Doctoral Thesis

A Study on an Appropriate Domestic Wastewater Tariff - A Case Study in Ho Chi Minh City, Vietnam

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ABSTRACT

Ho Chi Minh City has been coping with problems of severe water pollution due to entirely untreated wastewater discharge into canals and rivers. Experiencing the problems, the government has implemented the HCMC Sewerage Master Plan up to 2020 approved in 2001, in which 12 wastewater treatment plants were determined. However, lack of capital and efficient management mechanism has limited the HCMC's ability to well develop and expand wastewater services in planned time.

The challenge of wastewater field is the requirement of a huge initial investment and operation and maintenance (O/M) costs. Moreover, HCMC is anticipated to be one of the top 10 cities in the world most threatened by climate change, the issues of flood control and water pollution may become even more problematic and impose extensive additional costs. Yet, wastewater tariff has not established yet in Vietnam, only Environmental Protection Fee for wastewater, collected at 10% of supplied water price through the water bills from January 1st, 2004. Under the determination to address comprehensively urban water environmental improvement, the financial sustainability is a prerequisite that requires the sector timely introducing a wastewater tariff. To set up an appropriate tariff, tariff structure is one of the most important and how to set appropriate tariff levels is crucial.

The thesis aims to propose an appropriate tariff structure and pricing options for wastewater service tariff in order to achieve a sustainable service in HCMC with reference to the estimated Willingness-to-pay (WTP).

It consists of 9 chapters, which includes introduction in **Chapter 1**.

Chapter 2 gives overview background of the study area and wastewater sector. It briefly shows the population, socio-economic characteristics as well as situations of water and wastewater management and development in HCMC.

Chapter 3 contains two main categories of literature review: 1) valuation methodology adaptable for estimating household's WTP and 2) tariff setting.

Section 1, WTP evaluation, the CVM methodology for estimating the non-market value of the useful improvements in the wastewater treatment services is discussed, and provide the theoretical framework of this method. Section 2 reviews the studies especically in developing countries on the CVM in the context of wastewater treatment projects. Section 3 presents overview of tariff structures and tariff setting appoaches for wastewater in briefly.

Chapter 4 is just dedicated for CVM Questionanaire design. An interlace form of implementation was applied, meaning that questionnaire is designed in parallel literature review. The main aspects in CVM design: objectives, approaches and design steps are discussed. Common characteristics of survey design, different ways of presenting valuation questions are explained and selected the one most appropriate for study purpose. We then report the results of the pilot survey and shortly explain how questionnaire was revised based on feedback obtained from respondents to prepare for main survey.

Chapter 5 discusses the statistical results and descriptive outcomes of main survey. This chapter is organized in accordance with the questionnaire order and presented descriptive statistics and discussion in parallel.

First, household characteristics, noted differences between sample and general population averages are summarized. Second, awareness and attitudes about social issues in city are discussed and compared to other studies. In the relations of environmental issues and wastewater treatment preferences and WTP are focused to analyze respondents' attitudes towards WTP later. The third part is for water use information and wastewater disposal and health. Part 4, the results of social acceptance of wastewater tariff and bid response of single and double-bounded models and reasons of unwillingness to pay are discussed. Finally, respondents` choice of tariff structures and unit price is shown in last part.

The study also hypothesized that prior information regarding sewerage plans and the respondent's knowledge of existing WWTPs in the city act as the positive determinants on people' WTP for improved wastewater services in HCMC. Therefore, we also compare to examine whether there are significant differences in terms of socio-demographic characteristics between two groups, perception about wastewater tariff and bid responses (part 4) on different attributes according to the hypothesis to see if it follows the hypothesis.

Statistical results shows that there is no significant difference in socio-demographic characteristics between the two groups with and without prior information. Contrary to hypothesis, group provided without city plan get more positive responses than group with city plan. Water spending is at around 0.9% of household average income while food accounts for the biggest expenditure more than a quarter of income, followed by transportation (5%) then electricity (3.2%). Regarding perceptive attitudes, water pollution was the second priority issue that need to be solved and the polluter pay principle gained high consensus (71.4%), however, only 45% of respondents agree with increase in wastewater tariff, 14.6% neutral. According to respondents` opinion the high WTP only when high belief in Government and water environmental improvement are achieved. Then, in WTP question, only 23.7% and 38% of respondents say Yes for BID1 and BID2 respectively. It shows that, people have perceived well about environment and good attitudes towards the principle of `polluter pays` why their responses for tariff increase were low, and the reasons show that about 60% of cases are do not trust the administration and do not believe in the effectiveness of services.

Chapter 6 discusses yes and protest responses as well as model specification in detail. Then the results of a CVM study are presented. The adopted elicitation method is dichotomous choice that both models of single-bounded (SB) and double-bounded dichotomous choice (DBDC) were examined. The study examines two issues:

1) The WTP and factors influencing residents WTP in the largest urban area of Vietnam – HCMC based on total sample (n=341). Estimations were analyzed using both the SB and DBDC models to discuss advantages and disadvantages of DBDC formats.

In DBDC data, three different WTP prediction models were used to examine which model had the better predictive ability: Model 1 all original data, Model 2 without outliers with standardized residuals - 3.3 > ZResid > 3.3, Model 3 logarithmic transformation applied

to independent quantitative variables to reduce skewness in the distribution of the data. The comparison is based on log-likelihood and R^2, and Model 2 - DBDC, the best model will be chosen to compare with Model 4 - only SBDC.

Model 2, six predictors make a statistically significant contribution (BID, 10%EPF, KNOW, MARRIAGE, INFORMATION, and 1st & 2nd CHOICE). The strongest predictor was MARRIAGE (Odds ratio=Exp(B)=1.849).

The difference between Model 2 and Model 4 are *WP* (water payment), *GENDER*, *CHILDREN*, *INCOME(2)*, and *HOUSE(1)* which are only significant in Model 4, while the *MARRIAGE* and *KNOW* are only significant in Model 2.

2) WTP for the wastewater service based on the sample after excluding 5 households not connected water network or do not use water supply (Model 5, n=426) and 96 protest zero (Model 6, n=330). Only SBDC format was used for WTP estimation.

Results, Model 5 had eight determinants *BIB, location house and CANAL, WB, GEN, MAR, INFO, INC(1) and A-TARIFF* had significant influences on WTP.

Model 6 proved to be the better model in which about 40% of the variation of amounts that respondents were willing to pay for the wastewater service in HCMC was explained compared to 37% in Model 5. In Model 6, the statistically significant independent variables again include *BID, WB, INFO, INC, and A-TARIFF*.

The logistic regression models (Logit) was used to identify the relationship between WTP and a set of predictive factors (independent variable). The predictor variables used for two issues were considered partly different to examine the difference of WTP results.

For hypothesis, the belief that wastewater will be treated at WWTPs might influence residents' WTP for the wastewater service, however this variable had the negative significant sign meaning that who provided information are less willing to pay than others.

These models are compared in terms of overall performance based on Nagelkerke & Cox and Snell R-square, a kind of pseudo R^2, describe how many percentage of variation in the dependent variable is explained by variation in the independent variables. $R^2 > 0,2 –$ 0.5 indicates a good to excellent model. For calibration, the Omnibus Tests of Model Coefficient with low p-value is good calibration. In contrast, Hosmer & Lemeshow test with high p-value shows the data fit well the model.

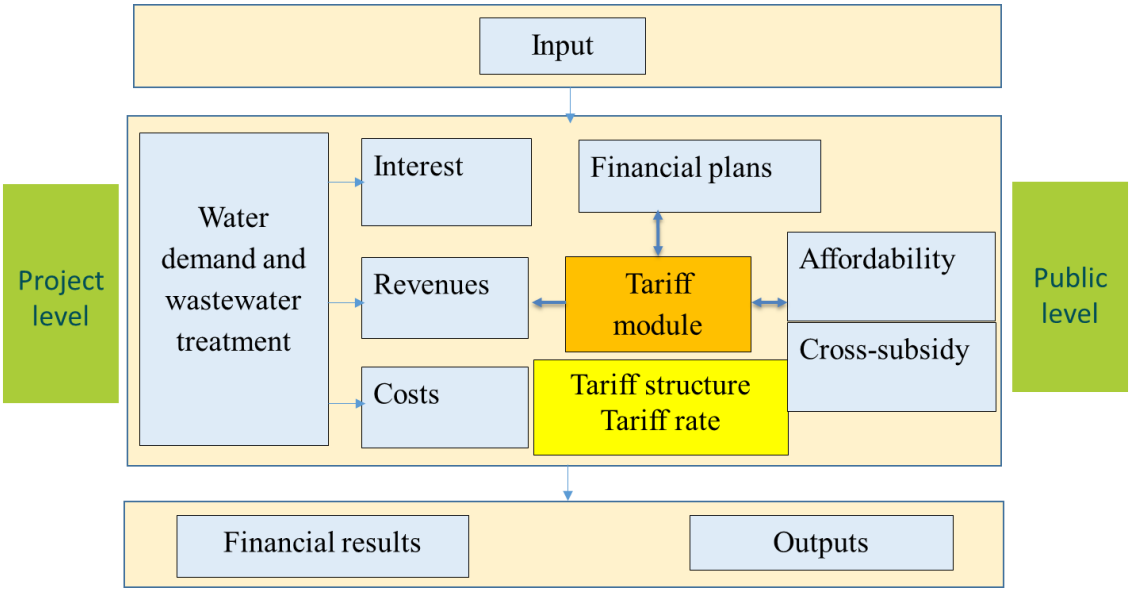
Factors influencing WTP were discussed and compared in detail and careful to other studies. The fluctuations of WTP levels are somewhat impacted differently by factors. Finally, in Section 5 the results estimated mean WTP by non-parametric method and parametric from different models such as Turnbull lower bound, Kriström and Upper bound mean are presented and discussed.

		Mean WTP (%water bill/month) in 2017 price
Non-parametric		
Turnbull $_{\text{Lower bound}}$		9.04
Kriström		17
Upper bound		25
Parametric		
SBDC Model		
Including Protest	Bid	21.5
	Variables	30.60
Excluding protest	Bid	26.8
	Variables	40.37
DBDC Model		
Model 4 $_{\text{SBDC}}$	Bid	14.25
	Variables	43.70
Model 2 $_{\text{DBDC}}$	Bid	15.30
	Variables	49.66

Chapter 7 discusses financing strategy for the urban wastewater sector in HCMC. Based on the current status of HCMC water supply and sewerage system, the situation of financing for wastewater services in HCMC and the sewerage systems infrastructure development target in according to planning water supply and sewerage systems to study the requirements and expenditure necessary to achieve infrastructure development targets. From there, consider and propose financial strategies to achieve targets of development of wastewater infrastructure in accordance to Master Plan. The chapter is opened by providing provisions and financial situation of wastewater treatment services in HCMC. Then target of infrastructure development and actual baseline supply of finance are drawn. In third section, financial strategies to achieve the above development targets in accordance with sewerage master plan are discussed and pointed out.

Chapter 8 proposes an appropriate tariff structure and price level for introducing wastewater tariff in HCMC in particular in transitional phase. The tariff calculation procedure is set up in accordance with current situation and conditions of city wastewater sector. The entire of calculation procedure are designed, modelled and run on Microsoft Excel Software. This Excel-based computerized model is capable of examining the interaction of a wastewater service's tariff with investment roadmaps, costs, customer WTP rates and physical conditions as shown below.

Two-part tariff structure is suitable for long-term sustainability in the actual conditions of HCMC and in line with the general experience and trend of the world. This structure ensures the purpose for promoting user`s awareness, equity, cross-subsidy and meeting revenue goals. The outstanding feature of the structure is its pricing, wastewater tariffs set as a percentage of water tariffs helps not only in accordance with the current legal regulations on environmental protection fees but also easy to understand, therefore easy to gain people`s consensus. When pricing, WTP and the average monthly income are examined careful together with the investment roadmap of WWTPs. Scenario 3 is proposed for tariff roadmap which covering 100% of O/M, interest and almost 60% of construction cost corresponding to 60% of wastewater treated for the period 2020 – 2025 while ATP is about 0.7% of income.



Chapter 9 describes study`s conclusion. WTP estimates and determinants from different models are compared and analyzed. The CVM analysis results shows that mean WTP was inconsistent in different estimate approaches. Mean WTP estimated by non-parametric methods are lower than mean WTP of parametric method. Differences in the mean WTP being commonly found in the literatures could be attributed to different valuation methods, different models and approaches and socio-economic and demographic variables.

The results show that the two-part tariff structure including a fixed and a variable fee is the most feasible structure. The pricing option in this structure that taken from mean WTP result is 35% water bill and unit water price applied is under norm of 4 – 6 m^3. The results of tariff roadmap show that in period of 2025 with fixed rate 15% and variable rate 20% of water tariff, the wastewater tariff accounts for 0.68% of monthly household income. This revenue can recover 100% of O/M, interest costs and approximately 60% of investment cost corresponding to the wastewater treatment rates in this period. This study would be a good effort for considering a concrete project of tariff setting, although there are several issues to be concerned for actual tariff application such as communication strategy using the persuasive messagesis, promoting transparency and opportunities that allow community engagement.

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Abbreviations and Glossary

CDF	Cumulative distribution function
CM	Choice modelling
CP	City plan
CVM	Contingent valuation method
DADR	Department of Agriculture and Rural Development
DBDC	Double-bounded dichotomous choice
DOF	Department of Finance
DOT	Department of Transportation
EPF	Environmental protection fee
GDP	Gross domestic product
HCMC	Ho Chi Minh City
NOAA	National Oceanic and Atmospheric Administration
O/M	Operation and maintenance
ODA	Official development assistance
PPP	Public private partnership
SAWACO	Saigon Water Company
SB	Single-bounded
SBDC	Single-bounded dichotomous choice
SDG	Sustainable Development Goal
VAT	Value added tax
VND	Vietnam dong
WTP	Willingness to pay
WWTP(s)	Wastewater treatment plant(s)

CHAPTER 1 INTRODUCTION

1.1 Background

Water pollution from untreated wastewater discharge is increasingly becoming a pressing environmental concern and a top government priority in Vietnam. Especially in cities with high population growth, rapid urbanization, industrialization and lack of community awareness, the problem of wastewater becomes more serious. Wastewater treatment is important to health of environment and human because it help reducing the transmission of excrete-related / waterborne diseases as well as reducing water pollution and consequent damage to ecosystem (Mara, 2004). Urban wastewater treatment is a critical need, however the required investment cost of wastewater treatment projects is two to three times that of the cost for water supply projects (U.S. Commercial Service, 2017). Hence, financial instruments and pricing policies are recognized as crucial water governance mechanisms that even may contribute to broader development goals. Typically, of 17 the Sustainable Development Goals (SDGs) to be gained by 2030, SDG 6 pointed out targets in which improved water quality, increased water use and affordability are mentioned. In order to achieve SDG6 requires a set of activities in which the mobilization and effective use of financial sources to meet investment demands in water sector is one of those activities.

Financially, key issues in wastewater sector has been pointed out. Prices and tariffs for water-related services in Vietnam are assessed to be low comparatively. Many reports claim that these prices are low compared to full costs of the services, to prices charged in comparable countries and low compared to willingness to pay (WTP) for better services (ADB, 2010; WHO et al., 2012).

Ho Chi Minh City (HCMC) has achieved noteworthy progress in economic development. However, the process of rapid urbanization and population growth has created enormous pressures on water environment in canals and rivers due to untreated wastewater discharge (Van Leeuwen et al., 2015) and infrastructure systems of sewerage which were built decades ago. The issue has become even more problematic especially during the rainy season, as flooding of sewage overflow is a significant health, environmental and socio-economic concern.

In light of these problems, the government has implemented the HCMC Sewerage Master Plan up to 2020 (approved in 2001), in which 12 centralized wastewater treatment plants (WWTPs) were developed. Over the past decade, HCMC has had considerable progresses in constructing WWTPs in accordance with its Master Plan and recently under a pollution reduction programmer, one of seven targets related to flood mitigation and response to climate change and sea-level rise in 2016-2020, the city has set itself a target of treating 80% of total daily household wastewater. However, there are still a large backlog of unmet investment demands compared to planning. Two major challenges are pointed out: (i) Financial aspects: the current wastewater fee is still too low to recover operation and maintenance (O/M) costs or system upgrades. Consequently, financial sustainability of sanitation projects after their construction is still a big concern. (ii) Social aspect: lack of public awareness and involvement into the environmental projects from ineffective management. Consequently, less enthusiasm for fee paying from the public.

Financially, a wastewater tariff has not yet been established in Vietnam and currently only an Environmental Protection Fee (EPF) for wastewater is in place, collected at 10% of the water tariff for all customers (from January 1, 2004). This revenue is used for O/M and construction costs for WWTPs however too low to cover and are generally subsidized by city budgets. Most of the O/M costs of sewerage and wastewater treatment systems are covered by city budgets; however, this budget is only sufficient to meet about 10–20% of O/M costs for collection systems excluding O/M costs of WWTPs.

Therefore, with such a large investment of WWTPs in the upcoming, in order to meet the complete infrastructure target and ensure a financial sustainability for expense of the wastewater services, it entails the sector to decide an increase in wastewater charges by introduction of a wastewater tariff as well as prepare a roadmap to increase revenue to achieve full cost recovery in the future. It is in line with the new Decree No. 154/2016/ND-CP of government issued in 2016 on the EPF for wastewater in which a wastewater fee of over 10% has been approved in accordance with certain area situations and conditions.

Tariff structure is one of the most important obstacles facing wastewater utilities and how to set appropriate tariff levels is crucial in tariff setting. The approach for an effective wastewater tariff setting is often challenging as it requests a long-term perspective and coordination of stakeholders. Especially, wastewater service in HCMC is in transitional phase in terms of construction and service charge from a historically subsidized system to targeted cost recovery, therefore adoption of a user charge with the objective of full cost recovery is not feasible in the transitional phase.

A possible approach of tariff setting for non-market benefits such as wastewater treatment services based on the users' WTP has been emphasized when the approach of full cost recovery pricing is infeasible, especially in the beginning stage of the tariff setting. Tariff setting also must be based on principles appropriate to specific conditions of municipality. Tariff principles from international best practice associated with equity (fairness), affordability, cost recovery, stability and simplicity are identified.

In order to ensure that wastewater pricing meets identified tariff principles, it requires an adequate knowledge of customer base and market once socio-economic factors and perspectives that are linked to the beneficiaries of wastewater services often determine the sustainability of the service. While cost recovery is a crucial component, the financial situation of residents needs to be understood to ensure that the charge levels are affordable. In fact, affordability and WTP for the wastewater service have become major issues regardless of whether the country is developed or developing (OECD, 2003) once the households have to allocate their limited income to different resources.

Hence, a study on tariff setting based on WTP, socio-economic factors, attitudes and perspectives that motivate the general public's WTP and overcome public resistance is particularly important for the successful development of wastewater services in developing countries as Vietnam. The findings could provide suggestions to the HCMC authority concerning managerial implications to enhance the effectiveness of strategies for the increase of wastewater tariffs.

1.2 Problem statement

There is ample research, report and guideline on the issues in tariff setting and design or tariff reform for mainly water supply including sewerage in developed and developing countries (Boland and Whittington, 1997; Klawitter, 2003; Hoque and Wichelns, 2013; Vucijak et al., 2015; Vanhille, 2015, Pajares et al., 2019). Most of studies aim to determine the economic feasibility for WWTPs in different types of charges that have been levied by authorities. These studies are mainly in Europe where wastewater treatment and tariff systems have installed. The studies for developing countries have been devoted toward the need for water tariff setting in related to cost recovery and cross-subsidy. However, no reasearch has been report on how to apply estimated WTP from the survey to design a suitable tariff structure and examine tariff levels for wastewater service in transitional phase in developing countries.

In the context of water environment in developing countries, the numerous studies have been implemented by applying CVM to value or to obtain community's WTP both rural and urban areas, local and large scale for improved water supply, tap water quality (Altaf, 1994; John and Douglas, 2000; Fujita et al., 2005; Campos, 2007; Hoang-Hue, 2018), improvement in the surface water quality (Choe et al., 1996; Vo, 2010; Ngo et al., 2015; Dung et al., 2016), flood control (Lizinski, 2015; Fuks and Chatterjee, 2008), improvement of sanitation such as toilets, sewerage connections and city-wide or local wastewater treatment (Whittington et al, 1993; Altaf, 1994; Altaf and Hughes 1994; Tapvong and Kruavan, 1999; Fujita et al., 2005; Campos, 2007; Tziakis et al., 2009; Nguyen, et al., 2012; Van Minh et al., 2013; Palanca-Tan, 2015).

Using CVM in the context of wastewater treatment also covers different issues. Most often it is used to analyze cost-benefit and value the benefits resulting from wastewater facilities and treatment project (Dixon, 2012; Tziakis et al, 2009; John and Douglas, 2000), the improved and/or upgraded existing treatment facilities (Tapvong and Kruavan, 1999), measuring the demand for improved urban wastewater service (Altaf and Hughes, 1994), examining residents` acceptability and WTP for a wastewater treatment plant in their place (Genius, 2012) and pricing the sewerage service (Campos, 2007). It is worth noting that in most analyses referring to wastewater treatment services, the WTP is related to the availability of sewerage and treatment system need in areas, level of treatment system, faced pollution situations and country's development level.

Nevertheless, there is a research gap concerning WTP for the wastewater treatment service that is in the transitional stage in large scale in developing countries. In Vietnam, it is not aware of studies using CVM to elicit residents' WTP in order to explore the public's preferences for an increase in price and evaluate cost recovery capacity for a sustainable urban domestic wastewater service in large scale. In addition, a CVM study for wastewater service has not been conducted in HCMC.

1.3 Research Objectives

The study focuses on to propose an appropriate wastewater service tariff structure and pricing options in order to achieve a sustainable service in HCMC, Vietnam. Particularly, the key issue that the study aims to address is the discussion appropriate tariff levels which could be charged based on WTP for future wastewater service in the city.

The measurement of WTP is a problematic because there is no market for public environmental services, so it is usually inferred from customers' preference and reference. The different models and methods applied for estimating the WTP may yield different mean WTP estimates. These may be because the models considered different factors affecting WTP. Therefore, CVM is used and WTP are examined by different models of two elicitation methods. The different models have different strengths and weaknesses that are utilized in handling the CVM problems such as large number of zero responses or high bid levels. Moreover, it may expect many protests in WTP in the transitional stage. The protesters may actually place an even higher or lower than the offered bid value but they deny to pay by a certain reason, hence this thesis also examines the models of including and excluding protests. These models seek to provide examination of the relative values of the methods as well as figure out determinants influencing the WTP. The estimated WTP can be used as a basis for pricing wastewater treatment service in HCMC. A detailed information of the market can allow city to consider the balance between revenue from tariff levels and cost recovery. These two objectives of the thesis are discussed through chapters.

The specific objectives are defined as follows:

- WTP investigation

  - to examine HCMC residents' perception on environmental issues and wastewater treatment preference and WTP for wastewater service in HCMC as well as their attitudes towards the principle of `polluter pays`. Then the internal contents of WTP can be implied.

  - to compare WTP estimates of HCMC households for wastewater service using parametric and non-parametric methods to gain a wide spectrum of WTP value for considering price setting.

  - to compare the differences in WTP between single-bounded and double-bounded dichotomous choice.

  - to analysis the differences in WTP between two issues: full sample and protest exclusion as well as different selected independent variables in regression to estimate WTP.

  - to examine factors influencing residents WTP in the largest urban area of Vietnam–HCMC, where and when projects for wastewater management are being implemented thoroughly.

  - to examine the hypothesis that whether prior information regarding sewerage plans and the respondent's knowledge of existing WWTPs in the city play as the positive determinants on WTP for improved wastewater services in HCMC.

  - to use the calculated values to apply to tariff setting (second objective of study)

- Tariff setting

  - to examine tariff setting methodology suitable and adaptable with HCMC context
  - to estimate revenue collected from tariff structures over years
  - to evaluate the responsiveness to needs of utilities and criteria/principles of tariff structures as well as pricing options
  - to assess and propose appropriate tariff structure and wastewater rate by the communities of criteria and objectives of tariff policy
  - to propose a tariff roadmap in accordance with a planned investment roadmap from a selected tariff structure.
  - financial analysis and wastewater tariff plan for sustainability of HCMC sewerage services.

To be able to investigate and answer for the objectives, an overall methodology is set up.

1.4 Methodology

The thesis first shows a picture of the current situation of wastewater service provided in HCMC and resident demands for the service. The analysis of the study provides a potential strategy for tariff setting or reform relied on detailed analyses of respondents` WTP, which could potentially change the critical situations of capital shortage and management mechanism that wastewater is facing. A comprehensive survey was conducted in 2017 in HCMC to provide data for this analysis. A literature review is presented to discuss the role of study of WTP measurement in wastewater sector development in HCMC. Experience of demand measurement from developing countries is reviewed.

The Contingent Valuation Method (CVM) is employed to estimate people` WTP for the WWT service. Also, people attitudes towards the wastewater issue, service and tariff are discussed. Application of different approaches for estimating WTP is presented to provide a comparison of mean WTP. The study's purpose is to find out price levels that people are willing to pay in order to test in models of tariff setting. And the more importance is what factors affecting and influencing residents' WTP. Hence, study only used one method eliciting WTP is dichotomous choice with both single and double-bounded format but analyze in different models with different explanatory variables.

Finally, the above analytic work is used to discuss the potential use of WTP data in setting tariff. A proposed tariff structure and charge levels are analyzed in relation to the social affordability and acceptability of charge increases by utilizing WTP data. Design an appropriate tariff structure and pricing options by considering scenarios of revenue requirements, cost allocation and cost recovery as following Figure 1.1

The study reviews the tariff setting methodologies applied in different part of the world to draw study own method based on available data and implementing stages of planning. The pricing rules for cost recovery of wastewater sector, tariff structures in use are

referred and cost allocation to different classes of customers is inherited from city water supply. The costs need to be recovered, feasible tariff structures are suggested and distribution rate of different customer classes all are determined for the setting model. Alternative tariff structures in model are considered as subjects to solve the question of cost recovery and fairness.

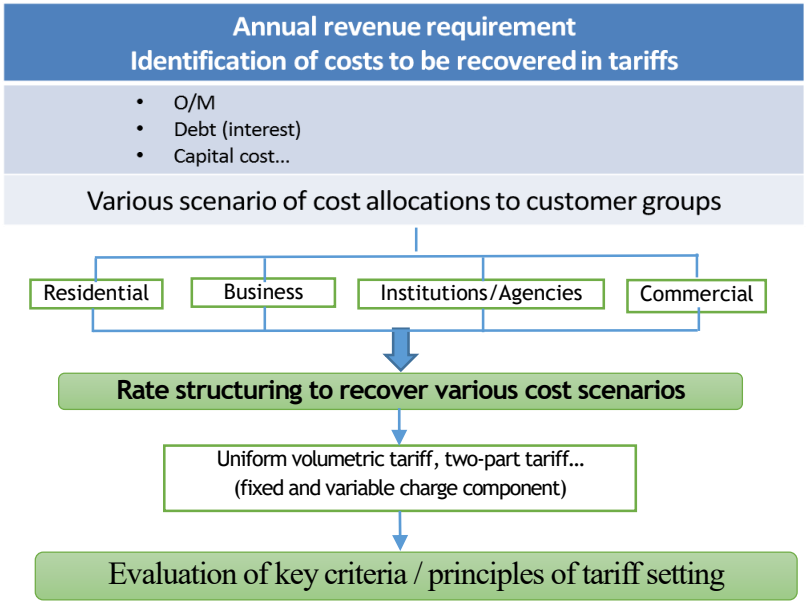


Figure 1. 1 Tariff setting process

1.5 Contribution of knowledge

From this study, there are three academic and practical contributions as follows:

i. Unique city-level service large sample survey in HCMC

The study conducted a large household survey to gain an understanding of "demand side" on tariff level for service and evaluate residents' WTP for wastewater treatment service in HCMC.

ii. Detailed `demand side` analysis for wastewater treatment service in HCMC in transitional phase as a regulatory input

A detailed analysis of demand for wastewater services in HCMC was carried out. Provide a unique baseline assessment for tariff policy setting in wastewater sector. The comparison of different valuation with different explanatory variables has been limited in the literature.

iii. Demonstration of the application of estimated WTP data into wastewater tariff setting and tariff roadmap in the context of transition.

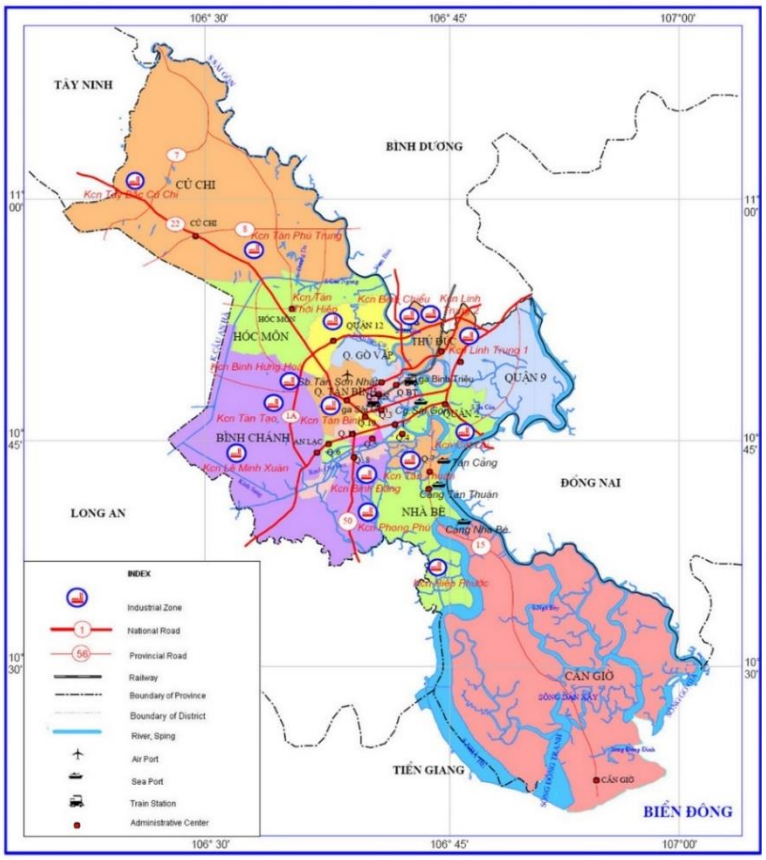
The use of WTP data for the analysis and setting of proposed tariff structure and pricing has not been fully documented in the literature and this thesis provides such a work.

CHAPTER 2 STUDY AREA

2.1 Introduction

This chapter gives overview background of the study area and wastewater sector. It briefly shows the population, socio-economic characteristics as well as situations of water and wastewater management and development in HCMC.

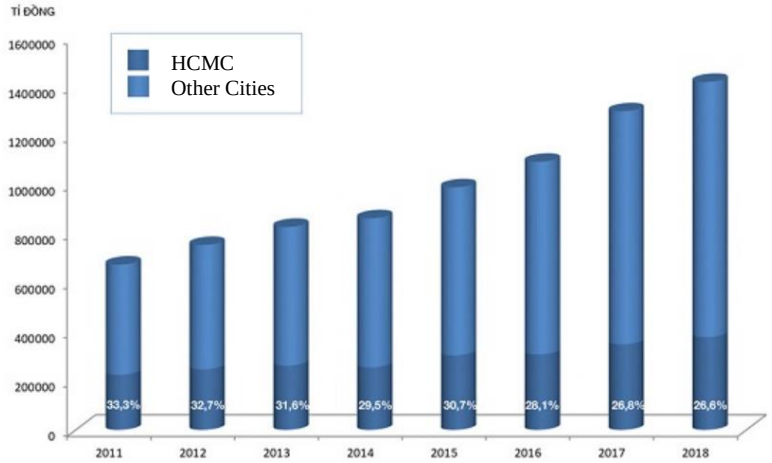
HCMC, the biggest city and a special urban, is located in the south of Vietnam, covering an area of 2,095 square kilometers with the largest population in Vietnam. HCMC is also an economic leader and one of the country's most important economic, cultural and educational centers. HCMC, 50 km from the East Sea in a straight line, is at the crossroads of international maritime routes. It has the largest port system and airport in Vietnam and is a transport hub of the southern region. HCMC has the highest population in the country. The city's official population has increased from 3 million people in 1975 to 6.24 million people in 2005 and to 8.64 million people in 2017 with an average population density of 3,900 persons/km^2 (General Statistics Office, 2017). However, the real population is supposed to be significantly higher than this because there are many unregistered people in HCMC. A map of the core area of HCMC is shown in figure 2.1.



Source: Galaxylands.com.vn

Figure 2. 1 Ho Chi Minh City map

In spite of HCMC covers only 0.6% of the total area and the population accounts for 10% of the whole country, the city's Gross Domestic Product (GDP) was accounted for 20% GDP in 2005 and 22% of GDP in 2018 of the country. The increase of 1% HCMC`s GDP, the national GDP increased by 0.21%. Ho Chi Minh City has also contributed a proud number about 33.3% in 2011 and 26.6% in 2018 to the national budget's revenue annually (Figure 2.2). City`s GDP was estimated about 5,538 USD/capita (2015) and 7,089 USD/capita (2018), twice as much as Vietnam’s average (Ho Chi Minh City Statistical Office, 2018)

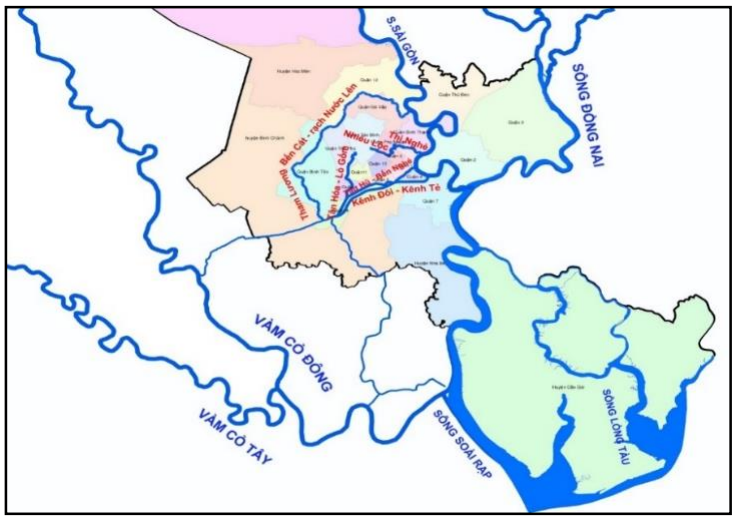


Source: Ho Chi Minh City Statistical Office, 2018

Figure 2. 2 HCMC`s contribution to the total national budget revenue

2.2 Water resources and water supply

HCMC is located downstream of the Saigon - Dong Nai river basin. City has an interlaced and dense system of rivers, canals and ditches of 3,020 routes with a total length of 5,075 km.



Source: HCMC flood control program report

Figure 2. 3 HCMC mainly river and canal system

There are four water resources used for water supply in HCMC such as Dong Nai River, Sai Gon River, and groundwater and rain water. The current and projected total daily water use demand for domestic activities in HCMC are 2.42 million m^3 in 2018 and 2.58 and 3.7 million m^3 in 2019 and 2025, respectively (DOT, 2018)[1]. The key water users in HCMC are residents and services. Water and wastewater charge are billed and collected by Saigon Water Company (SAWACO).

The principles are applied to set water tariff in HCMC based on a nation-wide policy in the Circular 95/2009. Water tariffs are set for different service tariff categories as follows.

- Total costs = Costs of Material + Personnel + General manufacturing + General management + Sales
- Average costs = Total costs / Sales volume

  (Sales volume = Total amount – Non-tariffable water volume)
- Average water tariff = Average costs + Appropriate profit (considered by People's Committees in accordance with local conditions)
- Retail price = Average water tariff × Ratio

Water tariff is classified into 4 categories: household, production units / facilities, administrative agencies, unions, and business, service units. Only households are applied progressive metered-rate structure while the remainders are applied basic metered-rate structure in order to promote the efficient use of water resources.

For households, there are 3 tariff categories according to used water blocks. Although water meters are allocated to households (numbers of people living in each household is registered), water tariff is calculated based on a progressive metered-rate structure per person.

Table 2. 1 Water tariff in HCMC

Unit: VND/m^3 (excluding VAT)

	Year	Year				
		2017	**2018**	**2019**	**2020**	**2021**
1	Household					
	4m^3/person/month	5,700	6,100	6,500	6,900	7,300
	Over 4m^3 to 6m^3/person/month	10,800	11,500	12,300	13,100	13,900
	Over 6m^3/person/month	12,100	12,900	13,800	14,700	15,600
2	Production units	10,200	10,800	11,500	12,200	13,000
3	Administrative agencies, unions	10,900	11,600	12,400	13,200	14,100
4	Business, service units	18,500	19,700	21,000	22,400	23,800

Source: Document of HCMC Authority[2]

[1] Based on actual statistic of SAWACO and Decision 729/QD-TTg 19th June, 2012 of Prime Minister on approval of the water supply planning of HCMC till 2025

[2] Document No. 474/TTr-LS-STC-SGTVT-SNNPTNT-VNPT (2017) of Inter-department of DOF - DOT - DADR - Research and Development Institute

Cross-subsidies in water tariff

Cross-subsidies by size. Three subsidy categories for households depend on the amount of consumption. The unit price per cubic meter is the lowest (5,700 VND) for water consumption of 4 m^3 or less per person. Therefore, cross-subsidies occur from households with large water consumption per person to those with small water consumption. Without cross-subsidies between different groups for the remaining categories, as the unit price is the same in each category.

Cross-subsidies by usage. In 4 different categories of households, production units, administrative agencies, and business/service units, water tariffs are set low for households and production units but high for business and service units, hence cross-subsidies occur from the latter to the former categories. Tariffs for production units are set low in order to attract industries.

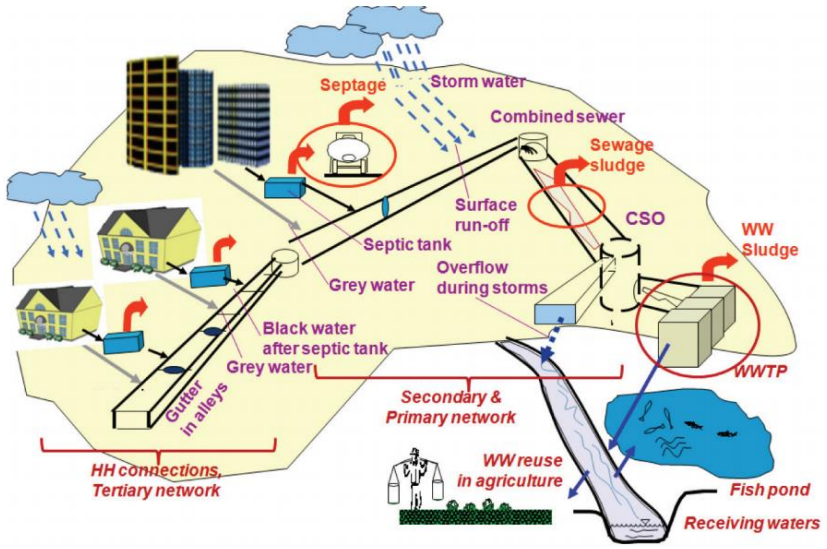
2.3 Sewerage system and wastewater management in HCMC

2.3.1 Current situation

Sewerage infrastructure systems in HCMC are considered quite well compared to the whole country. However, the economy is currently developing strongly and the city's population growth has made urban areas expanding rapidly while technical infrastructure, especially sewage and storm water systems being a combined system have not been developed adequately. In addition, HCMC is susceptible to flooding due to the geographical characteristics of low land, heavy rain and high tide. The sewerage sector was formerly managed by Department of Transportation - Steering Center for Urban Flood Control Program - City People`s Committee, currently is managed by the Department of Construction - Center for urban technical infrastructure management.

HCMC adopts the combined sewer systems. Only newly developed urban areas are introduced separate sewer and drainage systems. Service coverage of wastewater treatment is still low (less than 10% of urban wastewater is treated), thus over 90% of urban untreated wastewater combined with storm-water are finally discharged together into rivers and canals. Black water from households is mainly treated in household’s septic tank before being discharging into combined sewer systems, then into rivers and canals (Figure 2.4). Results of water quality monitoring of major canals and rivers in HCMC showed that concentrations of organic pollutants are 1.5 to 3 times, or even 10-20 times higher than the permitted standard in some areas (MONRE, 2010).

Sewerage charge is levied as environmental protection fees that calculated by multiplying the pre-tax water tariff by tariff rates (currently 10%). In case of household, standard water consumption 4m^3/person/month, wastewater charge is 600 VND/m^3 in 2018.



(Sources: Nguyen V.A., 2018)

Figure 2. 4 Typical combined sewerage systems in cities in Vietnam

2.3.2 Planning and investment plan of wastewater treatment systems

HCMC Sewerage Master Plan up to 2020 approved by the Prime Minister at Decision No. 752/QD-TTg dated June 2001. Accordingly, 12 centralized WWTPs will be constructed with a capacity of about 2 million m^3/day. In 2006, the first WWTP, named Binh Hung Hoa, was operated with a capacity of 30,000 m^3/day. Thus, in 2006, with the total demand for domestic wastewater treatment is 848,000 m^3/day, the rate of domestic wastewater treatment reaches 3.54%. By 2009, the second WWTP, Binh Hung, was operated phase 1 capacity of 141,000 m^3/day, increasing the treatment capacity to 171,000 m^3/day. Thus, with the total demand of wastewater treatment of 1,080,000 m^3/day, treatment rate reaches about 15.83%.

By 2018, the total amount of wastewater needs to be treated is about 1,937,984 m^3/day, increasing 1,089,984 m^3/day compared to 2006 while the total capacity of concentrated WWTPs is only 171,500 m^3/day. Therefore, the treatment rate is about 8.85%. By 2020, it is expected that the total volume of domestic wastewater is 2,200,000 m^3/day. The total treatment capacity is 993,200 m^3/day that reaches 45.15%. By 2025, it is expected that the total volume of domestic wastewater is 2,960,000 m^3/day and the total treatment capacity by 2025 according to the planning is 2,926,200 m^3/day, the treatment rate reaches 98.86 %.

Decision No. 24/QD-TTg of Prime Minister in January 2010, approval of adjusting general planning of HCMC construction to 2025, has determined 12 concentrated WWTPs with a total capacity of 2,912,000 m^3/day (excluding wastewater treatment units invested by private investors of residential areas with small capacity) in order to basically solve the problem of water pollution in the city, in the immediate future:

- By 2020, 3 WWTPs (total capacity of 1,080,000 m^3/day) with estimated investment costs for both interceptors and plants be 11,922.3 billion VND (ODA capital is 10,340 billion VND and PPP capital is 1,582 billion VND) are invested.

- By 2025, 8 remaining WWTPs and 03 upgraded-capacity plants (total capacity is 1,802,000 m^3/day). The estimated investment costs of the interceptors and plants is 28,195 billion VND (ODA capital 10,900 billion VND; PPP 17,295 billion VND).

2.3.3 Preparations for the wastewater service development

In response to the pressure of flooding and water environmental pollution due to rapid urbanization, moreover, under the pressure of great impact of climate change, in the past years the city has promoted the investment of urban drainage and wastewater treatment infrastructure development to better serve people's lives. Besides, HCMC is studying to implement central solutions such as: relocating production facilities that listed in category of units causing serious environmental pollution into planned industrial parks and industrial clusters; continue to construct and complete water supply and drainage works, waste treatment works meeting Vietnamese standards and regulations on environment.

Decree No. 80/2014/ND-CP dated August 6th, 2014 on Drainage and wastewater treatment, in Article 3, Clause 2 on the principle of general management "Polluters must pay for pollution treatment; revenue from sewerage and wastewater treatment services must meet step by step and then proceed to cover for service costs ". Implementing the undertakings of the City Party Committee as well as the direction of the City People's Committee in Official Letter No. 3239/UBND-DTMT dated June 27th, 2016, thereby assigning the Departments to research and propose the implementation of sewerage service charge according to Decree No. 80/2014/ND-CP and according to the actual city`s situation in order to report to the City People's Council for consideration and application.

CHAPTER 3 LITERATURE REVIEW

3.1 Introduction

This chapter contains two main categories of literature review, one for valuation methodology adaptable for estimating household's WTP for improved wastewater services and one for tariff setting.

Section 3.2, CVM methodology and its applications for estimating the non-market value of the useful improvements in the wastewater treatment services is discussed. Review of the former CVM studies especially in developing countries in the context of water environment and wastewater treatment projects also is discussed. Section 3.3 provides the theoretical framework of this method. Section 3.4, overview of tariff structures in use and approaches to setting tariff for wastewater are briefly presented.

3.2 CVM and its application

3.2.1 CVM application

The CVM is a valuation method used to roughly estimate the non-market value of the useful improvement and change in project that is not subject to traditional valuation in order to evaluate the efficiency/revenue, impacts or benefits of project implementation, investment or maintenance. In the survey, the respondents are directly asked to answer their WTP. Although, it has been found extensive applicability in environmental studies and public programs, there are few studies where CVM is applied in a valuation of wastewater service that is in the transitional stage in large scale in developing countries

Review of CVM studies that conducted in developing countries, elicitation method using dichotomous choice format accounts for a high percentage. This format is preferred over other formats as it reduces the cognitive burden for respondents. For dichotomous choice with follow-up questions, more precise information about respondents't WTP level can be obtained, at the same time the difference or how change of mean WTP at each round of single and bouble- bounded format are also interested to define whether any strategic behavior occur from respondent's responses.

3.2.2 General limitations of the CVM

The potential limitations that any CVM study could face are:

- Stated WTP may be different from actual their willingness and especially affordability.
- Risks of over- or underestimated WTP from respondents may happen.
- Interview skill and right questions for people revealing their willingness to pay.

Biases

Vehicle of payment bias happens when the respondents do not or could not undertand. To avoid this kind of bias, the suggested payment vehicle should be realistic and familiar to everybody.

Hypothetical bias is difference between true and stated WTP of the respondents. Most of studies find the hypothetical WTP higher than the actual WTP. This is believed that the level of familiarity of respondents with the good things mentioned in question is one of causes. By definition the contingent valuation questions are hypothetical, they describe benefits derived from offered or changed service in the future. It is generally difficult to obtain reasonable answers when respondents are unfamiliar with the service or do not have any previous experience about it. Appling CVM to value wastewater services, even if it is a familiar service to people, still can have certain elements of hypotheticity. In order to reduce the bias of hypothesis, the survey instrument should be designed in a manner to ensure that respondents are familiar with that service and respondents are given experience in both valuation and choice procedure. In certain cases, WTP might not change with the changing quantities of the public facilities being valued (Kahneman and Knetsch, 1992). For instance, the respondent's WTP does not vary much if the service offers five or ten more plants. This bias is known as embedding effect.

Strategic bias comes from the intention of the respondents by a certain effect that induce them to state their untrue WTP. For example, respondents may overbid when they believe that their bid can influence the service provision or quality. If they think that service provision is not dependent on the bid level, they may underbid. The strategic bias can be minimized by not giving hints to the respondents in the questionnaires to engage them in strategic behaviour and by choosing incentive compatible elicitation formats like the dichotomous-choice techniques.

The mentioned-above biases are common and serious in contingent valuation studies of environment. Those biases may not occur in water supply and sanitation sector studies because its services are relatively familiar to the respondents. Moreover, a well-designed and carefully implemented CV study with prior knowledge of these biases can effectively reduce most biases.

Protest

There are protest responses which show in the form of negative answers to the WTP question for a specific project, such as: "I do not trust the administration and allocation of collected fee source", "I do not believe that fee collection will result in improved wastewater service" or I already pay taxes and other public charges". Therefore, it should be considered to separate protest responses from genuine responses in order to obtain more reliable WTP results (Dziegielewska and Mendelsohn, 2007). However, the question whether the estimation of WTP is more biased by the exclusion or inclusion of protest bids (Frey and Pirscher, 2019). It is difficult to improve the methods because of: motivations behind protest responses are largely unclear, definitions of protest differ between studies and often only participants who state a zero WTP are asked for their reasons.

3.2.3 Review of former CVM studies in developing countries

The use of CVM in the context of water environment is broad and covers many areas. In developing countries, the numerous studies have been implemented by applying CVM to value or to obtain community's WTP for improved water supply, tap water quality (Altaf, 1994; Hoehn and Krieger, 2000; Fujita et al., 2005; Campos, 2007; Hoang-Hue, 2018), improvement in the surface water quality (Choe et al., 1996; Vo, 2010; Ngo et al., 2015; Dung et al., 2016), flood control (Lizinski, 2015; Fuks and Chatterjee, 2008), improvement of sanitation such as toilets, sewerage connections and city-wide or local wastewater treatment (Whittington et al, 1993; Altaf, 1994; Altaf and Hughes 1994; Tapvong and Kruavan, 1999; Fujita et al., 2005; Campos, 2007; Tziakis et al., 2009; Nguyen et al., 2012; Van Minh et al., 2013; Palanca-Tan, 2015). Applications have involved both rural and urban areas, local and large scale.

Using CVM in the context of wastewater treatment also covers different issues. Most often it is used to analyze cost-benefit and value the benefits resulting from wastewater facilities and treatment project (Dixon, 2012; Tziakis et al, 2009; Hoehn and Krieger, 2000), the improved and/or upgraded existing treatment facilities (Tapvong and Kruavan, 1999), measuring the demand for improved urban wastewater service (Altaf and Hughes, 1994), examining residents` acceptability and WTP for a wastewater treatment plant in their place (Genius, 2012) and pricing the sewerage service (Campos, 2007). It is worth noting that in most analyses referring to wastewater treatment services, the WTP is related to the availability of sewerage and treatment system need in areas, level of treatment system, faced pollution situations and country's development level.

Focusing on Vietnam, few studies have estimated user' preference for wastewater services. These studies were mainly conducted to estimate WTP for remediation of water pollution at small vocational villages regarding industrial wastewater (Ngo et al., 2015; Le et al., 2016) or for the construction of domestic wastewater treatment stations in rural areas (Nguyen et al., 2012). In addition, a CVM was used to measure the economic cost of river water pollution in the Mekong Delta (Vo, 2010). However, a CVM study for wastewater services has not been conducted in HCMC. Since WTP is different among cultural regions and even varies according to time and people's perceptions of water-related environmental improvements, this study centered on residents' WTP and the determining factors influencing people's decisions regarding the improvement of wastewater services in HCMC, Vietnam. In addition, unlike previous large city scale studies that examined WTP for wastewater services prior to the construction of WWTPs (Hoehn and Krieger, 2000; Palanca-Tan, 2015), this study examined WTP for wastewater services during the implementation and construction of WWTPs. Similar to Tapvong and Kruavan (Tapvong and Kruavan, 1999) that focused on improving the existing wastewater treatment system, information about the wastewater treatment facilities was provided to all the respondents during the survey. However, our study examined the effect of visual information on residents' WTP for improved wastewater services as an element of trust by split-sample design in two groups. The control group received no information about WWTPs plans for polluted water improvements, whereas the treatment group received written and verbal information.

Factors that have a link to variations in the level of WTP are generally more or less dependent on the actual situation of availability or deficiency of the service and the

severity of problems in the study area. The most significant predictors of WTP are current water usage and sanitation available to households (Whittington et al., 1993), recognized water pollution (Tziakis et al., 2009; Vo, 2010), and a satisfactory level of the current service (Fujita, 2005; Nguyen et al., 2012). A further factor is the quality and scope of the wastewater/sewerage services. Residents in Davao, Philippines had less WTP in the case when a more comprehensive sanitation plan was drawn up and shown to them, most likely due to people's distrust of the government (Choe et al., 1996). Another factor was the knowledge related to environment and wastewater projects as well as individual and household characteristics such as income, age, gender, career and education levels as well as location and water payments (Fujita, 2005; Genius et al., 2005; Tziakis et al., 2009; Tapvong & Kruavan, 2003; Ngo et al., 2015; Le et al., 2016; Nguyen et al., 2012 and Vo, 2010).

3.3 Theoretical Framework of CVM

3.3.1 Single-bounded dichotomous choice format

It is assumed that there exists a distribution of WTP, denoted by *W* across the residents in HCMC, with a mean $\mu W = X\beta$ and a variance $\sigma^2 W$:

$$W = X'\beta + \varepsilon \tag{3.1}$$

Where ε has a cumulative distribution function (CDF) with the mean and variance $\varepsilon \sim CDF(0,\sigma 2W)$. The term $X'\beta$ is a scalar found by multiplication of explanatory variables and a vector of parameters.

W from the WTP, is the unobserved or latent variable. Either "yes" or "no" to the asking price A is observed. To connect the underlying latent variable model to the CDF, the conditional probability of a randomly selected respondent responding "yes" is just the probability that the repondent's unobservable WTP is greater than the asking price.

$$\begin{aligned} P(\text{Yes}) \mid X) &= P(W > A) = P(X'\beta + \varepsilon > A) \\ &= P(\varepsilon > A - X'\beta) = P(\varepsilon / \sigma > A/\sigma - X'\beta/\sigma) \\ &= P(Z > A/\sigma - X'\beta/\sigma) = 1/(1 + \varepsilon^{A/\sigma - X'\beta/\sigma}) \end{aligned} \tag{3.2}$$

To actually undertake the estimation, the SPSS is used, using Logit command that estimate the parameters σ and β and provide "probability values" to examine the hypotheses that the vector of parameters β equal zero. The approach is a form of maximum likelihood non-linear estimation. The Logit model takes the form of log odds (probability of responding "yes" vs. "no").

$$N_i = \text{logit}\,(P_i) = \log\,(P_i / 1 - P_i) \tag{3.3}$$

In which P_i = probability of "yes" response to the bid level
β = coefficients to be estimated
X = variables that influence the probability including the bid amount

The expected value or mean WTP and the median are calculated using formula of Hanemann (1984) as follows:

$$\text{Mean WTP} = \ln[1+\exp(\beta_0)]/|\beta_1| \quad (3.4)$$

$$\text{Median WTP} = \beta_0/|\beta_1| \quad (3.5)$$

In which β_1 is the coefficient estimate on the bid and β_0 is the estimated constant calculated as the sum of the estimated constant plus the product of the other independent variables times their respective means.

3.3.2 Double- bounded dichotomous choice format

The double-bounded dichotomous choice model is an extension of the single-bounded dichotomous choice model. In this model, respondents are presented with two levels of bid where the second bid is contingent upon the response to the first bid. If the individual responds "yes" to the first bid, the second bid (denoted Biu) is an amount greater than the first bid (Bi < Biu); if the individual responds "no" to the first bid, the second bid (Bid) is an amount smaller than the first bid (Bid < Bi).

Therefore, there are four possible outcomes: 1) both answers are "yes-yes"; 2) both answers are "no-no"; 3) "yes" followed by "no"; and 4) "no" followed by "yes". The likelihoods of these outcomes are denoted γyy, γnn, γyn, γny, their respectively. Given the assumption that each respondent is maximizing utility, the formulas for these likelihoods are as follows. In the first case, we have Biu > Bi and:

$$\begin{aligned}\gamma^{yy}(B_i,B_i^u) &= \Pr\{B_i \le \text{max WTP and } B_i^u \le \text{max WTP}\} \\ &= \Pr\{B_i \le \text{max WTP}|B_i^u \le \text{max WTP}\}\ \Pr\{B_i^u \le \text{max WTP}\} \\ &= \Pr\{B_i^u \le \text{max WTP}\} = 1 - G(B_i^u,\theta) \quad (3.6)\end{aligned}$$

Since, $B_i^u > B_i$, $\Pr\{B_i \le \text{max WTP}|B_i^u \le \text{max WTP}\} \equiv 1$.

Similarly, $Biu < Bi$, $\Pr\{Bid \le \text{max WTP}|Bi \le \text{max WTP}\} \equiv 1$.

Hence, $\gamma nn(Bi,Bid) = \Pr\{Bi > \text{max WTP and } Bid > \text{max WTP}\} = G(Bid,\theta)$. (3.7)

When "yes" is followed by "no", we have $B_i^u > B_i$ and

$$\gamma^{yn}(B_i,B_i^u) = \Pr\{B_i \le \text{max WTP} \le B_i^u\} = G(B_i^u;\theta) \quad (3.8)$$

and when "no" is followed by "yes", we have $B_i^d < B_i$ and

$$\gamma^{ny}(B_i,B_i^d) = \Pr\{B_i \ge \text{max WTP} \ge B_i^d\} = G(B_i;\theta) - G(B_i^d;\theta) \quad (3.9)$$

Given a sample of N respondents, in which B_i, B_i^u, and BID are the bids used for the i_{th} respondent, the log-likelihood function takes the form as follows:

$\ln L^D(\theta) = \sum_{i=1}^{n}\{d_i^{yy} ln\gamma^{yy}(B_{i,}B_i^u) + d_i^{nn} ln\gamma^{nn}(B_{i,}B_i^d) + d_i^{yn} ln\gamma^{yn}(B_{i,}B_i^u) + d_i^{ny} ln\gamma^{ny}(B_{i,}B_i^d)\}$ (3.10)

in which d_i^{yy}, d_i^{nn}, d_i^{yn}, and d_i^{ny} are binary-valued indicator variables.

θ^D is the solution to the equation $\partial \ln L^D(\theta^D / \partial\theta) = 0$

subject to $\frac{\partial^2 lnL}{\partial Q^2} < 0$

The mean for the DBDC approach is calculated as the area under the probability function of bid acceptance using integration technique. The area shows the proportion of the respondents who are willing to contribute for the service at each price level. It can be expressed as:

$$Mean(WTP) = \int_L^U \frac{1}{1+e^{a+bWillingness}} db \quad (3.11)$$

where $1/(1+e^{a+bWillingness})$ is the probability of "yes" response and U and L are the upper and lower limits of the integration respectively.

The median is calculated as follows: α/B_1 (3.12)

Since in the model, we include covariates, α is a linear function of the covariates, instead of the intercept. That is $\alpha=X\beta$ where X is a vector of covariates and β is a vector of parameters.

The variables used in the study model are described in Chapter 6.

3.4 Tariff setting

Tariff setting approach

An appropriate wastewater tariff is incentives to improve sustainable sanitation services. Tariff setting practices differ widely from around the world, and there is no unification on which tariff structure is the best balances the objectives of the facility, consumers, and society (Whittington, 2002). Tariffs generate revenues to recover certain specific costs such as O/M costs, funds for the basic investment needs of wastewater infrastructure depending on various objectives and low-income class`s affordability needs to be considered to subsiding tariffs.

Many researches have shown that low tariffs are set largely for political, rather than practical, purposes. Moreover, the traditional approach of tariff pricing that focusing on social dimension of affordability is restrictive. However, a more complex approach including the financial and economic dimensions of affordability in water management should be considered and analyzed economically.

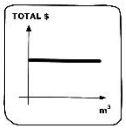
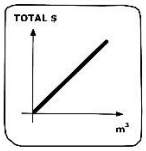
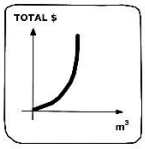
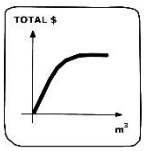
Tariff structure

Tariff structures are usually complex and difficult for consumers to understand. People are not generally aware about the costs of providing wastewater treatment services, it is

difficult for them to judge what a "fair" or appropriate price to pay is (Cardone and Fonseca, 2004). Furthermore, there is disagreement over the objectives of service pricing and tariff design therefore a tariff structure alone could not cover all the needs.

Wastewater tariffs can be set as a fixed percentage of water tariffs, or can be set separately. They are set as a single part or as a combination of two-part structures. A briefly overview of service tariffs generally adopted by water and wastewater utilities is given:

Table 3. 1 Summary of types of single part tariff structures against setting objectives

Tariff structure	**Description**	**Objectives**			
		Cost recovery	Economic efficiency	Equity	Affordability
Fixed charge 	Monthly water bill is independent of the volume consumed.	+	-	-	+
Uniform volumetric charge 	Charge by a rate proportional to water consumption (metering is needed). All units (cubic meters) are priced the same rate.	++	++	++	++
Increasing block tariff 	The unit charge is constant over a specific range of water use block and then increases as the consume increases	++	-	-	-
Decreasing block tariff 	the rate per unit of water is high for the initial (lower) block of consumption and decreases as the volume of consumption increases	++	-	-	-

Note: (++) Good
(+) Adequate
(-) Poor

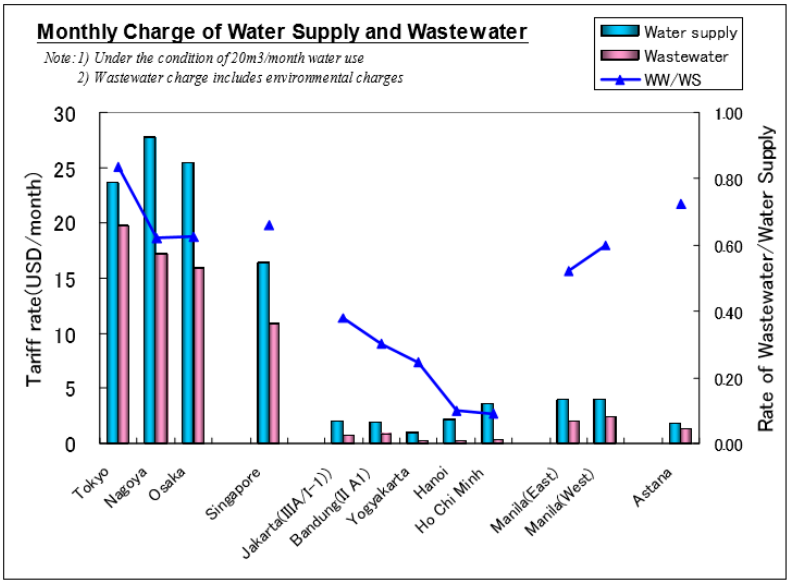
Source: Whittington et al., 2002

Two-part tariff structure is a combination of a fixed charge and a variable volumetric charge (e.g. increasing block or uniform tariff). This tariff structure is widely promoted by the World Bank and has been used favorably in many international tariff reform projects because this type is more equitable and efficient than the single tariff. The fixed part that is stabilized revenue flows usually corresponds to the fixed costs of production and administration or monthly infrastructure connection charges or environmental protection fee (as case applied in this study). In addition, efficient pricing in regulated markets as water, wastewater, and electricity services implies the two-part tariff structure (Coase, 1946 and Porcher, 2013).

Tariff rate

Water tariff rates are higher than wastewater tariff rates in most of developing countries as the wastewater treatment systems have not implemented comprehensively. The study of Hoque and Wichelns (2013) has revealed that the monthly water and wastewater bills per household in Asia cities that were sampled are generally less than 10 USD while the bills in cities of developed countries in U.S, Europe and Australia are six times (60 USD). The sampled water and wastewater bills ranges from 0.5 – 2.5% of household income.

In JICA (2009) report, water and wastewater tariff in Asian cities is shown in Figure 3.1



Source: JICA, 2009

Figure 3. 1 Rate of water and wastewater tariff in sampled Asian cities

In HCMC, the wastewater tariff rate that simulated replied on water tariff is around 0.34 USD/20m3 (1 USD = 17,500 VND in 2009) and is lower than in Manila (Philippines) and Jakarta (Indonesia) as shown in Figure 3.1. The financial simulation from JICA (2009) report shows wastewater charge in HCMC requires 30 – 50% of water charge and accounts for 1 – 1.5% of household expenditures. In other words, in order to gain same tariff level of Manila, HCMC`s wastewater tariff needs to be increased 3 – 5 times.

3.5 Summary

There is a research gap concerning WTP for the wastewater treatment service that is in the transitional stage in large scale in developing countries. In Vietnam, it is aware that this is the first study using CVM to elicit residents' WTP in order to explore the public's preferences for evaluating cost recovery capacity for a sustainable urban domestic wastewater service in HCMC. The tariff structure literature review, two-part tariff is the common and effective structure. Tariff setting approach depends on areal water management policy as well as area conditions. However, it is recommended that the tariff setting must be ensure the financial and economic dimensions and environmental costs.

CHAPTER 4 QUESTIONNAIRE DEVELOPMENT AND SURVEY DESIGN

4.1 Introduction

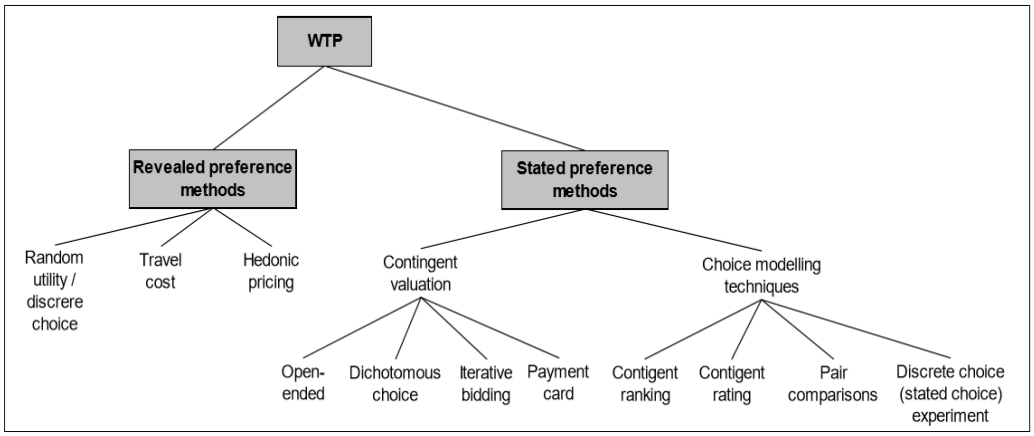
In Chapter 4, development of a CVM questionnaire and the survey design are described. The methods estimating WTP is reviewed at first, common characteristics of survey design, and different ways of presenting valuation questions are discussed, then the one most appropriate for study purpose is selected. Also, the results and feedback of the pilot survey are revised.

4.2 CVM Questionnaire development

4.2.1 Background

The objective of a CVM questionnaire is to elicit non-market value or specifically the maximum WTP for the useful improvement and changes in the quantity or quality of a service or through a project from a random sample of respondents. The mentioned changes may refer to a hypothetical or a real service.

There are two methods to estimate the economic values of or WTP for non-market goods and services. They are classified into two approaches such as stated and revealed preference as described in Figure 4.1.



Sources: Accent, 2010 (cited from Bateman et al., 2002, Kjaer, 2005)

Figure 4. 1 WTP valuation methods

Revealed preference approaches refer to actual market while stated preference approaches are based on hypothetical (but realistic) situations. Stated preference methods have two main categories that are CVM and Choice Modelling (CM) techniques. It is acknowledged that compared to CM, the approaches of CVM have been used for longer and it was found wide use to estimate WTP in the field of environmental economics because it provides an effective method for collecting WTP information in situations that it is difficult to develop choice scenarios for the service under study. However, which is more suitable depending on the research question in which CVM is more appropriate. The use of CVM in the context of water environment is broad and covers many areas. In

developing countries, it can be found in the studies of Altaf (1994), Fujita et al. (2005) for improved water supply, tap water quality, in Choe et al. (1996), Vo (2010) for improvement in the surface water quality and Whittington et al (1993), Tapvong and Kruavan (1999) and Fujita et al. (2005) for improvement of sanitation such as toilets, sewerage connections and city-wide or local wastewater treatment.

4.2.2 CVM survey design

The basic steps are suggested by many experts as well as in the guidelines for an effective CVM survey and dissemination of results. The different phases and steps involved in the WTP estimation applying the CVM are shown in Figure 4.2.

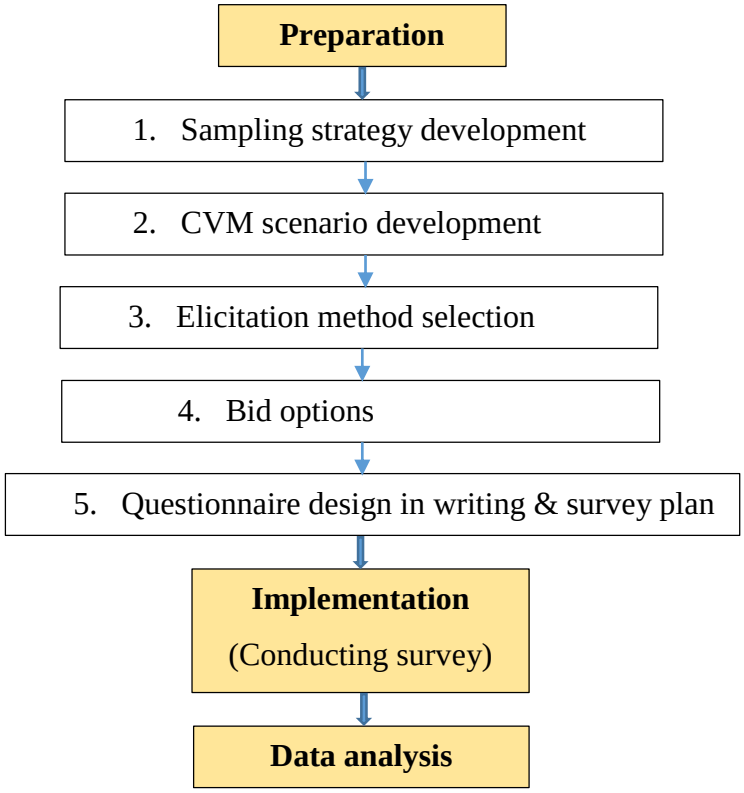


Figure 4. 2 Steps in a CVM study

4.2.2.1 Sampling

Representativeness to given target population of study objective is the important point of a sampling. There are several types of sampling method: accidental, snowball, quota sample, purposive, simple random, stratified and cluster samplings. Simple random sampling can minimize possible bias and simplifies analysis but there is a possibility of causing sampling error of non-representative sample. Stratified sampling and cluster sampling can address the problems of simple random by separating the sample into separate categories then selecting randomly from within these categories. Quota sampling also separates the sample but the selection from separated categories is not random, it is based on a quota requirement. This method can lead to bias with inappropriate quotas. An effective sampling strategy requires to delineate in sampling plan: 1) what is the target population, 2) decide the eligibility criteria, and 3) outline the sampling plan.

For interview technical, surveys can be carried out by methods of direct interviews, telephone and mail surveys. Face-to-face interviews are supported unequivocally in the literature as they generally produce the highest-quality WTP data but are expensive. Moreover, it depends on the context of a country, for example in developing countries education levels and email ownership are an obstacle to conduct mail or self-administered surveys and sometimes, it causes bias sample and answer quality as well. In this study, direct interview was employed.

4.2.2.2 CVM scenario development

To build the CVM scenario, this step requires careful consideration as the wording and form of the valuation questions as well as the payment vehicle are likely to impact the accuracy and reliability of respondents' responses. A typical valuation scenario should describe three following contents (Soden and Steel, 1999; Carson, 2000; Bateman et al., 2002):

- The improvement in or future service
- The hypothetical market, and
- The payment method.

i. Description of environment improvement in the service: The attributes or benefits of the future service or change in service are required to describe in a meaningful and understandable manner. Only essential information such as the scope of proposed changes and how the key different attributes/benefits (target state) of the service will change the status quo (reference state) according to the improvement of future service is provided to avoid a vague or overload description of the service.

> *Discharge situation of untreated wastewater from man activities has caused the worsening environmental pollution, especially water pollution at the canals and rivers in the HCMC. A comprehensive WWTPs system will be able to deal entire wastewater and partly flood control. The promotion of WWTPs construction according to master plan entails a financial sustainability for ensuring O/M effectiveness, reinvesting and upgrading the system.*

ii. The hypothetical market: refers to the social context in which the change or improvement takes place. In this description, the institution responsible for the improvement, the feasibility of improvement, conditions for service provision (e.g. respondents' perceived payment obligation), and time of provision should be included.

> *City has carried out many projects of water environment improvement in HCMC since Sewerage Master Plan approved in 2001. All domestic wastewater will be collected and treated by stages. The significant benefits of the domestic wastewater treatment service are improvement of living environment and hygienic condition in the city, the stable and safe source of city water supply with a further impact on the development of tourism and economy in general, as well as partly reduction of flooding incidences.*

Currently, HCMC has 3 operated WWTPs and the wastewater treatment plants are going to complete soon if your household contribute a certain amount. Suppose the City Authority wishes to encourage the increase in tariff for domestic wastewater services in coming future.

iii. Payment method: consists of payment vehicle, payment level, individual or household payment and timing of payment. The nature of goods or service decides the payment vehicle that can be coercive payment vehicle (e.g. tax, fee/charge and price increase) and voluntary payment (e.g. donation). Both vehicles have obstacles, the former could raise aspects of accountability and trust in the authority while the later may face an incentive to overstate their WTP. There are two types of payment levels. The reference level is respondents` disposable income and target payment level is the respondents` maximum WTP. Finally, timing of payment can be lump sum or timescale payment approaches and this is presented respondents with monthly or annual amounts in the elicitation question. According to the actual situation and law provisions, currently the environmental protection fee (EPF) is calculated as 10% on the price of 1m3 of water excluding VAT. Therefore, it is recommended that payment vehicle is a percentage coefficient of water supply tariff in order to ensure compliance with current legal regulations. In addition, it is easier for people to get consensus because first, it fits into the current reality (people are accustomed to calculating %), secondly, the coefficient of % of the water price will give a corresponding value that everyone will understand and know the basis for determining domestic wastewater charges. The selection of a fixed amount, for example 2,000 VND/m^3, in fact, it is studied on water tariff but when making the same method for wastewater fee, it will make people confuse and ask questions what is the platform and where is that number gotten while the sewage industry in HCMC is still developing and improving, so it can make people uncomfortable accepting that fee immediately. As a result, household and monthly payment are included and target payment level is selected.

4.2.2.3 Elicitation method

Selecting the elicitation method of monetary values, this step is a considerably important as different elicitation formats will produce typically different estimates. The most widely used formats are open-ended, payment cards, iterative bidding, and single-bounded dichotomous choice, double-bounded dichotomous choice. Each format has both pros and cons but in overall, payment cards and dichotomous choice are the most recommended formats (Bateman et al., 2002; Pearce and Ozdemiroglu, 2002; Accent, 2010). Dichotomous choice model is frequently recommended by researchers (Portney, 1994; Bateman et al., 2002; Del Saz-Salazar et al., 2009) and its application in water supply and sanitation projects has provided reliable results so far (Pattanayak et al., 2006). Dichotomous choice (DC) approach has received endorsement of the National Oceanic and Atmospheric Administration (NOAA) panel and it is easier for respondents to react to the question; help avoid outliers as it minimizes any incentive to strategically over-stated or under-stated WTP (Loomis, 1988; Moran, 1994; Ninan and Sathyapalan, 2005) however requires a large sample and stronger statistical assumptions (Accent, 2010).

However, no matter what approaches, when questioned, respondents must be reminded of the trade-off between money and benefits as well as household budget constraints (Bateman et al., 2002; Arrow et al., 1993).

…Consequently, please consider benefits that the improved wastewater services bring in to decide related payment as this may partly affect amount of expenditure available for your household needs

4.2.2.4 Bid option

Sample design retails choosing bid amounts that could be reflected from focus group discussion and pretest. As a result, a feasibility bid set was decided on by both a pre-test survey and the city's WWTP investment plans. Considering the construction plans, two new plants (total capacity: 730,000 m^3/day) and one upgraded plant (capacity: 469,000 m^3/day) are in the process of construction. An additional four WWTPs (total capacity of over 1 million m^3/day) are in the process of calling for investment. The city is deploying solutions to reach the target that 80% of total urban domestic wastewater is collected and treated before being discharged, by 2020 (Natural Resources and Environment Newspaper, 2017). Consequently, the lowest WTP suggested level was 15% and the highest WTP level was 80% of the water price in accordance with the pre-test and subsequent 80% treated sewage mass.

4.2.3 Questionnaire development

A questionnaire survey applied to the CVM was designed for examining WTP and factors influencing HCMC residents' WTP decisions. In deciding the questions included in questionnaire, the previous questionnaires and determinants affecting WTP in studies in the literature used in determining residential WTP for wastewater treatment projects were referred. The questionnaire included a series of structured questions was organized into six main sections (see Appendix 1):

Section 1: Awareness and opinions about social issues;

Section 2: Water use;

Section 3: Wastewater and health implications;

Section 4: Social acceptance of wastewater tariff and WTP for wastewater service

Section 5: Form of tariff structure and unit price; and

Section 6: Socio-demographic information.

Moreover, study referred and applied psycho-physical approach in question design for environmental applications by asking how they feel about water environment surrounding your living area (a specific environment) (e.g., how serious, good…). Also, use direct ranking, multi-dimensional scaling (Fischhoff, 2001) so that attitudes that respondents find difficult to express could be capture.

4.2.3.1 Awareness and opinions about social issues

Introductory questions that dealt with respondents' general background as well as awareness and attitudinal questions regarding environmental and current topical issues. In the relations of environmental issues and wastewater treatment preferences and WTP, the studies of cognitive psychologists and economists has proved the importance of additional factors such as the how people think and feel about environmental issues and

wastewater treatment, then what determines their attitudes towards the increase in wastewater charge in the context of perceived seriousness from water pollution. Therefore, interested environmental and social issues were raised to assess to see which the biggest concern in the community is. They were then asked to evaluate the levels of seriousness of the water pollution situation and the importance of urban wastewater collection and treatment in HCMC. Questions on the local people's awareness about cause and effect of urban water pollution and wastewater management cooperation between citizen and authority was raised to motivate their WTP for wastewater treatment services in HCMC by using agreement-with-statement scaling – Likert scale. The five-point scale of agreement from is used (1. Strongly disagree, 2. Disagree, 3. Do not know/neutral, 4. Agree and 5. Strongly agree). Thus, this section revealed respondent' awareness and attitudes toward water environment situation and implied 'polluter pay' principle.

Perceived quality of surrounding environment is thought to have a positive influence on WTP, therefore the study also included questions on water environmental situation in their living area, distance of house from canal and flood frequency as perceived by the respondents. These data will be selected to use as predictor variables in CVM model. Questions assessing the importance of wastewater treatment and reasons as perceived by respondents were also included in questionnaire.

4.2.3.2 Water use

WTP for an improved wastewater service is expected to be related to the household`s water consumption and current water tariff, therefore questions on monthly water consumption, water bill and their assessment of current water tariff were asked. In addition, these information help respondents visualize the amount spending on wastewater service based on percentage of water bill. Also, if they know or recognize the environmental protection fee for wastewater (10%) is included in their water bill and how they think about that fee level were asked in order to see how this perceived information affects people`s WTP. The end of this section, tap water quality, other water source used, and how much do they spend for water come from those sources were asked to find out any gap when comparing water consumption to household size.

4.2.3.3 Wastewater and health implication

This section consisted of questions about the household wastewater disposal, satisfied level with disposal system and if any member of their households' experience of water-borne disease in last 6 months to examine whether they have effects.

4.2.3.4 WTP for wastewater service

In Section 4 of the questionnaire, the CVM scenario and WTP question were designed referring to in many related studies and followed a valid CVM guideline provided by Carson (2000). The most common used format of CVM question is that the respondent is offered an implied binary choice between two alternatives, one being the status quo and other alternative having cost greater than when doing nothing (maintaining the status quo). Information about how the respondent feels about the alternative relative to the status quo and their WTP to gain that alternative is elicited. The respondent is told that an increase in service charge will be implemented for providing a better environment. The important

elements in establishing CVM question are that the respondent provides a 'favor or not favor' answer regarding the improvement compared to the status quo, what the service will bring about, how the service will be provided and how much it may cost have to clearly specified. A hypothetical service was defined to seek the respondents' WTP for the wastewater service in order to improve the quality of life. In order to ensure financial viability of wastewater treatment facilities, an increase in charge for wastewater services is indispensable. After the scenario description a question relating to people opinion about tariff increase was read: ***"Suppose the City Authority wishes to encourage the increase in tariff for domestic wastewater services in coming future. How would you feel about increase in wastewater tariff?*** ``. A response to this resulted in question for reasons. Regardless the negative answer, a question relating specifically to the WTP then was read to all respondents: ***"Currently your household is paying 10% EPF for wastewater based on monthly water bill. To contribute to the improvement of city wastewater services, would your household be willing to pay about _____% bill of water used of your household per month as a domestic wastewater charge?***

The study made used of the double-bounded dichotomous choice model regarding WTP with three different bid sets 20%, 40% and 60% that were offered to different respondents at random as follows: (15%, 20%, 40%), (20%, 40%, 60%), and (40%, 60%, 80%), where the second number of each set was the initial bid, the first number corresponded to the lower bid if respondent answered "no" to the initial bid, and the third number represented the higher bid, if respondent said "yes" to the initial bid. A random assignment of bid levels to respondents allows to trace out the distribution of WTP for the service. The percentage of willing to pay different amounts is determined as a parametric functional form assumed for WTP distribution, then mean WTP can be estimated.

For respondents whose answers were "no" for both questions (no-no), we enquired directly about their WTP using an open-ended format "What is the maximum amount of water bill percentage you would agree to pay?" This could be avoided in the case their WTP are out of the offered bids, for instance a respondent who encountered a high bid questionnaire said "no" completely for a WTP whereas they might be willing to pay at a certain lower level. If the answer remained "no", we enquired about the reasons for not being willing to pay any level of rate for wastewater services. The intention of this follow-up question is to differentiate protest responses and valid zero responses. Only the lack of value for the treatment service financing and the inability to afford it were classified as valid zeroes.

Questions of respondents` awareness of operated WWTPs in HCMC and wastewater tariff applied in other cities, countries were included before CVM question. The responses to these questions were considered to model the determinants of the valuations.

4.2.3.5 Tariff structure

This section 5 comprised questions regarding form of tariff structure and unit price that respondents want to suggest in case city will lay down as a policy for domestic wastewater tariff. This section is for second part of the study proposing an appropriate wastewater tariff applying for HCMC. Five basic structures were shown and explained to them for choice.

4.2.3.6 Socio-demographic information

Final section is about household characteristics such as: age, income, education level, gender, marital status, occupation, and household expenses, etc. This part is useful for checking the representativeness of the population. These socio-demographic characteristic as variables for testing response validity (e.g., whether income has significantly negative or positive impact on WTP?

4.3 Pilot survey

Before the main survey, a pre-test survey was carried out in June, 2017. 30 questionnaires were conducted by email and personal interview via phone with variety of sectors such as housewife, private company and public staffs, lecturers. The purpose of pilot is to test questions' understandability and the rationality of proposed price. Therefore, selecting right respondents was concerned because in addition to answering the questions, they were asked to write down or directly discuss during interview any feedback and comment upon contents and bid price for a better questionnaire and result. The pilot was done by the researcher so all of detailed comments on the questionnaire were taken notes.

Considering the feedback from the pilot, the main points need to be revised as follows:

- Re-layouting WTP question of double-bounded model for easy understanding;
- The recommended price should not be based on the water-consumed assumption of an average 4-persons household as it will introduce bias.
- Re-write some questions that are closer to the normal people

Adjustments were made and a bid set by percentage by each household water bill was replace as above mentioned. Consequently, the main survey was conducted later and its results are presented in later Chapter.

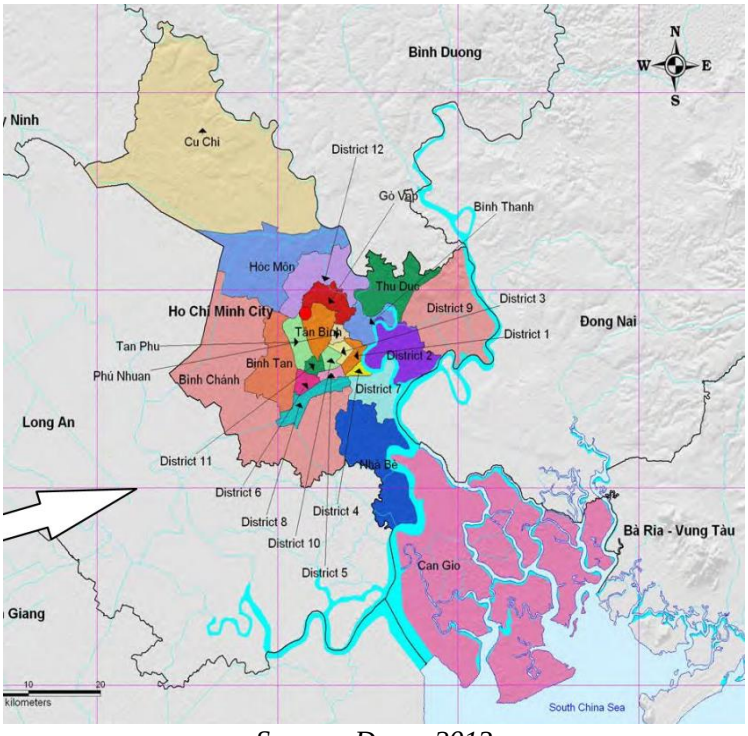
CHAPTER 5 RESULTS OF SURVEY

5.1 Introduction

As mentioned in Chapter 4, the statistical results and descriptive outcomes of main survey is discussed in this Chapter 5. This chapter is organized in accordance with questions in Questionnaire and presented descriptive statistics and discussion in parallel. A sampling method and the sample size used in the main survey also is described.

5.2 Sampling method and sample size

The sampling design is an important to make sure that the survey data obtained is adequately representative of population characteristics. Especially, since this survey is to reflect the entire city population, it required a sufficient sample size to generalize the results. The commonly used sampling techniques was chosen is stratified random sampling. The stratum is based on the districts. Since each district consists of a different number of wards, and the wards were selected randomly and proportionately to the number of wards in each district. Households per ward were chosen randomly. In order to cover areas with different environmental and economic conditions, households in 23 out of 24 districts/provinces of HCMC were surveyed (Figure 5.1). One not in the sample was Can Gio district as Can Gio, a district far from the city center, has a lower starting point and has different characteristics from other districts. Therefore, a separate water supply and low water tariff mechanism are applied for Can Gio.



Source: Dang, 2013

Figure 5. 1 Districts in HCMC

The elicitation method of dichotomous choice was applied, number of samples needed for the single-bounded and double-bounded method was decided based on formula as well as previous studies experience as presented in former chapter. Hence, the total sample size for the study was 431 households in HCMC.

Household's representatives interviewed should have an income or right of expenditure management. Households were included regardless of whether their house was owned or rented. The survey was conducted through direct interviews with individuals or groups of respondents after they were briefed on the survey's purpose, the questionnaire content.

5.3 Summary statistics

A total of 431 households completed the interview. From this total, there are 192 samples (44.5%) provided with information of WWTPs construction plan of the city and 239 samples (55.5%) provided without information.

5.3.1 Household characteristics

The sample's household characteristics are summarized in Table 5.1. From a total of 431 respondents, there were more male respondents than female (61.3% vs. 38.7% respectively). Most of the respondents were married (72.1%), the average family size was 3.95 (range 1-13), households with children accounted for 55.5% of the sample, and the average age of respondents was 35.25 (range 18-82). The majority of respondents held a college/university education (79.1%), followed by high school education (9.5%). A post-graduate education (master/PhD) was held by 9.0% of respondents and only 0.5% had no formal schooling. Of all respondents, 91.1% work in the formal sector (66% and 19.3% are private and government employees respectively; the remainder are business owners) and 8.9% work in the informal sector or are unemployed (0.5%). Regarding monthly household income, 45% of the sample population have an income of 18.1–33 million VND, 14.7% earn more than 33 million VND (ca. 1,500 USD according to the exchange range in 2018), and only 0.9% (4 households) have a low income (3–6 million VND). Data shows that 69.5% of respondents own their house, whereas 21.4% live in a rented house/unit, and 9.1% live with their parents or in a relative's house.

The education percentage of the survey sample seem high for two reasons: firstly, the two data sets regarding college and university education were combined, and secondly, regarding the interview, respondent without a high education were not confident to answer the questionnaire and passed it on to the highest educated member of the household who completed it. There is no significant difference in terms of socio-demographic characteristics between the two groups with and without prior information. Notably, there are some differences between the sample and general population averages in terms of higher education statistic. Although the survey was randomly assigned, these differences may affect the results of the comparison tests. The study survey results show that average income of HCMC residents ranging around 7 – 10 million VND/capita/month is quite close to other statistics. For instance, the average salary of Vietnamese labor is about 6.5 million VND/capita/month (General Statistics Office, 2017), while according to Salary Report for 2017 of VietnameWorks, HCMC holds the highest position in the average salary nationwide. Each employee here reaches an average of 456 USD (nearly 10.4 million VND/month) (VNExpress, 2018).

Table 5. 1 Household characteristics in the sample

Variable		With CP	Without CP	All
All sample		192	239	431
Age	<20 (%)	0.5	0	0.2
	21 – 29	25.1	26.5	25.9
	30 – 39	46.1	48.7	47.6
	40 – 49	21.5	16.8	18.9
	50 – 59	4.7	5.9	5.4
	>60 (%)	2.1	2.1	2.1
	Min	18	23	18
	Max	82	67	82
	Average	35.72	34.87	35.25
	Standard deviation	9.1	8.632	8.848
Gender	Male (%)	66.1	57.3	61.3
	Female (%)	33.9	42.7	38.7
Marital status	Single (%)	21.5	28.9	25.6
	Marriage (%)	75.9	69.0	72.1
	Divorced/Widowed (%)	2.6	2.1	2.3
Education	No schooling (%)	0	0.8	0.5
	Primary school (%)	1.0	0.8	0.9
	High school (%)	9.4	9.6	9.5
	College/University (%)	81.3	77.4	79.1
	Master/PhD degree	7.3	10.5	9.0
	Technical school	1.0	0.8	0.9
Occupation	Unemployed (%)	1.5	0.4	1.0
	Farmer (%)	0.5	0	0.2
	Self-employed (%)	6.8	3.8	5.1
	Government officer (%)	15.2	22.6	19.3
	Private employee (%)	67.0	65.3	66.0
	Own business-industry (%)	0.5	0.8	0.7
	Retired/Housewife (%)	4.7	5.0	4.9
	Small informal business (%)	3.7	2.1	2.8
Household size	Min	1	1	1
	Max	12	13	13
	Average	4.06	3.87	3.95
	Standard deviation	1.802	1.8	1.801
Children	Min	0	0	1
	Max	3	3	3
	Average	0.82	0.73	0.77
	Standard deviation	0.806	0.801	0.804
Income contributor	Min	1	1	1
	Max	7	6	7
	Average	2.39	2.32	2.35
	Standard deviation	1.043	0.991	1.014
Monthly income (VND)	Min	2	2	2
	Max	12	12	12

Variable		With CP	Without CP	All
	Average	7.71	7.37	7.52
	Standard deviation	2.680	3.059	2.898
(%)	(1) <3 million	0	0	0
	(2) 3 – 6 million	0.5	1.3	0.9
	(3) 6.1 – 9 million	2.6	8.8	6.1
	(4) 9.1 – 12 million	11.0	11.8	11.4
	(5) 12.1 – 15 million	10.5	10.5	10.5
	(6) 15.1 – 18 million	9.9	12.6	11.4
	(7) 18.1 – 21 million	17.3	12.2	14.5
	(8) 21.1 – 24 million	9.9	7.1	8.4
	(9) 24.1 – 27 million	9.4	6.7	7.9
	(10) 27.1 – 30 million	6.8	6.3	6.5
	(11) 30.1 – 33 million	11.0	5.9	7.7
	(12) >33 million	11.0	17.6	14.7
House ownership	Owner (%)	71.4	68.2	69.6
	Rented house (%)	18.2	23.8	21.3
	Living with relatives (%)	10.4	7.9	9.0
Monthly food expense (million VND)	Min	1.2	1	1
	Max	20	24	24
	Average	6.1	5.2	5.6
	Standard deviation	3.3	3.1	3.2
Monthly gas (VND)	Min	0	0	0
	Max	700,000	1,000,000	1,000,000
	Average	198,960	167,067	181,775
	Standard deviation	145,305	144,864	145,752
Monthly garbage tariff (VND)	Min	5,000	5,000	5,000
	Max	150,000	150,000	150,000
	Average	31,893	30,221	30,981
	Standard deviation	14,869	17,989	16,643
Monthly electricity tariff (VND)	Min	130,000	70,000	70,000
	Max	4,000,000	5,000,000	5,000,000
	Average	700,455	645,156	670,239
	Standard deviation	450,760	610,096	543,672
Monthly transportation expense (VND)	Min	100,000	120,000	100,000
	Max	6,000,000	5,000,000	6,000,000
	Average	1,177,068	1,044,267	1,105,172
	Standard deviation	1,035,680	901,358	965,851

Monthly household expenditure was surveyed to grasp the affordability of wastewater charge. The findings through the survey (Table 5.2) show that most of the families reported food is the biggest expenditure on a daily basis that accounted for more than a quarter of average household income, followed by transportation (5%) then electricity (3.2%). Expenses for water (included 10% of environmental fees) and gas are the same, around 0.9% of income. This is similar to average expenditure for water of 1.0% of income in Hanoi (JICA, 2011). Waste cost accounts for the lowest percentage compared to income (0.15%).

Table 5. 2 Estimated monthly non-housing expense by households compared to average monthly income

Average	**VND/month**	**% of income**
Household income	21,000,000	
Food	5,600,000	26.67
Transport	1,100,000	5.24
Electricity	670,000	3.19
Water	185,000	0.88
Gas	182,000	0.87
Other water source	132,000	0.63
Garbage	31,000	0.15

5.3.2 Awareness and opinions about social issues in city

In question (Q) 1, respondents were given different social issues that need to be solved to rank in accordance with their priority. According to the survey result, from the perspective of the respondents in this research sample, HCMC has many issues that society cares about. Accordingly, traffic was the most concerned urgent issue with 44.5% of choice for the most important, 13.2% for the second most important and 10.9% for the third most important. The issues that the HCMC population is the least concerned about are power and climate change when all three choices of the most, second and third importance have the lowest rate of 1.6%, 3.2%, 2.8% and 1.4%, 2.3% 2.6% respectively. For climate change issue, Lorenzoni and Pidgeon (2006) also found that this is less important than other social and personal in U.S and Europe after more than 15 years of carrying out study on awareness of climate change. After traffic issue, water pollution and air pollution receive a quite high level of interest from respondents in HCMC with a selection rate for the first, second and third important is 10.0%, 15.1%, 24.8% and 10.4%, 22.7%, 14.2% respectively. In the survey of Dang (2013), HCMC residents also ranked traffic as the top issue and followed by education, while natural resources and environmental management issue only received moderate concern. Similarly, in Tapvong and Kruavan (1999), traffic was also ranked as the main problem, followed by air pollution, water quality and solid waste. Palanca-Tan (2015) showed that top 3 lists of important environmental concerns for Manila residents are solid waste (92%), flooding (59%) and then water pollution (41%). The other issues pointed out were food safety, security, education, society`s vices, corruption, low salary. The ranked result of social issues that need to be solved for city residents is illustrate in the Figure 5.2.

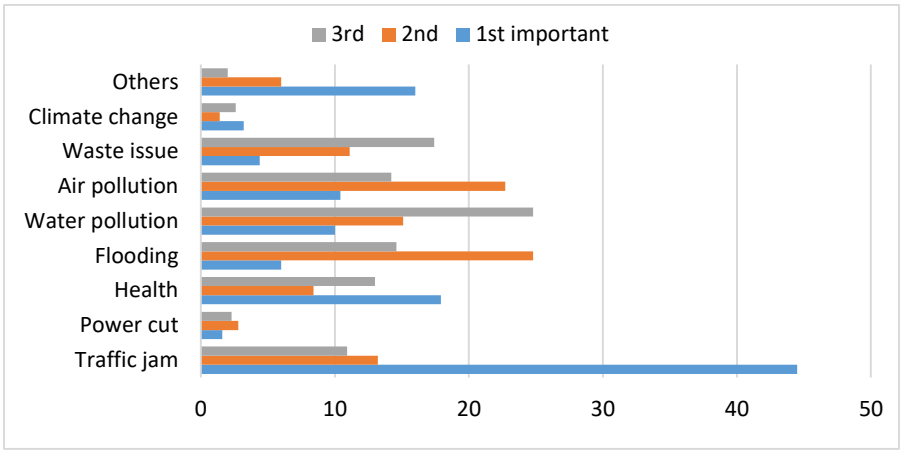


Figure 5. 2 Rank the importance of contemporary social issues in HCMC

In Q2, there are 5 environmental issues given respondent for assessing levels of seriousness. Considering the rating from very to extremely serious, there were a considerable concern for flooding and water pollution issues as they were received the assessment at levels from very to extremely serious are 55.0% and 50.8% respectively. While waste and air pollution had lower assessment rate in terms of seriousness (46.9%, 40.2% respectively), global warming was regarded less serious in HCMC resident`s assessment (29.9%). Consequently, the topic of this research, water pollution, is assessed as the most serious environmental issue to HCMC residents just after flooding issue. Figure 5.3 illustrates the assessment results.

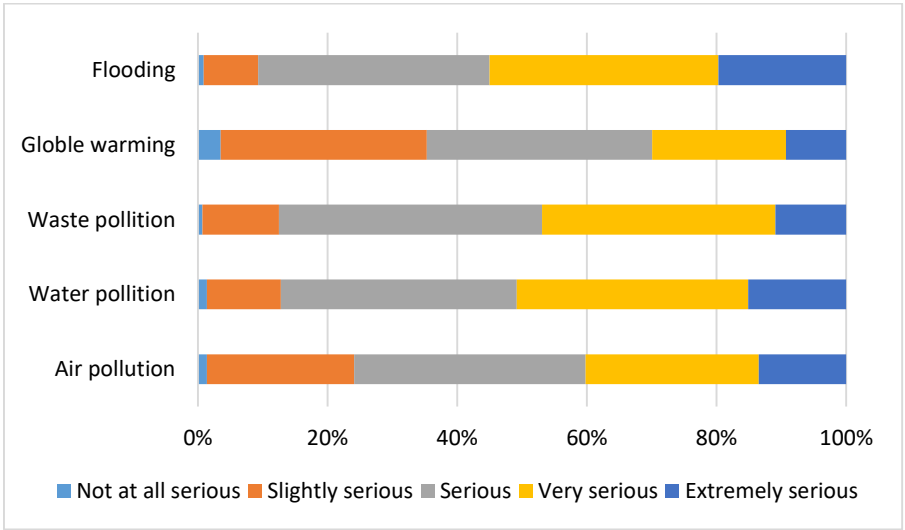


Figure 5. 3 The severity of environmental issues

In Q3, respondents were asked about their house distance from canals and water environment surrounding their living area. Over half of household (55.9%) in the survey sample lives near the canals. According to the results shown in Figure 5.4, over 55% of respondents think that water environment in their living area is normal. About 26% and 11.4% of them feel the areal water environment is bad and very bad respectively, and

only a small proportion of respondents whose houses are far from canals assessed good (7%) and very good (0.5%).

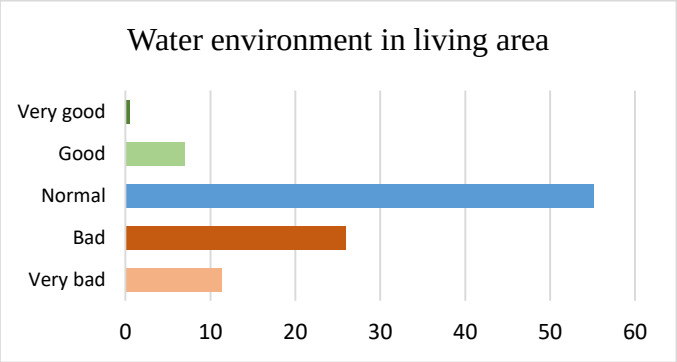


Figure 5. 4 Water environmental situation in respondents' living area

There is a moderate correlation (Pearson r = -0.455**) between the location of respondent's house and their assessment of water environmental situation in their living area (Table 5.3). A negative sign of Pearson r shows that the more near the canal, the worse the water situation is. The statistical result shows that a big proportion of bad and very bad assessment for areal water situation is from respondents living near the canal and vice versa.

Table 5. 3 The correlation between house distance and canals with assessed water environmental status

Near the canals * Status of water environment in living area Crosstabulation								
			Status of water environment in living area					
			1Very bad	**2**	**3**	**4**	**5Very good**	**Total**
Near the canals	Yes	Count	46	89	101	5	0	241
		% within Status of water environment in living area	93.9%	79.5%	42.4%	16.7%	0%	55.9%
	No	Count	3	23	137	25	2	190
		% within Status of water environment in living area	6.1%	20.5%	57.6%	83.3%	100%	44.1%
Total		Count	49	112	238	30	2	431
		% within Status of water environment in living area	100%	100%	100%	100%	100%	100%

Flooding frequency in the respondents` living area was asked in Q4. The survey result shows that the proportion of flooding by rain is more frequent than flooding by tide and the probability of flooding happening to the areas near canal is higher (Figure 5.5)

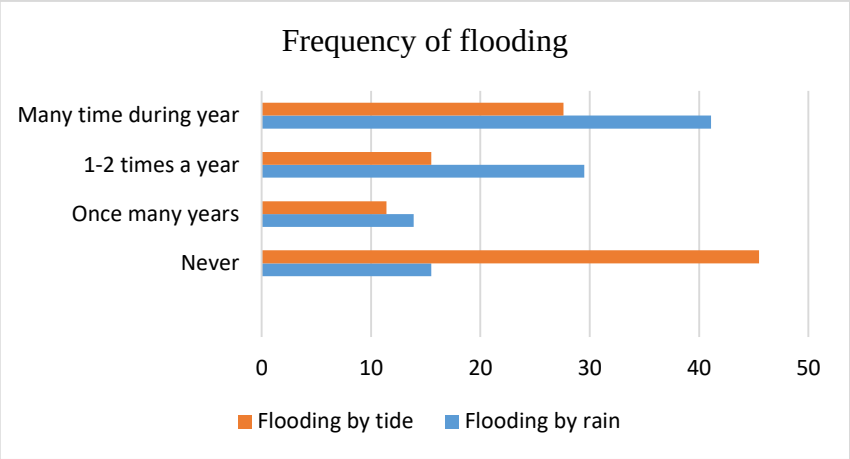


Figure 5. 5 Frequency of flooding in respondents` living area

The relations of water environmental issues and wastewater treatment preferences and 'polluter pay' principle are implied in table question 5. The respondents' attitudes to the domestic wastewater issue are summarized in Table 5.4.

Table 5. 4 Current wastewater issue and attitudes to the wastewater management

	Totally disagree (1)	Disagree (2)	Don't know (3)	Agree (4)	Totally agree (5)
Water pollution/wastewater issues of the city become increasingly serious in recent years.	4 0.9%	6 1.4%	5 1.2%	219 50.8%	197 45.7%
The major reason of water pollution is in consequence of untreated wastewater discharge from people's activities into rivers/canals.	1 0.2%	7 1.6%	9 2.1%	235 54.5%	179 41.5%
Wastewater/water pollution causes many negative impacts on current and future generations	0	0	8 1.9%	175 40.6%	248 57.7%
The untreated wastewater discharging directly into rivers will influence the input water quality of water supply plants.	1 0.2%	6 1.4%	37 8.6%	201 46.6%	186 43.2%
Wastewater collection and conveying to treatment plants can partly control city flooding.	14 3.2%	37 8.6%	78 18.1%	208 48.3%	94 21.8%
Settling wastewater/water pollution issues require the cooperation of city authority and people.	2 0.5%	5 1.2%	5 1.2%	198 45.9%	221 51.3%
Improving water environment/wastewater treatment is government/city authority's responsibility	15 3.5%	84 19.5%	18 4.2%	192 44.5%	122 28.3%
People should pay taxes/tariff of wastewater treatment services to contribute another revenue source so that City can improve and prevent water pollution effectively.	18 4.2%	70 16.2%	35 8.1%	232 53.8%	76 17.6%

As an indicator of attitude towards the current water pollution situation, for each respondent we can sum up their agreement level from questions. A person with a negative attitude can be defined to be who selected categories 1 or 2 (the first two categories) in each of these questions. A person with a positive attitude (i.e. who selected the last two categories) (presented in Table 5.5). The remainder is a 'neutral' person who answer 'Don't know' or neither agree nor disagree.

Table 5. 5 Positive attitudes towards city wastewater management

Statement	**% Agree**
Water pollution/wastewater issues of the city become increasingly serious in recent years.	96.5
The major reason of water pollution is in consequence of untreated wastewater discharge from people's activities into rivers/canals.	96
Wastewater/water pollution causes many negative impacts on current and future generations	98.1
The untreated wastewater discharging directly into rivers will influence the input water quality of water supply plants.	89.8
Wastewater collection and conveying to treatment plants can partly control city flooding.	70.1
Settling wastewater/water pollution issues require the cooperation of city authority and people.	97.2
Improving water environment/wastewater treatment is government/city authority's responsibility	72.8
People should pay taxes/tariff of wastewater treatment services to contribute another revenue source so that City can improve and prevent water pollution effectively.	71.4

Table 5.5 shows that 96.5% respondent agreed that water pollution and wastewater issues of the city become increasingly serious in recent years. The major cause of that water pollution is due to the untreated wastewater discharge from people's activities into rivers/canals, was thought by 96% of respondents. Thus, the respondents have perceived the impact of human on water pollution. For the consequence of water pollution, majority of people agreed that it affects negatively current and future generations (98.1% of respondents) and influences the intake quality of water supply plants (89.8%). Apart from common environmental benefits of wastewater collection and treatment, 70.1% of respondents think that wastewater collection and treatment at plants can partly control city flooding. As a result, for an attitude towards solution, up to 97.2% of respondents asserted that settling water pollution and wastewater issues require the cooperation of city authority and people. Nevertheless, 72.8% of respondents stated that improvement of water environment is government/city authority's responsibility. The explanation for this contradiction given by respondents is that the people just play supporting role and state is mainly in charge. One of supporting roles is financial contribution, so there were 71.4% of agreed responses with the statement 'People should pay taxes/tariff of wastewater treatment services to contribute another revenue source so that City can improve and prevent water pollution effectively'. This result is quite different with survey findings in Manila, Philippines in 2012 (Palance-Tan, 2015) that 79% of respondents believed that water pollution in Manila is a serious concern. However, only 41% of respondents agreed that all household must contribute fee for water-bodies treatment. It is possibly explained

that people do not think their domestic wastewater discharge is a major cause of water pollution but solid waste (98%) and wastewater discharge from factories/companies (92%). As a result, 81% respondent feels that government must be financially responsible for cleaning up water bodies.

For the importance of wastewater collection and treatment, according to the respondent's opinions, environmental protection is the highest-selected contribution of wastewater treatment (92.3%). The next contributions of the wastewater treatment are improved river water quality ensuring source of water supply (70.0%), reduced flooding partly (56.1%) and other reasons 3.8% such as: (i) the security of clean water source for future generation, (ii) treated water reuse, (iii) in accordance with the social and world tendency, (iv) to achieve a civilized and modern HCMC and (v) The current WWTPs have brought positive results, so need continue, (vi) if not treated, water pollution is an unavoidable issue.

Table 5. 6 The importance of wastewater treatment

Q6	The importance of wastewater collection and treatment in HCMC	Response	Percentage
	Important	426	98.8%
	Unimportant	5	1.2%
Q7	Why do you think it is important?		
	Protect the environment then improve quality of life and the hygienic conditions in the areas	393	92.3%
	Reduce partly the flooding that resulting in reduction of the social and financial consequences and traffic congestion	239	56.1%
	Improved river water quality since then ensuring quality of raw water source for water supply plant	298	70.0%
	Others	16	3.8%
Q8	Why do you think it is unimportant?		
	Wastewater collection and treatment do not affect directly my family benefits	0	0
	I do not believe in the role of wastewater collection and treatment in improving quality of water environment in city.	5	100%
	Others	1	20%

For 5 respondents who stated that wastewater treatment is unimportant, all 5 respondents gave main reason was that they do not they do not believe in the role of wastewater collection and treatment in improving quality of water environment in city. Only one other reason was given 'It is unnecessary'.

Interesting at all five of respondents who stated 'unimportant' are male and do not know the city has several operated WWTPs. Although no one of these five respondents believes wastewater tariff to be the best way financially of water environmental improvement, 3 of them agree to increase in tariff and 2 respondents say 'yes-yes' with both offered bids while the remainder say 'no-no' (Table 5.7).

Table 5. 7 Comparison of characteristics and attitudes of 5 respondents

	Know HCMC has WWTPs		Tariff-financially best way of water improvement				Increase in wastewater tariff			Gender	
	Yes	No	Yes	No	Maybe	Don`t know	Yes	No	No feeling	Male	Female
Unimportant	**0**	**5**	**0**	**2**	**2**	**1**	**3**	**2**	**0**	**5**	**0**
Important	277	149	184	62	166	14	191	172	63	259	167
Total (%)	64.3	35.7	42.7	14.8	39	3.5	45	40.4	14.6	61.3	38.7

5.3.3 Water use

98.8% of the sample households connect to the water supply system (see Table 5.8). Although city has effectuated the program of 100% households are supplied clean water, still have households especially tenants still use well-water as rental owners do not connect tap water for tenants, or they connect water system without use or small use. The 5 unconnected-water households are own-houses in far districts and rented houses and they mainly use well-water and bottled water for drink.

An average household pays 158,816 VND/month for their water use and consumes average 16 m^3 (range 2 – 75m^3). The survey recorded that people pay little attention to volume of use, especially in cases of automatic payment from bank). Some households use well-water in parallel with tap water for saving so the water payment in those families is not high while few families with swimming-pool consume a lot water. That is reason there is a big gap of water consumption. Also note that, there are a difference in water cost between home owner and tenants as applied structure of water price is increasing-block tariff and is stipulated differently for household and business

The water price was assessed as high and too high by 25.4% of respondents while only 5.6% of them thought that water price is low. A high percentage, 69.0% of the respondents supposed that the current water price is reasonable.

Only more than a half of respondents (54.2%) know or recognize the environmental protection fee (EPF) for wastewater (10%) is included in their water bill although this fee has been applied since 2004. For 10% of EPF of water bill, 66.2% of respondents thought reasonable, 17.6% and 3.5% of respondents answered high and too high respectively while 12% and 0.7% of interviewee said low and too low respectively.

Secondary water source but main source for water-unconnection houses that people use usually are bottled water (61.7% of cases) for drinking and well-water (36.5%). Very few households use river and rain water (1.8%). Average cost for this source 131,726 VND per month.

About water quality, a high percentage of the respondents answered that supplied water quality is good (71.4%) and only 1.6% said very good. 23.9% of the households assessed water quality as acceptable and 3.0% of respondents remarked other that it is unacceptable as sometimes tap water occurs turbid situation, or cannot assess due to have no information on water quality and water quality is unstable sometimes.

Table 5. 8 Household`s water usage

Q9	Does your house connect to the city water supply				Response	Percentage
	Yes				426	98.8%
	No				5	1.2%
Q10	How much is your household monthly average water consumption and bill					
	Response	min	max	mean	Std. Dev	
m^3	365	2	75	16.03	9.33	
VND	418	15,000	1,300,000	158,816	116,093	
Q11	The current prices of water supply in general				Response	Percentage
	Too low				0	0
	Low				24	5.6%
	Reasonable				294	69.0%
	High				97	22.8%
	Too high				11	2.6%
12	Do you know or recognize the environmental protection fee (EPF) for wastewater (10%) is included in your water bill?				426	
	Yes				231	54.2%
	No				195	45.8%
Q13	10% of EPF for wastewater					
	Too low				3	0.7%
	Low				51	12.0%
	Reasonable				282	66.2%
	High				75	17.6%
	Too high				15	3.5%
Q14	If your house is currently not connected to water distributors, or apart from using water supply from city system, which other water sources does your house use?				199	
	Well-water				81	36.5%
	Water vendor (bottled water for drinking)				137	61.7%
	River water				2	0.9%
	Others (rain water)				2	0.9%
Q15	If buying water or pumping from well/river, how much is your monthly average expenditure for the water come from these sources					
	Response	min	max	mean	Std. Dev	
	168	10,000	800,000	131,726	112,325	
Q16	The quality of water supplied to your house				Response	Percentage
	Very good (can drink at tap)				7	1.6%
	Good (cooking, bathing and boiled drinking-water)				305	71.4%
	Acceptable (bathing but not cooking, boiled drinking)				102	23.9%
	Others				13	3.0%

5.3.4 Wastewater and health

The sanitation issue in sample households is shown in the Table 5.9. In HCMC, sewerage projects are still implementing in accordance with Master Plan. All houses in HCMC have septic tanks according to construction regulation, the water from settling tank is discharged into sewerage then canal/river. Only areas where drainage is not yet available, they design a kind of seepage pit for both toilet and grey wastewater or discharge directly to open canal near their place. It is important to note that the responses may be influenced by the respondents' knowledge or experiences.

88.6% of surveyed households connected to municipal sewerage whereas other cases discharged wastewater into canals/river (6.7%) and open field (2.8%). Only 1.9% of households used seepage pit to store and treat their wastewater. The cases without connection to sewerage network are in new residential areas or in districts far from city center or in suburban.

Usually households connecting sewerage were satisfied with their discharge (60.3%), 5.3% and 0.2% stated very and extremely satisfied, then households discharging into open field, canal or seepage pit. Since such open drainage does not sanitize, then is susceptible to cause environmental pollution and disease.

Table 5. 9 Current sanitation

Q17	How do you dispose of your wastewater?	Response	Percentage
Toilet wastewater			
	Sewerage system	58	13.5%
	Septic tank	365	84.7%
	Open drainage canals/river	7	1.6%
	Others	1	0.2%
Grey wastewater			
	Sewerage system	382	88.6%
	Open field	12	2.8%
	Open drainage canals/river	29	6.7%
	Others	8	1.9%
Q18	Experience any of these disease in the last 6 months?	128	29.7%
	Diarrhea	85	19.7%
	Cholera	7	1.6%
	Dengue	40	9.3%
	Typhoid	3	0.7%
	Hepatitis A	1	0.2%
	No	303	70.3%
Q19	Are you satisfied with the current household wastewater disposal?		
	Not at all satisfied	22	5.1%
	Slightly satisfied	125	29.0%
	Satisfied	260	60.3%
	Very satisfied	23	5.3%
	Extremely satisfied	1	0.2%

Water-borne diseases have a close relationship with inadequate situation of sanitation system. The survey results (Table 5.9) shows within last 6 months Diarrhea (19.7%) was mentioned as acquired disease more frequent than dengue (9.3%), cholera (1.6%) then typhoid (0.7%) and hepatitis (0.2%). The morbidity of diarrhea which could be carried by parasite that is usually present in freshwater and dengue fever due to the emergence of mosquito was born from polluted water.

5.3.5 Social acceptance of wastewater tariff

Table 5.10 summarizes respondent perceptions about urban wastewater management. The survey shows that 64.3% of respondents know HCMC has several operating WWTPs, 39.4% of respondents have ever heard about wastewater tariff and only 23.7% know other several cities in Vietnam have applied wastewater tariff.

When asked if wastewater collection is the best way to improve the environment, 42.7% of the respondents agree with that and 39% think it is possible, only 14.8% of them did not think such. The remainder is neutral. Hence, 45% of respondents supported the increase in wastewater fee with the main reason is that increased wastewater tariff means quality of wastewater services will be better (96.4%). 40.1% of people did not agree with a fee increase because of the two reasons: unbelief in result and the burden of current subsistent expenses.

Table 5. 10 Respondent perceptions

Q20	Do you know HCMC has some operating WWTPs?	Response	Percentage
	Yes	277	64.3%
	No	154	35.7%
Q21	Have you ever heard about wastewater/sewage tariff?		
	Yes	170	39.4%
	No	261	60.6%
Q22	Several cities in Vietnam have applied wastewater tariff, do you know or have heard about that?		
	Yes	102	23.7%
	No	329	76.3%
Q23	Do you agree that wastewater tariff collection is the best way of water environmental improvement in terms of financial efficiency?		
	Yes	184	42.7%
	Maybe	168	39.0%
	No	64	14.8%
	Don`t know	15	3.5%
Q24	How would you feel about increase in wastewater tariff?		
	Agree	194	45.0%
	Not agree	173	40.1%
	No feeling	64	14.8%
Q25	If your answer is concurrence as increased wastewater tariff, what could be your reasons?	194	
	I think increased wastewater tariff means quality of wastewater services will be better	187	96.4%
	I see the existing wastewater fee is too low	40	20.6%
	I think if the increased wastewater tariff, it is not significant compared to my high enough income	21	10.8%
	Other reasons	16	8.2%
Q26	If your answer is unhappy as increased wastewater tariff, what could be your reasons?	173	
	Generally, I do not want an increase in price	40	23.1%
	I do not think that increase in wastewater tariff would be corresponding to the increase in treated wastewater quantity and quality	88	50.9%
	The common subsistence expenses such as prices of power, water, food that are increased continuously are the cost burden to people. Therefore, increase in wastewater fee while the state is with no support policy like price support to ease the cost burden made me unsatisfied	95	55.0%
	Other reasons	28	16.2%
Q27	If your answer is no feeling about increased wastewater tariff, what could be your reasons?	64	
	I think if wastewater tariff is increased, it is in accordance with socio-economic development and people’s income line	36	56.3%
	The state enforces, it forces to accept	36	56.3%
	Other reasons	13	20.3%

5.3.6 Perception on attributes

Table 5.11 shows that there are no significant differences in perception towards the attributes of groups provided with and without master plan information. Perhaps it is because the trust of respondents who knows city sewerage master plan is different from those who do not know about planning information. They know but because no changes in the environment have been seen so they do not believe in financial efficiency.

Table 5. 11 Perception of respondents on attributes of information

Variable	**%**	**With CP**	**Without CP**	**All sample**
N		**192**	**239**	**431**
Know HCMC has operated WWTPs	Yes	62.0	66.1	64.3
	No	38.0	33.9	35.7
Ever heard about wastewater tariff	Yes	39.1	39.7	39.4
	No	60.9	60.3	60.6
Know about other cities of Vietnam have applied wastewater tariff	Yes	20.8	25.9	23.7
	No	79.2	74.1	76.3
Wastewater tariff collection is the best way in terms of financial efficiency to serve water environmental improvement	Yes	37.0	47.3	42.7
	No	19.3	11.3	14.8
	Maybe	40.6	37.7	39.0
	Don`t know	3.1	3.8	3.5
Feel about increase in wastewater tariff	Agree	36.5	51.9	45.0
	Disagree	46.9	35.1	40.4
	No Feeling	16.7	13.0	14.6
Does increase in wastewater tariff lead your family to use less water than before:	Yes	56.8	68.2	63.1
	No	20.8	11.7	15.8
	Not sure, depend on price level	22.4	20.1	21.1

There are considerable differences of the knowledge and support for the tariff of wastewater service between the genders. 67.8% of male respondents know HCMC has operating WWTPs where as 58.7% of female knows. But for wastewater tariff, more female respondents said ‘ever heard about it’ compared to male respondents (42.5% compared to 37.5%). There seems to be similar perceptions between male and female respondents about know and unknow of wastewater tariff is being applied in some other cities in Vietnam. For financial efficiency of wastewater tariff collection, more female respondents agreed for it compared to the male respondents (49.7% vs. 38.3%). Similarly, 49.1% of female respondents agreed on increase in wastewater tariff in the future compared with 42.4% of male respondents. For tendency of water saving as tariff of wastewater service increases, 70.1% of female respondents thought that they would use less water than before while this percentage of men is 58.7%. The reasonable reason is because most of women usually participate in housework activities and they own a nature of saving (see Table 5.12)

Table 5. 12 Perception of respondents on wastewater tariff by gender

Variable	%	Female	Male
N		**167**	**264**
Know HCMC has operated WWTPs:	Yes	58.7	67.8
	No	41.3	32.2
Ever heard about wastewater/sewerage tariff:	Yes	42.5	37.5
	No	57.5	62.5
Know about some other cities of Vietnam have applied wastewater tariff	Yes	25.1	22.7
	No	74.9	77.3
Wastewater tariff collection is the best way in terms of financial efficiency to serve water environmental improvement	Yes	49.7	38.3
	Maybe	35.3	41.3
	No	9.6	18.2
	Do not know	5.4	2.3
Feel about increase in wastewater tariff	Agree	49.1	42.4
	Disagree	35.3	43.6
	No Feeling	15.6	14.0
Does increase in wastewater tariff lead your family to use less water than before:	Yes	70.1	58.7
	No	11.4	18.6
	Not sure, depending on price level	18.6	22.7

5.3.7 Bid responses of respondents

(Q28) The willingness of HCMC's residents to pay for an improved sewerage service, if it would improve water environment, is implied by yes responses. As mentioned in Chapter 4, the study also wants to examine whether WTP of respondents who provided with information of sewerage master plan and who know about city WWTPs is higher than others.

5.3.7.1 Single-bounded format

The percentage of "Yes" responses to the initial bid abides to the theory of demand: WTP goes down when the bid levels go up. This happens to all cases of groups with and without city planning information provided prior as well as cases of know or unknow operating WWTPs in the city (Figures 5.6 and 5.7). The highest percentage of 'yes' response was in the lowest bid of 20% in all scenarios (36.2%, 47.6%, 43.3% and 40.7% in the group With CP, Without CP, Know and Unknow WWTPs respectively) while the highest bid of 60% only gained 5%, 9.6%, 10% and 2.3% of WTP in group With CP, Without CP, Know and Unknow respectively.

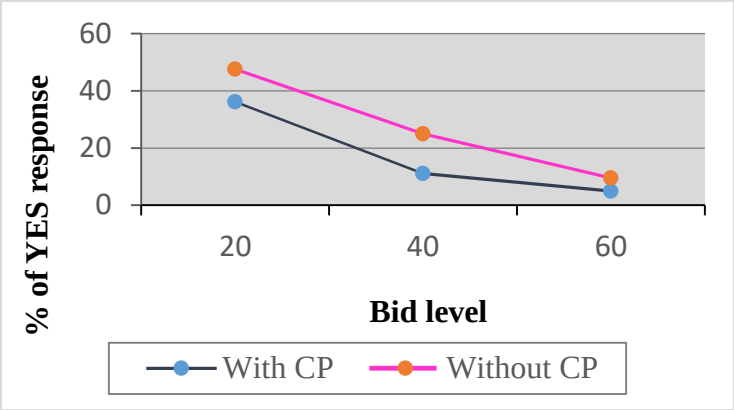


Figure 5. 6 Percentage of 'Yes' responses to the first bids by groups

On overall, Without CP group get more positive responses than With CP group and similarly the proportion of saying `yes` to the first bid of Know WWTPs was higher than Unknow WWTPs. (see Figure 5.6, 5.7 and Table 5.13, 5.14)

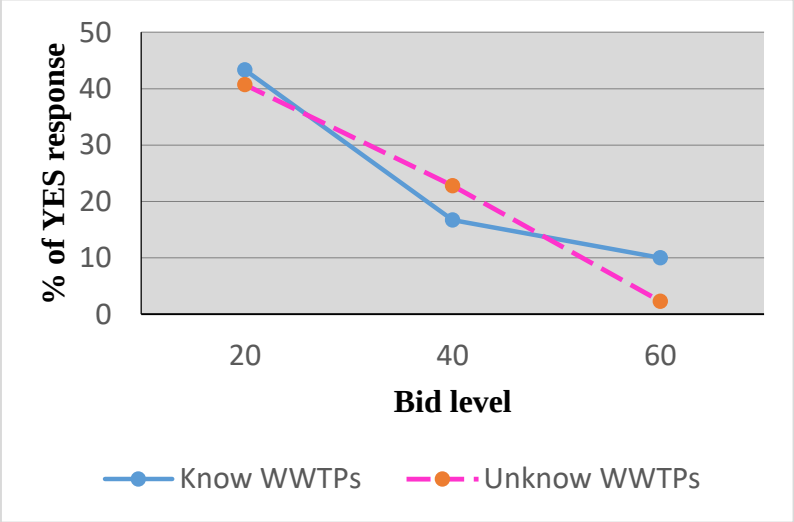


Figure 5. 7 Percentage of 'Yes' responses to the first bids by knowledge

5.3.7.2 Double-bounded format

The percentage of 'Yes' responses to second bid seems to have similar percentage between bid levels in groups of With and Without CP, only one case of the highest bid 80% no one in group Without CP said 'Yes' (Figure 5.8)

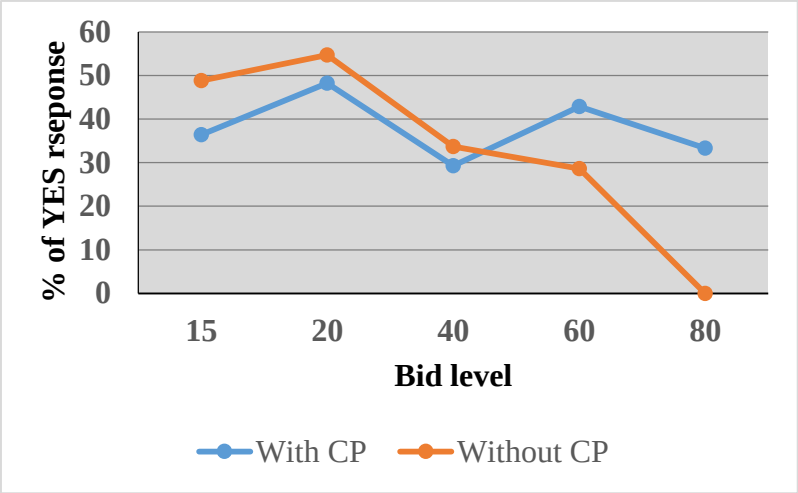


Figure 5. 8 Percentage of Yes response to the second bid by group

For case of knowledge in second bid, it differs from the first bid results. On overall, Know get less positive responses than Unknow (Figure 5.9). Similar to Group case, case of no any `Yes` for the highest bid 80% fallen into case of Know WWTPs.

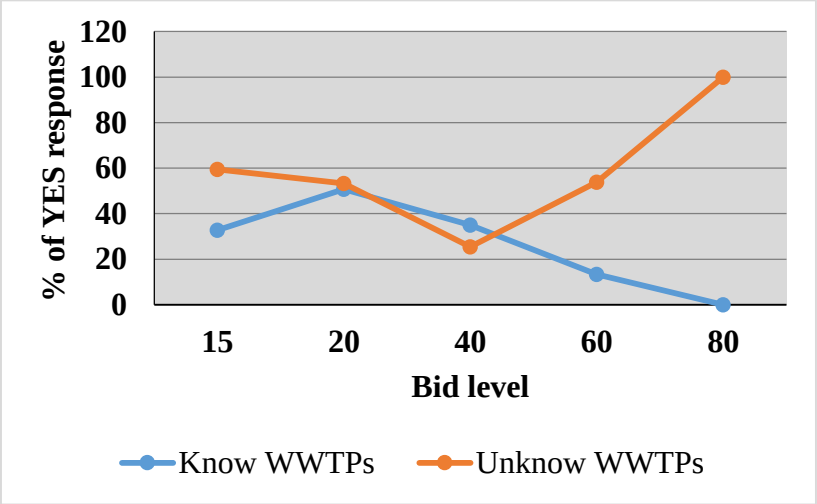


Figure 5. 9 Percentage of Yes response to the second bid by knowledge

The summary tables of Yes (Y), No (N) responses to and frequency of bid levels in the initial and second bids for Groups and Knowledge are shown in Table 5.13, 5.14, and 5.15 respectively.

Table 5. 13 'Yes' responses to the first and second bid by Groups

1st bid		With CP	Without CP	Total	2nd bid	With CP	Without CP	Total
20	Y	25 (36.2)	39 (47.6)	64 (42.4)	**15**	16 (36.4)	21 (48.8)	37 (42.5)
	N	44 (63.8)	43 (52.4)	87 (57.6)		28 (63.6)	22 (51.2)	50 (57.5)
40	Y	7 (11.1)	21 (25.0)	28 (19.0)	**20**	27 (48.2)	35 (55.6)	62 (52.1)
	N	56 (88.9)	63 (75.0)	119 (81.0)		29 (51.8)	28 (44.4)	57 (47.9)
60	Y	3 (5.0)	7 (9.6)	10 (7.5)	**40**	24 (29.3)	35 (33.3)	59 (31.6)
	N	57 (95.0)	66 (90.4	123 (92.5)		58 (70.7)	70 (66.7)	128 (68.4)
					60	3 (42.9)	6 (28.6)	9 (32.1)
						4 (57.1)	15 (71.4)	19 (67.9)
					80	1 (33.3)	0 (0)	1 (10.0)
						2 (66.7)	7 (100)	9 (90.0)
All	**Y**	**35 (18.2)**	**67 (28.0)**	**102 (23.7)**		**71 (37.0)**	**97 (40.6)**	**168 (39.0)**
	N	**157 (81.8)**	**172 (72.0)**	**329 (76.3)**		**121 (63.0)**	**142 (59.4)**	**263 (61.0)**

Table 5. 14 'Yes' responses to the first and second bid by Knowledge

1st bid	Know WWTPs	Unknow WWTPs	Total	2nd bid	Know WWTPs	Unknow WWTPs	Total
				15	18 (32.7)	19 (59.4)	37 (42.5)
20	42 (43.3)	22 (40.7)	64 (42.4)	**20**	38 (50.7)	24 (53.3)	62 (51.7)
40	15 (16.7)	13 (22.8)	28 (19.0)	**40**	43 (35.0)	16 (25.4)	59 (31.7)
60	9 (10.0)	1 (2.3)	10 (7.5)	**60**	2 (13.3)	7 (53.8)	9 (32.1)
				80	0 (0)	1 (100)	1 (10.0)
All	**66 (23.8)**	**36 (23.4)**	**102 (23.7)**		**101 (36.5)**	**67 (43.5)**	**168 (39.0)**

Table 5. 15 Frequency of bid levels in different cases

	City Plan		WWTPs				City Plan		WWTPs		
1st bid	With (%)	Without (%)	Know	Unknown	Total	2nd bid	With (%)	Without (%)	Know	Unknown	Total
						15	44 (22.9)	43 (18.0)	55 (19.9)	32 (20.8)	87 (20.2)
20	69 (35.9)	82 (34.3)	97 (35.0)	54 (35.1)	151 (35.0)	**20**	56 (29.2)	63 (26.4)	75 (27.1)	45 (29.2)	119 (27.6)
40	63 (32.8)	84 (35.1)	90 (32.5)	57 (37.0)	147 (34.1)	**40**	82 (42.7)	105 (43.9)	123 (44.4)	63 (40.9)	187 (43.4)
60	60 (31.3)	73 (30.5)	90 (32.5)	43 (27.9)	133 (30.9)	**60**	7 (3.6)	21 (8.8)	15 (5.4)	13 (8.4)	28 (6.5)
						80	3 (1.6)	7 (2.9)	9 (3.2)	1 (0.6)	10 (2.3)
All	**192**	**239**	**277**	**154**	**431**		**192**	**239**	**277**	**154**	**431**

In the double-bounded analysis, as mentioned in Chapter 3, the 4 types of answer are obtained (Table 5.16): "Yes-Yes" if the respondents agree to pay both the first bid and the second bid; "Yes-No" if the respondents agree to pay the first bid but do not agree to pay the second bid; "No-Yes" if the respondents do not agree to pay the first bid but agree to pay the second bid; and "No-No" if the respondents do not agree to both the first and second bid.

The results showed that the percentage of those who would like to pay for both bids decreased if the bid values increased. The percentage answered 'yes' for the two lower bids was 12.6% and it was 33.1% for those who both answered 'no'. The percentage of respondents who said 'yes' for the two highest bids was 0.8% and was 62.4% for those who said 'no' to both.

Table 5. 16 Frequency classified by bid values

Bid levels (%) 1st bid (2nd bid)	No. of respondents	YY NY	YN NN	YY NY (%)	YN NN (%)
20% (15 / 40)	151	19	45	12.6	29.8
		37	50	24.5	33.1
40% (20 / 60)	147	9	19	6.1	12.9
		63	56	42.9	38.1
60% (40 / 80)	133	1	9	0.8	6.8
		40	83	30.1	62.4

5.3.7.3 Open-ended question

Respondents whose answers were "no" for both bids (No-No) were inquired directly their maximum WTP using an open-ended format. 60 out of 189 respondents who answered No-No agreed to contribute for the wastewater service at their suggested price, made up 13.9% of sample (Table 5.17).

Table 5. 17 Proportion of open-ended responses

If NO for both bids, are you willing to pay					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	129	29.9	29.9	29.9
	Yes	60	13.9	13.9	43.9
	BID	242	56.1	56.1	100.0
Total		431	100.0	100.0	

5.3.7.4 Reasons of unwillingness to pay

At last, the 129 respondents (30%) disagreed to contribute any amount were asked a follow-up question of the reasons shown in Table 5.18.

The respondents were asked to choose more than one answer. 25.9% and 25.2% of respondents out of 100% of the "No-No" responses believed that payment will not solve the problem because they do not trust the authority`s financial administration and allocation, hence fee collection will not result in an improved service. 9.4% of all respondents thought that the costs of treating wastewater should all rest under the government. 16.9% of them thought the current wastewater fee is high.

In terms of saving water if wastewater tariff increases, 63% of respondents said they would use less water than before and 21% of them were not sure because their decision depends on the tariff rate.

Table 5. 18 Reasons for not willing to pay

Q30	If you are not willing to pay any level of rate for wastewater treatment service, please could you share which are your reasons	Response 129	Percentage
	I cannot afford to pay any additional expenditure to what I am now paying.	16	6.0%
	I think the current fee for wastewater is high	45	16.9%
	I think the fee of wastewater treatment must be burden by authority/government	25	9.4%
	I do not trust the administration and allocation of collected fee source	69	25.9%
	I do not care about quality of water and environment	4	1.5%
	I do not believe that fee collection will result in improved wastewater service	67	25.2%
	I do not believe that the improved wastewater service will result in the better water supply quality or flooding reduction	27	10.2%
	Other reasons	13	4.9%
Q31	In case the wastewater tariff increase to certain amount, do you think about or intend to use less water than before, on the other hand, to save on / economize water so the bill of water and wastewater is maintained as before even increased wastewater tariff?	431	
	Yes, I think so	272	63.1%
	No, I do not think about that yet	68	15.8%
	Not sure, it is up to the price level	91	21.1%

5.3.8 Tariff structure

The highest recommended tariff structure is in accordance with percentage of water price that made up 56.1% of choice, followed by the type of two-part tariff that accounted for 15.3%. The unit price of VND/m^3/person were the most chosen (approximately 40%). This proves that the arguments in tariff design section on appropriate payment vehicle and feasible tariff structure of the study are consistent with the majority.

Table 5. 19 Suggested structure and unit price for wastewater tariff

Q32	In case, City will lay down as a policy the domestic wastewater tariff collection, which form of tariff structure that you/your family want to suggest?	Response	Percentage
	Wastewater tariff is calculated as a percentage of water bill	242	56.1%
	Wastewater tariff is calculated by a specific amount of money per capita? (e.g. 5000, 10.000, 15.000 VND/month/capita)	44	10.2%
	Wastewater tariff is calculated by a specific amount of money per household? (20.000, 40.000, 60.000 VND/month/household)	32	7.4%
	Wastewater tariff is divided into 2 parts: fixed price (VND/household/month) + Variable price according volume of water use	66	15.3%
	Wastewater tariff is calculated by uniform rate (plus fixed charge or not fixed charge)	39	9.0%
	Other reasons	8	1.9%
Q33	Which the following way of unit price that you suggest to apply?		
	VND/m^3/person	171	39.7%
	VND/m^3/household	143	33.2%
	Do not want to suggest because we are against any further tariff payment	66	15.3%
	Don't know	51	11.8%

5.4. Summary

Overall, the education levels of the survey sample seem high. Although it may affect the results of the comparison tests, it ensures that the respondents well understood the questionnaire contents to answer. Water spending is around 0.9% of household sample income while electricity is 3.2%. Water pollution was ranked second after traffic issue.

The respondents had highly perceived the impact of human on water pollution, so the proportion of agreement with the principle of `polluter pays` was high (71.4%). However, only 45% of respondents supported the increase in wastewater fee. Providing information of sewerage master plan did not have positive effect respondents` decision on their WTP for the service and the main reasons for unwillingness to pay was low trust in the management mechanism.

CHAPTER 6 WILLINGNESS TO PAY AND DETERMINANTS

6.1 Introduction

In this chapter, the results of CVM study are explained. In Section 2, the `yes` response and protest data are discussed. The Section 3 presents the results modelled single-bounded (SB) and double-bounded dichotomous choice (DBDC). The models in single-bounded dichotomous choice (SBDC) format estimated parametrically with consideration of excluding protest are presented in Section 4. Finally, in Section 5 the results estimated mean WTP by both non-parametric and parametric methods from different models are presented and discussed. The estimated WTP is utilized as input information on tariff level of the wastewater service from demand side with consideration. CVM was opted for eliciting city residents` stated WTP. The elicitation method adopted is dichotomous choice that both models of SB and DBDC were examined. The study examines two issues:

i) The WTP and factors influencing residents WTP in the largest urban area of Vietnam – HCMC based on total sample (n=341). Estimations were analyzed using both the SB and DBDC models to discuss advantages and disadvantages in using the DBDC format.

ii) WTP for the wastewater service based on the sample after excluding 5 households reported that their houses are not connected water network or do not use water supply but groundwater (Model 5, n=426) and 96 protest zero (Model 6, n=330). In this time, only SBDC format was used for WTP estimation.

The logistic regression models (Logit) was used to test the proposed models and identify the relationship between WTP (dependent variable) and a set of selected predictive factors (independent variable) due to the dependent variable (dummy WTP) is dichotomous choice. Some predictor variables used in second issue were different from first issue.

In addition, the study hypothesized that the belief that wastewater will be treated at WWTPs might influence residents' WTP. In order to investigate this impact, a case control study, including inhabitants provided with the information (cases) and inhabitants provided without information (controls), was conducted.

6.2 Treatment of data for protest answers and extreme values

As described in Chapter 4, the contingent valuation elicitation method applied is DBDC format. The respondents were requested to state their WTP for wastewater service. The respondents were asked to answer YES or NO to the randomly offered bid, the follow-up bid was asked depending on the initial response, if respondents say "no" to the initial bid, they were asked a lower bid and the higher bid was asked if respondent said "yes" to the initial bid. The initial bid is called a SB model while DB model includes initial and follow-up bids. For answers were "no" for both bids (no-no), an open-ended question and reasons of unwillingness to pay for the wastewater service were asked to separate the protest responses from true zero responses.

The total of 431 usable survey questionnaires, there were 329 respondents (76.3%) that responded NO to the initial bids. In other word, in SBDC round, 102 respondents (23.7%) gave WTP > 0. In DBDC round, 189 respondents (43.9%) that answered NO-NO for both bids were asked a maximum amount that they are willing to pay for the service. 60 out of 189 respondents agreed to contribute for the wastewater service at their suggested price. At last, the 129 respondents (30%) disagreed to contribute any amount were asked a follow-up question of the reasons shown in Table 6.1. Only the lack of value for the treatment service financing and the inability to afford it were classified as genuine zeros (32 respondents), therefore, reasons 4, 5, 6, and 7 are treated as zero protests (97 respondents).

According to Dziegielewska and Mendelsohn (2007) it should be considered to separate protest responses from genuine responses in order to obtain more reliable WTP results. However, Halstead et al. (1992) and Frey and Pirscher (2019) applied estimates of WTP with and without different types of protest to prove the bias in WTP results may occur when excluding protest or whether the estimation of WTP is more biased by the exclusion or inclusion of protest bids. It is difficult to improve the methods because of: motivations behind protest responses are largely unclear, definitions of protest differ between studies and often only participants who state a zero WTP are asked for their reasons. Exclusion of protest also depends on the content, purpose and the reality of study.

Table 6. 1 Reasons for unwillingness to pay

		%
1	I cannot afford to pay any additional expenditure to what I am now paying.	6.0
2	I think the current fee for wastewater is high	16.9
3	I think the fee of wastewater treatment must be burden by authority/government	9.4
4	I do not trust the administration and allocation of collected fee source	25.9
5	I do not care about quality of water and environment	1.5
6	I do not believe that fee collection will result in improved wastewater service	25.2
7	I do not believe that the improved wastewater service will result in the better water supply quality or flooding reduction	10.2
8	Other reasons	4.9
	Total	**100**

Table 6.1 above gives the reasons that made respondents unwilling to pay. The major reason of unWTP for wastewater service was trust barriers in terms of financial admiration and allocation and improved efficiency, accounting for 51.1% (25.9% and 25.2%) and 10.2% of the negative responses respectively; followed by the claim that the current fee 10% for wastewater is high (17%), wastewater treatment must be burden by government (9.4%). 6% of negative responses were due to income constraints and 4.9% of respondents provided other reasons for their unWTP such as the tariff should be proceeded when the wastewater treatment systems are completed; should focus on collecting fee from businesses; I paid sufficient tax; Accept a fee increase once the state

is committed to bring effectiveness of water management. There were 3 extreme response cases that made up 1.1% of respondents who stated that they do not care about quality of water and environment as their unwilling reason

The inconsistencies in the provided information by respondents were checked at spot, for example water consumption compared to household size, income compared to household size, living expenditure. Some cases were recorded extremely high or low value however those observations were not excluded from the analysis because those are right information after confirm with the respondent and considered as interesting or exception.

6.3 Factors affecting households' WTP decision in different models

In this section, the first interest issue of study is investigated – that is, analyzing WTP and factors affecting people's WTP using both the SB and DBDC models to discuss advantages and disadvantages in using the different format. Logistic regression is a powerful statistical method of modeling a binary outcome (takes the value 0 or 1 like willing or not willing to pay) with one or more explanatory variables. The WTP is estimated by a parametric approach that allows making inferences based on parameter estimates easier than non-parametric approaches, although the non-parametric method is simple to calculate and does not affect by distributional mis-specification.

6.3.1 Predictor variables

The study's predictor variables are referenced selectively from previous relevant studies and own characteristics of the HCMC. Factors that have a link to variations in the level of WTP are generally more or less dependent on the actual situation of availability or deficiency of the service and the severity of problems in the study area. The most significant predictors of WTP are current water usage and sanitation available to households (Whittington et al., 1993), recognized water pollution (Tziakis et al., 2009; Vo, 2010), and a satisfactory level of the current service (Fujita et al., 2005; Nguyen et al., 2012). A further factor is the quality and scope of the wastewater/sewerage services. Residents in Davao, Philippines had less WTP in the case when a more comprehensive sanitation plan was drawn up and shown to them, most likely due to people's distrust of the government (Choe et al., 1996). Another factor was the knowledge related to environment and wastewater projects as well as individual and household characteristics such as income, age, gender, career and education levels as well as location and water payments (Fujita et al., 2005; Genius et al., 2005; Tziakis et al., 2009; Tapvong and Kruavan, 1999; Ngo et al., 2015; Le et al., 2016; Nguyen et al., 2012; and Vo, 2010).

The beneficiaries' WTP for the improved wastewater services is assumed to be a function of their awareness, attitude towards the water environment, tariff levels, and other individual issues as well as socioeconomic variables. Considering the results from the empirical and theoretical literature, the following testable hypotheses are examined:

1. The most crucial factor influencing positively people's WTP is income;
2. Respondent's awareness, concerns, and geographical positioning of housing areas was used to measure the resident's water environment-related quality of life. When assessing sanitation status, it is assumed that people would be willing to pay more if the sanitation status is bad, in order to have better health and living environment conditions;
3. The monthly water payment, household size, and number of children influence residents' WTP;
4. Respondents' WTP depends on the situation or satisfaction levels of the current sewerage services;
5. Age, gender, and marital status significantly affect WTP for improved wastewater services;
6. Educational levels and type of career of the respondents have positive effect on WTP;
7. Prior information about the city's sewerage master plan could have a positive effect on respondents' attitudes towards future wastewater services and, in turn, could influence their WTP.

Table 6.2 presents the summary of descriptive statistics of explanatory variables used in the logistic regression.

The form of the Logit model is as follows:

$$\text{Logit } P = \text{Ln}\,[P/1\text{-}P] = \beta o + \beta 1\text{BID} + \beta 2\text{CANAL} + \beta 3\text{WP} + \beta 410\%\ \text{EPF} + \beta 5\text{AGE} + \beta 6\text{KNOW} + \beta 7\text{GENDER} + \beta 8\text{MARRIAGE} + \beta 9\text{Hhsize} + \beta 10\text{CHILDREN} + \beta 11\text{INFORMATION} + \beta 12\text{INC} + \beta 13\text{EDU} + \beta 14\text{CAREER} + \beta 15\text{HOUSE} + \beta 16\text{SATISFY} + \beta 171\text{st\&2nd CHOICE} \quad (6.1)$$

6.3.2 Model specification

The three different WTP prediction models were used with a logistic regression on the DBDC data to examine which model had the better predictive ability. For Model 1 all original data were used, while for Model 2 samples with two outliers of input data with standardized residuals $-3.3 \geq (\text{ZResid}) \geq 3.3$ were removed to avoid an impact on regression models from those outliers. For Model 3, logarithmic transformation was applied to independent quantitative variables to reduce skewness in the distribution of the data and to improve the predictive ability of the model. Model 4, only SBDC answers were used for analysis after the removal of seven outliers with $-3.3 \geq (\text{ZResid}) \geq 3.3$. This model was compared with Model 2 to discuss advantages and disadvantages in using the DBDC format. The regression models were chosen based on log-likelihood and R^2.

Table 6. 2 Explanatory variables and descriptive statistics

Variable	**Descriptive**	**Mean**	**Standard Deviation**
BID1	SBDC bid		
BID	Follow up bid		
CANAL	1 = respondent's house near canal, 0 = otherwise	0.56	0.497
WP	Water payment in VND/month	151,469	92,550
10% EPF	Respondent opinion on 10% of environmental protection fee for wastewater is currently being paid 0 = low, 1 = reasonable, 2 = high	1.08	0.572
AGE	Age of respondent (year in number)	35.19	8.868
KNOW	1 = know about WWTPs in city, 0 = do not know about WWTPs	0.64	0.479
GENDER	1 = male, 0 = female	0.61	0.487
MARRIAGE	1 = married, 0 = single and divorced/widow	0.72	0.448
Hhsize	Number of people in respondents' household	3.95	1.8
CHILDREN	Number of children in household	0.77	0.8
INFORMATION	1 = with information of WWTPs plan, 0 = without information	0.45	0.497
INCOME	VND/month/household 0 = 12 million or less 1 = 12.1 – 18 million 2 = 18.1 – 24 million 3 = 24.1 – 33 million 4 = More than 33 million	1.92	1.327
EDU	Education level 0 = High school and less 1 = Junior College/University 2 = Master/PhD degree	0.97	0.456
CAREER	0 = No work 1 = Self-employed 2 = Privately employed 3 = Government employed	1.99	0.710
HOUSE	0 = Rented house 1 = Owner 2 = Living with relative	0.88	0.538
SATISFY	Respondents' satisfaction from current wastewater disposal 1 = not at all satisfied 2 = slightly satisfied 3 = satisfied 4 = very satisfied 5 = extremely satisfied	2.67	0.668
1st & 2nd CHOICE	1 = first bid, 2 = second bid	1.5	0.5

6.3.3 Factors influencing WTP for the wastewater service

As can be seen in Table 6.3, regarding estimates of goodness-of-fit R^2 among three models (Model 1, 2 and 3) using DBDC formats, R^2 of Model 2 with two outlier removal is higher than R^2 of Model 1 and Model 3. The significant factors in these models remain the same, apart from the INFORMATION variable. This result indicates that removing outliers is better than using logarithmic transformation for coping with an outlier problem in this case. Consequently, Model 2–DBDC was selected for the following discussion and compared with the results of Model 4–SBDC.

Table 6.3 presents regression results from the single-bounded (Model 4) and double-bounded models (Model 2). As shown in the table, the six predictors in Model 2 make a statistically significant contribution *(BID, 10%EPF, KNOW, MARRIAGE, INFORMATION, and 1st & 2nd CHOICE,)*. The strongest predictor of the WTP response was MARRIAGE which is statistically significant at very near to 1% level, recording an Odds ratio=Exp(B)=1.849. This indicates that respondents who are married are approximately two times more likely to be willing to pay for the wastewater service than those who are single, if controlling for all other factors in the model. It can be seen that almost all married people have moderately good and stable incomes as well as general concerns and responsibility for family health. However, the marriage variable was not significant in study by Nguyen et al., (2012) in a rural area. Other examined remain studies were not considered marriage variable in their study model.

The coefficients of knowledge about existing WWTPs in the city (*KNOW*) and *INFORMATION* were negative, implying that respondents who knew about WWTPs in city and who were provided with prior information regarding WWTP plans would be less inclined to pay. This unexpected result contrasts to findings by Tapvong and Kruavan (1999) that showed respondents who were aware of the project had a higher probability of paying. However, the results of this study are similar to findings by Genius *et al.* (2005) where respondents who knew a lot about the terms of wastewater, WWTPs, and septic tank treatment (not about existing WWTPs) were unwilling to pay. One possible explanation of this is the fact that the associated severe environmental threat had not yet come to the surface. In addition, the counter-intuitive result is similar to that of Choe *et al.* (1996) where there was less WTP in cases where a comprehensive sanitation plan was shown due to people's distrust of the government. The following residents' opinions were recorded from our study: respondents agree that the costs of wastewater collection and treatment should be contributed by the people, provided that (i) the fee must suit "every pocket" (especially low-income households) and the scope of the wastewater services, and (ii) there is transparency regarding the financial management of the tariff source and that people have a right to know about the projects and their related costs. The WWTPs in the city have been operating for decades and news concerning plant operations, new constructions, and investments are often reported on the media. Therefore, the randomly prior provided information for those who know about WWTPs might not show its effect on respondent WTP. In addition, the provided information might cause a negative psychological influence on respondents as they might think that they have to pay more and more amount when the WWTP plans are completed. Another possible explanation is that these respondents might view the water pollution problems less important. Therefore, for these respondents, information regarding the wastewater plan was not as important as contextual factors relating to obvious results of an improved water environment and their

trust in the city's implementation management. The other external influence or environmental effect was the increase in VAT that the government had introduced at a time may have affected respondents' WTP.

Table 6. 3 Estimated model for single and double-bounded models

Variables				
	Model 1	**Model 2**	**Model 3**	**Model 4**
BID/BID1	-.056***	-.061***	-1.732***	-.098***
CANAL	-.225	-.189	-.213	-.268
WP	.000	.000	.020	.000**
10% EPF				
10% EPF (1)	-1.621***	-1.703***	-1.580***	- 2.700***
10% EPF (2)	-2.697***	-2.863***	-2.714***	-4.198***
AGE	-.011	-.016	-.331	-.018
KNOW	-.384**	-.398**	-.401**	-.356
GENDER	.275	.322	.291	-.670*
MARRIAGE	.659***	.615***	.678***	.502
HHSize	-.026	-.036	-.111	-.023
CHILDREN	.070	.122	.069	.464*
INFORMATION	-.289	-.344*	-.286	-.746**
INCOME				
Income(1)	.113	.153	.091	.493
Income(2)	.318	.398	.274	1.046*
Income(3)	.213	.317	.155	.584
Income(4)	.182	.218	.080	.521
EDU				
Edu(1)	-.348	-.430	-.328	-.350
Edu(2)	.092	.086	.085	.663
CAREER				
Career(1)	-.210	-.286	-.242	.655
Career(2)	-.172	-.323	-.112	-.399
Career(3)	.150	.024	.225	-.224
HOUSE				
House(1)	-.189	-.179	-.187	-.891**
House(2)	-.217	-.247	-.261	-.140
SATISFY				
Satisfy(1)	.168	.274	.216	-.462
Satisfy(2)	.275	.433	.322	.132
Satisfy(3)	.502	.699	.548	1.313
Satisfy(4)	-19.413	-19.283	-19.538	-16.504
1^{st} & 2^{nd} choice	.562***	.598***	.538***	
Constant	2.890***	3.296***	7.240***	6.561***
R^2	***28.6%***	***30.8%***	***27.6%***	***51.7%***
% Predicted correct	***75.8%***	***76.2%***	***75.9%***	***86.1%***
-2LL	***875.624***	***850.364***	***883.042***	***275.911***
N	***431***	***429***	***431***	***424***

As described in our hypothesis, the *BID* was negative and significant at the 1% level, which indicates that the higher the bid, the less likely respondents are willing to pay for the service. This result is consistent with most other studies and abides by the economic theory of demand. The respondents' WTP for wastewater service was negatively related to what they think about the current wastewater fee *10% EPF*. The result suggests that the respondents who rate 10%EPF from reasonable to high or too high were less likely to pay an additional fee for the service compared to those who rate it as low. One possible explanation for this is that respondent are not willing to pay as much, as they think they have not seen a much better change of water quality at canals currently as mentioned "I would pay more upon condition that I see the better water environment". Thus, the households' WTP for the service has traditionally been linked to the principle of price versus quality effect. Only one study by of Fujita *et al.* (2005) examined the sanitation tariff variable in their analysis but found it to be insignificance. Other studies were conducted at a time when wastewater fees had not yet been implemented.

Regarding *1st & 2nd CHOICE* variable, the respondents' WTP for the wastewater service was positively related to the 1st & 2nd choice. This means that the choice of the 2nd bid was Exp(B)=1.7 times more likely to receive a "yes "compared to a "yes" for the initial bid. In other words, when the bid decreases, the respondents are more likely to say "yes".

6.3.4 Comparing regression result between single and double-bounded choice answers

When comparing Model 2 with Model 4, the regression results of Model 4–SBDC have a better goodness of fit regarding the adequacy of the model. The predictors which differs between Model 2 and Model 4 are *WP* (water payment), *GENDER*, *CHILDREN*, *INCOME(2)*, and *HOUSE(1)* which are only significant in Model 4, while the *MARRIAGE* and *KNOW* are only significant in Model 2. The results presents that most demographic variables were insignificant in Model 2. This result might be caused by a high correlation among these demographic variables and the 1st and 2nd choice variable. Thus, 1st and 2nd choice is a significant determinant of WTP in Model 2, where the demographic variables did not affect WTP after controlling for the initial questions.

Although follow-up questions in the DB model (Model 2) are expected to increase in statistical efficiency with more observation as the number of responses increase, a key disadvantage of the DB model, as observed by many researchers, is that respondents' answers to the second bid may be influenced by the initial bid and may lead to a difference in WTP estimates. In other words, statistical and behavioral inconsistencies are observed between the first and second response (Bateman et al., 2001, and Habb and McConnell, 2002) indicated that respondent's behaviors are altered after the first question in DB model.

Water payment (*WP)* was found to be a significant (5%) and positive variable in explaining respondents' decision concerning their WTP for the wastewater service. The results are contrary to our hypothesis that the higher the water payment the more unwilling the households would be to pay for the wastewater services, but consistent with findings in a study by Tziakis *et al* (2009) that indicated the larger the consumed amount of water, the more willing people are to pay a percentage contribution fee for wastewater based on the water bill. However, a different point can be explained as follows: holding other variables constant, respondents whose families used large water volumes are

approximately 0.00 times (Odds ratio=.000) more likely to be willing to pay for the wastewater service than those whose families used less water. Although the water payment variable is significant, its effect level on WTP was trivial. In other words, there is not clear difference in WTP between high and low water payment.

Regarding the variable of *GENDER*, our results indicate that men are less likely to pay an additional amount for wastewater services than women. This result contrasts with the findings of previous studies by Palanca-Tan (2015) and Nguyen (2012), but is consistent with the findings of Tziakis *et al*. (2009) that women's WTP is, on average, higher than men's. A possible explanation is that women are willing to pay more for water and sanitation services as they spend most of their time on family-related tasks and are more concerned about unhygienic water sources. Furthermore, due to women's roles in urban families, they may actively decide on expenditure. Households with children (*CHILDREN*) are willing to pay on average higher amounts. Similar results are found in a study by Tziakis *et al.* (2009). This shows families' concern for their children's safety in a future environment; they are willing to contribute to environmental improvement so that their descendants can enjoy a better environment.

However, *GENDER*, *CHILDREN* and *INCOME* variables were not significant in Model 2–DBDC. To explain this a correlation test was carried out with the result that there was no correlation among variables. Another possible way to explain the insignificance of these variables is the fact that the *MARRIAGE* variable was the strongest predictor and had a high influence on WTP in Model 2. The variables gender, children and income are implied in or are represented by marriage variable as almost all married people have children, a moderately stable income, as well as general concerns and responsibility for family health.

The respondents who own a house (*HOUSE*) were less likely to be willing to pay than those who live in rented house. This result differs from our hypothesis as the tenants usually pay for water costs twice or three times more than house owners, depending on the form of house for rent as well as the hosts. There are two possible reasons: firstly, most tenants in this our study sample were single and working, therefore, their consumed water per month is low; secondly, some house owners may be more motivated to pay as explained by one of the respondents "if I own a house I am willing to contribute a higher wastewater fee because I enjoy a right water price". This result is unique to HCMC as it is not in line with results from other studies.

However, only household with an income range of 18.1–24 million VND/month (*INCOME*), that has the strongest predictor with Odds ratio=2.847, showed a positive relationship with WTP for wastewater services compared to the lower and higher income groups. This finding was not completely linked to the 'ability to pay' principle. It can be explained by the fact that high-income households are situated in a better living environment and therefore, do not usually experience water-related pollution. In general, household income was also found to be a significant variable affecting respondent's WTP for wastewater service by Palanca-Tan (2015) but not in findings by Tziakis *et al.* (2009).

6.4 Analysis of protest answers and its influence on WTP

6.4.1 Predictor variables

In this section, the second interest issue of study is investigated – that is, analyzing WTP and factors affecting people's WTP using SBDC models with consideration of including and excluding protests. In addition, the 5 households without connecting water supply or do not know tap water are excluded from the sample to examine the difference of estimation of WTP between two models.

The selection of determinants for WTP is referred to the previously executed research on WTP for improved wastewater projects in developing countries. In this study, the selective determinants were decided so as to consistent with the current context of the implementation of city WWTPs master plan. Moreover, independent variables were check their impacts on the model, variables were not significant in models of first issues were excluded and new variable were considered. The independent variables applied in the regression model are shown in Table 6.4.

$$\text{Logit P} = Ln\,[P/1\text{-}P] = \beta_o + \beta_1\text{BID} + \beta_2\text{CANAL} + \beta_3\text{WP} + \beta_4\text{GEN} + \beta_5\text{MAR} + \beta_6\text{INFO} + \beta_7\text{INC} + \beta_8\text{HOUSE} + \beta_9\text{SERIOUS} + \beta_{10}\text{A-TARIFF} \quad (6.2)$$

6.4.2 Awareness and attitude of respondents contradict willingness

As analysis in the Chapter 5, section 5.3.2, almost all respondents perceived the city serious water pollution issue and they understand that the untreated wastewater discharge from people's activities is the major reason of water pollution in city rivers/canals. Thus, for the attitude towards 'polluter pay' principle, over 70% of sampled respondents agreed with this point of view 'People should pay wastewater tariff for treatment service'. However, only 45.3% of those respondents concurred increase in wastewater tariff (40.4% disagree and 14.6% no feeling) and just 23.9% of 'YES' response for the offered bid levels. Water pollution issue is not a top priority of city`s citizen and their low trust in government that support the argument that households` WTP for wastewater service is not high. Because of this contradictory phenomenon, the protest rejection model is decided to examine WTP.

Table 6. 4 Description of variables applied in the regression model

Metric/ordinal variables					
Variable	**Description**	**Mean**	**S.D.**	**Max**	**Min**
BID	Bid levels (% water bill): 20, 40, 60				
WTP	WTP for wastewater service	7.04	14.16	60	0
WP	Household monthly water bill	158,282	115,094	1,300,000	15,000
INC	Total monthly household income (ordinal) 0 = ≤ 12 millions; 1 = 12.1 - 24 millions 2 = 24.1 – over 33 millions	1.19	1.71	2	0
A-TARIFF	Respondent's awareness of tariff payment for wastewater service (ordinal) 1 = Totally agree; … 5 = Totally disagree	3.65	1.07	5	1
Dummy variables					
Variable	**Description**				**% of respondents**
Pr(WTP)	The probability that a respondent is willing to pay for the wastewater service 1 = stated WTP > 0				23.9
CAN	Location of residence near canal 1 = Yes; 0 = No				
GEN	Gender of respondent 1 = Male; 0 = Female				61.3
MAR	Marital status of respondent 1 = Married; 0 = Otherwise				72.5
HOUSE	Ownership of house 1 = Owner; 2=relative house, 0 = Rented house				69.5
SERIOUS	Respondent's attitude toward the city wastewater/water pollution issue (ordinal) 0 = Not serious; 1 = Serious				65.0
INFO	Sewerage master plan information was provided respondent 1 = Yes; 0 = No				44.8

6.4.3 WTP estimates

The zero responses accounted for really high proportion, 76% of all responses for WTP = 0 in the offered bid levels. The response to the protest zero amounted to 22.5% of the sample (96 protest zero were out of 426 respondents). After a follow-up question, zero responses reduced to 30% of the sample while protest zero made up 75% of the zero response. This study has considered exclusion of protest responses from the data sample, although there are not many studies about protest exclusion in the sector-related CVM

literature as removing protest resulted in an increase in positive WTP responses in the total response from. However, it should think that in this study, those protests are not really unwilling to pay but there are certain reasons inducing them unwilling. If those causes are improved, the ability of WTP will be improved.

Table 6. 5 Result of the logistic regression analysis

Variable	Model 5 – Including protest responses			Model 6 – Excluding protest responses		
	B	S.E	Exp(B)	B	S.E	Exp (B)
BID	-.076***	.010	.927	-.085***	.011	.919
CANAL(1)	-.554**	.279	.575	-.486	.299	.615
WP	.000***	.000	1.000	.000***	.000	1.000
GEN(1)	-.595**	.284	.552	-.491	.306	.612
MAR(1)	.760**	.354	2.138	.597	.374	1.816
INFO(1)	-.915***	.293	.400	-.576**	.314	.562
INC						
INC(1)	.922***	.415	2.515	1.079***	.444	2.943
INC(2)	.742*	.450	2.101	.862**	.476	2.368
HOUSE						
HOUSE(1)	-.512	.380	.599	-.578	.404	.561
HOUSE(2)	.194	.544	1.214	.320	.601	1.376
SERIOUS(1)	.432	.429	1.541	.710	.454	2.035
A-TARIFF	.454***	.150	1.575	.307**	.166	1.360
Constant	.199	.804	1.220	1.033	.878	2.809
-2LL	335.890 (Chi-square 118.591)			288.270 (Chi-square 110.351)		
Correctly predict	77.0 - 82.2%			69.9 - 78.5%		
R^2	0.245 - 0.372			0.287 - 0.407		
N	421 (5ZResid3.0)			326 (4ZResid3.0)		

*, **, *** denotes significance at 10%, 5%, and 1% level respectively

The R^2 reveals that 37% - 40% of variation in the WTP is explained by the explanatory variables included in the two models. The correctly predict number shows that 78 – 82% observations were correctly allocated to predict WTP either ‘yes’ or ‘no’, indicating a good fit to the data.

Table 6.5 presents the analysis results of the logistic regression coefficient, stardard error and odds ratio for each of the predictors. Taking into account all the answers - Model 5, and applying a 0.05 criteria of statistical significance, there were eight determinants *BIB, location house and CANAL, WB, GEN, MAR, INFO, INC(1) and A-TARIFF* had significant influences on the decision to pay the charge of wastewater service. The *BID* was negative and significant at the 1% level, which indicates that the likelihood of saying yes decreases when the bid is increased. This result is consistent with most other studies and abides by the economic theory of demand. There was a significant negative correlation at 5% level between house location and WTP for wastewater service. The odds ratio for *CANAL* indicates that when holding all other variables constant, households living near the canal were 0.6 times less likely to pay for the wastewater service than

those living far from the canals. Most canals in HCMC are polluted and mainly low-income people living along and near the canals, so it could be due to financial constrains. Regarding the variable of *GENDER*, the correlation between gender and WTP was significantly negative at 5% level, reflecting that men were likely to pay less for wastewater services than women. This result both contrasts and is consistent with the findings of previous studies. A possible explanation is that women spend most of their time on family-related tasks and are more concerned about unhygienic water sources. Furthermore, modern women in urban families now are more financial autonomy, then decide on expenditure.

The attitude of respondents to information *(INFO)* of the future WWTPs master plan mentioned in scenario was found to have a significant negative impact on respondent's WTP for wastewater service at 1% level, implying that know of information of sewerage master plan leads respondents to be less inclined to pay. In contrast, there was a positive significant correlation between income *(INC(1))* and WTP at 1% level. Interestingly, the water payment *(WP)* was found to be a significantly positive value (1% level) in explaining residents` decision regarding their WTP for the service. The regression results also indicate that awareness of paying wastewater tariff in accordance with polluter pays principle had a positive influence in explaining WTP (significant at 1% level). In addition, married variable *(MAR)* was statistically significant positive at 5% level, showing that married respondents are more likely to be willing to pay for wastewater service than single people.

The exclusion of protest responses in analysis Model 6 generally increases the absolute values of the obtained coefficients but it does not much affect the significance of the parameters. The exceptions in this analysis are the variables *CANAL, GEN, and MAR* that were not significant. Model 6 proved to be the better model in which about 40% of the variation of amounts that respondents were willing to pay for the wastewater service in HCMC was explained compared to 37% in Model 5. In Model 6, the statistically significant independent variables again include *BID, WB, INFO, INC, and A-TARIFF*.

Variables which are statistically insignificant in all of the cases include house ownership *(HOUSE)* and respondent's attitude toward the city wastewater/water pollution issue *(SERIOUS)*.

Summary, the greatest importance should be attributed to income *(INC)* which has a very positive impact both on the decision to pay as well as on how much money is contributed. Only household with an income range 12.1–24 millions VND per month has the strongest prediction level of the WTP response with Odds ration Exp(B)=2.515 (Model 5) and 2.943 (Model 6). This means that this income group respondents are about 2.5 – 2.9 times more likely to be willing to pay for wastewater service than the low income group (≤ 12 millions) and higher income groups. Moreover, an awareness of 'polluter pays' for wastewater service *(A-TARIFF)* also has a statistically significant positive influence on the decision to pay. However, the signs of coefficients are contrary to what was expected should be pointed out. In this case, master plan information *(INFO)* which has a negative impact in both proposed models.

6.4.4 Attitudes, awareness and WTP

The use of CVM in Vietnam conditions in terms of city scale wastewater sector is rare. If it is used, it refers to the context of planned construction projects in rural areas or in craft villages (Ngo et al., 2015, Le et al., 2016, Nguyen et al., 2012, Phuong et al., 2016) or economic cost of river water pollution (Vo, 2010), or water supply (Pham and Tran, 2005; Hoang, 2018), and sanitation (Van et al., 2013). It has never before been utilised with regard to operated and planned wastewater treatment facilities in large scale. According to our knowledge, this is the first study that investigates city community WTP and determinants influencing their WTP for wastewater service in HCMC in transitional stage. Hence, it is worth mentioning that firstly, there is no reference point for HCMC - Vietnam conditions. Thus, it is difficult to conclude whether the differences between the results obtained in this study and other studies relating to wastewater service or the construction of wastewater treatment/sewerage facilities in developed countries with more developed economies that do not arise from the difference in the level of prosperity, or the citizens' awareness. Even in developing countries, conditions of wastewater facilities and water pollution situation are different. Contributing public projects with private resources is a rather sensitive topic in Vietnam especially in the study sector. This reluctance is expressed by the high percentage of refusals to pay the offerred fee levels (about 76%) and any amount to contribute the sustainable wastewater service in HCMC (about 30% in total sample)

The findings reveals that water payment variable *(WP)* has significantly positive (1%). This is different from our hypothesis that the higher the water payment the more unwilling to pay for the wastewater service, however consistent with findings in a study by Tziakis et al. (2009) that found the household consumed larger amount of water, they are more willing to pay for wastewater. However, there was a specially different point in this predictor, its Odds ratio = 1 meaning that the same probability of WTP occuring between two situations of used-large water volumes and used less water. Although the variable is significant, its effect level on WTP was trivial.

For respondents' awareness and view about environment issues, the survey results showed that wastewater was not a top priority and serious issue as the seriousness of urban water pollution and wastewater issues is ranked after the flood seriousness. In addition, among eight key social issues that need to be given priority to solve, water pollution was ranked second after traffic issue. Furthermore, the regression output in Table 4 shows that *SERIOUS* variable was not statistically significant as its p-value=0.314 (Model 5) and 0.118 (Model 6) > Sig. 0.05. It indicates that there is no correlation between serious and WTP variable, on the other hand, there is no association between the changes in respondent's attitude toward the wastewater issue and the shifts in the WTP. However, it had a positive influence on WTP, explaining that those who see wastewater issue is from serious level or more, they are more willing to pay for the treatment service 1.5 – 2 times compared to those stated the problem of water pollution is not serious.

The statistic results show that over 71% of respondents agreed and totally agreed that they should pay for wastewater treatment service and the regression results also indicate that *A-TARIFF* variable had a positive influence in explaining WTP (significant at 1% level), meaning that the probability of WTP rises when respondent's awareness of paying wastewater tariff in accordance with polluter pays principle expressed by the level of

agreement increase by 1 (e.g. from agree to total agree, neutral to agree…), and the predicted odds of WTP changes by a factor of 1.5 times. However, the percentage of respondents accepting a fee increase is lower. It show that people have right perception of polluter pays principle and perceived water pollution situation, but an individual`s negative social attitude and other perceptions that influenced people trust in wastewater service quality affected much on their WTP decision making.

An unexpected result contrasts to findings by Tapvong and Kruavan (1999) that the project information provision had a significantly positive influence on WTP probability. One possible explanation of this finding is that wastewater management through nearly completed wastewater treatment system has been performed effectively and was trusted. Nevertheless, this counter-intuitive result is similar to that of Choe et al. (1996) there was less WTP in cases a comprehensive sanitation plan was shown as their distrust in government. Recorded from our survey is that most of respondents agree with the polluter pays principle which the costs of wastewater treatment should be borne by who discharge wastewater, provided that an affordable fee, transparent revenue management. However, the information regarding the wastewater master plan had a negative impact in explaining WTP especially for respondents who see the information was not as important as contextual factors relating to obvious results of an improved water environment and their trust in the government.

Negative social attitudes as well as trust and faith reflect the reasons for refusal. Most of the WTP = 0 answers are protest responses. 96 of the 128 people who were not willing to bear the any cost for the city wastewater service made such a decision mainly due to their belief that they contribute sufficently to public finances by paying taxes and other financial obligations towards the State and do not trust the administration and allocation of collected fee source. The percentage of protest responses can be considered as high, however, it is difficult to assert whether it is significant compared to other studies based on CVM at the similar context. For instance, in literature on this topic, smaller levels of protest responses was pointed out 4.5%, 3.8% and 9.8% in studies respectively of Tapvong and Kruavan (1999) in the context that a large number of centralized WWTPs is in operation, Tziskis et al. (2009) and Genius et al. (2005) that elicit people WTP for the provision of WWTPs in rural and coastal tourist area.

The second issue concerns the itself sewerage sector. Up to study time, there are only 2 operated WWTPs out of total 12 plants according to the Sewerage Master Plan approved in 2001. The resource for infrastructural construction far exceeded the preparation of city, the master plan could not be in planned time. Moreover, the demand for wastewater improvement is silent compared with fields of transport, flooding in terms of both residents` assessment and city budget allocation. Therefore, the respondents, being aware of the stagnacy of implementation and used to `live with floods`, have required that ‘I will pay for the service when I see the improvement in wastewater management or a better water enviornment’ (cited from the answers in survey), in other word they may not have enough motivation to pay for now.

A reverse circumstance could also be considered. The inhabitants have assumed that ‘the state enforces, it forces to accept’, ‘how people are I will be like that’. Such an opinion or approach would have resulted in a decision to allocate a specific amount for an improved service despite a general may dislike for the fee.

These are the main reasons for the possible differences between the case of HCMC wastewater service and other cases reviewed in literature regarding the infuence of various determinants on WTP. It is crucial, however, that among the analyzed variables, the most important one to have a positive influence on the decision to pay the fee for the wastewater service, was level of income *(INC)*. This result is fully in line with the trend occurring in most reviewed cases. Furthermore, evidence from analysis results reveals that factor of trust in authorities significant impact the decision of WTP. It can be seen that the relations of realistic, psychological elements and even prejudice have influences on or intervene in people WTP decision making. Survey results also show what motivates people` WTP. Trust helps people make the 'leap of faith' into action such that one can be willing to pay or can pay even high amount without hesitation. Evaluating environmental goods or service is affected by attitudes. People may have some feelings when they face whatever question. For example, when asked `WTP for a environmental service`, strong feelings can overshadow the details of environmental seriouness in questions.

In terms of mean WTP, the limitation of the study is that estimated WTP between parametric and non-parametric is quite different. It shows determinants that study selected to examine influenced significantly WTP. The parametric mean WTP is likely to have been overestimated may also due to the number of bids offered is small. Nevertheless, despite the limitations caused by the present survey design, study findings may help understanding what influence and motivate residents` WTP by assisting city authority to formulate better policies for sustainable wastewater treatment service and management.

6.5 Mean WTP

6.5.1 Non-parametric mean WTP

The parametric method to calculate WTP requires a distributional assumption, therefore once the distribution is misspecified, WTP estimates may be inconsistent. To avoid this potential limitation, a distribution free lower-bound mean estimate is recommended by Turnbull (1976). Another non-parametric approach which produces a higher WTP estimate is proposed by Kriström (1990).

The frequency of each bid is presented in Table 6.6.

Table 6. 6 Number of yes response

Bid	Yes response	%
WTP = 0	591	68.6
15	37	4.3
20	127	14.7
40	87	10.1
60	19	2.2
80	1	0.1

The cumulative number and proportion of 'Yes' response (P_i) are calculated for each bid (B_i) (see Table 6.7).

Table 6. 7 Proportion of YES response

N = 862				
i	BID (B_i)	Cumulative number of YES response	Proportion of YES response (P_i)	Cumulative probability $\mu_i = P(WTP \leq B_i) = 1\text{-}P_i$
1	15	271	31.44%	68.6%
2	20	234	27.15%	72.9%
3	40	107	12.41%	87.6%
4	60	20	2.32%	97.7%
5	80	1	0.12%	100%

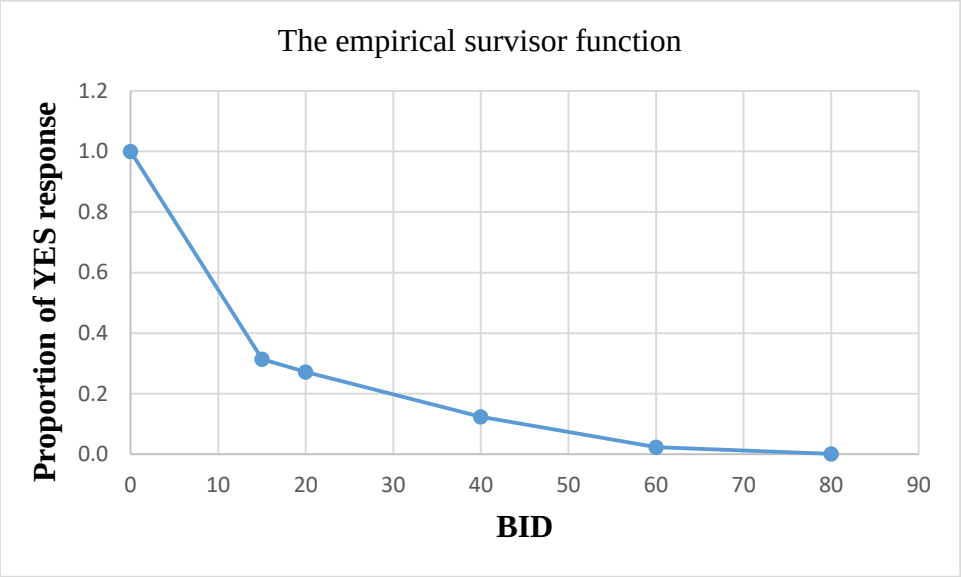


Figure 6. 1 The empirical survivor function

As can be seen from the Table 6.7 and Figure 6.1, the percentage of respondents who responsed a minimum WTP of B_i, decrease with B_i. As WTP amount at the cumulative prbability μ_i = 50%, the median lies between bids 15% and 20%. The median WTP could be approximated as 17.5% by using linear interpolation:

Median WTP = 15 + (50% - 31.44%) x (20 - 15) / (27.15% - 68.6%) = 17.5% (6.3)

6.5.1.1 Mean – Turnbull

This estimator provides a lower bound estimate of an average WTP for the sample data. Since using the lower bound of each interval, Turnbull is a conservative estimation and is calculated as:

$$Mean_{Lower\ bound} = P_1 B_1 + \sum_{i=2}^{n} P_i \left(B_i - B_{i-1}\right) \quad (6.4)$$

The variance of the Mean:

$$Var(Mean) = \sum_{i=1}^{n} \frac{P_i\,(1-P_i)(B_i-B_{i-1})^2}{N} \quad (6.5)$$

In which: N is the sample size.

Table 6.8 shows the calculation of

$Mean_{Lower\ bound}$ = 9.04%

Var ($Mean_{Lower\ bound}$) = 0.12%

Standard deviation ($Mean_{Lower\ bound}$) = $(0.12)^{1/2}$

Table 6. 8 Calculation of $Mean_{Lower\ bound}$ and Variation of Mean

N = 862					$Mean_{Lower\ bound}$	$Var_{Lower\ bound}$
i	BID (B_i) %	Cumulative number of YES response	YES (P_i)	NO (1-P_i)	P_i *(B_i-B_{i-1})	(P_i*(1-P_i)*(B_i-B_{i-1})^2)/N
0	0		100%	0.0%		
1	15	271	31.44%	68.4%	4.72	0.056
2	20	234	27.15%	72.7%	1.36	0.006
3	40	107	12.41%	87.5%	2.48	0.050
4	60	20	2.32%	97.6%	0.46	0.011
5	80	1	0.12%	100%	0.02	0.001
		Total			**9.04**	**0.12**

6.5.1.2 Kriström Mean

The Mean WTP in accordance with Kriström is approximated as the area under the survisor function. The area under the survivor function as a sum of trapezoids that calculated by the following formula:

Mean $WTP_{Kriström}$ =

$$= Mean_{Lowerbound} + \frac{1}{2}B_0(1-P_0) + \sum_{i=1}^{n}\frac{1}{2}\lfloor P_i - P_{i-1}\rfloor(B_i - B_{i-1}) + \frac{1}{2}P_k(B^* - B_k)$$

=9.04+0+(15-0)*|31.44%-100%|/2+(20-15)*|27.15%-31.44%|/2+…+(80-60)*|0.12%-2.32%|/2 = 17% (6.6)

This approximation formula assumes that survivor function is linear within each interval with lower limit B_{low} and upper limit B_{upper}. Thus, in expected WTP calculation, the weight putting on the interval is equal to the average of P_{low} and P_{upper} (P_{low} and P_{upper} are the percentage of respondents who reported a minimum WTP of B_{low} and B_{upper} respectively). Consequently, at the same bid interval, the weights used to calculate Mean WTP by Kriström method are higher than the weights used in the Turnbull method.

$MeanWTP_{Kriström}$ = 17% > $MeanWTP_{Turnbull}$ = 9.04%

6.5.1.3 Upper bound Mean

Using a similar procedure of the Turnbull lower bound as above calculated, a $Mean_{Upperbound}$ can be calculated based on formular suggested in Vaughan and Rodriguez (2001).

$$Mean_{Upperbound} = \sum_{i=1}^{n} P_i \, (B_{i+1} - B_i) \quad (6.7)$$

$Mean_{Upperbound}$ = (15-0) *100% + (20-15) *31.44% +…+ (80-60) *2.32%

≈ 25%

Briefly, as expected from the shape of the survivor function, the different mean estimates:

$Mean_{Lowerbound} < Mean_{Kriström} < Mean_{Upperbound}$

However, not as expected, median was higher than $Mean_{Lowerbound}$ and equal to $Mean_{Kriström}$. This was due to a large number of respondents' WTP were concentrated at level 20%.

6.5.2. Parametric Mean WTP

WTP estimated econometrically from the results that was proceeded by using the binary logistic regression command. In this case we examine the case of SBDC sample, no explanatory variables were included and the original typical syntax of logistic regression is presented below as an example of exported results after running models.

```
LOGISTIC REGRESSION VARIABLES WTP
  /METHOD=ENTER BID
  /SAVE=SRESID ZRESID
  /CASEWISE OUTLIER(2)
  /PRINT=GOODFIT CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	416.050[a]	.117	.175

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.034	1	.853

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	BID	-.056	.009	43.684	1	.000	.945	.929	.961
	Constant	.847	.299	8.044	1	.005	2.333		

a. Variable(s) entered on step 1: BID.

To calculate mean and median WTP for SBDC format, using the Equation 3.4 and 3.5 respectively (In Chapter 3). The formula is simply:

$$\text{Mean WTP} = \ln[1+\exp(\beta_0)]/|\beta_1| = \ln[1+2.333]/0.056 = 21.5\%$$

$$MedianWTP = -\frac{\beta_0}{\beta_1} = -\frac{0.847}{-0.056} = 15.13\%$$

When no control variables are included in the estimation, the mean WTP is about 21.5% water bill. Now we examine the mean when outliers ($-3.0 \leq ZResid \leq 3.0$) in the model are excluded:

```
USE ALL.
COMPUTE filter_$=(ZRE_2 = 3.0 & ZRE_2 >=  - 3.0).
VARIABLE LABELS filter_$ 'ZRE_2 = 3.0 & ZRE_2 >=  - 3.0 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
LOGISTIC REGRESSION VARIABLES WTP
  /METHOD=ENTER BID
  /PRINT=GOODFIT CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	356.082[a]	.182	.279

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	BID	-.082	.011	57.849	1	.000	.921	.902	.941
	Constant	1.472	.335	19.282	1	.000	4.359		

a. Variable(s) entered on step 1: BID.

Mean WTP = $\ln[1+\exp(\beta_0)]/|\beta_1| = \ln[1+4.359]/0.082 = 20.5\%$

Median WTP = -(1.472/(-0.082)) = 18%

Similarly, average WTP in the case of no protest is ln[1+exp(1.586)]/(-0.066)) = 26.8% and no outlier is ln[1+exp(2.317)]/(-0.094) = 25.6%

As can be seen, when excluding outliers, the R^2 increases and mean also increase, but not the case of no protest, the mean is the same even removing ten outliers, it is because a large number of protests have been excluded and the outliers' effect is not strong.

Now, examine mean WTP when all the variables included in the models (see Table 6.3 and 6.5). Expanding Equation (6.1) and (6.2), we have:

Issue 1:

$$- (\beta o + \beta 2CANAL + \beta 3WP + \beta 410\%\ EPF + \beta 5AGE + \beta 6KNOW + \beta 7GENDER + \beta 8MARRIAGE + \beta 9Hhsize + \beta 10CHILDREN + \beta 11INFORMATION + \beta 12INC + \beta 13EDU + \beta 14CAREER + \beta 15HOUSE + \beta 16SATISFY + \beta 171st\&2nd\ CHOICE\ (\text{only in DBDC})) / [\beta 1BID] \quad (6.8)$$

Issue 2:

$$- (\beta_o + \beta_2 CANAL + \beta_3 WP + \beta_4 GEN + \beta_5 MAR + \beta_6 INFO + \beta_7 INC + \beta_8 HOUSE + \beta_9 SERIOUS + \beta_{10} A\text{-}TARIFF) / [\beta_{1BID}] \quad (6.9)$$

The results obtained from both parametric and non-parametric method applied in this study are summarized in the Table 6.9.

It can be seen that WTP changes quite much when including control variables evaluated at their mean values. The mean values are higher in DBDC models than in SBDC in all cases and at the same elicitation model but mean value is high once protest exclude. Responses regarding WTP are not high, suggesting 0.15 – 0.25% monthly expense in case mean WTP of 15 – 25% water tariff is estimated without consideration of factor variables and 0.3 – 0.4% of water tariff with consideration of factor variables.

Household affordability is assumed subsequently according to the results of survey. About 0.9 – 1% of the monthly expense is spent for water bill (see Table 5.2), hence the environmental fee for wastewater is deemed at 0.1% of the monthly expenses as wastewater tariff is collected at 10% of water tariff. The World Bank (WB) has set a benchmark of affordability to pay (APT) is at 4% for water service and at 1% for public sanitation service of household's consumable income. In line with this, in order to satisfy World Bank's benchmark, an additional amount of 0.9% of monthly expense should be allocated to wastewater tariff. In the survey, some of respondents expressed high WTP at 60 – 80% of water tariff equivalent to 0.6 – 0.8% of monthly expenses.

Table 6. 9 The results obtained from both parametric and non-parametric method applied

		Mean WTP (%water bill/month) in 2017 price
Non-parametric		
Turnbull $_{\text{Lower bound}}$		9.04
Kriström		17
Upper bound		25
Parametric		
SBDC Model		
Including Protest	Bid	21.5
	Variables	30.60
Excluding protest	Bid	26.8
	Variables	40.37
DBDC Model		
Model 4 $_{\text{SBDC}}$	Bid	14.25
	Variables	43.70
Model 2 $_{\text{DBDC}}$	Bid	15.30
	Variables	49.66

However, from the survey results, average water expense is about 1% of average household income/monthly expenses that equal 1/4% under WB's benchmark. As a result, the ratio 4:1 of WB could be 1:0.25 in this actual case.

6.6 Summary

The study applied CVM to evaluate the WTP for wastewater service in HCMC and to examine the determinants influencing WTP in the context of transitional stage. In this chapter, we show how the CVM data was handle and results of significant determinants influencing the WTP as well as mean WTP calculated in different models. The study produced several results using different models. Selected models were shown the better fit according to R^2 or Chi-square.

The estimations of mean WTP are calculated based on the distribution described by the logit (logistical) or probit (cumulative normal equations) formulas. To overcome the constraint of a given distribution (Kristrom, 1990; Turnbull, 1976), non-parametric methods have also been developed to calculate mean WTP, however, these techniques can lead to inconsistent results depending on bid amount and sample size (Kelly et al., 2001). Moreover, these methods do not include other elements as socio-economic characteristics. Each method has its own advantages and disadvantages; it needs to caution when interpreting results. To date, there is no single method that can accurately calculate WTP from dichotomous choice questions.

The results also show the differences between the WTP in different issues. For SBDC, the parametric WTP in all sample (43%) is higher than the WTP in sample excluding protest (40). It seems weird, this might indicate that different selected explanatory

variables might affect the result of analysis as every independent variable has its own weight effect on dependent variable.

For factors affecting WTP for wastewater service in HCMC, apart from the global factors such as price level, income level, service knowledge and satisfaction, the study indicated the factor of scope of change in the wastewater services in addition to offering financial information related to projects and services that have a considerable effect on WTP. The majority of respondents expressed that people should pay taxes/tariff for wastewater treatment services as a source of revenue for the city to improve and prevent water pollution effectively. However, the proportion of WTP was smaller due to some determined factors. A key factor noted during our survey is residents' confidence in their government. In order to gain public support for an additional wastewater fee, it is crucial to make that project- and finance-related information available and to explain that the charges are essential for an effective improvement of water quality.

Many studies have explored the positive effects that certain important variables, such as education level, career, and age have positive effects on WTP. However, respondents with a high education had a lower WTP, although this relationship is not statistically significant. This may be due to the fact that they are usually young and therefore, have less experience concerning the high water quality in the past and the extremely bad current situation of water pollution, as the city already has some treatment plants.

Chapter 7 FINANCING STRATEGY OF THE URBAN WASTEWATER SECTOR IN HCMC

Based on the current status of water supply and sewerage of HCMC, the situation of financing for wastewater treatment services in HCMC and the sewerage infrastructure development target in according to planning water supply and sewerage systems in HCMC to study the requirements and expenditure necessary to achieve infrastructure development targets. Finally, the financial strategies are considered and proposed to achieve targets of wastewater infrastructure development in accordance to Master Plan.

7.1. Provision and financial situation of wastewater services in HCMC

7.1.1. Status of water supply and sewerage system of HCMC

7.1.1.1. Water supply

Current water supply capacity is about 2,422,480 m^3/day. Rate of population is supplied water is 100% (2,025,996 subscribers) (DOT, 2018), including: households, production units, administrative agencies, and business/service units.

7.1.1.2. Drainage and sewerage

Currently, there are three WWTPs in operation with total capacity of 171,500 m^3/day. The treatment capacity is still very low (current treatment rate is 8,85%). Therefore, about over 90% of all urban effluents are discharged into the canals and rivers without treatment. Urban water supply (hence wastewater generation) has increased far more quickly than wastewater treatment capacity. Recognizing the problem, in the General planning of HCMC construction to 2025, the City People's Council has established the target constructing remaining domestic WWTPs with a total treatment capacity of 1,110 million m^3/day (in 2020) and 3,076 million m^3/day (in 2030), and by 2025 approximately 100% of the wastewater would be treated. However, to ensure planned implementation, finance is a key issue that should be considered.

7.1.2. Finance of wastewater collection and treatment services in HCMC

EPF for wastewater at 10% of the water tariff for all customers is in place from January 1, 2004 at the Decree No. 67/2003/ND-CP dated June, 2003. Currently, regulations on EPF on wastewater comply with Decree No. 154/2016/ND-CP November 16th, 2016 of Government. The regulation on EPF for wastewater has raised the awareness of organizations and individuals on environmental protection; forcing polluters to pay for improving environment from the pollution of wastewater.

Statistically, the amount of collected fees in 2016 was 1,287 billion VND, 2017 was 2,102 billion VND, strengthening the budget used for the reduction of environmental pollution in the locality. However, this revenue only partially satisfies the environmental protection requirements from wastewater (prevention, restriction and controlling of environmental pollution, technological solutions and solutions for wastewater treatment), but there is no source to treat domestic wastewater before being discharged into the environment. The

low level of EPF is not enough to cover the cost of construction, and maintenance of the drainage system.

In fact, Decree No. 154/2016/ND-CP stipulates a higher 10% environment protection fee can be applied depending on local condition. However, there are few localities that set higher fees, HCMC currently applies 10% of water tariff.

The investment costs for construction and maintenance of drainage and wastewater treatment systems are huge. Hence, in addition to regulations on environmental protection fees for wastewater, localities can collect drainage service and water treatment fees from investing sewerage and wastewater treatment systems under Decree No. 80/2014 / ND-CP of the Government (higher than EPF). Decree No. 80/2014 / ND-CP released on August 6th, 2014 is about Drainage and wastewater treatment, regulating the general principles of water drainage and wastewater treatment: "Polluters have to pay for the treatment pollution; revenue from sewerage and wastewater treatment services must gradually meet and compensate for drainage service costs".

Currently, HCMC Party Committee is directing the City People's Committee to assign Departments to do study to propose the collection of drainage service fees in accordance with Decree No. 80/2014/ND-CP, and in line with the actual situation in HCMC to ensure the funding for investment and sustainable development in drainage and wastewater treatment.

7.2. Infrastructure development targets and baseline supply of finance

7.2.1. Infrastructure development targets

Targets for the development of wastewater collection and treatment infrastructure have been determined by orientation of water supply and sewerage planning in HCMC on the basis of the official policy documents. These targets are summarized as follows:

7.2.1.1. Water supply

The Decision No. 729/QĐ-TTg 19/6/2012 of Prime Minister on approval of the water supply planning of HCMC to 2025 has defined that 100% of population using clean water, rate of water loss reducing from 32% (in 2015) to 25% (in 2025). Water supply statistics over the years and future allocation plans according to planning are shown in Table 7.1.

Table 7. 1 Water supply planning

Year	Water supply capacity (m^3/day)
2018	2.422.480
Forecast for 2019	2.580.000
Forecast for 2020	2.750.000
Forecast for 2025	3.700.000

Source: Vietnam Government document[3]

[3] *Decision No. 729/QĐ-TTg on HCMC water supply planning*

Regulations on the standard water supply demand and norm for the special urban like HCMC are as follows:

- Regulations in QCVN 01:2018/BXD - National technical regulation on construction planning issued by the Ministry of Construction in Decision No. 04/2008/QD-BXD on April 3, 2008, the standard water supply demand for HCMC, a special urban, is 200 liters/person/day (equivalent to 200 liters * 30/1000 = 6m^3/person/month).

- Decision No. 24/QD-TTg in 2010 on approval of adjusting general planning of HCMC construction to 2025, the norm of water supply is 200 liters/person/day (equivalent to 200 liters * 30/1000 = 6m^3/person/month).

7.2.1.2. Drainage and sewerage:

Decision No. 24/QĐ-TTg in 2010 on Approval of adjusting general planning of HCMC construction to 2025 has determined: Construction and development of the sewerage system with a total length 6,000km of sewer within 581km^2; Construction of 11 urban domestic WWTPs with a total treatment capacity of: 1,110 million m^3/day (2020) and 3,076 million m^3/day (2030); Construction of 129km of right bank dike, 20km of left bank in Saigon River; and 9 tidal control sluices. In which, WWTPs will be invested according to planning as shown in Table 7.2

Table 7. 2 Treatment capacity of WWTPs

Year	Treatment capacity (m^3/day)
2018	171.500
2019	185.200
Forecast for 2020	993.200
Forecast for 2025	2.926.200

Source: Vietnam Government document[4]

7.2.2. Expenditure necessary to achieve infrastructure development targets

In order to achieve mentioned-above wastewater infrastructure development targets, the necessary cost of construction and O/M of WWTPs are estimated as follows (Table 7.3):

Table 7. 3 Costs need to be recovered over years under planning

Unit: Billions VND

	Contents	Year 2018	Year 2019	Year 2020	Year 2025
1	Construction costs	2,331	2,331	11,922	28,195
2	O/M cost	197	226	586	2,188
3	Interest	46	46	206	218

[4] *WWTPs are invested under Decision No. 24 / QD-TTg dated 06/01/2010 of the Prime Minister on approval of adjusting general planning of Ho Chi Minh City Construction to 2025*

Construction cost is estimated based on Decision No. 24/QD-TTg, the project file, and the investment capital rate announced by the Ministry of Construction in Decision No. 451/QD-BXD dated Apr 21, 2015.

The O/M cost of domestic wastewater treatment is based on Decision No. 451/QD-BXD dated April 21, 2015 of the Ministry of Construction. In which:

- The level of cost of domestic wastewater treatment (hereinafter referred to as the O/M cost level) is the estimated expense for treating $1m^3$ of wastewater in order to recover the costs related to process of operating wastewater treatment facilities with a reasonable profit.

- The level of O/M cost is calculated in the conditions of normal operation, the treated wastewater quality meets the selected technology requirements and meets the standard B according to QCVN 14: 2008/BTNMT - National technical regulation on domestic wastewater.

- The level of O/M cost is determined on the basis of calculating the costs related to the operation of the WWTP. The cost of treatment for 1 m^3 wastewater includes direct costs, general costs, norm profits and VAT but does not include fixed asset depreciation costs.

The loan interest from ODA capital: 2%/year (refer to loan agreements).

7.2.3. Baseline supply of finance

Under Vietnamese law, sewerage systems and WWTPs are considered public works and are invested and construct by Government. O/M cost of the sewage utilities also rely mainly on Government funding as the current revenue is not enough for O/M expenses and capital for investment. Therefore, in addition to Government budget, funds and loans from foreign governments, international financial institutions are also being used increasingly. HCMC has also policies to attract private capital and foreign capital to mobilize financing of construction of the sewerage systems and WWTPs.

In the future, when Vietnam is assessed as a middle-income country, the official development assistance (ODA) flow to Vietnam is expected to decrease. At the same time, with the increasing public debt, Vietnam in general and HCMC in particular have established a variety of policies to provide incentives for international and domestic businesses to invest in the wastewater sector in order to divert investment in WWTPs with private capital. Some cases of private investors and international financial institutions are investing in WWTPs in HCMC as follows:

- Lotte E&C - Huvis Water - Honor Shine Global Joint venture has proposed to invest in sewer systems and WWTPs for three basins of Tan Hoa - Lo Gom, Tay Sai Gon and Binh Tan.

- Using capital of the WB to invest in building a WWTP for Nhieu Loc-Thi Nghe river basin.

- Upgrade the capacity of Binh Hung WWTP by the capital of Japan International Cooperation Agency (JICA).

- Phu Dien Company (Vietnam) bidding to operate Tham Luong-Ben Cat WWTP.

- Trung Nam Company (Vietnam) proposes to invest in North Saigon 1 WWTP; City Land Company (Vietnam) proposes to invest in North Saigon 2 plant.

In most developed countries, the costs of investment, O/M, and interest of WWTPs were funded by the government. However, after that, the costs of O/M and interest have been used from wastewater fee. Finally, the current revenue from wastewater charges can ensure the costs of investment, O/M, and interest.

Vietnamese government has recognized the importance of collecting domestic wastewater charges and has established legal bases for applications. The legal basis for domestic wastewater charges is laid down by 2014 about revision of the Law on Environmental Protection. In order to apply these legal bases into practice, a variety of policy guidelines have been gone through such as: The Decree No. 154/2016/ND-CP on environmental protection fee for wastewater; the Decree No. 80/2014/ND-CP on the water drainage and wastewater treatment. At the same time, the orientation of increase in wastewater charges has been given to cover all investment, O/M costs. Whereby localities are allowed to increase fees in proportion to local circumstances.

Therefore, the financial sources for investment, O/M, and loan interest for wastewater treatment infrastructure according to the development plan of HCMC from 2020-2025 are from the following main sources and financial instruments.

- Domestic wastewater fees (from households; production units; administrative agencies, unions; business and service units and other consumers);
- State budgets;
- Grants, non-refundable aids; and
- Loans from foreign countries, non-governmental organizations;

7.3. Financial strategies to achieve development targets of wastewater infrastructure in accordance to Master Plan

From the above analysis of the financial situation and sources funding for investment, O/M, and interest, some comments can be drawn. If the current trend continues, the domestic wastewater charge is able only enough to cover the O/M costs of WWTPs. All domestic financial resources are only enough to cover the O/M costs of wastewater collection and treatment systems, lack of capital for investing new treatment systems according to planning is inevitable. Therefore, city must continue to use a large amount of financial loans from foreign countries and international financial institutions for investment in the planning WWTPs, this can lead to unsustainable development. Hence, prerequisites for long-term sustainability is to consider increasing domestic wastewater charges within the affordability limits.

In fact, the below-cost of wastewater fee and over-subsidized from state budget have increased the scarcity of capital and budget. HCMC has comparatively low fee and tariff for wastewater-related services and thus creates low revenue across the wastewater sector. These revenues are much lower than the costs of investment and O/M of wastewater systems; lower than the price charged in comparable countries; and lower than the consumers` WTP (for good or better service levels). Therefore, a challenge is to seek a strategy to increase wastewater revenue to cover for investments, O/M and loan interest for sewage system in transitional phase.

The general policy of the HCMC People's Committee attaches great importance to attract foreign finance to investment in sewage infrastructure system. However, HCMC People's Committee and local experts have also pointed out some obstacles of using foreign finance such as the technology, equipment procurement, etc. will be bound by sponsors. This also creates dependence of the operation process (operating costs, parts, chemicals, etc.). Interest expenses and profit margins expected by foreign investors are often too high. Therefore, in addition to some bilateral cooperation programs in the wastewater sector in HCMC, such as loans from Japan (JICA) and the WB, HCMC People's Committee also want to balance the budget to invest in WWTPs (one of which is from the wastewater fee).

The Vietnamese law allows local authorities to raise domestic wastewater fees, however when researching to apply them in practice, local authority considerations often prevent the timely application of fee adjustments. Through research and WTP surveys, it has been shown that consumers are willing to pay if services are improved. According to survey data, the current water bill on average is about 1.1% (UN environment *et al.*, 2018) of urban household income. This thesis`s survey results also show the similar findings: people stated that they are willing to pay for wastewater services if they see the improvement of water environmental quality and average household water bill is about 1% of average monthly household income. Although not high, there is a room for increasing the tariff level for financing a portion of cost recovery. In order to collect fee adequately from people, HCMC authority should consider factor affecting people` WTP in which people satisfaction is one of the key factors.

There are many forms of pricing and tariff structures for domestic wastewater being applied in the world. The two-part tariff structure is suitable for the actual conditions of HCMC as well as in accordance with the current calculation of domestic water tariff. Then, the fee is based on the actual water consumption to influence the behavior, perceptions of users and the average monthly fee (not based on the actual water consumption) to meet a specific revenue target. In principle, the two-part tariff framework can be adjusted to achieve two specific targets simultaneously.

It should be noted that for all scenarios and calculating methods, total domestic water and wastewater charge must be compared with household disposable income. In particular, it is necessary to ensure that not a single household pays too much compared to the available income for domestic water and wastewater.

7.4. Summary

On the above analysis, one of the financial strategies to achieve development targets of wastewater infrastructure in accordance to Master Plan is wastewater tariff with the following consideration:

- Domestic wastewater fee rates for all users will gradually increase to meet the strategy, target and investment roadmap or scope of service change with consideration of affordability;

- Revenues from wastewater fees will grow in proportion to the growth of the economic and population, and will additionally grow due to the growth of per average monthly water consumption;

CHAPTER 8 WASTEWATER TARIFF STRUCTURE AND TARIFF LEVELS

8.1 Introduction

In Vietnam, the current regulation for sewerage services does not ensure the necessary level of sustainability of wastewater treatment services. One of the main issues that wastewater sector faces is inadequate tariff. Cost recovery is partly defined by the tariff rate, and according to theory a sufficient rise in prices may recover any level of costs. Legislative framework for tariff setting for wastewater service has not established in Vietnam as wastewater sector has just been focused recently especially in the large cities as HCMC. Hence, it is essential to develop a tariff setting methodology for wastewater service in HCMC especially in transitional phase. Different phases might have different methodologies of tariff setting.

This study attempted to collect basic data in order to examine amount to be paid by beneficiaries for the services (i.e. tariff levels), through estimating Affordability-to-Pay (ATP) of beneficiaries based on household's income and expenditures, and Willingness-to-Pay (WTP) of beneficiaries. The results of the study would enable appropriate wastewater service pricing options to be suggested with reference to the estimated WTP for wastewater services.

The methodology that defines tariff level and tariff structure in order to able to ensure cost recovery for O/M, interest and investment under a proposed tariff-setting procedures is suitable to HCMC context. The methodology also includes detail instructions for tariff roadmap that containing the key performance indicators and calculating instruction. Key performance indicators in periods are estimated based on data of the entire planning period.

International tariff-setting principles applied in this study and suitable to local conditions and situations are:

- Affordability, which defined the highest possible price level that average households can pay from their income as well as the average expense per person.

- Environmental efficiency, which is to some extent already in use through application of the defined water fees as in this case wastewater fee is set up based on percentage of water fee. Moreover, this already apply through application of EPF for wastewater. Therefore, a model of two-part tariff should be proposed in HCMC case.

- Cost recovery, which is a very crucial principle, it requires a full understanding of all costs pertaining to wastewater treatment services for full cost recovery purpose. However, in transitional phase it is infeasible to think about full cost recovery and that is not to mention the words of developing country.

- Fairness, which can be improved through cost allocation, type of structure and pricing for low income people.

This chapter consists of 2 main parts. Frist, an appropriate tariff structure and price levels are proposed based on tariff setting framework for wastewater in transitional phase. The results of CVM study would enable appropriate wastewater service pricing options to be suggested with reference to the estimated WTP. Second, 4 scenarios of cost recovery are designed and many different tariff levels are allocated suitably to 4 groups of customers to consider a tariff roadmap suitable for transitional phase of HCMC wastewater service. The roadmap is calculated and analyzed on the selected tariff structure from first part.

The tariff calculation procedure is set up in accordance with current data conditions of city wastewater sector. The entire of calculation procedure and related data are designed, modelled and run on Microsoft Excel Software. This Excel-based model capable of examining the interaction of a wastewater service's tariff with investment roadmaps, costs, customer WTP rates and physical conditions.

8.2 Methodology of the analysis

8.2.1 Concept of tariff setting and calculation

The following figure shows the concept and framework for analysis methodology.

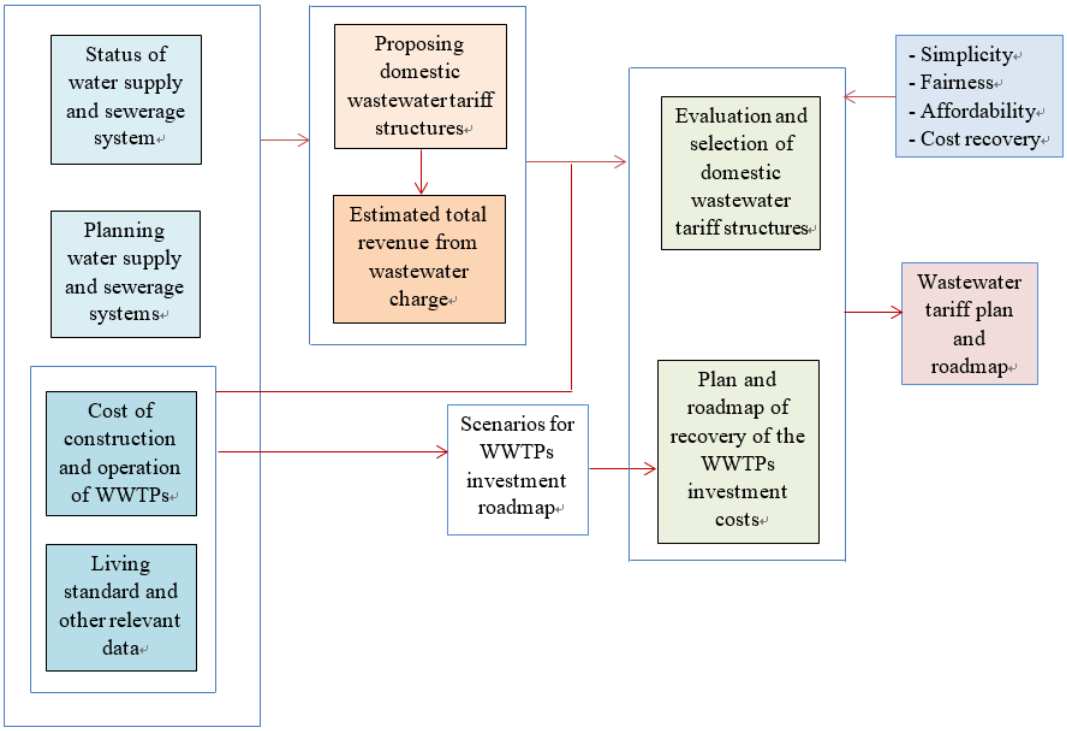


Figure 8. 1 Concept of the analysis methodology

Considering the actual situation and investment policies of WWTP, it can be seen wastewater service in HCMC is in transitional phase, therefore the necessary costs that are considered such as O/M, interest and construction cost need to be recovered according to the roadmap. In transitional phase, recovery at least for O/M cost is a core objective for a sustainable urban wastewater operation.

Moreover, domestic wastewater treatment is a public service that using most of the state budget and loans to non-profit investment and operation. Therefore, top goal is to recover the interest and O/M expenses so that the state budget will be used for reinvesting the next wastewater projects instead of subsidy for O/M.

On the other hand, investment of wastewater works is public service to improve environmental quality, thereby improving the quality of life, economic life, helping socio-economic development and thereby increasing revenue for the state budget (from income taxes). That additional budget revenue continues to be used for public services - welfare, hence the recovery of 100% of investment costs, depreciation costs and other costs should not be applied especially in the current transitional phase of wastewater sector in developing countries as Vietnam in general and HCMC's development plans in particular

As a result, key points of the methodology are applied as follows:

- The wastewater tariff for domestic use is design to recover the necessary costs of system development.

- The system development cost is combined by O/M (excluding depreciation cost), interest and a part of construction cost. The necessary cost for wastewater service is set by the proportions of household sewage to non-household sewage (4 different sectors of water use).

- In the analysis, wastewater discharge is calculated according to statistically actual and projected water consumption in HCMC.

- The capacity of WWTP is used to calculate treated wastewater rate by years, choose corresponding O/M cost and estimate construction cost.

- The proportion of used water to the total annual water use volume of each sector is directly proportional to the ratio of the number of subscribers using water to the total number of subscribers that contract to HCMC Water Company. Therefore, it is proposed to use the percentage of the amount of water used by each sector to calculate the % allocation of the cost for each respective sector.

- The wastewater tariff for non-household use is set in accordance with adjustment coefficient of water tariff. The tariff for non-household use is twice or 3 times as much as that for household use.

- The wastewater tariff for household is set in accordance with i) the water price of 1 m^3 of the norm of 4m^3/person/month and ii) price of norm of 4-6m^3/person/month.

- In the analysis, 4 scenarios of roadmap of investment and cost recovery are built in accordance with the different-completed investment planning, treated wastewater rate.

A tariff setup and financial achievement in each case are estimated based on these concepts.

8.2.2 Calculation flow

From the concept, a calculation flow is summarized in the below Figure 8.2

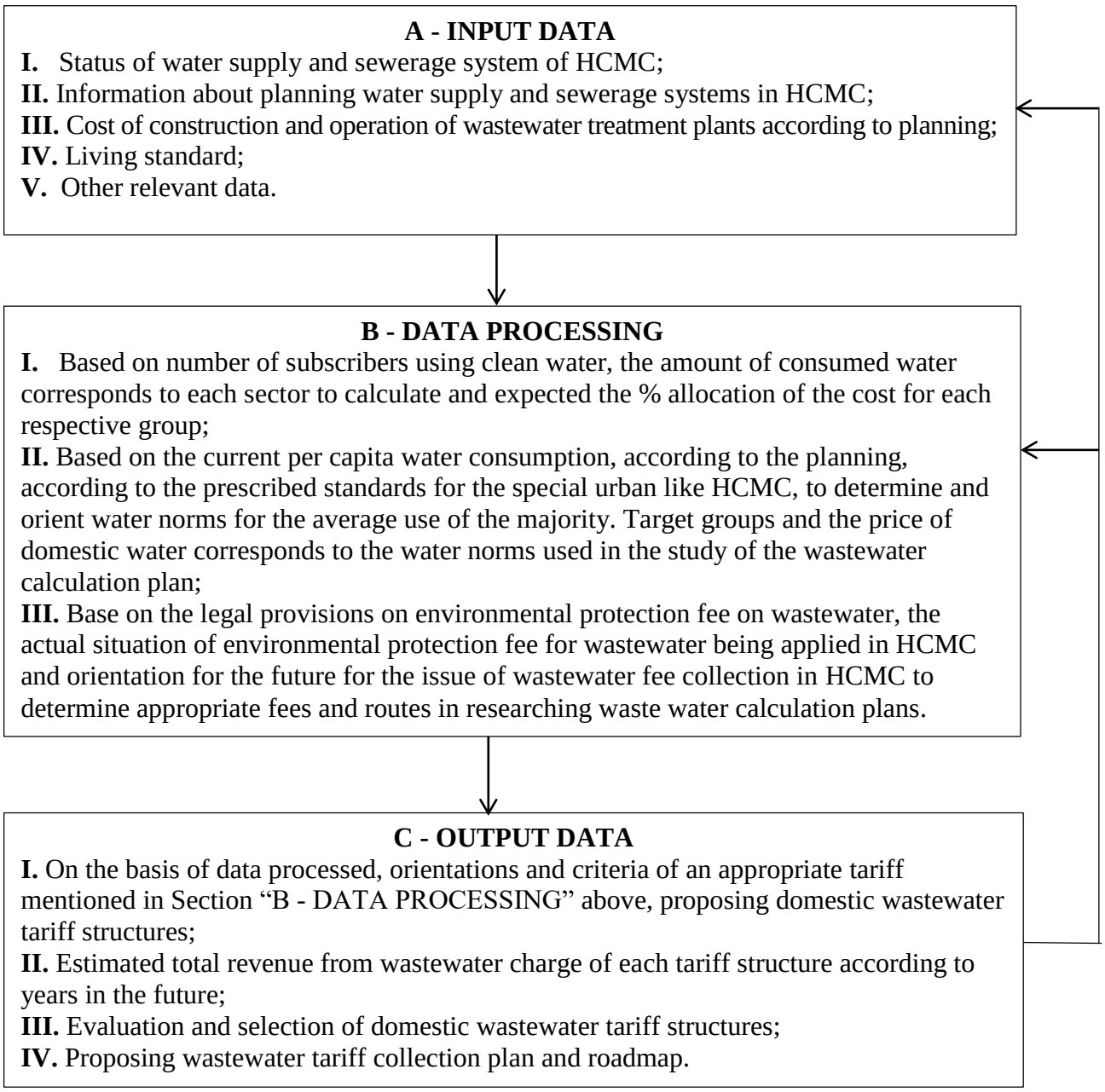


Figure 8. 2 Folder tree of calculation flow

8.2.3 Cases for the analysis

The examined cases for tariff setting and roadmap are summarized as follows.

Table 8. 1 Cases for the analysis

Case No.	Price of $1m^3$ water	Tariff structure and pricing
1	Norm $4m^3$/person/month	15% of water tariff
2	Norm $4m^3$/person/month	Fixed rate (10%) + variable (15%)
3	Norm 4 – $6m^3$/person/month	Fixed rate (15%) + variable (15%)
4	Norm 4 – $6m^3$/person/month	Fixed rate (10%) + variable (15% for Sector 1) and (20% for Sector 2, 3, 4)

The cases are set based on the following conditions:

Tariff structures and pricing

- Same as current application, % of water tariff
- Two-part of tariff = fixed rate + variable rate that is gained by the survey. Moreover, this type of structure is recommended to use in developing countries in many reviewed studies
- Price levels are set based on estimated mean WTP in this study.

In setting the tariff roadmap, the following 4 scenarios are taken into account:

Table 8. 2 Scenarios of tariff roadmap

Scenario	Description
1	+ Investment in accordance with the planning for the period 2020-2025 + Recovering 100% of O/M costs, loan interest + Rate of construction cost recovery corresponds to treatment rate in the period
2	- Investing 80% compared to the planning for the period 2020-2025 - Recovering 100% of O/M costs, loan interest - Rate of construction cost recovery corresponds to treatment rate in the period
3	+ Investing 60% compared to the planning for the period 2020-2025 + Recovering 100% of O/M costs, loan interest + Rate of construction cost recovery corresponds to treatment rate in the period
4	- Investment in accordance with the planning for the period 2020-2025 - Recovering 100% of O/M costs, loan interest - 15%/year of construction cost is recovered (corresponds to the % interest rates for private capital mobilized from bank, government bonds…) and 4% increase in the following years (corresponds to the average annual inflation rate)

Water consumption

- Regulations in QCVN 01: 2018/BXD - National technical regulation on construction planning, the standard water supply demand for the special urban like HCMC is 200 liters/person/day and night (equivalent to 200 liters * 30/1000 = 6m3/person/month)

- Decision No. 24/QD-TTg, the norm of water supply is 200 liters/person/day

- Statistically, average per capita water use is 148 * 30/1000 = 4.44m3/person/month

8.3 Data input

8.3.1 Updated status of water supply and sewerage system in HCMC

Updated data in 2018 are collected from summary data of HCMC Department of Transportation. Besides the overall data on status of water supply system, the detailed data are needed for building and selecting options of domestic wastewater tariff structure, including:

Water supply

Current water supply capacity is 2,422,480 m^3/day and there are 2,025,996 subscribers are supplied clean water, in which number of subscribers corresponds to each sector is shown in Table 8.3. The household subscriber accounts for the highest rate of 82.7%, followed by business and service unit subscribers accounting for 16.6%.

Table 8. 3 Water subscribers and percentage

Sectors	Quantity	%
Households	1,675,767	82.71
Production units	3,266	0.16
Administrative agencies, unions	10,181	0.50
Business, service units	336,752	16.62

Source: Statistics of Saigon Water Corporation – SAWACO in 2018

The amount of consumed water corresponds to each sector (m^3/year) is estimated in Table 8.4.

Table 8. 4 Annual and monthly consumed amount of sectors

Sectors	**Annual consumed amount** (Unit: Million)	**%**	**Monthly consumed amount (**$4m^3$/person)
Households	384,978	73.77	19.14
Production units	21,764	4.17	555.31
Administrative agencies, unions	25,226	4.83	206.48
Business, service units	89,869	17.22	22.24

Source: Statistics of Saigon Water Corporation - SAWACO in 2018[5] and calculation

From the above-mentioned statistics, it can be seen the proportion of used water to the total annual water use volume of each sector is directly proportional to the ratio of the number of subscribers using water to the total number of subscribers that are contracted to supply water by HCMC water sector. Therefore, it is proposed to use the percentage of the amount of water used by each sector to calculate the % allocation of the cost for each respective group.

The price of domestic water is being applied for each specific sectors as follows (Table 8.5):

Table 8. 5 The water tariff in use in HCMC

Unit: VND/m^3 (excluding VAT)

	Year	**Year**				
		2017	**2018**	**2019**	**2020**	**2021**
1	Household					
	$4m^3$/person/month	5,700	6,100	6,500	6,900	7,300
	Over $4m^3$ to $6m^3$/person/month	10,800	11,500	12,300	13,100	13,900
	Over $6m^3$/person/month	12,100	12,900	13,800	14,700	15,600
2	Production units	10,200	10,800	11,500	12,200	13,000
3	Administrative agencies, unions	10,900	11,600	12,400	13,200	14,100
4	Business, service units	18,500	19,700	21,000	22,400	23,800

Source: Document of HCMC Authority

Statistically, per capita water consumption is 148 liter/person/day.

[5] Number of subscribers and annual water consumed volume of sectors are obtained directly from data statistic of SAWACO

Drainage and sewerage

Currently, number of plants in operation is 3 WWTPs with total capacity of 171,500 m^3/day.

- Bình Hưng WWTP: 141.00 m^3/day.
- Bình Hưng Hòa WWTP: 30.000 m^3/day.
- Tân Quy Đông WWTP: 500 m^3/day.

8.3.2 Information about water supply and sewerage systems planning in HCMC

Statistically, water supply and sewerage data over the years and allocation plans for future years according to planning are shown in Table 8.6 and Table 8.7 respectively.

Regulations on the standard demand and the norm of water supply for the special urban like HCMC are stipulated in:

- QCVN 01: 2018/BXD - National technical regulation on construction planning issued by the Ministry of Construction in Decision No. 04/2008/QD-BXD on April 3rd, 2008, the water supply standard is 200 liters/person/day (equivalent to 200 liters * 30/1000 = 6m^3/person/month).

- Decision No. 24/QD-TTg on approval of adjusting general planning of HCMC Construction to 2025, the norm of water supply is 200 liters/person/day.

Table 8. 6 Forecast of water supply

Year	Water supply capacity (million m^3/day)	Notes
2018	2,423	Rate of population is supplied water (100%)
Forecast for 2019	2,580	
Forecast for 2020	2,750	
Forecast for 2025	3,700	

Source: Vietnam Government document[6]

[6] Decision No. 24/QĐ-TTg 06/01/2010 of Prime Minister on Approval of adjusting general planning of HCMC construction to 2025

Table 8. 7 Expected WWTPs investment plan

Year	Treatment capacity (m^3/day)	Notes
2018	171,500	
2019	185,200	Capacity addition of Residential area WWTP 17,3ha in District 2: 3,000m^3/day; Residential area 18.4 ha in District 2: 7,000m^3/day; Vĩnh Lộc B residential area: 3,700m^3/day (The amount of water used increased by about 6.5% compared to 2018)
Forecast for 2020	993,200	*NL-TN WWTP; *Bình Hưng WWTP Phase 2; * TL-BC WWTP Total capacity of 03 WWTPs is 1,080,000m^3/day (TL-BC plant: 131,000m3/day has not operated yet due to project of interceptor construction is being suspended). The amount of water used increased by about 6.5% compared to 2019.
Forecast for 2025	2,926,200	* West Sài Gòn WWTP * Tân Hóa Lò Gốm WWTP * South Sài Gòn 1 WWTP * North Sài Gòn 2 WWTP * North Sài Gòn 1 WWTP * Bình Tân WWTP * Cầu Dừa WWTP * Tây Bắc WWTP * Phase 2 Nhiêu Lộc-Thị Nghè WWTP * Phase 3 Bình Hưng WWTP * Phase 2 Tham Lương Bến Cát WWTP with total capacity 1,802,000m^3/day

Source: Vietnam Government document

8.3.3 Cost of construction and O/M of WWTPs according to planning

Based on the scale and treatment capacity of WWTPs according to the development plan of HCMC from 2018-2025 above, construction cost is estimated based on Decision No. 24/QD-TTg, the project file, and the investment capital rate announced by the Ministry of Construction in Decision No. 451/QD-BXD dated Apr 21st, 2015. The O/M cost of domestic wastewater treatment is based on Decision No. 451/QD-BXD. The loan interest from ODA capital: 2%/year (refer to loan agreements).

Table 8. 8 Summary of O/M, interest and construction costs for years

Unit: Billions VND

	Contents	Year 2018	Year 2019	Year 2020	Year 2025
1	Construction costs	2,331	2,331	11,922	28,195
2	O/M cost	197	227	587	2,189
3	Interest	47	47	207,	218
Total costs of O/M and interest		*244*	*273*	*794*	*2,407*
Total costs of construction, O/M and interest		**2,575**	**2,604**	**12,716**	**30,602**

8.3.4 Living standard:

The monthly average income per capita and monthly average income per capita at current prices by type of expenditure are shown in Table 8.9 and Table 8.10 respectively

Table 8. 9 Average income/month/person

Unit: Thousand VND

	Year 2016	Year 2017	Year 2018
The monthly average income per capita	4,839	5,109	5,543

Source: Ho Chi Minh City Statistical Office (2018)

Table 8. 10 Expense on housing, water and electricity

Unit: Thousand VND

	Year 2016	Year 2017	Year 2018
Housing, water & electricity	263,6	309,1	365,8
Proportion % of expenditure compared to income	5,45%	6,05%	6,6%

Source: Ho Chi Minh City Statistical Office (2018)

8.3.5 Other relevant data

The legal provisions on environmental protection fee on wastewater such as Decree No. 154/2016/ND-CP.

The actual application of EPF for wastewater in HCMC, 10% on the selling price of 1m3 of clean water excluding VAT.

Findings from survey results has been done in HCMC in 2017: mean WTP, people`s attitude toward the increase in wastewater fee (Agree an increase in fee in accordance with the level of municipal wastewater treatment), and type of tariff structure and unit price were suggested by respondents

8.4 Data processing

8.4.1 Allocation rate of cost

Based on number of subscribers using clean water, the amount of consumed water corresponds to each sector to calculate and expect the percentage of allocation of the cost for each respective group. Specifically, the percentage of cost allocation for each sector after statistic and analysis are shown in Table 8.11.

Table 8. 11 Percentage of cost allocation for each sector

Sectors	Rate of cost allocation
Households (Hereinafter referred to as "Sector 1")	73.77%
Production units (Hereinafter referred to as " Sector 2")	4.17%
Administrative agencies, unions (Hereinafter referred to as " Sector 3")	4.83%
Business, service units (Hereinafter referred to as " Sector 4")	17.23%

8.4.2 Applied water price for household sector

Based on the current and planning per capita water consumption and the prescribed standards for the special urban as HCMC to determine and orient water norms for the average use of the majority of sectors as well as the water price corresponds to the water norms used. Domestic water price of the "Sector 1" is assumed based on:

- QCVN 01: 2018/BXD and Decision No. 24/QD-TTg are 200 liters/person/day (equivalent to 200 liters * 30/1000 = 6 m^3/person/month).
- Statistically, average per capita water use is 148 * 30/1000 = 4.44m^3/person/month.
- Statistically, the average monthly water consumption of sector 1, a standard household of 5 people consumes 19.14 m^3/month (equivalent to 3.83 m^3/person/month). And the water demand forecast will continue to increase and only be able to stop at the standard level of 6 m^3/person/month.

Therefore, it is proposed to use the domestic water price corresponding to the norm of 4 m^3/person/month to study (current minimum average price) for the group "Sector 1". For the remaining groups, the water prices corresponding to each group are used (because these groups only have one fixed price per m^3, there is no selling price by block).

8.4.3 Tariff level

Base on the legal provisions on EPF for wastewater, the actual situation of EPF being applied in HCMC and future orientation for the wastewater tariff issue in HCMC to determine appropriate fee levels and roadmap in the options setting wastewater tariff. Expenses need to be considered to recover from source of wastewater charge (analyzed

in 8.2.1) according to the priority order including (1) O/M costs, (2) interest for investment loans, and (3) investment costs.

Domestic wastewater tariff structures are proposed by references to:

- The provisions of the Government's Decree No. 154/2016/ND-CP in 2016 on EPF for wastewater and relevant law provisions, currently the EPF is calculated as 10% on the selling price of $1m^3$ of clean water excluding VAT. Therefore, it is recommended that domestic wastewater tariff should be calculated on the basis of a percentage coefficient of water supply tariff in order to ensure compliance with current legal regulations.

- In addition, the calculation of wastewater charge in proportion to the cost of water consumption will make it easier for people to get consensus. Because, first, it fits into the current reality (people are accustomed to calculating %), secondly, from the coefficient of % according to the price of water will give a corresponding value that everyone will understand and know the basis for determining domestic wastewater charges. The selection of the fee is 1000 VND/m^3 or 2000 VND/m^3, ... in fact, it is studied on water tariff but when making the same method for waste water fee, it will make people confuse and ask questions what is the platform and where is that number gotten while the sewage industry in HCMC is still developing and improving, so it can make people uncomfortable accepting that fee immediately.

Price levels and tariff roadmap are defined from the data of development planning of wastewater treatment systems in HCMC in accordance with different stages.

8.4.4 Criteria for setting tariff structure

Proposed criteria of a wastewater tariff structure including Simplicity (as mentioned in 8.4.3 above), Fairness, Affordability (will be compared to monthly income and living standard from input data) and Cost recovery (how many percentages the revenue can cover O/M, interest and construction costs will be presented for comparison and selection)

8.5 Proposed scenario for tariff structures

Tariff structures are proposed based on current applied regulation, survey result and literature review.

Currently, EPV for wastewater is collected at 10% on the water price excluding VAT in accordance with Government's Decree No. 154/2016 / ND-CP dated November 16th, 2016 and relevant law provisions. Therefore, it is recommended that domestic wastewater tariff should be continued to calculate on this basis in order to ensure compliance with current legal regulations.

In section 5.3.8, the survey result shows the structure of fixed percentage of water tariff was gained the highest recommendation (56.1%), followed by the two-part tariff structure (15.3%) with the unit price of VND/m^3/person were the most chosen. As presented in literature review section 3.4, two-part tariff is the most common used and recommended structure by its positive features.

Therefore, the two mentioned-above basic structures are proposed for wastewater tariff setting and there are 3 different tariff rates are set for the two-part structure to examine how cost recovery can reach. On the basis of data processed as well as orientations and criteria mentioned in Section 8.4 above, tariff structures are set as follows:

Structure 1: Domestic wastewater fee is 15% on payment of water consumption (excluding VAT). Accordingly, domestic wastewater charges are calculated as a percentage of the price of clean water.

$$F = f * K \quad (8.1)$$

In which:

F: Wastewater charge must be paid (VND/m^3).

f: Selling price of $1m^3$ water excluding VAT (VND/m^3). In which, particularly for "Sector 1", the water price is calculated according to the price of $1m^3$ of the norm of $4m^3$/person/month; for the remaining groups, the water prices corresponding to each sector are used.

K: Coefficient 15%.

Structure 2: Domestic wastewater tariff consists of a fixed fee plus variable fee according to the amount of water used. In particular, the fixed fee is equal to the current environmental protection fee on wastewater for the average monthly water consumption of each sector; The variable fee is equal to 15% of the cost of water consumed - excluding VAT.

$$F = f + C \quad (8.2)$$

In which:

F: Wastewater charge must be paid (VND).

f: Fixed fee (VND/month).

The fixed fee is calculated by the current environmental protection fee on wastewater: 10% of water consumption cost (excluding VAT) on the number of m^3 of average monthly water consumption of each sector.

Similar to Structure 1, for "Sector 1" water price is calculated at the price level corresponding to the $1m^3$ selling price of the norm of 4 m^3/person/month; for the remainders, the water prices are applied correspondingly for each sector are used.

f = Amount of m^3 water used (average monthly water consumption of each sector) x Water price (VND/m^3) x Fee rate (10%)

C: Payable variable fee.

C = Amount of water used (m^3) x Water price (VND/m^3) x Fee rate (15%).

Similar to Structure 1, for "Sector 1" water price is calculated at the price level corresponding to the 1 m^3 selling price of the norm of 4 m^3/person/month; for the remainders, the water prices are applied correspondingly for each sector are used.

Structure 2a: Domestic wastewater tariff consists of a fixed fee plus a variable fee according to the amount of water used. In particular, the fixed fee is 15% of consumed water cost - excluding VAT - for the average monthly water consumption of each sector; the variable fee is equal to 15% of the cost of water consumed - excluding VAT.

$$F = f + C \quad (8.3)$$

In which:

F: Wastewater charge must be paid (VND).

f: Fixed fee (VND/month).

The fixed fee is calculated by the current environmental protection fee on wastewater: 15% of water consumption cost (excluding VAT) on the number of m^3 of average monthly water consumption of each sector.

Differ from Structure 1 and Structure 2, for "Sector 1" water price is calculated at the price level corresponding to the 1m^3 selling price of the norm of 4 – 6 m^3/person/month; for the remainders, the water prices are applied correspondingly for each sector are used.

f = Amount of m^3 water used (average monthly water consumption of each sector) x Water price (VND/m^3) x Fee rate (15%).

C: Payable variable fee.

C = Amount of water used (m^3) x Water price (VND/m^3) x Fee rate (15%)

Differ from Structure 1 and Structure 2, for "Sector 1" water price is calculated at the price level corresponding to the 1m^3 selling price of the norm of 4m^3-6m^3/person/month; for the remainders, the water prices are applied correspondingly for each sector are used.

Structure 2b: Domestic wastewater tariff consists of a fixed fee plus variable fee according to the amount of water used. In particular, the fixed fee is 15% of consumed water cost - excluding VAT - for the average monthly water consumption of each sector; The variable fee is equal to % of the cost of water consumed - excluding VAT (15% with Sector 1; 20% with Sector 2, 3, 4).

$$F = f + C \quad (8.4)$$

In which:

F: Wastewater charge must be paid (VND).

f: Fixed fee (VND/month).

The fixed fee is calculated by 15% of water consumption cost (excluding VAT) on the number of m^3 of average monthly water consumption of each sector.

Similar to Structure 2a, for the group "Sector 1" water price is calculated at the price level corresponding to the 1 m^3 selling price of the norm 4 – 6 m^3/person/month; For the remainders, the water prices are applied correspondingly for each sector are used.

f = Amount of m^3 water used (average monthly water consumption of each sector) x Water price (VND/m^3) x Fee rate (15%)

C: Payable variable fee.

C = Amount of water used (m^3) x Water price (VND/m^3) x Fee rate (15% with sector 1; 20% with the sectors 2, 3, 4)

Similar to Structure 2a, for "Sector 1" water price is calculated at the price level corresponding to the 1m^3 selling price of the norm 4 – 6 m^3/person/month; For the remainders, the water prices are applied correspondingly for each sector are used.

8.6 Total revenue

Total revenue from wastewater charges through future years corresponding to each tariff structure are estimated and showed in following tables.

Table 8. 12 Revenue from wastewater charge of Structure 1 through the future years

Year	Revenue from wastewater charge in the years (Billion VND)
2018	1,165
2019	1,322
2020	1,499
2025	2,699

Table 8. 13 Revenue from wastewater charge of Structure 2 through the future years

Year	Revenue from wastewater charge in the years (Billion VND)
2018	1,667
2019	1,919
2020	2,207
2025	4,386

Table 8. 14 Revenue from wastewater charge of Structure 2a through the future years

Year	Revenue from wastewater charge in the years (Billion VND)
2018	2,475
2019	2,878
2020	3,341
2025	6,855

Table 8. 15 Revenue from wastewater charge of Structure 2b through the future years

Year	Revenue from wastewater charge in the years (Billion VND)
2018	2,667
2019	3,096
2020	3,588
2025	7,301

8.7 Evaluation and selection of domestic wastewater tariff structures

Total revenue from wastewater charge of each tariff structure according to years are summarized in Table 8.16.

Table 8. 16 Revenue estimated from different structures

Unit: Billions VND

	Year 2018	Year 2019	Year 2020	Year 2025
Structure **1**	1,165	1,322	1,499	2,699
Structure **2**	1,667	1,918	2,207	4,386
Structure **(2a)**	2,475	2,878	3,341	6,855
Structure **(2b)**	2,667	3,096	3,588	7,301

Total of investment costs, operation costs, interest for WWTPs according to investment situations (Table 8.17):

Table 8. 17 Total of O/M, interest and investment costs for years

Unit: Billions VND

	Contents	2018	2019	2020	2025
1	Construction costs	2,331	2,331	11,922	28,195
2	O/M cost	197	226	587	2.188
3	Interest	46	46	207	218
Total costs of O/M and interest		*243*	*273*	*794*	*2,406*
Total costs of construction, O/M and interest		**2,575**	**2,604**	**12,715**	**30,601**

Evaluate domestic wastewater tariff structures based on the criteria: recovering operation costs, interest, investment cost is calculated and presented in Table 8.18 and Figure 8.3.

Table 8. 18 Ability to meet considerable criteria of structures

	Ability of recovery		
	O/M costs	**Interest**	**Investment cost**
Structure 1	100% for the years: 2018, 2019, 2020 and 2025	100% for the years: 2018, 2019, 2020 and 2025	40% for year 2018 45% for year 2019 6% for year 2020 1% for year 2025
Structure 2	100% for the years: 2018, 2019, 2020 and 2025	100% for the years: 2018, 2019, 2020 and 2025	61% for year 2018 71% for year 2019 12% for year 2020 7% for year 2025
Structure (2a)	100% for the years: 2018, 2019, 2020 and 2025	100% for the years: 2018, 2019, 2020 and 2025	96% for year 2018 100% for year 2019 21% for year 2020 16% for year 2025
Structure (2b)	100% for the years: 2018, 2019, 2020 and 2025	100% for the years: 2018, 2019, 2020 and 2025	100% for 2018 and 2019 23% for year 2020 17% for year 2025

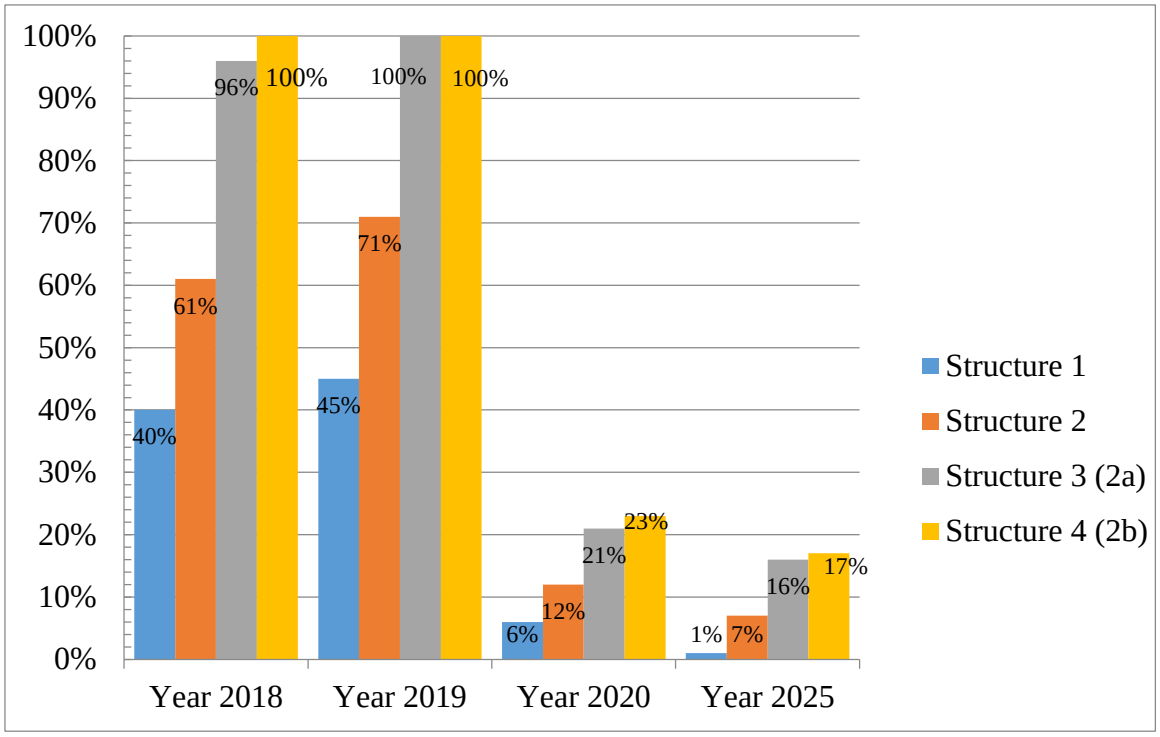


Figure 8. 3 Ability to cover the costs of O/M, interest, and construction from the total revenue

Evaluate domestic wastewater tariff structures based on the criteria: suitable to the living standards of the population are shown in Table 8.19 and Figure 8.4.

The average monthly fee per capita is still lower than the monthly average per-capita living expenses for housing, electricity and sanitation expenses according to the statistics of 2018 of the Statistics Department of HCMC.

In the remaining years, the increase rate in water price is estimated at 6%, while the increase rate in income is forecasted at 8.5%, therefore the % coefficient of wastewater charge levels to be paid monthly in subsequent years will be lower than the calculation year - it means year 2018.

In addition, the fee calculation according to structure 2, 2a and 2b is to ensure fairness (whether people use water or self-exploited groundwater, all their wastewater are discharged into the environment). At the same time, the two-part tariff method of wastewater charge (including fixed fee and variable fee according to amount of water used) has been applied to industrial wastewater sector in Vietnam and has been recommended developing countries to apply.

The rates of wastewater charge for household from Structure 2a and 2b are similar, therefore the parameters of the appropriateness assessment for the monthly fee rate per person relative to the living standard are also similar.

Table 8. 19 Affordability of structures

Structure	**Appropriateness of each person's monthly average charge compared to the resident's living standard**	
Structure 1	5,855 VND year 2018 6,546 VND year 2019 7,297 VND year 2020 12,196 VND year 2025	Taking the 2018 milestone for comparison, the monthly fee level per capita only accounts for 0,106 % of the average monthly income; 1,6 % of per capita living expenditure per month for expenses of housing, electricity, water, and sanitation.
Structure 2	8,563 VND year 2018 9,620 VND year 2019 10,772 VND year 2020 18,567 VND year 2025	Taking the 2018 milestone for comparison, the monthly fee level of each people only accounts for 0,154 % of the average monthly income; 2,341 % of per capita living expenditure per month for expenses of housing, electricity, water, and sanitation.
Structure (2a)	15,456 VND year 2018 17,631 VND year 2019 20,030 VND year 2020 36,321 VND year 2025	Taking the 2018 milestone for comparison, the monthly fee level of each people only accounts for 0,279 % of the average monthly income; 4,225 % of per capita living expenditure per month for expenses of housing, electricity, water, and sanitation.
Structure (2b)	15,456 VND year 2018 17,631 VND year 2019 20,030 VND year 2020 36,321 VND year 2025	Taking the 2018 milestone for comparison, the monthly fee level of each people only accounts for 0,279 % of the average monthly income; 4,225 % of per capita living expenditure per month for expenses of housing, electricity, water, and sanitation.

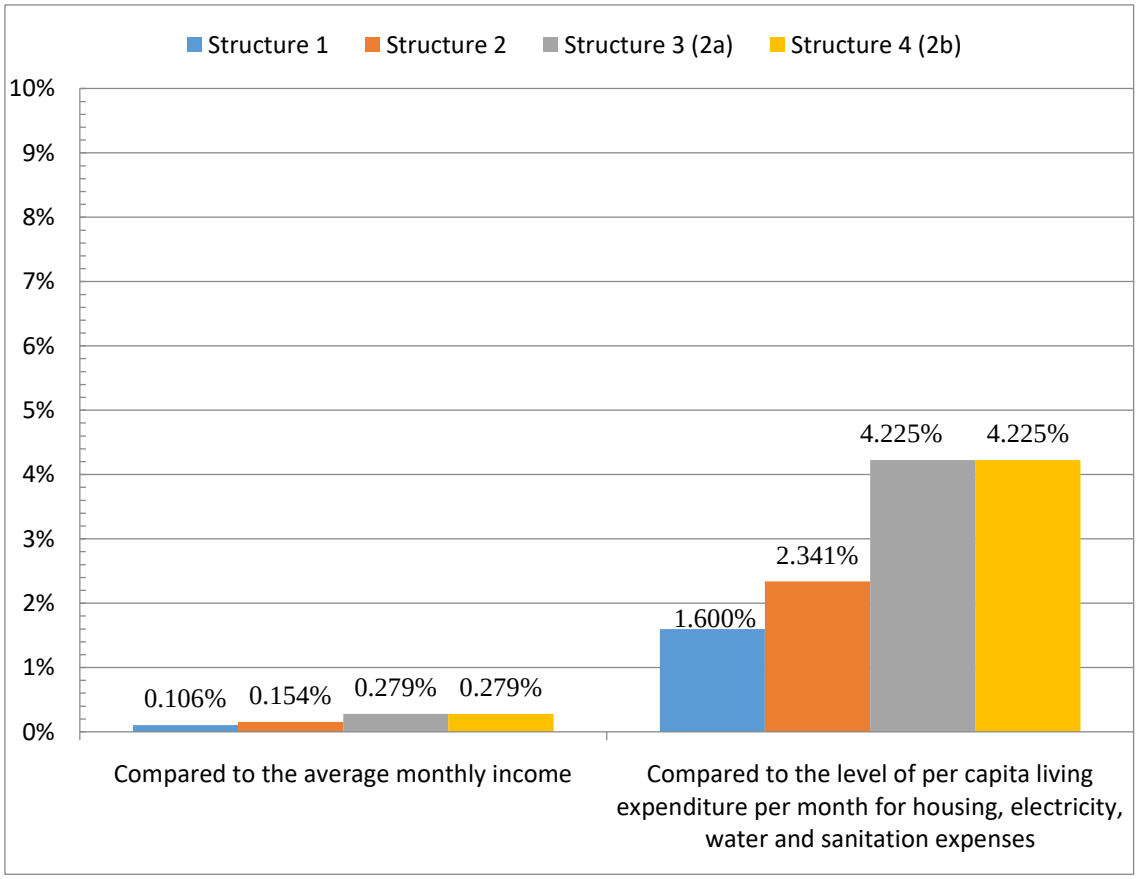


Figure 8. 4 Affordability of tariff levels corresponding to different structures

Evaluating the appropriateness of each structure (level, the rate of fee increase over each year) with the actual situation of EPF for wastewater being applied in HCMC, the future orientation of wastewater charges in HCMC and residents` desire as well as willingness to pay based on the last survey. On that basis, a tariff structure is selected for detail study.

From the above analysis and evaluation, Structure (2a) and Structure (2b) allow more revenue to be collected than the rests and it is still consistent with per capita expenditure in HCMC. Moreover, Structure (2b), the wastewater tariff includes a fixed fee plus the variable fee according to the amount of water used, also is in accordance with the socio-economic situation apart from meeting mentioned orientation and resident`s WTP.

In which, fixed fee is equal to % of consumed water cost (-VAT) for the average monthly water consumption of each sector and variable fee is equal to % of consumed water cost (-VAT) (% values are applied separately to different sectors and values applied to sectors 2, 3 and 4 are larger than sector 1)

Therefore, it is recommended that the tariff Structure (2a) should be applied in the first stage of the introduction to the tariff policy. The following years it is possible to apply the manner of Structure (2b) and only adjust the coefficients in accordance with the WWTP investment roadmap as well as socio-economic situation.

8.8 Proposal of wastewater tariff roadmap

Depending on the plan and situation of WWTPs investment, the tariff roadmap and tariff structure are proposed in accordance with each stage so as to suit the planning and investment wastewater collection and treatment systems as well as socio-economic situation of HCMC.

8.8.1 Investment roadmap

Scenarios for investment roadmap of WWTPs are built based on the data of the WWTPs planning of HCMC according to stages, expectation of WWTPs investment roadmap for each successive year (starting from the year of original data - 2018).

According to the HCMC development planning, the situation of wastewater treatment in period of 2018 - 2025 are determined as in Table 8.20.

Table 8. 20 Expected wastewater treatment in the period 2018 - 2025

Unit: Thousands m^3/day

Contents	Year			
	2018	2019	2020	2025
Water supply capacity	2,422	2,580	2,750	3,700
Total amount of treated wastewater	1,938	2,064	2,200	2,960
WWTPs investment	171	185	993	2,926
Treatment rate	8.85%	8.97%	45.15%	98.86%

Source: Vietnam Government document (Decision No. 24/QĐ-TTg)

For estimated investment roadmap for WWTPs in the period of 2020-2025, currently, there is no detailed planning for water supply and drainage system development in the period 2020-2025. Therefore, based on the above general planning for 2020 and 2025, the roadmap is expected to be evenly distributed for years. Then, the investment roadmap is proposed as follows (Table 8.21):

Table 8. 21 Proposed investment roadmap

Unit: Thousands m^3/day

Contents	Year					
	2020	2021	2022	2023	2024	2025
Water supply capacity	2,750	2,940	3,130	3,320	3,510	3,700
Total amount of wastewater to be treated	2,200	2,352	2,504	2,656	2,808	2,960
WWTPs investment	993	1,379	1,766	2,153	2,539	2,926
Treatment rate	45.15%	58.66%	70.54%	81.06%	90.44%	98.86%

Source: Vietnam Government document (Decision No. 24/QĐ-TTg)

Determine the cost of investment, operation and maintenance, interest of wastewater treatment plants according to development planning based on the scale and treatment capacity of WWTPs according to the development plan of HCMC from 2018 - 2025 above, the costs of investment, O/M and interest of WWTPs are determined (Table 8.22)

Table 8. 22 Forecast of costs of O/M, interest and construction

Unit: Billions VND

	Contents	2018	2019	2020	2025
1	Construction costs	2,331	2,331	11,922	28,195
2	O/M cost	197	226	586	2,188
3	Interest	46	46	206	218
Total costs of O/M and interest		*243*	*273*	*793*	*2,406*
Total costs of construction, O/M and interest		**2,574**	**2,604**	**12,715**	**30,601**

The costs of investment, O/M, and interest under the scenarios of investment roadmap for the period 2020–2025 are estimated based on above-mentioned costs of construction, O/M and interest for WWTPs according to planning period. The plant investment roadmap in the period of 2020-2025 is expected to be evenly distributed over the years. At that time, the roadmap of investment, O/M, and interest costs for WWTPs follows the above the investment roadmap scenario as presented in Table 8.23.

Table 8. 23 Costs of investment, O/M and interest follow the investment roadmap scenarios

Unit: Billions VND

	Contents	2020	2021	2022	2023	2024	2025
1	Construction costs	11,922	15,176	18,431	21,685	24,940	28,195
2	O/M cost	586	907	1,227	1,547	1,868	2,188
3	Interest	206	209	211	213	215	218
Total costs of O/M and interest		*793*	*1,116*	*1,438*	*1,761*	*2,084*	*2,406*
Total costs of construction, O/M and interest		**12,715**	**16,292**	**19,870**	**23,447**	**27,024**	**30,601**

8.8.2 Recovery ability

Building a plan and roadmap of recovery of the WWTPs investment costs (Costs of construction, O/M, and interest) corresponding to the scenarios of plant investment roadmap as mentioned above.

Based on the results of analysis and calculation, construction costs account for the largest proportion of the investment costs for wastewater treatment systems. Normally,

construction costs account for more than 90%. Therefore, the goal is to develop a plan to recover the construction costs to reinvest in the future. At that time, the recovery roadmap for investment expenses must be in line with the WWTPs investment roadmap, in which the following criteria must be based on: the proportion of wastewater treated, capital recovery demand for reinvestment, HCMC socio-economic situation.

Based on the percentage of treated wastewater capacity was calculated based on the scenario of investment roadmap of WWTPs in Table 8.20 and 8.21, a recovery roadmap of the WWTPs investment costs is determined as follows (Table 8.24)

Table 8. 24 Investment cost recovery ability

Contents	**Year**					
	2020	**2021**	**2022**	**2023**	**2024**	**2025**
Construction costs	45%	58%	70%	81%	90%	98%
O/M cost	100%	100%	100%	100%	100%	100%
Interest	100%	100%	100%	100%	100%	100%

(In which: The percentage rate of construction costs recovery corresponds to the percentage rate of treated wastewater by WWTPs)

In the next calculation step, from the investment cost recovery roadmap for the above-mentioned wastewater treatment systems, a wastewater tariff roadmap is built, from then on compare and evaluate with the criteria of income per capita, people's willingness to pay, ... in order to adjust the roadmap for recovering investment costs.

8.8.3 Design, calculation and evaluation tariff roadmap scenarios

On the basis of the investment cost recovery roadmap and 4 scenarios of investment roadmap as mentioned in section 8.2.3, Table 8.2, the charge plans are given to determine the revenue of the respective years. In this part, detail calculation of selected tariff roadmap under Scenario 3 is presented whereas other scenarios are shown in comparison graphs.

Compare and evaluate the wastewater charge rates to the criteria of average income per capita, household`s WTP,.... to be able to adjust the coefficients in the tariff structure of charge options accordingly and as a basis for proposing and selecting the tariff roadmap. Accordingly, the fee options for years are as follows:

- Fee option for year 2019:

According to the calculation results, selection of tariff structure, Structure (2a) meets the criteria for ensuring the cost source for construction, operation, interest for 2019; at the same time, is consistent with the average per capita income and willingness to pay of the people (based on survey data).

Therefore, the option of domestic wastewater tariff is proposed as follows: Domestic wastewater tariff (excluding VAT) consists of a fixed fee (15%) plus a variable fee (15% of the cost of water consumed).

- Fee option for year 2020:

As analyzed and calculated in the content of the investment and recovery roadmap, O/M costs, interest, a part of construction costs in 2020 needs to be recovered. The percentage of construction cost recovery corresponds to the percentage of treated wastewater by WWTPs.

Accordingly, the cost recovery percentage and the corresponding recovered amount are calculated in Table 8.25. From the year 2020, the Structure 2b is applied for calculation.

Table 8. 25 Cost recovery and covered amount year 2020

Unit: Billion VND

	Contents	**Year 2020**	**Recovery rate**	**Amount to be recovered**
1	Construction costs	7,153	27%	1,937
2	O/M cost	352	100%	352
3	Interest	124	100%	124
Total				**2,413**

Water tariff in HCMC in 2020 as shown in Table 8.26:

Table 8. 26 Water price of different sectors in 2020

Domestic water prices (VND/m^3)				
Sector 1 (block 4 m^3)	**Sector 1 (block 4-6 m^3)**	**Sector 2**	**Sector 3**	**Sector 4**
6,900	13,100	12,200	13,200	22,400

Applying the tariff structure equation (8.4) as suggested in section 8.7 in order to examine tariff roadmap. In this case, water prices are multiplied by different wastewater tariff rates in fixed and variable fees that described as follows:

$$F = f + C$$

f = Number of m^3 water used (monthly average consumption level of each sector) x Water price (VND/m^3) x {R1 (%) for Sector 1; R2 (%) for Sector 2; R3 (%) for Sector 3; R4 (%) for Sector 4}.

C = Amount of water used (m^3) x Water price (VND/m^3) x {R'1 (%) for Sector 1; R'2 (%) for Sector 2; R'3 (%) for Sector 3; R'4 (%) for Sector 4}.

In order to ensure the tariff roadmap as mentioned (ensure the percentage of recovery of cost items and the amount to be recovered for the calculation year), the calculation coefficients are defined as follows (see Table 8.27):

Table 8. 27 Proposed coefficient for estimation

Sectors	**Fixed fee coefficient**		**Variable fee coefficient**	
Sector 1	R1	15%	R'1	15%
Sector 2	R2	15%	R'2	15%
Sector 3	R3	15%	R'3	15%
Sector 4	R4	15%	R'4	15%

Check and evaluate the appropriateness of the wastewater fee payable with the criteria of per capita income, recovery roadmap for investment costs are shown in Table 8.28

Table 8. 28 Appropriateness of charge payable for year 2020

	Sector 1		**Sector 2**	**Sector 3**	**Sector 4**
	Fixed	Total			
Average monthly payable fee (VND)	6,176	20,030	2,934,824	1,264,302	226,544
Monthly income	0,349 %				
Monthly expenditure	5,295 %				
O/M cost and interest	100%				
Investment cost	40%				

The capital recovering ability for investment cost items is in line with the roadmap set out as shown in Table 8.25 (100% of the O/M and interest cost and meet 27% of the construction costs corresponding to treatment rate for the year 2020), however, in this year with such tariff rate the investment cost recovery gain 40% higher than setting plan. Average monthly fees of different sectors are presented in Table 8.28.

For sector 1, this cost level is consistent with the WTP according to the survey data in 2017 (about VND 5,000/month/person). While, this is the fee level at 2020, it is certain that people's WTP will increase with the city socio-economic growth (at least 8.5% / year => 5,000 *1.085*1.085*1.085 = 6,386 VND/month). The monthly fee level per capita only accounts for 0.3% of the average monthly income and 4.6 % of per capita monthly living expenditure for housing, electricity, water and sanitation expenses.

According to statistics (see Table 8.3 and 8.4), the water subscriber of household sector makes up the highest proportion (82.7%), followed by business and service units (16,6%), the administrative agencies and unions (0.1%), and the Production units (0.16%). At the same time, the volume of water consumed by the households' accounts for the highest percentage (73.77%), followed by the Business and service units (17.23%), Administrative agencies and unions (4.83%), and Production units (4.17%). In addition, HCMC is orienting a socio-economic development towards transferring from production to business and services. Therefore, when assessing the payable fee rate, it is necessary to consider and assess affordability of the household sector compared to the living standard and city socio-economic situation. According to the calculation data, the payable fee items of the above sectors are appropriate.

As can be seen, the treatment rate at the present time is 27% is much higher than the rate of suggested wastewater charge (15% of water price) for the largest water users (Households) in this scenario. This is consistent with the opinion of the majority of respondents (they stated that when the treated wastewater rate increases, the wastewater fee should be increased).

From the above calculation, comparison and evaluation data, the fee option according to Structure (2b) with the above charge coefficients is appropriate.

- Fee option for year 2021:

Steps are similar to year 2020, but treatment rate and water tariff are higher while tariff rates of fixed and variable fee remain same as year 2020.

Table 8. 29 Cost recovery and covered amount year 2021

Unit: Billion VND

	Contents	**Year 2021**	**Recovery rate**	**Amount to be recovered**
1	Construction costs	9,105	35%	3,205
2	O/M cost	544	100%	544
3	Interest	125	100%	125
Total				**3,874**

Table 8. 30 Water price of different sectors in year 2021

Domestic water prices (VND/m^3)				
Sector 1 (block 4 m^3)	**Sector 1 (block 4-6 m^3)**	**Sector 2**	**Sector 3**	**Sector 4**
7,300	13,900	13,000	14,100	23,800

Table 8. 31 Proposed coefficients for year 2021

Sectors	**Fixed fee coefficient**		**Variable fee coefficient**	
Sector 1	R1	15%	R'1	15%
Sector 2	R2	15%	R'2	15%
Sector 3	R3	15%	R'3	15%
Sector 4	R4	15%	R'4	15%

Table 8. 32 Appropriateness of charge payable for year 2021

	Sector 1		Sector 2	Sector 3	Sector 4
	Fixed	Total			
Average monthly payable fee (VND)	7,222	22,706	3,260,225	1,441,724	257,780
Monthly income	0,32 %				
Monthly expenditure	4,86 %				
O/M cost and interest	100%				
Investment cost	35%				

- Fee options for year 2022:

In this year, the recovery rate of investment cost is 42%, applied water tariff and tariff rates are as follows:

Table 8. 33 Water price of different sectors in year 2022

Domestic water prices (VND/m^3)				
Sector 1 (block 4 m^3)	**Sector 1 (block 4-6 m^3)**	**Sector 2**	**Sector 3**	**Sector 4**
7,811	14,873	13,910	15,087	25,466

Table 8. 34 Proposed coefficients for year 2022

Sectors	**Fixed fee coefficient**		**Variable fee coefficient**	
Sector 1	R1	15%	R'1	20%
Sector 2	R2	15%	R'2	20%
Sector 3	R3	15%	R'3	20%
Sector 4	R4	15%	R'4	20%

Table 8. 35 Appropriateness of charge payable for year 2022

	Sector 1		Sector 2	Sector 3	Sector 4
	Fixed	Total			
Average monthly payable fee (VND)	8,506	31,676	4,341,645	2,022,824	399,973
Monthly income	0,45 %				
Monthly expenditure	6,85 %				
O/M cost and interest	100%				
Investment cost	43%				

- Fee options for year 2023:

In this year, the recovery rate of investment cost is 48%, applied water tariff and tariff rates are as follows:

Table 8. 36 Water price of different sectors in year 2023

Domestic water prices (VND/m^3)				
Sector 1 (block 4 m^3)	**Sector 1 (block 4-6 m^3)**	**Sector 2**	**Sector 3**	**Sector 4**
8,358	15,914	14,884	16,143	27,249

Table 8. 37 Proposed coefficients for year 2023

Sectors	**Fixed fee coefficient**		**Variable fee coefficient**	
Sector 1	R1	15%	R'1	20%
Sector 2	R2	15%	R'2	25%
Sector 3	R3	15%	R'3	20%
Sector 4	R4	20%	R'4	35%

Table 8. 38 Appropriateness of charge payable for year 2023

	Sector 1		**Sector 2**	**Sector 3**	**Sector 4**
	Fixed	Total			
Average monthly payable fee (VND)	9,857	35,765	5,587,803	2,298,742	622,764
Monthly income	0,51 %				
Monthly expenditure	7,82 %				
O/M cost and interest	100%				
Investment cost	49%				

- Fee options for year 2024:

In this year, the recovery rate of investment cost is 54%, applied water tariff and tariff rates are as follows:

Table 8. 39 Water price of different sectors in year 2024

Domestic water prices (VND/m^3)				
Sector 1 (block 4 m^3)	**Sector 1 (block 4-6 m^3)**	**Sector 2**	**Sector 3**	**Sector 4**
8,943	17,028	15,926	17,273	29,156

Table 8. 40 Proposed coefficient for year 2024

Sectors	**Fixed fee coefficient**		**Variable fee coefficient**	
Sector 1	R1	15%	R'1	20%
Sector 2	R2	20%	R'2	30%
Sector 3	R3	15%	R'3	20%
Sector 4	R4	25%	R'4	40%

Table 8. 41 Appropriateness of charge payable for year 2024

	Sector 1		**Sector 2**	**Sector 3**	**Sector 4**
	Fixed	Total			
Average monthly payable fee (VND)	11,697	40,572	7,657,312	2,658,174	834,070
Monthly income	0,59 %				
Monthly expenditure	8,96 %				
O/M cost and interest	100%				
Investment cost	54%				

- Fee options for year 2025

In this year, the recovery rate of investment cost is 60%, applied water tariff and tariff rates are as follows:

Table 8. 42 Water price of different sectors in year 2025

Domestic water prices (VND/m^3)				
Sector 1 (block 4 m^3)	**Sector 1 (block 4-6 m^3)**	**Sector 2**	**Sector 3**	**Sector 4**
9,569	18,220	17,040	18,482	31,197

Table 8. 43 Proposed coefficient for year 2025

Sectors	**Fixed fee coefficient**		**Variable fee coefficient**	
Sector 1	R1	15%	R'1	20%
Sector 2	R2	20%	R'2	35%
Sector 3	R3	15%	R'3	25%
Sector 4	R4	25%	R'4	50%

Table 8. 44 Appropriateness of charge payable for year 2025

	Sector 1		**Sector 2**	**Sector 3**	**Sector 4**
	Fixed	Total			
Average monthly payable fee (VND)	13,967	46,054	9,364,235	3,517,000	1,081,360
Monthly income	0,67 %				
Monthly expenditure	10,27 %				
O/M cost and interest	100%				
Investment cost	61%				

This level of cost is not consistent with the WTP according to the survey data in 2017 (VND 5,000/month/person). However, this is the fee level at year 2025, people's WTP will increase together with the socio-economic growth (at least 8.5% / year => 5,000 x 1.085^8 = 8,850VND/month). This WTP is assumed at 20% of water tariff, so in 2025 the tariff rate will be increased corresponding to treatment rate. The CVM results show that obtained mean WTP under parametric method ranges from 30 – 45% of water bill.

Estimation results of tariff roadmap under Scenario 3 are presented by the following graphs:

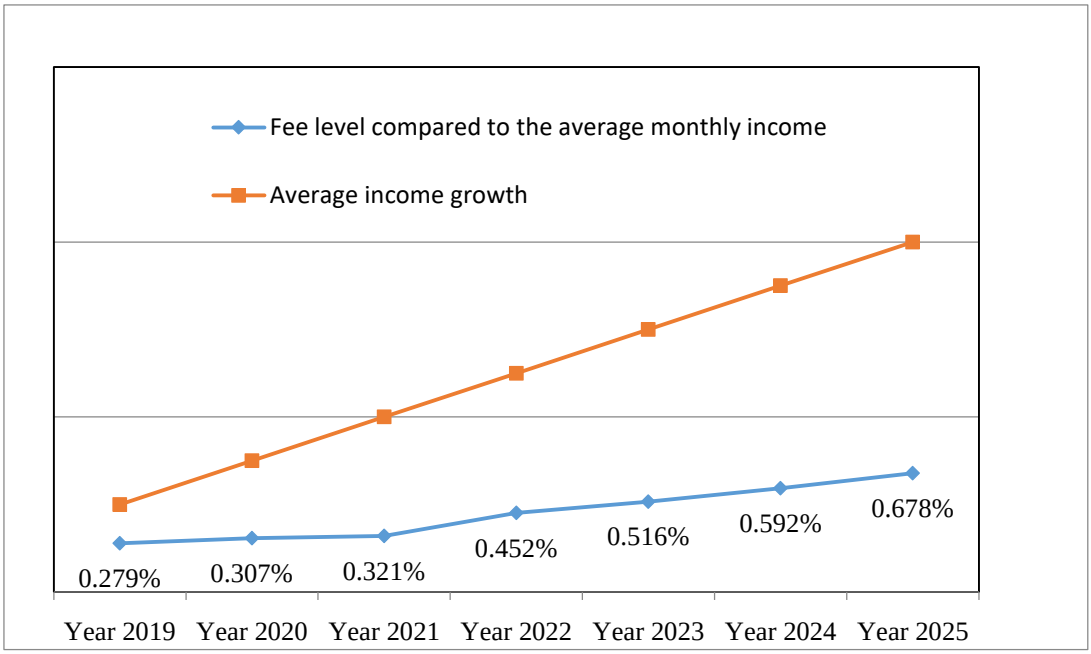


Figure 8. 5 The conformity of tariff rate compared to the income (Scenario 3)

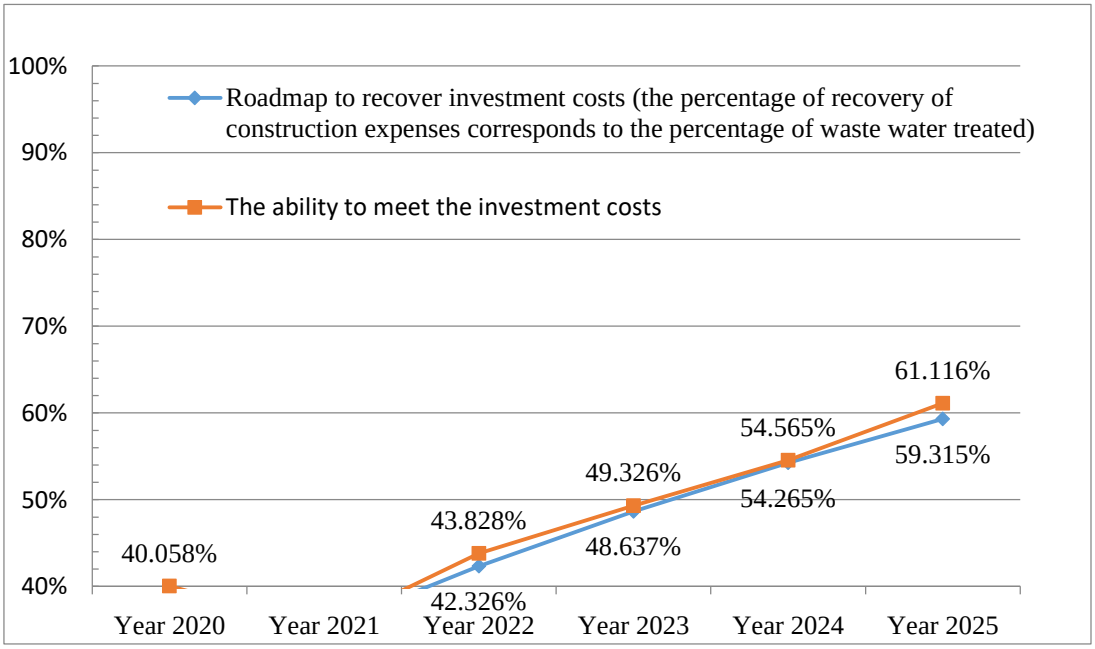


Figure 8. 6 Compatibility of tariff roadmap with investment costs (Scenario 3)

A comparison with 3 remain tariff roadmap scenarios:

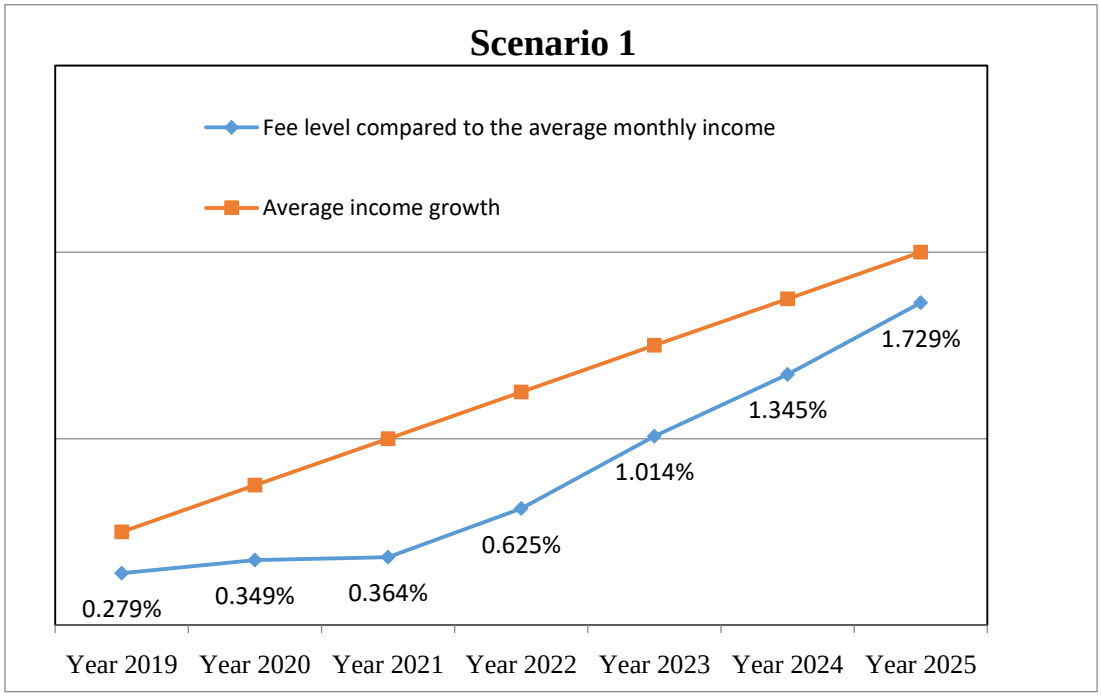


Figure 8. 7 The conformity of tariff rate compared to the income (Scenario 1)

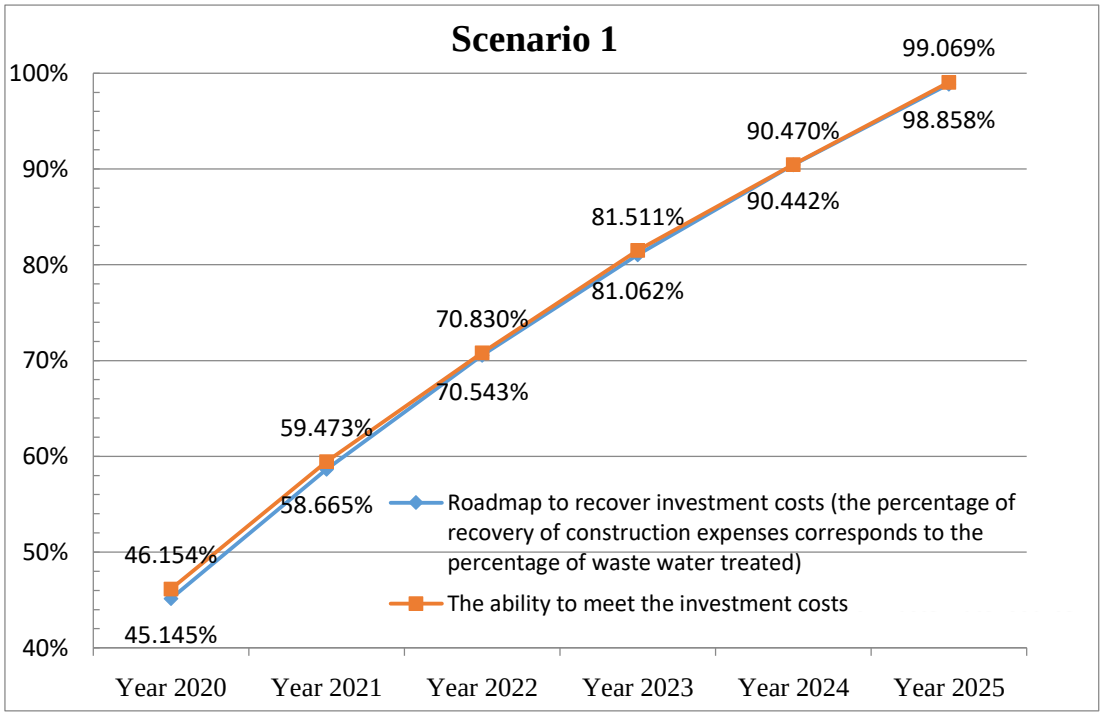


Figure 8. 8 Compatibility of tariff roadmap with investment costs (Scenario 1)

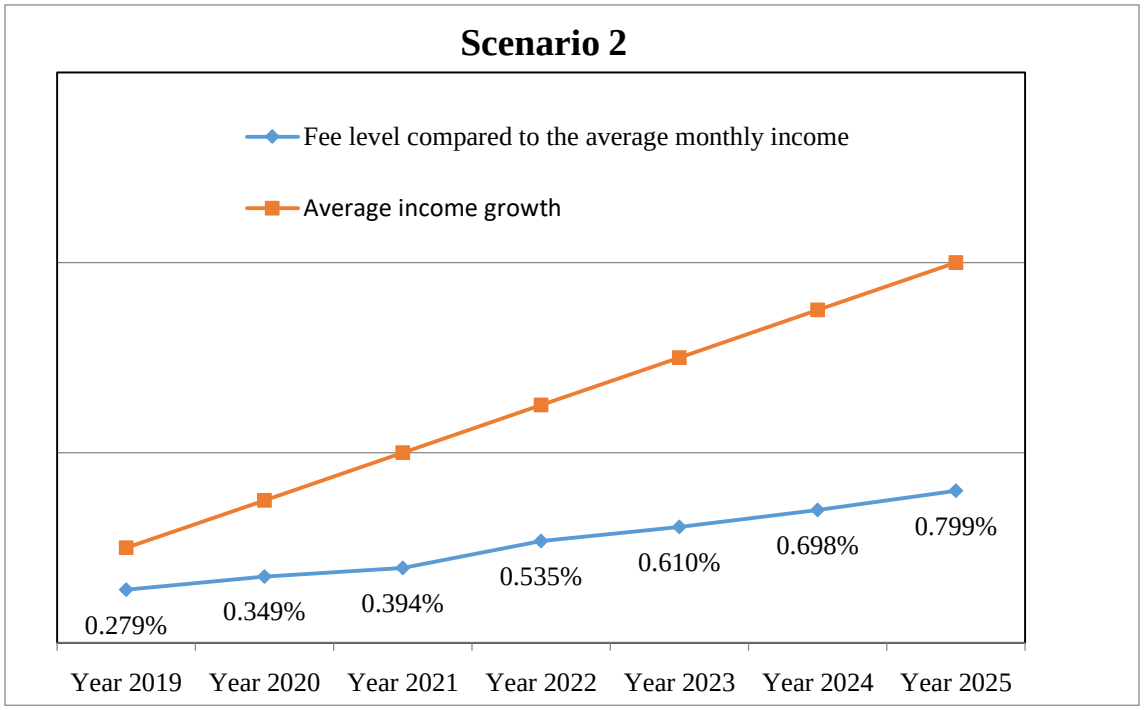


Figure 8. 9 The conformity of tariff rate compared to the income (Scenario 2)

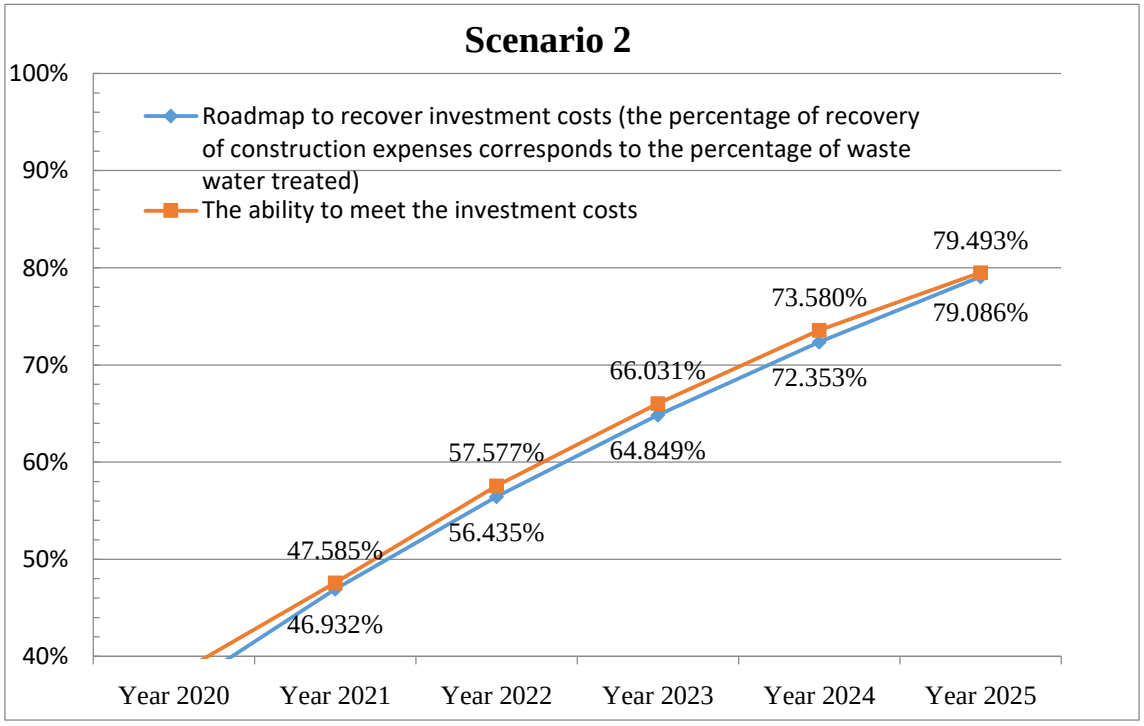


Figure 8. 10 Compatibility of tariff roadmap with investment costs (Scenario 2)

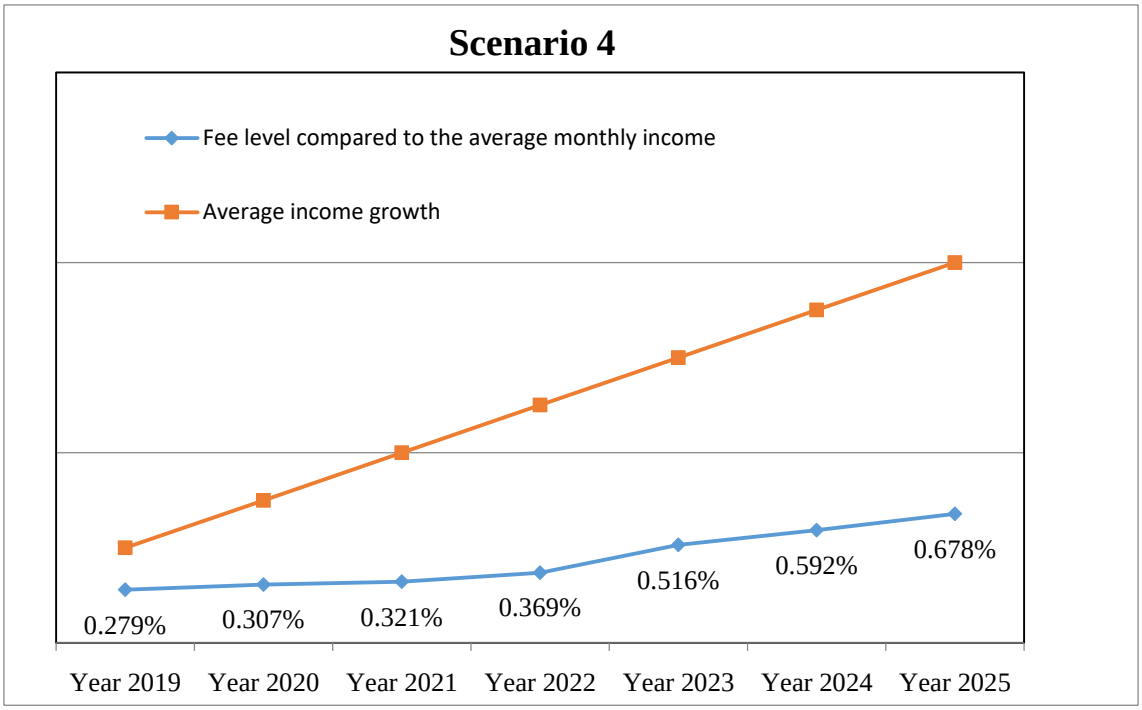


Figure 8. 11 The conformity of tariff rate compared to the income (Scenario 4)

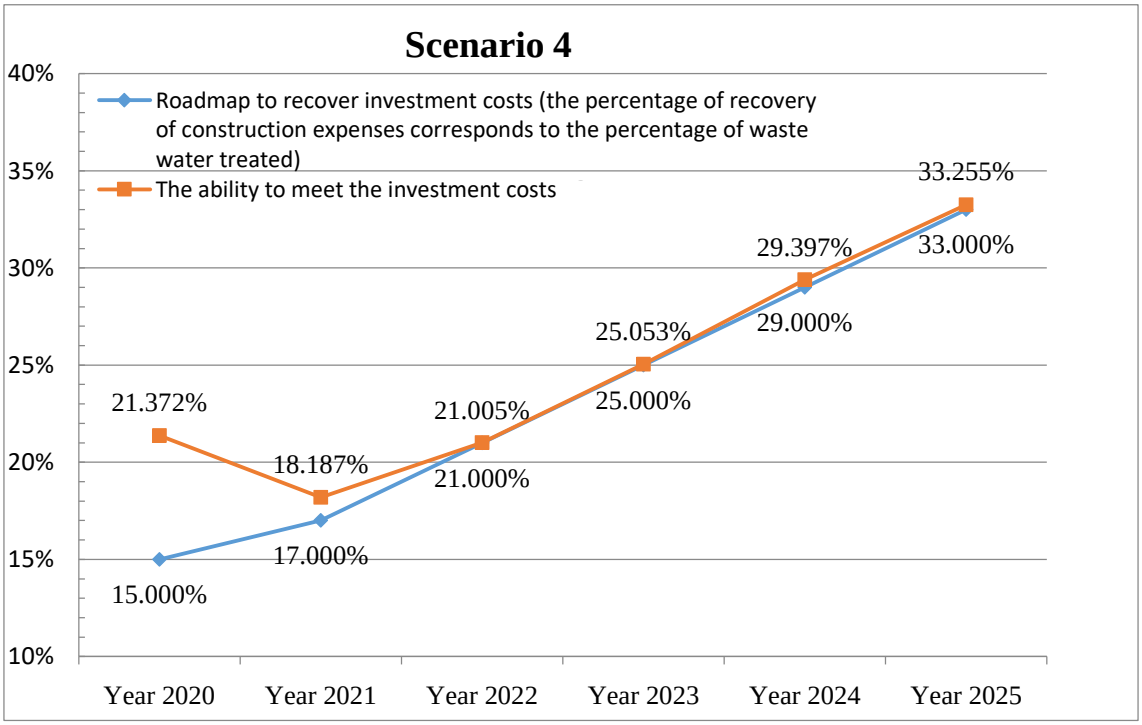


Figure 8. 12 Compatibility of tariff roadmap with investment costs (Scenario 4)

8.8.4 Evaluation and selection of an appropriate tariff roadmap

Among the obtained results of the 4 scenarios of wastewater tariff roadmap, the roadmaps of scenario 3 and 4 are most appropriate based on the evaluation of level of meeting main targets: average fee level that each person must pay monthly is in line with the WTP according to the survey results, in line with the average monthly income and the average per capita living expenditure per month for housing, electricity and sanitation, and ensure the ability of cost recovery according to the scenario.

At the same time, the roadmaps of scenario 3 and 4 are consistent with the opinions of the majority of people through interviews (when treated wastewater rate is increased, the increase in wastewater charge should be considered). The increase level in wastewater charges in accordance with people`s WTP is to gradually improve the cost recovery without causing socio-economic stress for the community. Moreover, these changes can promote consumer behavior change to increase effectiveness of water resource use.

In addition, scenario 3 and 4 are one of the two most suitable and reasonable scenarios compared to current situation of investment, development, and planning of water supply and drainage system of HCMC, as well as in accordance with capital mechanism, investment cash flow for WWTPs of HCMC in particular and Vietnam in general.

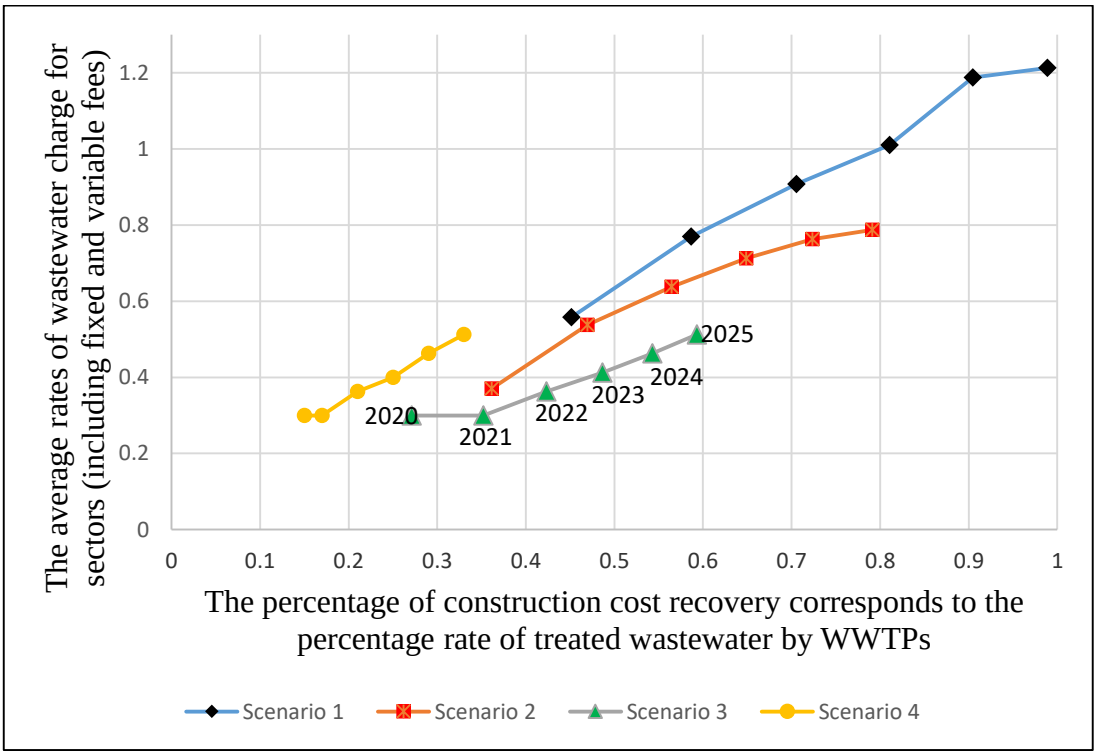


Figure 8. 13 Tariff rates corresponding to investment cost recovery level in scenarios

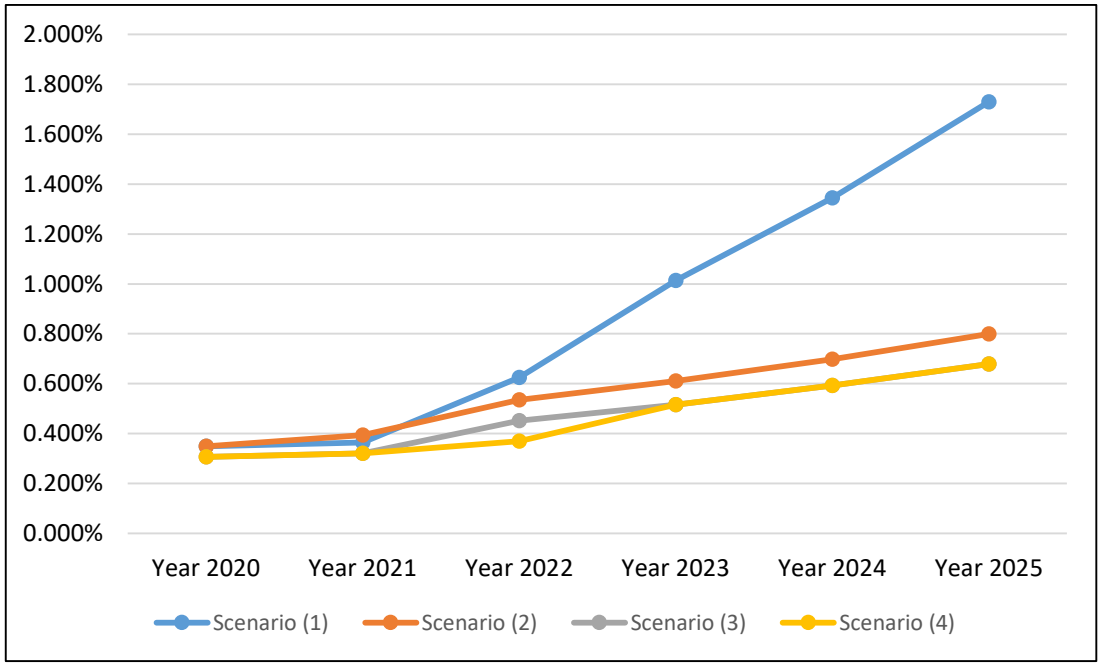


Figure 8. 14 Tariff rates against averge monthly income in scenarios

Specifically, for the scenario 3 - a roadmap of investment reaching 60% of total treated wastewater capacity compared to the WWTPs planning of HCMC in the period 2020-2025 is reasonable compared to 100% as the ambitious goal. As planned, the wastewater treatment rate in 2018 reached 8.85%, reaches 8.97% in 2019, reaches 45.15% in 2020 and reaches 98.86% in 2025. However, considering the actual investment situation to date, the plan until 2020 can only be achieved 60% of the plan (i.e. the rate of wastewater treatment reaches 27.09% in 2020 and 59.31% in 2025).

As for the scenario 4 - an investment roadmap in accordance with the planning for the period 2020-2025 and the construction cost will be recovered about 15% / year (corresponding to the percentage of private capital mobilization from bank loans, government bonds, ...) and 4% increase in the following years (corresponding to the average annual inflation rate) are in line with capital structure and investment cash flow for WWTPs and in accordance with the nature of public and welfare service investment.

In terms of feasibility of investment progress, Scenarios 1 cannot be achieved in reality as treatment target is set by 100% in 2025. In order to recovery of costs, it requires a high tariff rate that accounts for approximate 1.8% of average income while this is just over 0.6% in scenario 3 in 2025.

With the above analysis based on the obtained calculation results, the roadmap corresponding to the scenario 3 is the most appropriate when considering all aspects of the investment, development and planning situation of water supply and drainage system in HCMC such as capital structure, cash flow for investment, the nature of public investment, fee level is lower than treated wastewater rate.

Table 8. 45 Summary design rates set for tariff roadmap scenario (3)

Contents	Year					
	2020	**2021**	**2022**	**2023**	**2024**	**2025**
The percentage of construction cost recovery corresponds to the percentage rate of treated wastewater by WWTPs	27%	35%	42%	48%	54%	59%
The average rates of wastewater charge for sectors (including fixed and variable fees)	30%	30%	36%	41%	46%	51%

As can be seen in Table 8.45, the average tariff rates of all sectors range from 30 – 50% and tariff rate of households (Sectors 1) is always ensured in range of estimated WTP and in these designs household tariff rate accounts for 30 – 35% of water tariff.

CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

Wastewater issues affect both human living conditions and socio-economic activities. However, they have been overlooked when compared to other priority infrastructure and due to the limitation of management capacity and cost recovery ability from users. Currently, wastewater management in HCMC, Vietnam is in the transitional phase in terms of construction and service charge. The financial sustainability is a prerequisite that requires to introducing a tariff for wastewater. Wastewater rates that meets principles of tariff setting taking into account local conditions requires an adequate knowledge of customer base and market. Moreover, a possible approach of tariff setting for non-market public services based on the users' WTP has been emphasized when the approach of full cost recovery is infeasible especially in the transitional stage. Hence, this research is to gain an understanding of "demand side" on tariff level for service and evaluate residents' WTP. The study then aims to determine whether WTP-estimated rates contribute sufficient revenue to cover the economic costs of O/M costs, the investment and interest costs of WWTPs.

Affordability and WTP for wastewater tariff, however, are actually lower than the service costs. Therefore, the policy goals for this field development should be adopted appropriately so as to setting a tariff plan taking account of the demand side and their payment capacity. The study provides overview of tariff setting to promote sustainable urban wastewater management in HCMC. The study considers investment needs in the wastewater sector, and sets investment scenarios and tariff rates to examine wastewater fee that are likely to generate needed financial capital.

The WTP estimate was implemented through a survey of 431 respondents in 23 districts in HCMC during August and September, 2017 in line with Contingent Valuation Method. In the study it was hypothesized that the belief that entire wastewater in Ho Chi Minh City will be treated at WWTPs in according with Sewerage Master Plan might influence positively on people` WTP for the service, therefore a split-sample design was applied: a case group provided with the master plan information and a control group provided without information. The key findings of the study are apart from the global factors such as price level, income level, and water payment as well as service knowledge and satisfaction, the study indicated the scope of change and financial transparency of projects have a considerable effect on WTP. The majority of respondents expressed that they should pay for service, however the proportion of WTP response was small mainly due to their confidence in government.

Using the CVM, mean WTP is estimated by non-parametric approaches of Turnbull, Kriström and Upper bound was 9%, 17% and 25% respectively. In parametric approach, mean WTP including explanatory variables is higher over twice than mean WTP including only bid. The mean WTP of the models only bids ranges from 15 – 26% of water bill that account for half of mean WTP of the models full explanatory variables. The results also show the differences between the WTP in different issues. In the same SB model, the mean WTP of all sample (43%) is higher than the WTP in sample excluding protest (40%). It seems weird, however this might indicate that different

selected explanatory variables might affect the result of analysis as every independent variable has its own weight effect on dependent variable. It is logical the results when mean WTP excluding protest (40%) is higher than one including protest (30%) and mean WTP in single-bound model (43%) is lower than one in double-bounded model (49%).

Differences in the mean WTP being commonly found in the literatures could be attributed to different valuation methods, different models and approaches and socio-economic and demographic variables. Each method has its own pros and cons, it needs to caution when interpreting results. To date, there is no single method that can accurately calculate WTP from dichotomous choice questions.

The proposed methodological approaches for tariff setting and tariff roadmap are applied to actual treatment and investment situations and the planned investment roadmap over periods. This analysis relied on calculating the net value of revenue generated from the two proposed tariff structure and different pricing options and then these revenues are compared to principles or criteria to examine their meets in terms of affordability, fairness, and cost recovery of each structures. The results show that the two-part tariff structure including a fixed fee and a variable fee is the most feasible structure. The pricing option in this structure that taken from mean WTP result is 35% water bill and unit water price applied is under norm of 4 – 6 m^3.

Structure (2b), two-parts tariff which is suitable with the general experience and trend of the world and in accordance with the actual conditions of HCMC. In which, a fixed fee and a variable fee both ensure the purpose of affecting the behavior and awareness of users and also to meet revenue goals.

In addition, the outstanding feature of the fee structure is that it is calculated based on the amount of water used and the water tariff has been well set up. On the basis of pricing, selection of the wastewater tariff rate as a percentage of water tariff help not only in accordance with the current legal regulations on environmental protection fees but also easy for people to understand, therefore easy to get consensus from the people. In addition, when pricing, WTP and the monthly income are examined careful together with the investment roadmap of wastewater treatment system according to the planning.

Based on the information obtained from the empirical study carried out and the established principles and criteria, scenarios of tariff roadmap were developed. The results of selected tariff increase roadmap that is in line with investment roadmap for WWTPs, socio-economic growth, payment capicity and cross-subsidies confirm that the room for increasing the tariff level to finance a portion of the service cost would be feasible to their affordability. The results show that in period of 2025 with fixed rate 15% and variable rate 20% of water tariff, the wastewater tariff accounts for 0.68% of monthly household income. This revenue can recover 100% of O/M, interest costs and approximately 60% of investment cost corresponding to the wastewater treatment rates in this period.

The obtained calculation results, the roadmap under the scenario 3 is the most appropriate when considering all aspects of the investment, development and planning situation of water supply and drainage system in HCMC such as capital structure, cash flow for

investment, the nature of public investment, fee level is lower than treated wastewater rate.

This study would be a good effort for considering a concrete project of tariff setting, although there are several issues to be concerned for actual tariff application such as communication strategy using the persuasive messagesis, promoting transparency and opportunities that allow community engagement.

The study results also reveal the benefits of understanding public awareness and attitude in tariff establishment. Moreover, the positive outcome of WTP to achieve cost recovery depends on level of public awareness, attitude, trust and their involvement as stakeholders of projects.

9.2 Recommendations

Current wastewater charge level is set quite low compared to O/M costs for systems. If this tariff level is remained over later years when the more WWTPs will be put into operation, the risk of serious financial deficient in sewerage works is unavoidable in the future. Hence, a wastewater tariff be reformed to appropriate rates and considering the cross-subsidy principle is recommended. This principle ensures an affordable tariff for the poor class, and revenue deficient is supplemented by levying higher charge to the high income and business / service sectors.

In developed countries, there is always public involvement in city sewerage works in order to promote public awareness not only on water environmental conservation, but also consensus creation. The survey results also prove that water pollution was the second priority that need to be solved and the polluter pay principle gained high consensus, however, the high WTP only when high belief in Government and water environmental improvement are achieved.

O/M costs vary much depending on applied treatment technology and established measures for efficient O/M saving (e.g. remote management system, improvement of sludge treatment process). This issue need to be specially attended in the future and it can be implemented by intelligence sharing on successful experience, unsuccessful cases and O/M know-how.

It is recommended that the wastewater tariff is started from the WTP level in order to introduction of the wastewater tariff avoiding heavy objections from the people. The wastewater tariff later can be raised to the level that recovering O/M costs. It is needed to take into consideration the appropriate time for raising of the tariff. The estimated and applied WTP for tariff setting in this study is between 20 to 45% of water tariff, it is suggested that the wastewater fee should be increased from the current charges of 20% – 25% (5% for fixed fee as EPF and 15% – 20% for variable fee).

Table 9. 1 Example of recommended wastewater rate

Unit: m^3/person/month

Norm	Volume used	Water tariff	Water bill	Wastewater tariff			Total (VND/person)
				Fixed	Variable		
				15%	15%	20%	
4	4	6,100	24,400	3,660	3,660	4,880	7,320 – 8,540
4 – 6	6	11,500	47,400	7,110	7,110	9,480	14,220 – 16,590

It can be seen one person uses 4 m^3 or 6 m^3 water per month, month payable wastewater fee is about 7,500 – 8,500 or 14,000 – 16,500 VND/person/month respectively that equivalent to price of a bottle of pure water Aquafina 1.5L or a can of beer Sapporo 330ml respectively.

For long term target, the wastewater tariff should meet with the full cost recovery including O/M, equipment replacement and depreciation and reinvestment in accordance with the economy growth. This can be applied after achieving a comprehensive the wastewater treatment system.

A roadmap for increasing revenue and achieving cost recovery is necessary. It is recommended that in transitional phase at least O/M cost and interest and a part of investment cost are funded through wastewater tariffs paid by sectors. Willingness to charge customers to recover costs should be considered as a part of local authority wastewater policy. Increased cost recovery would ensure better compliance with both the "affordability" principle and improve financial sustainability. Here are solutions to achieve targets above:

- Increase wastewater fees incrementally over time in accordance with WTP surveys and the economic basis needs to be analyzed to determine the appropriateness of change.
- Increase awareness and belief of residents
- Financial support for poor households and allocate costs equitably could be provided through tariff cross-subsidies
- The new provisions should be implemented gradually and a comprehensive training program would be essential to support this effort.

Future research challenges are defined based on study limitation. The study estimated the WTP of the household water consumers for service sustainability while there are 4 types of consumers. Therefore, it is necessary to take into consideration all water use sectors for the estimation of total economic benefits of service improvement.

APPENDIX 1

QUESTIONNAIRE

A STUDY ON AN APPROPRIATE DOMESTIC WASTEWATER TARIFF – A CASESTUDY IN HCMC

Determination of Willingness to pay for domestic wastewater treatment services

To the household

I am a graduate student of Toyo University, Japan and am conducting the survey on tariff collection of wastewater services in HCMC. I would like to interview you several questions please.

The Questionnaire consists of issues related to environment, water use and domestic wastewater tariff collection in HCMC. Your responses are very crucial in order to grasp the community's demand as well as expectations that will enable the researcher to make proposal to City.

The survey takes about 30 minutes to complete.

Your responses are only used for academic study and will be completely kept confidential.

To express heartfelt thanks.

Date:_____

Section 1: Awareness and opinions about social issues in city

Q-1. Please rank the following issues in terms of importance need to be solved for city residents
(1=the most important, 2=second most important, and 3=third most important, then 4, 5,)

____ Traffic jam
____ Power cut
____ Health
____ Flooding
____ Others (please specify):_____
____ Water pollution in canals and rivers
____ Air pollution
____ Waste issue
____ Climate change

Q-2. Please rate the seriousness of the following environmental issues in HCMC

	Not at all serious (1)	Slightly serious (2)	Serious (3)	Very serious (4)	Extremely serious (5)
Air pollution					
Water pollution					
Waste management					
Global warming					
Flooding					

Surrounding environment

Q-3. Is your house near a canal or river?

How is the water environmental situation in your living area?

☐ Very good (5) ☐ Good (4) ☐ Normal (3) ☐ Bad (2) ☐ Very bad (1)

Q-4. Is your house/area flooded?

	Never (1)	Once many years (2)	1-2 times a year (3)	Many times during year (4)
Flooded by rainfall				
Flooded by high tide				

Q-5. **Please share your rate of agreement on the following statement.**

	Strongly disagree (1)	Disagree (2)	Don't know (3)	Agree (4)	Strongly agree (5)
Water pollution/wastewater issues of the city become increasingly serious in recent years.					
The major reason of water pollution is in consequence of untreated wastewater discharge from people's activities into rivers/canals.					
Wastewater/water pollution causes many negative impacts on current and future generations					
The untreated wastewater discharging directly into rivers will influence the input water quality of water supply plants.					
Wastewater collection and conveying to treatment plants can partly control city flooding.					
Settling wastewater/water pollution issues require the cooperation of city authority and people.					
Improving water environment/wastewater treatment is government/city authority's responsibility					
People should pay taxes/tariff of wastewater treatment services to contribute another revenue source so that City can improve and prevent water pollution effectively.					

Q-6. How do you assess the importance of wastewater collection and treatment in HCMC area in terms of the improvement of people's life quality as well as protection of the source of water supply and public health and environment?

☐ Important (→ Q-7) ☐ Unimportant (→ Q-8)

Q-7. Why do you think wastewater collection and treatment is important? *(can choose more than 1 answer*)

The wastewater collection and treatment can contribute to:

_____ (1) Protect the environment then improve quality of life and the hygienic conditions in the areas

_____ (2) Reduce partly the flooding that resulting in reduction of the social and financial consequences and traffic congestion

_____ (3) Improved river water quality since then ensuring quality of raw water source for water supply plant

_____ (4) Others (please specify):_____

Q-8. Why do you think wastewater collection and treatment is unimportant? (can choose more than 1 answer)

_____ (1) Wastewater collection and treatment do not affect directly my family benefits

_____ (2) I do not believe in the role of wastewater collection and treatment in improving quality of water environment in city.

_____ (3) Others (please specify):_____

Section 2: Water use

Q-9. Does your house connect to the local water supply system?

☐ **Yes** **(ask all below questions)**

☐ **No** **(Proceed to Q-14)**

Q-10. How much is your household monthly average water consumption and bill?

_____m^3 _____VND

Q-11. What do you think about the current prices of water supply in general?

Level	Too low (1)	Low (2)	Reasonable (3)	High (4)	Too high (5)
Water supply price					

Q-12. Do you know or recognize the environmental protection fee for wastewater (10%) is included in your water bill?

☐ Yes ☐ No

Q-13. What do you think about 10% environmental protection fee (EPF) for wastewater?

Level	Too low (1)	Low (2)	Reasonable (3)	High (4)	Too high (5)
10% EPF					

Q-14. If your house is currently not connected to city water distributors, or apart from using water supply from city system, which other water sources does your house use?

☐ Well-water ☐ River

☐ Water vendor's ☐ Others (please specify):

_____

Q-15. If buying water or pumping from well/river, how much is your monthly average expenditure for the water come from these sources? _____

Q-16. How do you assess the quality of water supplied to your house? (Choose 1 answer)

_____ (1) Very good (can drink at tap)

_____ (2) Good (use for cooking, washing, bathing and boiled drinking-water)

_____ (3) Acceptable (for washing but not cooking and not for boiling drinking-water)

_____ (4) Others (please specify): _____

Section 3: Wastewater and Health

Q-17. How do you dispose of your wastewater?

17.1 Toilet wastewater

☐ Sewerage system ☐ Open drainage canals/river

☐ Septic tank ☐ Others (specify) _____

17.2 Grey wastewater (washing/bathing/kitchen)

☐ Sewerage system ☐ Open drainage canals/rivers

☐ Open field ☐ Other (specify) _____

Q-18. Did any member of your household experience any of these disease in the last 6 months?

☐ Diarrhea ☐ Cholera ☐ Dengue

☐ Typhoid ☐ Hepatitis A ☐ Others: _____

☐ No

Q-19. Are you satisfied with the current household wastewater disposal?

Not at all satisfied (1)	Slightly satisfied (2)	Somewhat satisfied (3)	Very satisfied (4)	Extremely satisfied (5)

Section 4: Social Acceptance of Wastewater tariff

It can be seen that the discharge situation of untreated wastewater from man activities has caused the worsening environmental pollution, especially water pollution at the canals and rivers in the city. Truly, the Dong Nai river, a main source of raw water supply for HCMC, is being polluted increasingly. There are many reasons but mainly by wastewater discharge from domestic and agricultural, industrial activities in which, domestic wastewater is account for the highest percentage of entire city wastewater. It is judged that domestic wastewater itself is a fearful water source pollution-causing agent and is leading environmental peril in Vietnam at present.

To solve these situations, our City has carried out many projects of wastewater collection and treatment in HCMC since 2001. All domestic wastewater will be collected and treated by stages. The significant benefits of the domestic wastewater collection and treatment are environmental protection, improvement of the quality of life and hygienic condition in the city area, with a further impact on the development of tourism and economy in general, as well as partly reduction of flooding incidences (e.g. indirect damage, nuisance and public health problems caused by uncontrolled flooding and polluted surface water runoff).

Constructing the wastewater collection system and treatment facilities requires a huge initial capital expenditure and operation and maintenance costs. However, the environmental protection fee for wastewater included in households' water bills is currently 10% of water price. In order to ensure financial viability of wastewater treatment facilities, an increase in charge for wastewater services is indispensable, therefore a survey should be implemented to determine people's ability and willingness to pay (WTP) for tariff increase of wastewater services.

Q-20. Do you know HCMC has some operated WWTPs?

☐ Yes ☐ No

Q-21. Have you ever heard about wastewater/sewage tariff?

☐ Yes ☐ No

Q-22. Several cities in Vietnam have applied wastewater tariff, do you know or have heard about that?

☐ Yes ☐ No

Q-23. Do you agree that wastewater tariff collection is the best way of water environmental improvement in terms of financial efficiency?

☐ Yes ☐ No ☐ Maybe ☐ Don't know

Currently, HCMC has 3 WWTPs are under operation that treat approximately 7-8% city domestic wastewater, one existing WWTP has being upgraded, two new WWTPs are constructing and other 4 WWTPs are under calling investments. The wastewater treatment services of city are going to complete soon by stages if your household contribute a certain amount.

Suppose the City Authority wishes to encourage the increase in tariff for domestic wastewater services in coming future.

Q-24. How would you feel about increase in wastewater tariff?

☐ Concur (→ Q-25)

☐ Not concur (→ Q-26)

☐ Have no feeling about the tariff increase (→ Q-27)

Q-25. If your answer is concurence as increased wastewater tariff, what could be your reasons? (can choose more than one)

1_____ I think increased wastewater tariff means quality of wastewater services will be better

2_____ I see the existing wastewater fee is **too** low

3_____ I think if the increased wastewater tariff, it is not significant compared to my high enough income

4_____ Other reasons (please specify): _____

Q-26. If your answer is unhappy as increased wastewater tariff, what could be your reasons? (can choose more than one)

1_____ Generally, I do not want an increase in price

2_____ I do not think that increase in wastewater tariff would be corresponding to the increase in treated wastewater quantity and quality

3_____ The common subsistence expenses such as prices of power, water, food that are increased continuously are the cost burden to people. Therefore, increase in wastewater fee while the state is with no support policy like **price support** to ease the cost burden made me unsatisfied

4_____ Other reasons (please specify): _____

Q-27. If your answer is no feeling about increased wastewater tariff, what could be your reasons? (can choose more than one)

1_____ I think if wastewater tariff is increased, it is in accordance with socio-economic development and people's income line

2_____ The state enforces; it forces to accept

3_____ Other reasons (please specify): _____

As above-mentioned, before increasing wastewater tariff, a referendum would be carried out to determine how city residents would support the increase in price as well as their ability and WTP for the improved services. As a result, in this survey, we would like to know if your household will be willing to contribute to the projects of domestic wastewater services, when polluted canals and rivers due to discharge of domestic wastewater gradually are improved so that the improved areal living environment, the stable and safe source of water supply for city as well as reduction of flooding incidence and then prevention of waterborne diseases are able to be achieved.

You are participating in the survey that is only to explore your opinion about ability and WTP for improved wastewater services in our city. Although this is not a real referendum for an actual increased wastewater tariff but we desire to gain your valuable sincere opinion as if a survey for an actual increase in wastewater tariff is taking place. Consequently, please consider benefits that the improved wastewater services bring in to decide related payment as this may partly affect amount of expenditure available for your household needs.

As your answer in **Q-10**, your household's monthly average water consumption and bill are:
_____m^3 _____VND

Q-28. Currently your household is paying 10% EPF for wastewater based on monthly water bill. To contribute to the improvement of city wastewater services, would your household be willing to pay about _____% bill of water used of your household per month as a domestic wastewater charge?

☐ Yes → **Q-28a. How about the rate level of _____%, are you still willing to pay?**

☐ Yes ☐ No

☐ No → **Q-28b. How about the rate level of _____%, are you willing to pay?**

☐ Yes ☐ No

Q-29. If you are not willing to pay for the above levels, is your household willing to pay for the improved services?

☐ Yes => How much? _____ % /month (Proceed Q-31)

☐ No (Proceed Q-30)

Q-30. If you are not willing to pay any level of rate for wastewater treatment service, please could you share which are your reasons: (can choose more than one)

_____ I cannot afford to pay any additional expenditure to what I am now paying.

_____ I think the current fee for wastewater is high

_____ I think the fee of wastewater treatment must be burden by authority/government

_____ I do not trust the administration and allocation of collected fee source

_____ I do not care about quality of water and environment

_____ I do not believe that fee collection will result in improved wastewater service

_____ I do not believe that the improved wastewater service will result in the better water supply quality or flooding reduction

_____ I do not fully understand the issue

_____ Other reasons (please specify):
_____

Q-31. In case the wastewater tariff increase to certain amount, do you and your family think about or intend to use less water than before, on the other hand, to save on / economize water so the bill of water and wastewater is maintained as before even increased wastewater tariff?

☐ Yes, I think so ☐ No, I do not think about that yet

☐ Not sure, it is up to the pricing level

Section 5. Assessment of Institutional Arrangements

Q-32. In case, City will lay down as a policy the domestic wastewater tariff collection, which form of tariff structure that you/your family want to suggest?

☐ Wastewater tariff is calculated as a percentage of water bill

☐ Wastewater tariff is calculated by a specific amount of money per capita? (e.g. 5000, 10.000, 15.000 VND/month/capita)

☐ Wastewater tariff is calculated by a specific amount of money per household? (20.000, 40.000, 60.000 VND/month/household)

☐ Wastewater tariff is divided into 2 parts: fixed price (VND/household/month) + Variable price according volume of water use

☐ Wastewater tariff is calculated by uniform rate (plus fixed charge or not fixed charge)

☐ Other (please specify): _____

Q-33. Which the following way of unit price that you suggest to apply?

☐ VND/m^3/person ☐ Do not want to suggest because we are against any further tariff payment

☐ VND/m^3/household ☐ Don't know

Section 6. Socio-demographic information

1. Age: _____
2. Gender: _____ Male _____ Female
3. Marital status: _____ Single _____ Marriage _____Separated / Divorced / Widowed
4. Education level of interviewee

   ☐ No schooling ☐ Primary school ☐ High school

   ☐ Careers guidance ☐ Junior College/University ☐ Master/PhD degree

   ☐ Others (please specify): _____

5. Employment of

Interviewee	Household head
☐ Unemployed	☐
☐ Agriculture	☐
☐ Own business-service	☐
☐ Government employee	☐
☐ Private employee	☐
☐ Own business-industry	☐
☐ Retired/Housewife	☐
☐ Small informal business	☐
☐ Others_____	☐ Others_____

6. Household size: _____ Adults
   _____ Teenager (from 13 to 19)
   _____ Children (from less 12 years old)
7. How many people contribute to your household income? _____

8. Please mark your currently monthly household income in suitable case (including income of all family member having income) (*This information will be solely used for research purpose and will be kept confidential)*

☐ Less than 3.000.000 VND

☐ 3.000.100 VND - 6.000.000 VND

☐ 6.000.100 VND - 9.000.000 VND

☐ 9.000.100 VND - 12.000.000 VND

☐ 12.000.100 VND - 15.000.000 VND

☐ 15.000.100 VND - 18.000.000 VND

☐ 18.000.100 VNĐ - 21.000.000 VND

☐ 21.000.100 VNĐ - 24.000.000 VND

☐ 24.000.100 VNĐ - 27.000.000 VND

☐ 27.000.100 VNĐ - 30.000.000 VND

☐ 30.000.100 VNĐ - 33.000.000 VND

☐ More than 33.000.000 VND

9. Housing ownership:

_____ Owner _____ Rented house _____ Living with relatives

10. About monthly household expense, how much does your household spend on the following items?
Food: _____ Gas: _____ Waste: _____

Electricity: _____ Transportation: _____

To express heartfelt thanks

BIBLIOGRAPHY

[ADB] Asian Development Bank (2010). Vietnam Water and Sanitation Sector Assessment, Strategy and Roadmap. Southeast Asia Department Working Paper. Manila: ADB.

[DOT] Department of Transportation (2018). Summary report year 2018, orientation and tasks of 2019 (based on report of water supply of SAWACO - Saigon Water Company)

[JICA] Japan International Cooperation Agency (2009). The Republic of Kazakhstan - The study in sewerage operation and maintenance know-how transfer. Final report. Nippon Koei Co., LTD. Nihon Hels Industry Corporation.

[JICA] Japan International Cooperation Agency (2011). People`s Committee of Hanoi City – Socialist Republic of Vietnam. Study for introduction of PPP for sewerage facilities in Hanoi. Final report. Oriental Consultants Co., Ltd., Water Agency Inc., Orix Corporation, Padeco Co., Lrd., and Yokohama Water Co., Ltd.

[MONRE] Ministry of Natural Resources and Environment (2010). National state of environment 2010 – An overview of Vietnam environment.

[UN Environment] United Nations Environment Programme, Resources and Markets Branch (2018). Pricing reforms for sustainable water use and management in Vietnam. Working paper.

[WHO] World Health Organization, Ministry of Health - Vietnam Health Environment Management Agency (VIHEMA), and United Nations International Children's Fund (Unicef) (2012). Vietnam Water Sector and Sanitation Sector Assessment Report.

Accent and RAND Europe (2010). Review of Stated Preference and Willingness to Pay Methods.

Accent and RAND Europe (2010). Review of stated preference and willingness to pay methods. Accent report on WTP FINAL, CH.09.04.10.

Altaf, M.A. (1994). Household demand for improved water and sanitation in a large secondary city: Findings from a study in Gujranwala, Pakistan. Habitat Int., 18, 45–55.

Altaf, M.A. and Hughes, J.A. (1994). Measuring the demand for improved urban sanitation services: Results of a contingent valuation study in Ouagadougou, Birkina Faso. Urban Studies, 31, 1763–1776.

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R., and Schuman, H. (1993). Report of the NOAA Panel on Contingent Valuation. National Oceanic and Atmospheric Administration.

Bateman, I. J., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozedemiroglu, E., Pearce, D., Sugden, J., and Swanson, J. (2002). Economic valuation with stated preference techniques: A manual, Edward Elgar, Cheltenham, UK.

Bateman, I.J., IH Langford, AP Jones, GN Kerr: Bound and path effects in double bounded and triple bounded dichotomous choice contingent valuation. Resource and Energy Economics 23: 181–213. 2001.

Calia, P. and Strazzera, R. (1998). Bias and efficiency of single vs. double bounded models for contingent valuation studies: A Monte Carlo Analysis. Working Paper. CRENoS, (http://veprints.unica.it/331/).

Campos, M. R. A. (2007). Regulatory Pricing of Water and Sewerage Services in Metro Manila. PhD thesis, Southeast Asian Regional Center for Graduate Study and Research in Agriculture, University of the Philippines Los Baños.

Carson, R.T. (2000). Contingent valuation: A user's guide. Environ. Sci. Technol, 34, 1413 – 1418.

Choe, K., Whittington, D., Lauria, D. T. (1996). The economic benefits of surface water quality improvements in developing countries: A case study of Davao, Philippines. Land Economic, 72(4), 519–537.

Coase, R. H. (1946). The Marginal Cost Controversy. Economica, 13:169–182.

Dang, D.T. (2013). People`s awareness on climate change and assessment of impact mitigation policy: Case study of Ho Chi Minh City, Vietnam (Nhận thức về biến đổi khí hậu và đánh giá của người dân cho chính sách giảm thiểu tác động: Nghiên cứu trường hợp Thành phố Hồ Chí Minh, Việt Nam). In study project of `Willingness to pay for Climate Change Mitigation Policies in Vietnam` sponsored by EEPSEA and HCMC University of Economy.

Del Saz-Salazar, S., Hernández Sancho, F., and Sala Garrido, R. (2009). The social benefits of restoring water quality in the context of the Water Framework Directive: A comparison of willingness to pay with willingness to accept. Sci Total Environ, 407(16): 4574-83.

Dixon, J. A. (2012). Enhanced cost benefit analysis of IDB waste water treatment projects with special consideration to environmental impacts – Lessons learned from a review of four projects. Discussion paper No. IDB-DP-254. Washington, DC, United States: Inter-American Development Bank.

Dziegielewska, D. P. and Mendelsohn, R. (2007). Does "No" mean "No"? A Protest Methodology. Environmental and Resource Economics, 38(1): 71-87.

Fischhoff, B. (2001). Environmental Cognition, Perceptions, and Attitudes. ELSEVIER-International Encyclopedia of the Social & Behavioral Sciences, Pages 4596-4602.

Frey, U. J. and Pirscher, F. (2019). Distinguishing protest response in contingent valuation: A conceptualization of motivations and attitudes behind them. PLoS ONE 14(1): e0209872. https://doi.org/10.1371/journal.pone.0209872

Fujita, Y., Fujii, A., Furukawa, S., and Ogawa, T. (2005). Estimation of willingness to pay (WTP) for water and sanitation services through contingent valuation method (CVM) – A case study in Iquitos City, The Republic of Peru. JBICI Review, 10, 59–87.

Fuks, M. and Chatterjee, L. (2008). Estimating the willingness to pay for a flood control project in Brazil using the Contingent Valuation Method. Journal of Urban Planning and Development, 134(1).

General Statistics Office (2017). Statistical Summary Book of Vietnam. Statistical Publishing House, Hanoi, Vietnam.

Genius, M., Manioudaki, M., Mokas, E., Pantagakis, E., Tampakakis, D., and Tsagarakis, K. P. (2005). Estimation of willingness to pay for wastewater treatment. Water Science and Technology: Water Supply, 5(6), 105–113.

Giraud, K. L., Loomis, J. B., and Cooper, J. C. (2001). A Comparison of Willingness to Pay Estimation Techniques from Referendum Questions. Environmental and Resource Economics.

Haab, T.C., and McConnell, K. E. (2002). Valuing Environmental Natural Resources: The Econometrics of Non-Market Valuation. Northampton, MA: Edward Elgar Publishing.

Hanemann, W.M. and Kanninen, B. (2001). The statistical analysis of discrete-response CV data. In: Bateman, I. J. and Willis, K. G. (eds): Valuing environmental preferences: Theory and practice of the contingent valuation method in the US, EU, and Developing Countries. Oxford University Press, Oxford, UK.

Hanemann, W.M., Loomis, J., and Kanninen, B. (1991). Statistical efficiency of double bounded dichotomous choice contingent valuation. American Journal of Agricultural Economics, 73, 1255 – 1263.

Herath, G., J. Yang, Pattanayak, S., and C. van den Berg (2006). Wilingness-to-pay and design of water supply and sanitation projects: A case study. ERD Technical Note Series, Economics and Research Department No. 19. Asian Development Bank.

Ho Chi Minh City Statistical Office (2018). Statistical Yearbook of Ho Chi Minh City and Ho Chi Minh City Socio-economic Report. Ho Chi Minh City Statistical Bureau.

Hoang-Hue T. (2018). People`s willingness to pay to improve clean water service in Dong Trieu Commune, Quang Ninh Province. VNU Journal of Science: Earth Science and Environment, Vol 34, No. 3 (2018) 110-119. [in Vietnamese with English abstract]

Hoehn, J. P., and Krieger, D. J. (2000). Economic analysis of water investment and tariffs in Cairo, Egypt. Water Resources Planning and Management, 126(6), 345-350.

http://kttvqg.gov.vn/tin-tuc/8017/TP.-H%C3%B4-Chi-Minh:-Den-nam-2020,-80-nuoc-thai-sinh-hoat-duoc-xu-ly-dat-chuan.html

Janmaimool, P, and Watanabe, T. (2014). Evaluating determinants of environmental risk perception for risk management in contaminated sites. Int J Environ Res Public Health, 11(6): 6291-6313.

Kahneman, D. and Knetsch J. (1992). Valuing public goods: The purchase of moral satisfaction. Journal of Environmental Economics and Management, vol. 22, issue 1, 57-70.

Kriström, B. (1990), "A Non-Parametric Approach to the Estimation of Welfare Measures in Discrete Response Valuation Studies," Land Economics, 66, 2, 135-139.

Le, T. P. D., Nguyen, H. D., and Nguyen, T. H. G. (2016). Willingness to pay for remediation of water environment in wooden craft village of Dong Ky, Bac Ninh. Vietnam J.Agri.Sci., 14(2), 274–280. [in Vietnamese with English abstract]

Le-Dung, T. P., Nguyen-Dat, H., Nguyen-Giang, T. H. (2016). Willingness to pay for remediation of water environment in wooden craft village of Dong Ky, Bac Ninh. Vietnam J.Agri.Sci., Vol. 14, No. 2: 274-280. [in Vietnamese with English abstract]

Lizinski, T., Wroblewska, A., and Rauba, K. (2015). Application of CVM method in the evaluation of flood control and water and sewage management projects. Journal of Water and Land Development. No. 24 (I-III): 41-49.

Lorenzoni, I. and Pidgeon, N. (2006). Public views on climate change: European and USA perspectives. Climatic Change 77: 73–95.

Mara, D. (2004). Domestic wastewater treatment in developing countries. Earthscan Publisher.

Natural Resources and Environment Newspaper: Ho Chi Minh City: Up to 2020, 80% domestic wastewater is going to be treated to come up to the standard. Ministry of Natural Resources and Environment, Vietnam Meteorological and Hydrological Administration, 2017. http://kttvqg.gov.vn/tin-tuc/8017/TP.-H%C3%B4-ChiMinh:-Den-nam-2020,-80-nuoc-thai-sinh-hoat-duocxu-ly-dat-chuan.html [accessed in 2018, in Vietnamese]

Ngo, T. T., Tran, T. T. H., Vu, T. T. (2015). Estimation of willingness to pay of local residents in order to minimize water pollution at vocational village of Van Phuc – Ha Dong. Journal of Forestry Science and Technology, 2, 123–130. [in Vietnamese with English abstract].

Nguyen, H. T., Hoang, V. M., and Nguyen, V. H. (2012). Applying contingent valuation method to study willingness to pay for construction of wastewater water system at a rural area of Vietnam. TCNCYH Insert, 79(2), 151–157. [in Vietnamese].

Nguyen, V. A. (2018). Water and wastewater management in Vietnam: Status, Plans, and Business Opportunities. Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering and Science and Technology Department, Vietnam Association of Water Supply and Sewerage (VWSA).

OECD (2003). Key Issues and Recommendations for Consumer Protection: Affordability, Social Protection, and Public Participation in Urban Water Sector Reform in Eastern Europe, Caucasus and Central Asia. Organization for Economic Co-Operation and Development.

Palanca-Tan R. (2015). Knowledge, attitudes, and willingness to pay for sewerage and sanitation services: A contingent valuation survey in Metro Manila, Philippines. Environmental Science and Management, 18(2), 44–52.

Pattanayak, S. K., C. van den Berg, J-C. Chen, and G. van Houtven (2006). The use of willingness to pay experiments: Estimating demand for piped water connections in Sri Lanka. World Bank Policy Research Working Paper No. 3818, The World Bank, Washington DC.

Pham, K. Nam and Tran, V. H. Son (2005). Household demand for improved water services in Ho Chi Minh City: A comparison of Contingent Valuation and Choice Modeling estimates. EEPSEA Research Report.

- Porcher, S. (2013). Efficiency and Equity in two-part tariffs: the case of residential water rates. Journal of Applied Economics, Volume 46, 2013 – Issue 5: Environmental and Natural Resource Economics Policy and Management. [https://doi.org/10.1080/00036846.2013.857001]

Portney, P. R. (1994). The Contingent valuation debate: Why economists should care. Journal of Economic Perspectives 8(4), 3-17.

Soden, D. L. and Steel, B. S. (1999). Handbook of Global Environmental Policy and Administration. Public Administration and Public Policy/74. Marcel Dekker, Inc – New York-Basel.

Steyerberg, E. W., Vickers, A. J., Cook, N. R., Gerds, T., Gonen, M., Obuchowski, N., Pencina, M. J. and Kattan, M. W. (2010). Assessing the performance of prediction models: a framwork for traditional and novel measures. Epidemiology, 21(1): 128-38.

Tapvong, C. and Kruavan, J. (1999). Water quality improvements: A contingent valuation study of the Chao Phraya River. EEPSEA Research Report.

Turnbull, B. W. (1976). The Empirical distribution function with arbitrarily grouped, Censored and Truncated Data. Journal of the Royal Statistical Society, B38, 3, 290–295.

Tziakis, I., Pachiadakis, I., Moraitakis, M., Xideas, K., Theologis, G., and Tsagarakis, K. P. (2009). Valuating benefits from wastewater treatment and reuse using contingent valuation methodology. ScienceDirect, Desalination 237, 117–125.

U.S. Commercial Service (2017). Vietnam – Environmental and pollution control equipment and services. Vietnam Country Commercial Guide. export.gov. https://www.export.gov/apex/article2?id=Vietnam-Environmental-and-Pollution-Control-Equipment-and-Services [accessed in 2018].

Van Leeuwen, C. J., Nguyen, P. D., and Dieperink, C. (2015). The challenges of Water Governance in Ho Chi Minh City. Integr Environ Assess Manag, 9999, 1–8.

Van M., H., Nguyen-Viet, H., Thanh, N. H., and Yang, J. C. (2013). Assessing willingness to pay for improved sanitation in rural Vietnam. Environ Health Prev Med., 18(4):275-84.

Vaughan, W. J. and Rodriguez, D. J. (2001). "Obtaining Welfare Bounds in Discrete-Response Valuation Studies: Comment," Land Economics, 77, 3, 457-465.

VNExpress (2018). The average salary in HCMC is the highest in the country. News. Ministry of Science and Technology. https://vnexpress.net/thoi-su/luong-binh-quan-o-tp-hcm-cao-nhat-nuoc-3719089.html [accessed in 2019, in Vietnamese]

Vo, T. D. (2010). Economic cost of river water pollution in the Mekong Delta. Science Journal, 15b, 264–273. [in Vietnamese with English abstract].

Whittington, D. (2002). Municipal water pricing and tariff design: A reform agenda for cities in developing countries. Issue brief 02-29. Resources for the Future.

Whittington, D., Boland, J., and Foster, V. (2002). Water tariffs and subsidies in South Asia: Understanding the basics, South Asia Energy and Infrastructure Unit, World Bank

Whittington, D., Lauria, D. T., Wright, A. M., Choe, K., Hughes, J. A., and Swarna, V. (1993). Household demand for improved sanitation services in Kumasi, Ghana: A contingent valuation study. Water Resources Research, 29(6), 1539–1560.