$$

$$\text{Model4}: -63,358 + 0.447X1 + 4,193X2 + 377.7X3 + 14,149X5 - 7,708X5 + 8,663X6 + 0.00514X7 - 20,777X8 \quad (5)$$

$$\text{Model5}: -82,188 + 0.448X1 + 4,344X2 + 388.9X3 + 14,843X5 - 7,244X5 + 5,820X6 + 0.0065X7 - 1,248X8 + 6,177X9 \quad (6)$$

Numbers enclosed in parentheses represent the standard error of estimation (SEE), which estimates the coefficient's standard deviation (Table 2). The coefficient is the number not enclosed in parentheses. The coefficient calculates the predicted change in the dependent variable due to the control variable (est1);

Table 2: Regression results of WTP in five controlling variables, reflecting respondents' socioeconomic factors and four variables of interest

Variables	Probability for WTP for drinkable water				
	Est1	Est2	Est3	Est4	Est5
Variabel of control					
Income per day	0.453***	0.459***	0.457***	0.447***	0.448***
	(0.0389)	(0.0391)	(0.0416)	(0.0413)	(0.0413)
Education level	3,366	3,812	3,807	4,193*	4,344*
	(2,541)	(2,557)	(2,561)	(2,537)	(2,542)
Age	620.6**	628.1**	628.1**	377.7	388.9
	(304.0)	(303.7)	(304.0)	(310.0)	(310.2)
Marital status (1 = married; 0 = else)	14,626	14,293	14,282	14,149	14,843
	(9,645)	(9,638)	(9,649)	(9,549)	(9,578)
Gender (1 = male; 0 = female)	-5,808	-4,271	-4,306	-7,708	-7,244
	(11,500)	(11,538)	(11,557)	(11,482)	(11,494)
Variable of Interests					
Quality of water		7,164	7,171	8,663*	5,820
		(5,009)	(5,015)	(4,983)	(5,806)
Expenditure for water consumption			0.00193	0.00514	0.00650
			(0.0222)	(0.0220)	(0.0221)
Main water source (1 = water from company; 0 = ground water)				-20,777***	-21,248***
				(6,169)	(6,189)
Satisfaction level on current water source					6,177
					(6,471)
Constant	-35,723	-76,414*	-76,354*	-63,358	-82,188*
	(34,285)	(44,525)	(44,575)	(44,285)	(48,483)
R-squared	0.234	0.237	0.237	0.254	0.255

Notes: *= Probability value (p-value) less than (<) 0.1; **=p-value<0.05; ***=p-value<0.01; the coefficient of regression is the number that is not in parentheses; the number inside the parentheses indicates SEE

control variable and quality of primary water source (est2); control variable, quality of primary water source, and expenditure for water consumption (est3); control variable, rate of primary water source, expenditure for water consumption, and direct water source (est4); and control variable and variable of interest (est5). The regression result in Table 2 indicates five estimates of the model. The model shows an coefficient of determination (R-squared) value from 0.234 (est1) to 0.255 (est5). Note that model 5 has the highest R-squared value of 25.5% in WTP for drinkable water, which has been explained by various variables in the study. By contrast, the remaining 74.5% is explained by other variables not included in the regression model equation. Hence, model 5 was chosen as the primary model for the analysis. Daily income significantly influences WTP for drinkable water in all estimations. In est5, an income increase of IDR 1,000 (USD 0.063) will increase WTP to IDR 448 (multiplied by 1,000 for a more straightforward interpretation). In est4 and est5, an increase in education by one year tends to significantly increase WTP to IDR 4,344 (USD 0.27). This finding indicates that citizens with higher education levels increases WTP value to IDR 2,542 (USD 0.16) compared with citizens with low/less education. These findings align with previous research that WTP increases with income and education, thereby ensuring drinkable water quality (Jianjun *et al.,* 2016). Analysis of the age variable shows that est1, est2, and est3 have a positive and significant effect on WTP. Thus, an increase in age by 1 year will increase WTP to IDR 628.1 (USD 0.04). This result aligns with previous research, in which WTP for clean water consumed is influenced by age (Rananga and Gumbo, 2015). The first variable of interest is the quality of the primary water source. According to Table 2, citizens' direct water source quality positively correlates with WTP for drinkable water. Consequently, an increase in home water quality by 1 level will increase WTP for drinkable water to IDR 8,663 (USD 0.55 USD) (est4). Citizens who are subscribers of public water services tend to have lower WTP for drinkable water by IDR 21,248 (USD 1.34) compared with respondents using groundwater. The following variable of interest is the satisfaction level, which has a positive but insignificant impact on WTP for drinkable water. On the basis of est5, an increase in satisfaction by 1 level will increase WTP by IDR 6,177 (USD 0.39). This study conducted a graphical analysis through figures to further understand the significance of the variable to strengthen the OLS model.

Graphical testing is needed to assess the significance variable based on Table 2. Graphical testing results are presented Fig. 2, Fig. 3, and Fig. 4. The trend with a linear slope is shown in Fig. 2. That is, the income variable significantly influences WTP decisions. Higher household income significantly affects the respondents' WTP for safe drinkable water (Chatterjee *et al.,* 2017). Fig 2. shows a positive relationship, indicating that citizens' WTP will increase as their income increases. The finding confirms the hedonic consumption theorem, in which spending increases as income increases (assuming that drinkable water is an everyday resource). The linear regression data distribution indicates that most respondents choose the WTP for monthly drinkable water under IDR 100,000 (USD 6.30). The research findings show that the higher a person's income, the higher the WTP. That is, people with low incomes have difficulty making payments. Accordingly, this research found a WTP value based on the agreement of the majority of the respondents. The DKI Jakarta government must immediately overcome this phenomenon. A posible solution is to optimize subsidies for low-income people. The following control variable is education

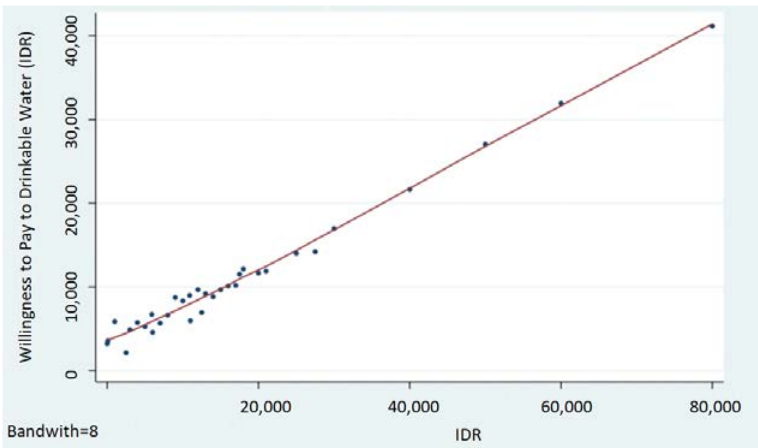

Fig 2: Control variables of income per day

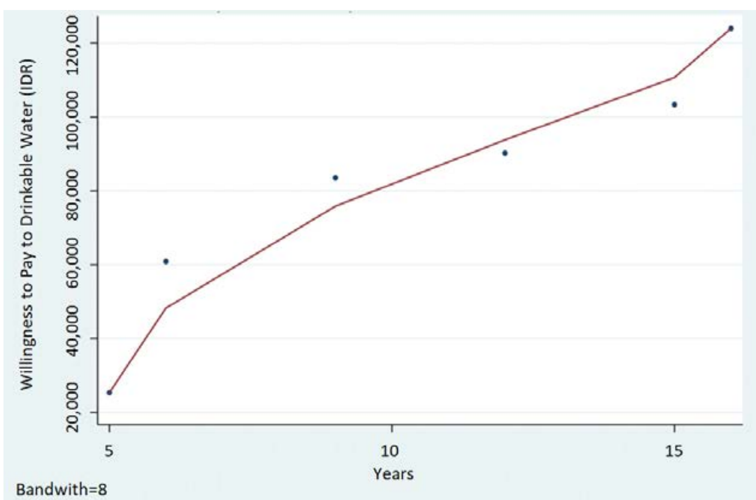

Fig. 3: Control variables of education level

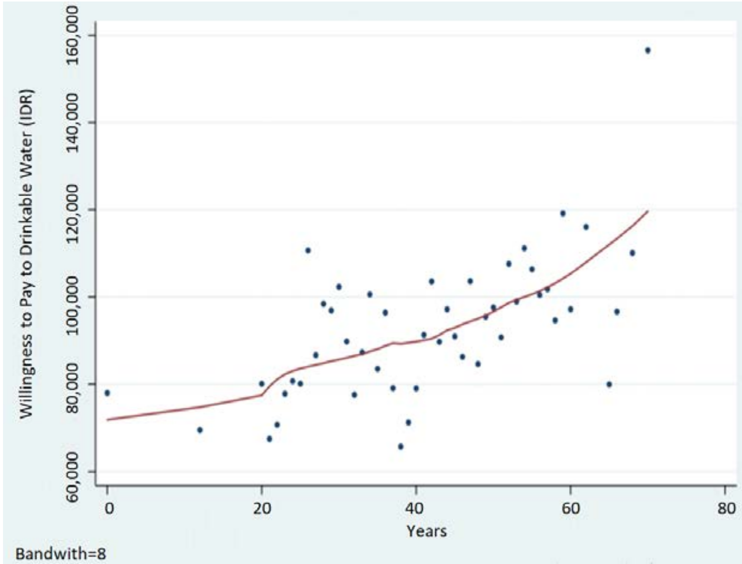

Fig. 4: Control variables of age

level (Fig. 3). The study results show that the higher a person's education, the higher the WTP for drinkable water. Analysis shows that the slope of WTP increase is weakly positive. That is, the increase rate of WTP is lower than the increase in age (Fig. 4). Older people know more about the consequences if they do not pay for clean water.

As shown in Fig. 5, water quality has a fluctuating relationship with WTP for drinkable water. When water quality is excellent (score: 5), WTP decreases to between IDR 80,000 (USD 5.04) and IDR 90,000 (USD 5.67 USD). There appears to be an optimal level of WTP for drinkable water (score: 4), in which citizens will value it highly to pay environmental guarantees to ensure clean water. Water contamination occasionally occurs owing to regional ecological environment degradation (Aregay *et al.,* 2016). Hence, quality of drinkable water is influenced by environmental degradation in Indonesia, which occurs owing to mining operations (Meutia *et al.*, 2023), domestic waste activities, industry, and uncontrolled agricultural activities (Sulthonuddin *et al.*, 2018). The Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017 concerning Environmental Health Quality Standards and Health Requirements for Water for Hygiene, Sanitation, Swimming Pools, Aqua Solutions, and Public Baths (Peraturan Menteri Kesehatan Republik Indonesia Nomor 32 Tahun 2017 Tentang Standar Baku Mutu Kesehatan Lingkungan dan Persyaratan Kesehatan Air untuk Keperluan Higiene Sanitasi, Kolam Renang, Solus Per Aqua, dan Pemandian Umum) explains that the use of water for sanitary hygiene purposes must meet environmental health quality standards in the form of physical, biological, and chemical parameters. The physical parameters that must be met are turbidity, with a maximum quality standard of 25 nephelometric turbidity unit (NTU), maximum color of 50 true color unit (TCU), maximum dissolved solids of 1000 milligrams per liter (mg/l), maximum air temperature of plus or minus (±) 3 °C, tasteless, and odorless. Biological parameters that must also be met are the presence of total coliforms of a maximum of 50 colony forming units (CFU)/100 milliliters (ml) and the complete absence of *Escherichia coli*. Lastly, the chemical parameters that must be met are to have a maximum pH of 6.5–8.5 mg/l, maximum of 1 mg/l iron, maximum of 1.5 mg/l fluoride, maximum hardness of 500 mg/l, maximum of 0.5 mg/l manganese, máximum of 10 mg/l nitrate (as N), máximum of 1 mg/l nitrite (as N), maximum 0.1 mg/l cyanide maximum, máximum of 0.05 mg/l detergent, and máximum of 0.1 mg/l pesticide. Providing water parameters for sanitation hygiene aims to ensure safe water use for personal hygiene (e.g., brushing teeth and bathing) and household needs

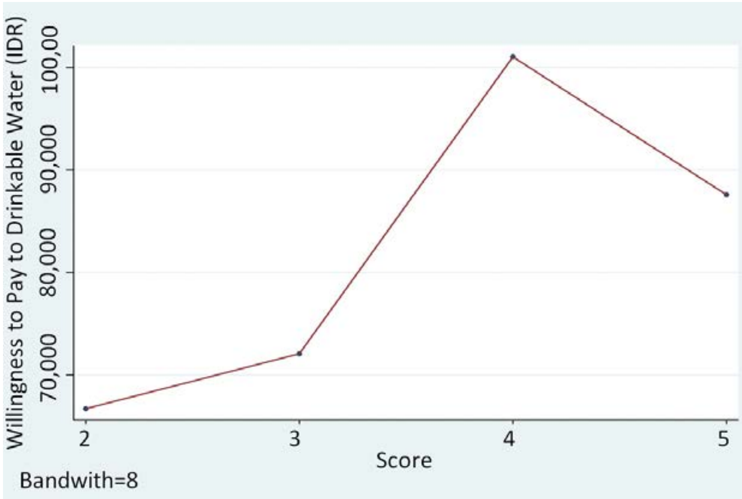

Fig. 5: Impact of water quality

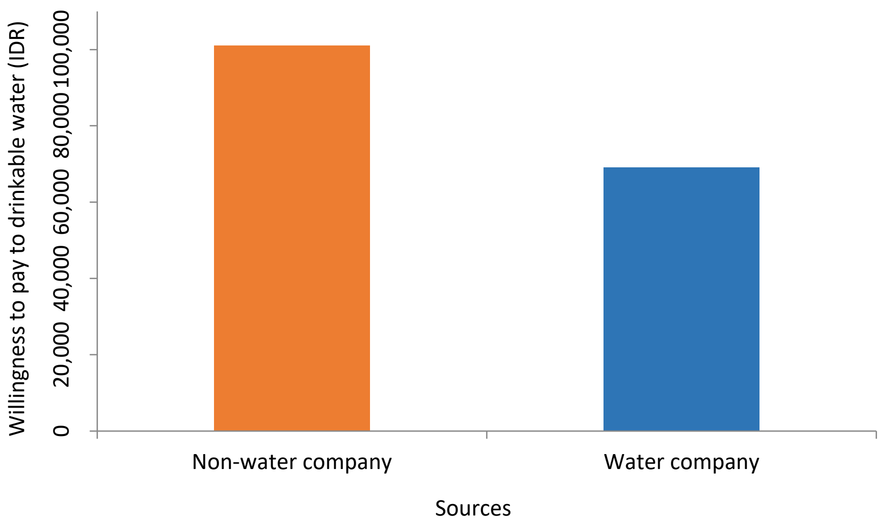

Fig. 6: WTP by main water sources

(e.g., washing cooking ingredients, eating utensils, and clothing). The regulation also states that water from sanitation hygiene can be used as raw drinkable water (Pemerintah Indonesia, 2017). As shown in Fig. 6, subscribers of public water services have lower WTP for drinkable water compared with groundwater users. That is, the cost of non-subscriber water companies is higher for non-public water companies owing to the higher maintenance of tools, electricity, and treatment. Water quality provided by public water companies is superior to groundwater managed on a large scale. Water companies work with technology. The customer perspective shows concern for the physical environment, with the majority agreeing to choose water companies because they ensure quality. Water companies often share information on their physical environment (Moore *et al.,* 2023). Given that subscribers already pay for the utility service, their WTP is lower. However, groundwater consumers have higher WTP because they do not pay for the utility service and expect higher water quality for environmental protection. The public's desire to buy water can be mitigated by establishing regulations, such as implementing cross-subsidies

Table 3: Expenditures of water supply establishment 2021 in Jakarta by water company (BPS RI., 2023)

Type of expenditure	Total (million IDR)	Total (million USD)
Employee compensation	505,483	31,83
Cost of chemical	39,004	2.46
Cost of operational	616,635	0.039
Cost of recovery and environmental management	0	0
Cost of fuel and lubricant	3,228	0.21
Cost of electricity	177,405	11.17
Another cost	637,104	43.12

between developing districts, which is the most efficient policy instrument. Efficient and sustainable water pricing should be based on a thorough understanding of consumer preferences related to their attitudes toward the costs of water supply security. Analysis of consumer WTP to improve water supply security (WSS) is required by policy makers and other authorities responsible for improving WSS (Wang *et al.,* 2018).

Influence of the living habits of Jakarta's citizens on WTP for drinkable water

The analysis of the control and interest variables indicates that most people are "willing and able" in terms of the WTP value for drinkable water below IDR 100,000 (USD 6.30 USD). This result is shown in the data distribution in the regression is Figs. 1 and 2. Only a few respondents chose to pay over IDR 100,000 (over USD 6.30) owing to high income and the high need for water for business or the number of family members. The WTP value is paid to drinkable water distribution companies in the hope that respondents will receive the appropriate quantity and quality of water. Drinkable water distribution companies also provide data on WTP allocations from all customers for water supply establishments. These companies present all costs to consumers (including operational and environmental costs). As shown in Table 3, expenditures are highest in the other cost categories, requiring a markedly detailed explanation of the budget allocation. The opinion of DKI Jakarta residents on PAM Jaya still needs to be considerably optimal in providing a clean water supply to all citizens of Jakarta (Hermawan and Hananto, 2022). The suitability of the quantity and quality customers receive must be evaluated to equalize perceptions and quantity and quality improvement. The total cost of infrastructure renewal and upkeep are components relating to the cost of environmental conservation to ensure that water is well distributed. The respondents' assessment as consumers of the purchase and selling prices of companies must be discussed further. The most crucial aspect is to improve and monitor the environment around the company's water resources (Khan *et al.,* 2019). Risk management and risk efficiency indicated that the mechanism for meeting the needs of clean water in Indonesia, namely public–private partnerships, is one of the most influential and sustainable, with 43.8% of the allocated risk being transferred from the government to the project company, and 25% becoming shared risk (Wardhana, 2020). There are government regulations on the classification of clean water customer groups based on the Second Amendment of the Governor of Jakarta Province to Governor Regulation Number 11 of 2007 concerning Automatic Drinkable Water Tariff Adjustments for Semester 1 of 2007. These regulations indicate that the classification of water use (0–3 m^3, >3–10 m^3, >10–20 m^3, and >20 m^3) is further grouped by cost. In Jakarta, it is 31.11 m^3/household/month in 2021 (data obtained from the total volume of water sold divided by the number of household customers from PAM Jaya) (BPS RI., 2023) with expenditure from IDR 32,666 (USD 2.06) to IDR 304,878 (USD 19.21). This finding is consistent with the study findings in Fig. 3. That is, public spending is below IDR 200,000 (USD 12.60), but some consumers in this study are WTP over IDR 200,000 (USD 12.60). Compared with drinkable water bottles, the price per large pack (19 liters) is about IDR 20,000 (USD 1.26). If one household consumes 31.11 m^3/household/month, then households have to spend IDR 32,747,368 (USD 2,062.34). On the bases of these data, drinkable water from PAM Jaya is a significantly better and have lower price than drinkable bottles for households in

Jakarta. The cluster of customers is not plotted based on the household's primary income. Stakeholders must consider income factors to cluster customer groups in drinkable water distribution.

Empowerment of urban community in water management

An analysis of indicators of the largest pollutant sources for Jakarta's groundwater quality indicates that domestic (household) waste activities are supported by hydrogeological conditions and soil characteristics in each region (Dinas LH DKI Jakarta, 2021). Environmental issues of water pollution in groundwater (Fadly *et al.,* 2017), surface water lakes, rivers, and oceans have a high risk of pollution. The previous study shows that most respondents choose drinkable companies, but challenges arise on how much value water for WTP has been released because of diversity in the community. The challenges refer to the ability to pay and use water wisely or not by consumers. Previous research has suggested that subsidies in Jakarta through the cross-subsidy mechanism enable water consumers in high-water consumption families to pay less than they should, which does not stimulate water-saving behavior (Suratin *et al.,* 2019). The relationship between service quality dimensions with customer satisfaction and WTP shows that responsiveness, reliability, and tangible significantly affect customer satisfaction but only up to level 4 satisfaction. Customer satisfaction will increase customer loyalty to service providers. Eventually, customer loyalty and satisfaction will significantly increase WTP (Haumann *et al.,* 2014). The study shows that satisfaction with services, such as clean water sources provided by PAM Jaya, will enhance customers' desire to pay for the services of PAM Jaya. Customer satisfaction has emerged as a critical component of company strategy. Many businesses have developed systems for monitoring and improving customer service (Koschate and Hoyer, 2013). Reviewing consumer behavior in managing drinkable water is crucial. A challenging aspect is to assist consumers in connecting water consumption to the environment. Promoting education on wise water usage through various means is essential to make communities aware of environmental justice. Massive education effort can be exerted by disseminating digital content (Sá *et al.,* 2023) and incorporating water management topics into the school curriculum (Amahmid *et al.,* 2018). The reason is that education will lead to improved water-conservation behavior (Xiong *et al.,* 2016). Digital solutions fostering social awareness should be integrated into sustainable urban water management and infrastructure development (Sá *et al.,* 2023). Another essential factor is to acknowledge the limitations of digital education, given that Internet access may be restricted for specific individuals. Community empowerment for water education should be continuous to change the behavior to respect the environment. Society should evolve to conserve rivers and their surroundings (Hynes *et al.,* 2021). All parties must be responsible for this conservation because the populace has established a practice of discarding rubbish into river streams (Nurwahdah *et al.,* 2023). Serious effort must be exerted to overcome water pollution, including increasing community participation by improving upstream land cover and water absorption in urban areas (Abidin, 2023). Technical effort in modifying the behavior of urban residents to consume, appreciate, and utilize water is also required to integrate mitigation and sustainability in the empowerment element. Society's empowerment can be achieved through influential figures within small clusters in the surrounding environment who provide examples and recommendations for water management practices, such as utilizing sensor-equipped faucets. Using sensor-based taps can be highly beneficial (Salehi *et al.,* 2020) in cases where water users forget to turn off the faucet or develop Internet of Things (IoT) (Tasong and Abao, 2019). Although the philosophy of the hydrological cycle guarantees water availability, monitoring significant climate change and implementing technical water management measures is crucial. In urban environments, rainwater harvesting (Campisano *et al.,* 2017) can be employed with installations on rooftops (Johnson *et al.,* 2022), as well as utilizing recycled water through a loop system (Casazza *et al.,* 2021). The quality and quantity of wáter must be recognized. As shown in Fig. 7, public awareness of purchasing drinkable water is caused by income per day, education level, age, quality of water, and main water source. Purchasing drinkable water must start with increasing public knowledge of the importance of providing quality drinkable water that does not endanger health. Increasing knowledge can be done through health communication strategies using various media that can reach the public,

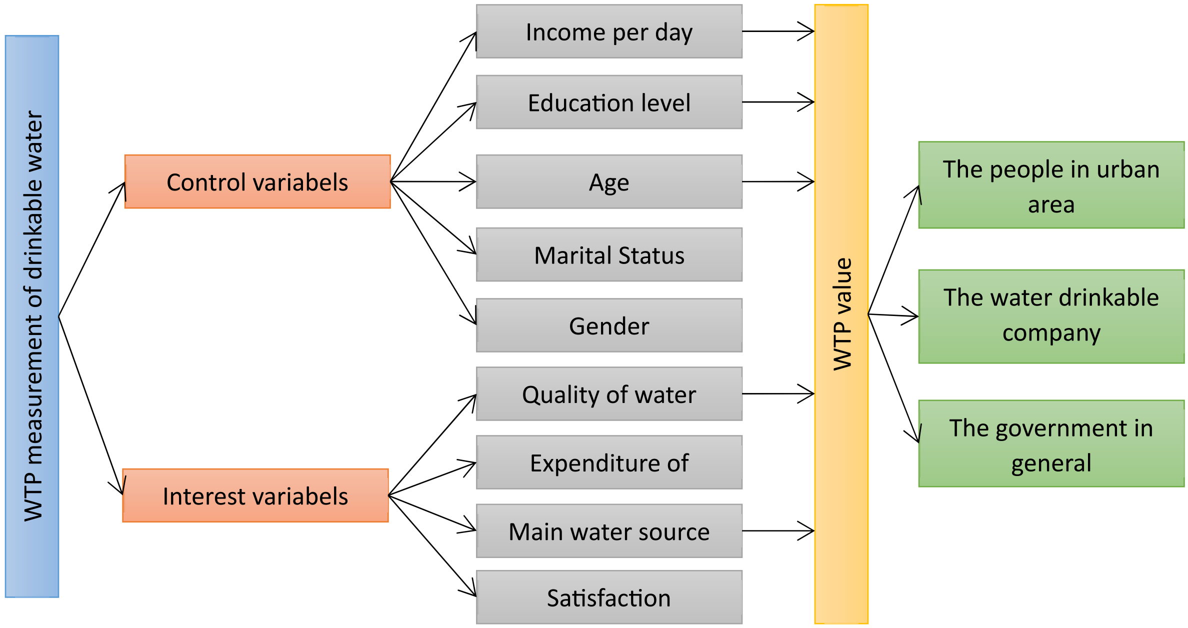

Fig. 7: Implications of WTP for urban planning

including social media, mass media, and other telecommunications media. Environmental health officers in community health centers can also work with health promotion officers to reach communities directly and enable exposure to information. A multi-sector approach, involving the government, state-owned companies, and the private sector, also plays an essential role. The government can participate in licensing the establishment of drinkable water supply businesses accompanied by periodic monitoring and evaluation by regulations. The private sector and state-owned companies can ensure affordable access to drinkable water that meets standards, thereby reducing barriers, including time and distance, which may prevent people from purchase drinkable water. Companies must also guarantee customer rights and carry out their responsibilities as indicated in the Minister of Health Regulation, Indonesia number 492/MENKES/PER/IV/2010, stating that every drinkable water operator must guarantee that the results of its production are safe for health (Pemerintah Indonesia, 2010).

CONCLUSION

Assessment of WTP for drinkable water in Jakarta considered five control variables, reflecting the respondents' socioeconomic factors and four variables of interest. The control variables include income, education, age, marital status, and gender. The four variables of interest are the quality of the leading water source, total expenditure for water consumption, dummy variable representing the water source, and current satisfaction level with the existing primary water source. The coefficient values of the control variables, namely, daily income (0.448), education level (4.344), and age (628.1), exhibit a positive correlation and a statistically significant impact. The results indicate a positive and statistically significant association between the coefficient values of the variables of interest, namely, quality of water (8.663) and main water source (21.248), in WTP for drinkable water. The highest R-squared value of 25.5% in WTP for drinkable water has been explained by various variables in the study. By contrast, the remaining 74.5% is explained by other variables not included in the regression model equation. Model 5 was chosen as the primary model for the analysis. Daily income will increase WTP to IDR 448 (multiplied by 1,000 for a more straightforward interpretation), education will increase to IDR 4,344 (USD 0.27), education levels will increase WTP value to IDR 2,542 (USD 0.16) compared with citizens with low/less education, the age variable will increase WTP to IDR 628.1 (USD 0.04), and water quality will increase WTP to IDR 8,663 (USD 0.55). Citizens who are subscribers of public water services tend to have lower WTP of drinkable water by IDR 21,248 (USD 1.34) than respondents with groundwater. The discussions indicate that the drinkable WTP most often chosen by the public is below IDR 100,000 (below USD 6.30) per month, and the interest variable on the water source quality factor shows the same thing. The preceding description illustrates that challenges and problems can arise from companies as drinkable water providers and the community as consumers. Community empowerment programs should educate and shift the paradigm that the availability of clean drinkable water is only occasionally guaranteed without interruption. Consequently, the implications of this research to build a framework for companies and governments are that various factors influence WTP decisions and abilities. However, the most logical decision is when they are willing to subscribe to water companies because environmental pollution in water is high risk for health. This study's novelty significantly contributes to determining WTP for citizens of DKI Jakarta, PAM Jaya in particular, and the government in general because every province in Indonesia has its own regional drinkable water Company. In addition, local governments manage these companies in collaboration with the central government. This finding indicates that the policy issue of targeting must be considered. Drinkable water can be accessed in communities through cross-subsidies. Another policy is WTP for drinkable water with a cluster system based on the control variable of income per day (level significance of 99%) to make WTP affordable for people in urban areas.

AUTHOR CONTRIBUTIONS

H.A. Negoro participated in methodology, validation, software, formal analysis, and preparing pictures and tables of study results. N.I.D. Arista participated in writing the original draft, reviewing and editing, and preparing pictures and tables of study results. D.E. Purba was the corresponding author, supervising the study, writing—review and editing, obtaining funding, and conceptualization.

ACKNOWLEDGEMENT

This study was funded by Kementerian Riset dan Teknologi/Badan Riset dan Inovasi Nasional, grant number [8/E1/KP.PTNBH/2021] and grant number [NKB 187/UN2.RST/HKP.05.00/2021] Research and Development (Risbang), Universitas Indonesia.

CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the authors.

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ABBREVIATIONS

°	Degrees
°C	Degrees Celsius
ʻ	Minutes
–	Until
%	Percent
β_0	Intercept
$\beta_1 - \beta_9$	The coefficient parameter of the independent variable

<	Less than
±	Plus or minus
BPS RI	Badan Pusat Statistika Republik Indonesia (Central Statistics Agency of the Republic of Indonesia)
CFU	Colony Forming Units
Dinas LH DKI Jakarta	Dinas Lingkungan Hidup Daerah Khusus Ibukota Jakarat (Special Regional Environmental Service for the Capital City of Jakarta)
E	East
Est	Estimation model
Fig.	Figure
IDR	Indonesian rupiah
IoT	Internet of Things
km^2	Square kilometers
m^3	Volume (cubic meters)
mg/l	Milligrams per liter
ml	Milliliters
mm	Millimeters
NTU	Nephelometric Turbidity Unit
OLS	Ordinary least squares
PAM Jaya	Perusahaan Umum Daerah Air Minum Jaya (Jaya Regional Public Company for Drinkable Water)
p-value	Probability value
pH	Potential of hydrogen
R-squared	Coefficient of determination
S	South
SEE	Standard error of estimate
SPSS	Statistical package for the social science
TCU	True Color Unit
USD	United States dollar
UTC	Universal Time Coordinated
WSS	Water Supply Security
WTP	Willingness to Pay
$X1 - X9$	Variables

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HOW TO CITE THIS ARTICLE

Arista, N.I.D; Negoro, H.A.; Purba, D.E., (2024). Evaluation of willingness to pay and challenges to community empowerment in urban drinkable water. Global J. Environ. Sci. Manage., 10(2): 557-572.

DOI: 10.22034/gjesm.2024.02.09

URL: https://www.gjesm.net/article_708807.html