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# What are the important factors promoting connection to municipal water supplies? People's preferences for water services in Dagon South Township, Yangon City, Myanmar, assessed using a Randomized Conjoint Experiment

Hiromichi Muraoka* and Keisuke Kawata†

**Abstract**

Yangon City, the largest city in Myanmar, does not have enough municipal water services so many people have to make do with their own water sources including private wells. To remedy this situation, Yangon City proposes to expand the existing municipal water services to people who do not currently have connection to them. This research project examines the preferences relating to the new policy scenario for municipal water services and seeks to identify the factors that will attract consumers to connect to these services and move away from their own water sources. This is carried out using a randomized conjoint experiment in the Dagon South Township area of Yangon City. This township has the second largest population in Yangon City. Our results show that reductions in connection fees and improvements in water quality largely increase people's acceptance of new policies, while better wastewater treatment has little impact. The results also imply that people are satisfied with the present water sources to some extent but show the necessity for further measures to promote connection. In addition, we found significant differences in peoples' preferences when considering their level of education, whether or not they live in a block with partial municipal water services, and their gender. These results show the necessity to communicate with people considering the above situation and take effective measures to promote their connection to municipal water services in the future. At the same time, the sustainability of water services should be considered, including increases in water tariffs, since people may accept improved but more costly water services.

**Keywords:** Urban water supplies, randomized conjoint experiment, Myanmar.

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## 1. Introduction

Access to safe water is important in the daily life of human beings. In 2015, the Sustainable Development Goals (SDGs) for 2030 set Goal 6 to ensure access to water and sanitation for all. This included the SDG target 6.1 "Proportion of population using safely managed drinking water services." In addition, the demand for safe water is increasing under the environmental changes induced by the COVID-19 pandemic following the World Health Organization's advice to protect ourselves on the basics of good hygiene included frequent washing of hands (WHO 2020).

Heavy pressure on water demand also comes from urbanization. 55% of the world's population now lives in urban areas and expansion of these will lead to 68% of the World's population being in cities by 2050 (UN 2018). In developing countries the provision of water distribution services often lags behind the needs of the population because of the huge investment required for urban infrastructure as a whole. Padowski and Gorelick (2014) show that by 2040 at least 70 cities in 39 countries will be vulnerable to this reason for the decline in access to safe water.

Thus, it is often the case that the provision of a social service such as piped water supplies cannot catch up with the speed of population growth and city expansion in developing countries. Therefore, new dwellers invest in private wells to acquire water for their daily life, resulting in an increase of groundwater extraction. Such investments make individuals less vulnerable in the short term, but they can make a region as a whole more vulnerable with respect to water resources in the long term (Srinivasan et al. 2013). In Myanmar, while access to safe water under SDG Goal 6 has improved in urban areas, only 18% of the urban population have a piped water supply to their premises and this water is untreated (UNICEF 2015). Under such circumstances, people develop their own water sources such as private wells. However, these are not used for drinking water and only 16% use tap water for drinking (ADB 2018).

Yangon City, which is the largest city in Myanmar, is faced with this situation. While many city residents have their own water sources, such as private wells, neighbor's taps or wells for their daily life, Yangon City has several issues. For example, there is limited groundwater, ground subsidence from over extraction, and hygiene issues with the water (van der Horst 2017; SuLatt et al. 2015). While the Yangon City Development Committee (YCDC) has the responsibility to provide government water services, and promotes its piped water services, the coverage was only 35% in 2014, with a very limited water quality and distribution time. The survey report was to cover 46% of households by 2020 and 80% by 2045 (JICA 2014).

Thus, the city has the intention to improve water services, but the slow rate of increase in distribution and the difficulty in reaching all households in the near future may force the question

of how to distribute water to people, such as putting priority on certain areas or on equitable distribution to a large area but with lower quality services. At the same time, services acceptable to people are required for them to connect to government water supply systems since people can choose their present water sources or develop a new connection to it. In this environment, it is necessary to understand the demand side preferences for government water supplies, such as what kind of water services are potential customers willing to take from the YCDC piped water supply? This information can be used for policymaking to promote the spread of connections.

We carry out the following actions in this research. The first task is to clarify the demand side preference to connect to the YCDC municipal water supply, which involves changing from their existing water sources. This has several conventional issues, including water quality, distribution time, water pressure, and water tariff level, which we examine using the conjoint experiment methodology. Many contingent valuation studies in the past have focused on the primary factors that determine demand. We consider that water services are composite, with several attributes, and this has an unbundling impact on the preference for each attribute. While there has been little research on decision making relating to the connection to water distribution systems under various factors, Gunatilake et al. (2006) adopted conjoint analysis based on conventional factors in Sri Lanka. We develop these factors in a more comprehensive manner by considering the actual field situation in Yangon, adding the factors of connection fee and wastewater treatment since the connection fee is considerable (about 200,000 Kyat - equivalent to US$114) and residents have concerns about contamination from wastewater on water supplies given the environment of poor drainage and wastewater treatment. By using those factors that are relevant to the actual situation, it is possible that we can understand their impact on YCDC residents' preference to connect to the government water services and the implications of policy for water supply infrastructure in this situation.

The second objective is to understand average willingness to pay (WTP) for municipal water services from the aspect of water tariffs. At present, the tariff on the water that YCDC supplies is quite low (88Kyat/$m^3$ (equivalent to US$ 0.05) or 1800Kyat/month (equivalent to US$ 1.1)) compared to those in other countries. The water tariff in similar cities is 400 Riel/$m^3$ (equivalent to US$ 0.1) in Phnom Penh (2021), 3,550 Rupiah/m3 (equivalent to US$ 0.25) for low level households in Jakarta (2021), 5,973 Dong/$m^3$ (equivalent to US$ 0.26) in Hanoi (2015). The low tariff in Yangon City has a negative impact on the sustainability of water services. The previous data on WTP in the master plan (JICA 2014) showed that there seems to be little difference between drinkable water and non-drinkable water in Yangon City and the WTP for both is low.

The percentage of respondents whose WTP per household per month is less than 2,000 Kyat is 60% and 68%, respectively. On the other hand, Chan et al. (2018) showed that a majority (61%) of respondents in Insein Township in Yangon City are willing to pay more for improved water services. This may imply that people in Yangon City are not willing to show prices. Research on Ho Chi Minh City (Pham and Son 2005) revealed that WTP by conjoint analysis is higher than that by the contingent valuation method and conjoint experiments can contribute to the understanding of potential preferences on WTP. In addition, several studies show that there are multiple factors influencing WTP such as age, income, households with children under 5 years old, gender, and so on (Entele and Lee 2020; Twerefou1 et al. 2015). Tarfasa and Brouwer (2013) show that women and households living in the poorest part of the city value improvements in water quality. Therefore, it is important to analyze the factors including water tariff that promote connection to water services in Yangon City using the preference of the people.

In this paper, we conduct a randomized conjoint experiment instead of conventional conjoint analysis, as developed by Hainmueller, Hopkins, and Yamamoto (2013). They revised conventional conjoint analysis in the framework of a randomized experimental design that can estimate the casual effect of components on respondent choice probabilities without bias. The traditional conjoint experiment uses an orthogonal design to reduce the number of potential alternatives. The traditional orthogonal experimental method on the main effect assumes that there are no degree of interaction effects. In our context, this assumption may induce serious bias. The randomized conjoint experiment does not require assumptions about the degree of interaction. The advantage of a randomized design is that it can estimate the average marginal component effects (similar to the main effect) even if the size of each component effect depends on other attribute levels (Hainmueller, Hopkins, and Yamamoto 2014). Using the randomized conjoint experiment, the level of attribute is randomly assigned for making choice sets. Using this methodology, we surveyed people who have no connection to municipal piped water services in Dagon South Township in the eastern part of Yangon City (Government of Myanmar 2017).

Our results show that decreases in connection fees and improvements in water quality among the attributes set in this research largely increase acceptance of new policy of water services, while wastewater treatment has little impact. The results also imply that people are satisfied with the present water supply to some extent but shows the necessity for further measures to promote connection to municipal piped water services. In addition, we found significant differences by education level on the attributes of water quality, and residents in a block with partial municipal water services on the attributes of connection fees, and gender on the attributes of water tariff and wastewater treatment.

The next section describes the water supply situation and gives an overview of the survey area. Section 3 discusses survey design and implementation in detail including design of the conjoint experiment, the household survey, and descriptive statistics. Section 4 explains the results of the research. Finally, Section 5 provides the discussion and conclusion of this research.

## 2.Background of the Yangon Water supply system and an overview of the Survey area

### 2.1 Overview of the Survey area

Yangon City is the largest city in Myanmar with a population of 5.2 million (Government of Myanmar 2014) and consists of 32 townships. The survey area, Dagon South Township, is located in the eastern part of Yangon City and has the second largest population of 371,646 (Government of Myanmar 2014, Figure 1) in the City. Yangon City has been expanding since the late 1980's and the government has started to build new townships in peripheral areas of the city, including the Dagon South Township (Zeyar 2019). The township has several industrial areas and the proportion of employed persons working in the sector of "Manufacturing" is the highest with 20.8%, while in the Yangon Region as a whole only 14.9% of the employed population is working in this sector. More recently, the township has faced a large negative impact from the COVID-19 pandemic. A survey in July 2020 showed that 58% of workers had experienced decreased work and as many as 60% of households saw their income fall by 50% or more (Muraoka 2020).


**Figure 1:** Map of South Dagon Township in Yangon City

### 2.2 Water Supply Situation

The water supply services by the government in Yangon started in 1879 using the water sources of Kandawgyi Lake. They have been expanding ever since and the coverage in 2014 was 35% of households in the city and 25% in Dagon South Township. The coverage in the township reached 27% in 2019 based on the information from YCDC, while their plan was for 37% in 2020 (JICA 2017). Only 16 of the 32 of the wards in the township receive municipal water services. However, not all areas of these 16 wards can receive it and the services is limited to several hours per day and several days a week. Under this situation, YCDC is constructing piped water supply facilities with a coverage target in the township of 47% by 2025. On the other hand, households in the township have their own water sources, most of which are private tube wells for non-drinking purposes, while the major source for drinking purposes is bottled water.

## 3.Survey Design and implementation

### 3.1 Data Description

The survey area is the Dagon South Township. The smallest formal administrative area in Myanmar is a ward under a township and Dagon South Township has 32 wards. In addition, under

wards there are informal administrative areas that are called blocks and are headed by a block leader. Our survey was conducted in two stages since we could not obtain complete household lists for Dagon South Township and the wards for a direct household survey. The first survey was conducted from March 5 to March 14 2020 to obtain information on the number of blocks, the situation of their water supplies, and the number of households in the blocks under South Dagon Township for use in the second stage. As a result of this first stage we found 293 blocks with 73,020 households.

The second stage was a household survey conducted from July 2nd to July 21st 2020, after the first wave of COVID-19. The wards in this survey are shown in Figure 2. We randomly chose 120 from 293 blocks and found the households that had no connection to piped water supply from YCDC. Then, 10 households in each block were randomly selected and a household survey of a total of 1,200 households was conducted. For regression, weight back was made based on the total number of households in the selected blocks.

The household survey consists of a conjoint experiment as described in the next section followed by questions seeking information on characteristics such as age, gender, education, occupation, family size and monthly income, water use situation, and response to COVID-19. Descriptive statistics of the households selected are shown in Table 1. There is a limitation regarding the sampling; 3 of the 32 wards did not accept the household survey, and some blocks provided only a partial list of households due to preparation for a general election and concern about COVID-19. Despite these limitations the data is useful since a large number of the wards and blocks are covered and the households surveyed from the partial lists provided are spread throughout those blocks (Figure 3).

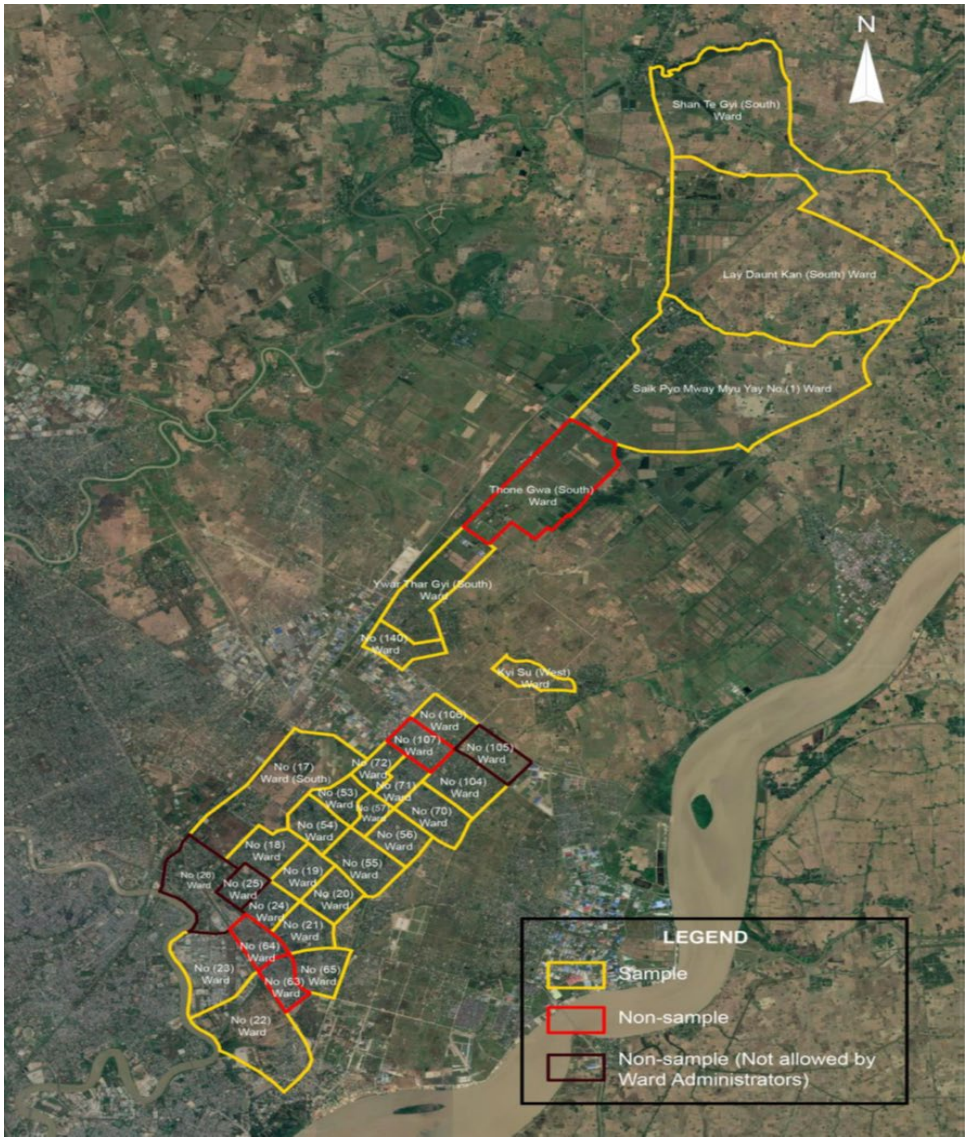



**Figure 2:** Wards included in the second survey


**Figure 3:** Example of distribution of samples under blocks with a partial household list (Ward 20, Block 9, and Block 14)

| **Descriptive Statistics of Respondents** | | **Frequency** | **Percent** |
|---|---|---|---|
| Gender | Female | 698 | 58% |
| | Male | 502 | 42% |
| Age | <30 years old | 150 | 13% |
| | 30-45 years old | 408 | 34% |
| | >45 years old | 642 | 54% |
| Ethnic | Myanmar | 1016 | 85% |
| | Others | 184 | 15% |
| Educational Level | Primary School | 289 | 24% |
| | Middle School | 388 | 32% |
| | High School | 326 | 27% |
| | University | 104 | 9% |
| | Vocational School | 1 | 0% |
| | None or Preschool | 92 | 8% |
| Primary activity | Salaried work | 186 | 16% |
| | Self-employment | 392 | 33% |
| | Family chores (e.g., housewife) | 408 | 34% |
| | Pension/retire | 46 | 4% |
| | Unemployment | 137 | 11% |
| | Others | 31 | 3% |
| Household size | 1-4 persons | 677 | 56% |
| | 5-7 persons | 439 | 37% |
| | 8-10 persons | 71 | 6% |
| | >10 persons | 13 | 1% |
| Monthly household income (Kyat) | <=150,000 | 62 | 5% |
| | 150,001-300,000 | 264 | 22% |
| | 300,001-450,000 | 265 | 22% |
| | 450,001-600,000 | 213 | 18% |
| | 600,001-750,000 | 121 | 10% |
| | >=750,001 | 275 | 23% |
| Main Water Source | Private well | 481 | 40% |
| | Public Tap or well | 14 | 1% |
| | Neighbor's Tap or well | 276 | 23% |
| | Spring/Pond/Rainwater | 119 | 10% |
| | Water sold | 310 | 26% |
| Access to drinking water | Bottled water | 973 | 81% |
| | Private well/tube well | 122 | 10% |
| | Others | 105 | 9% |
| Concern on wastewater nearby into water you use | Strong/Somewhat agree | 721 | 60% |
| | Neither agree nor disagree | 13 | 1% |
| | Strong/Somewhat disagree | 466 | 39% |
| Concern on wastewater emission into environment | Strong/Somewhat agree | 776 | 65% |
| (such as river, lake, pond) | Neither agree nor disagree | 27 | 2% |
| | Strong/Somewhat disagree | 397 | 33% |

**Table 1:** Descriptive statistics from the household survey

### 3.2 Experimental Design

In this research, we use the conjoint experiment methodology developed by Hainmueller, Hopkins, and Yamamoto (2013) to understand the choices in water service policy. The conjoint experiment is an analytical method in the framework of a randomized experimental design that enables us to estimate the causal effects of each attribute under a range of policy scenarios on the respondent's choice preferences without the bias found in conventional conjoint analysis.

In this research, we generated hypothetical municipal piped water service policy scenarios by YCDC and provided three policy scenarios, that is, the two hypothetical piped water supply policies by YCDC and the status quo. On each of these scenarios the respondents put a ranking on 'accept or not municipal water services' instead of their own water sources. While the status quo of water supply varies among respondents, and the improvement levels compared to the hypothetical policies also vary, this heterogeneous variation can be captured by the individual preference parameter.

Each policy scenario is characterized by seven attributes. The attributes were prepared based on the key components of the water services to implement their connection and the information from the first survey. At the beginning of the second survey, we conducted pilot interviews and found that the attributes and levels were understood by the respondents. The attributes are water quality, water distribution time, water pressure, connection fee, installments of the connection fee, wastewater treatment, and water tariffs. The detailed attributes and their respective levels can be seen in Figure 4.

The first attribute is water quality and that has two levels, namely drinkable as is or drinkable after treatment (boiled, filtered).

The second attribute is water distribution time, and this has two levels, 24 hours, or 12 hours. The level of both alternatives was prepared from the field situation of the present YCDC water supply system where people do not drink supplied water as it is and there is a very limited distribution time (less than 12 hours per day in this Township). In addition, under COVID-19, people needed an improvement in water quality so that it is expected that the attribute of water quality can capture preferences during/after COVID-19.

The third attribute is water pressure, and this has two levels, always enough or 75% of respondents' needs, since several leaders of blocks that receive municipal water supply partially responded that water pressure is very low or low.

| Attributes | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| Water Quality | Drinkable as it is | Drinkable after Treatment (boil, filter) | | |
| Water Distribution Time | 24 hours | 12 hours | | |
| Water pressure (flow of water from tap) | Always enough | 75% of your needs | | |
| Connection fee (pipe installation, registration fee, etc) | 200,000 Kyat | 100,000 Kyat | 0 | |
| Installment of connection fee payment | 1 payment | 20 monthly installments | | |
| Wastewater | without clean treated water to river/lake | with clean treated water to river/lake | | |
| Tariff (per person per month) | 400 Kyat/person/month | 800 Kyat/person/month | 1,200 Kyat/person/month | 1,600 Kyat/person/month |

**Figure 4:** The detailed attributes and their levels

The fourth and fifth attributes are the connection fee to municipal piped water services and its payment installments. The former has three levels, and the latter has two levels. Based on meetings with township and ward officers, the average connection fee is 200,000 Kyat (equivalent to US$114) including design and installation of water pipes. Since this seems relatively high when we look at average monthly income (or the distribution of monthly income) in the descriptive statistics, we prepared levels of discount prices and 20 monthly installments to see whether such arrangement can promote the connections that YCDC would like to realize.

The sixth attribute is wastewater treatment, again with two levels under a common condition of smooth flow of wastewater from residential neighbors that was included in the explanation before each respondent ranked the three scenarios. The water supplied becomes wastewater and flows to rivers, ponds, lakes, and so on. However, in the field there are limited smooth flows in drainage and no wastewater treatment before discharge which leads to environmental degradation. Under such situations people have concerns about contamination by wastewater in the water supply and about environment degradation. This attribute is expected to capture additional respondent preferences for environment improvement related to water supply.

The last attribute is the water tariff, and this has four levels. The present water tariff on YCDC water supply is 88 Kyat/m3 or 1800Kyat/month. This is quite low compared to cities in other countries and this means that it is not easy to maintain a good water services using revenue alone.

To understand the acceptance of higher water tariffs, we set the minimum levels at 400Kyat/person/month and beyond. To calculate 400Kyat, we used the average family members of 4.7 in Dagon South Township to divide the 1800 Kyat/month of the YCDC monthly tariff. We used Kyat/person/month as the unit of measurement since respondents have not used municipal water supplies and are not familiar with price per volume (i.e., Kyat per cubic meter).

These seven attributes and levels give 384 policy scenarios in total, two of which are randomly paired, and a choice set was constructed (an example of a choice set is given in Figure 5). At the beginning of interview, each respondent was asked to give a ranking among three scenarios, that is, a choice set (two scenarios) and the status quo. Each 1,200 respondents were asked to make ranking decisions five times for five different choice sets. As a result, the dataset includes 6,000 observations.

| **Water Quality** | Drinkable after Treatment (boil, filter) | Drinkable as it is |
|---|---|---|
| Water distribution time | 12 hours | 12 hours |
| Water pressure (flow of water from tap) | Always enough | 75% of your needs |
| Connection Fee (pipe installation, registration fee, etc) | 100,000 Kyat | 100,000 Kyat |
| Installment of connection fee payment | 1 payment | 20 monthly installments |
| Wastewater | Without clean treated water to river/lake | Without clean treated water to river/lake |
| Tariff (per person per month) | 1,200 Kyat/person/month | 400 Kyat/person/month |

**Figure 5:** Example of a choice set

### 3.3 Estimation Strategies

Based on the data obtained, we estimate choice probabilities and welfare gains. Choice probabilities consist of two types, namely internal choice probability and external choice probability. Internal choice probability observes the respondent's preference between two policy scenarios without the status quo. In internal choice probability, 1 is assigned to the policy scenario with the highest ranking, and 0 is otherwise used, regardless of the ranking of the status quo. The external choice probability observes the respondent's preferences for hypothetical policy scenarios over the status quo. Here, 1 is assigned to any hypothetical policy scenario with a higher ranking than that of the status quo. If the status quo is the highest or the lowest ranking, both hypothetical policy scenarios are given 0 or 1, respectively.

For both probabilities, we estimate the average marginal component effect (AMCE) of each of the policy attributes. Hainmueller, Hopkins, and Yamamoto (2013) suggest estimating the AMCE by OLS because all explanation variables are dummies, and the AMCE is estimated by fully nonparametric means. We use their model as follows:

$$y_{itj} = \sum_{l=1}^{L} \sum_{d=2}^{Di} \beta_{ld} a_{itjld} + u_{itj}$$

where: $\alpha_{itjld}$ is a dummy variable for the *d*-th level of an attribute *l* of a policy *j* in task t of a respondent *i*, *L* is the number of attributes, *Di* is the number of levels of an attribute *l*, $\beta_{ld}$ is its coefficient, and $u_{itj}$ donates the error term. Then, $y_{itj} \in \{0, 1\}$ is a choice indicator variable for the estimation of the internal choice probability. $y_{itj} = 1$ if the preference rank of policy j is higher than its alternative policy. In the estimation of the external choice probability, $y_{itj} = 1$ if the preference rank of policy *j* is higher than the status quo.

Note that each of the respondents sampled randomly were asked to make ranking decisions five times for five different choice sets. Since it is necessary to avoid the bias that may result from correlation in error terms, cluster-robust standard errors at the respondent level suggested by Hainmueller, Hopkins, and Yamamoto (2013) are adopted.

For the estimation of welfare gains, we adopted the equation used by Hninn et al. (2016, 2017) to estimate the lower bound of the marginal average welfare gain. First, we estimate the bound of welfare. Our conjoint data can provide only an estimator of choice at $C_{ij} = 400, 800, 1200 \; and \; 1{,}600 \; kyat$ for the water tariff on households. We estimate the WTP distribution as follows:

$$\hat{F}(400) = 1 - \hat{Y}_{ij|Cij=400}$$

$$\hat{F}(800) - \hat{F}(400) = \hat{Y}_{ij|Cij=400} - \hat{Y}_{ij|Cij=800}$$

$$\hat{F}(1{,}200) - \hat{F}(800) = \hat{Y}_{ij|Cij=800} - \hat{Y}_{ij|Cij=1{,}200}$$

$$\hat{F}(1{,}600) - \hat{F}(1{,}200) = \hat{Y}_{ij|Cij=1{,}200} - \hat{Y}_{ij|Cij=1{,}600}$$

where: $\hat{Y}$ represents an individual choice indicator and $\hat{F}$ represents the share of individual WTP.

Then, we estimate the lower bound of the marginal welfare gain. The estimated marginal choice probabilities can be obtained by the following regression:

$$y_{itj} = \gamma_0 + \gamma_{1{,}200} * a_{itj1{,}200} + \gamma_{800} * a_{itj800} + \gamma_{400} * a_{itj400} + u_{itj}$$

where $a_{1,200}, a_{800}\ and\ a_{400}$ are dummy variables for the choice burden as 1,200 Kyat, 800 Kyat and 400 Kyat, respectively and $\gamma_{1,200}, \gamma_{800}\ and\ \gamma_{400}$ are their coefficients. $u_{itj}$ is the error term and $y_{itj}$ is an indicator variable. In this equation, $y_{itj} = 1$ means the preference rank of policy j is higher than that of the status quo. Using the estimated coefficients, the estimator of the marginal structural choice probabilities are obtained as $\hat{Q}(400) = \hat{\gamma}_0 + \hat{\gamma}_{400}$, $\hat{Q}(800) = \hat{\gamma}_0 + \hat{\gamma}_{800}$, $\hat{Q}(1{,}200) = \hat{\gamma}_0 + \hat{\gamma}_{1,200}$, and $\hat{Q}(1{,}600) = \widehat{\gamma_0}$, where hat (^) implies an estimated coefficient. Then, the following equation yields the estimator of the lower bound:

$$\begin{aligned}\underline{\hat{C}} = {} & 400 * \left[\hat{Q}(400) - \hat{Q}(800)\right] + 800 * \left[\hat{Q}(800) - \hat{Q}(1{,}200)\right] + 1{,}200 \\ & * \left[\hat{Q}(1{,}200) - \hat{Q}(1{,}600)\right] + 1{,}600 * \hat{Q}(1{,}600) \\ = {} & 400 * \left(\hat{\gamma}_{400} + \hat{\gamma}_{800} + \hat{\gamma}_{1,200}\right) + 1{,}600 * \widehat{\gamma_0}\end{aligned}$$

Similarly, the equation of the estimator of the lower bound of the conditional average welfare gain, which shows the estimated average welfare gain is naturally an increasing function of a constant term and the coefficients, is as follows:

$$\widehat{\underline{C|}}_{A_l=a_l} = 400 * \left(\hat{\gamma}_{400}^{d_i} + \hat{\gamma}_{800}^{d_i} + \hat{\gamma}_{1,200}^{d_i}\right) + 1{,}600 * \gamma_0^{d_i} \quad (1)$$

Where: A is a vector of attributes and *a* is the realized values of A.

## 4. Results

### 4.1 Average component effects of policy attributes

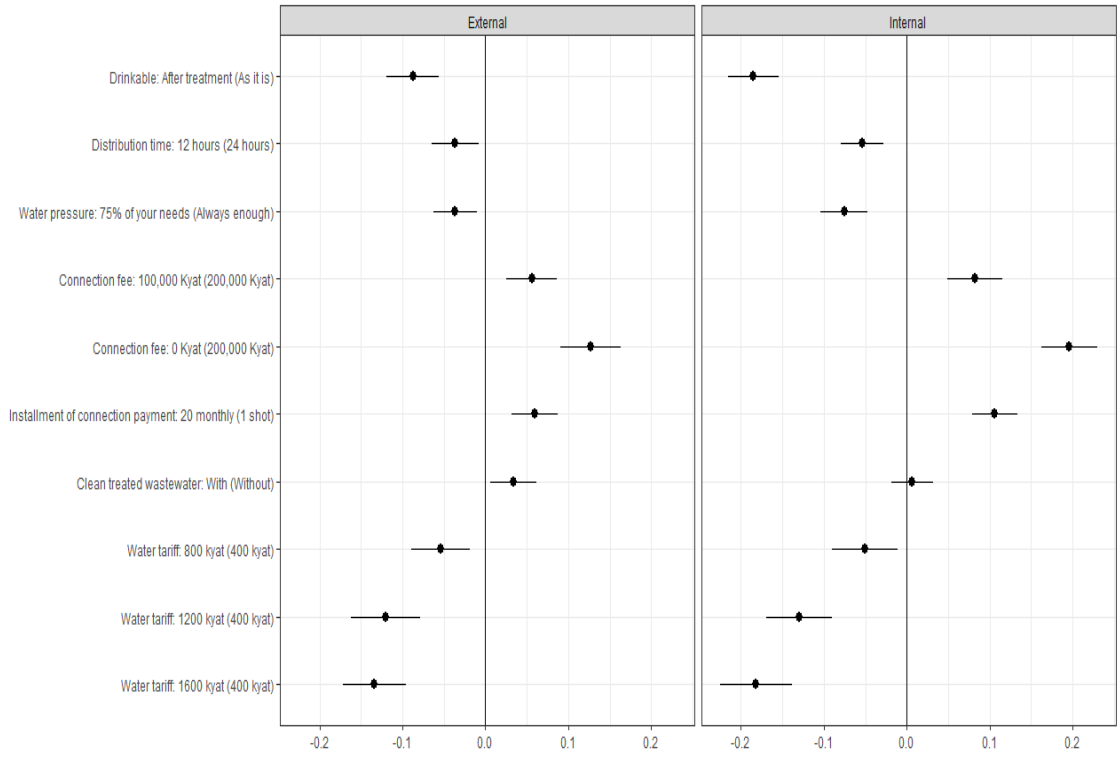
The results of the choice probability analysis are summarized in Figure 6 and Table 2. External choice probability and internal choice probability both show similar trends. As for the attributes, a connection fee of 0 has the 2nd largest impact on peoples' acceptance of the proposed policy for external choice probability, at about 12.7% points, and is the largest for internal choice probability, over 19.6% points. Even with a policy of 100,000 Kyat for the connection fee, the acceptance increases by 5.6% and 8.2% points respectively. Paying the connection fee by installments (20 months) has a smaller impact on this attribute. This implies that the normal connection fee (200,000Kyat) is too high to enhance connection take-up compared to monthly income, and that people had concerns over the level of the connection fee.

In terms of the attributes of water quality, duration of water supply, and pressure of water, people put the highest priority on water quality among them. The present situation is that what water people have is not drinkable as it is, and it is usual for people to buy bottled water or carry out treatment such as boiling and/or filtering. People expect drinkable water when water is supplied by government.

In terms of the attribute of wastewater treatment, clean treated wastewater has the smallest impact on policy acceptance though it looks positive enough to enhance connections in external choice

probability. On the other hand, 65% strongly agree or somewhat agree with concerns on wastewater emissions to the environment (such as rivers, lakes, ponds) (Table 1). While water use in households leads to wastewater emissions, our data imply that it is still premature to think that people have enough awareness of the "polluter pays" principle.

Regarding the payment attribute, it is natural that policy acceptance decreases as water fees rise. For external choice probability, compared to the present situation of YCDC piped water services where the average water fee per person is 400 Kyat, the highest water fee (1,600 Kyat/month/person) has the largest impact and decreases policy acceptance by 13.4% points. A water fee of 1,200 Kyat decreases acceptance by 12.0% points, followed by a decrease of 5.4% points at under 800 Kyat. When it comes to comparison with the connection fee, it appears that a zero connection fee could almost offset a decrease in the monthly water fee of 1,600 Kyat. With an average household size of 4.7 persons, the increase of water fee amounts to 1,200 *4.7 = 5,640 Kyat/month/household, which covers a connection fee of 200,000 Kyat in about 3 years.




*Note:* Horizontal bars represent 95% confidence intervals.

**Figure 6:** Result of the choice probability (External and Internal)

| Attributes | Level | External | Internal |
|---|---|---|---|
| Water Quality | Drinkable after Treatment | -0.08778*** | -0.185432*** |
| | | (0.02706) | (0.01545) |
| Water Distribution Time | 12 hours | -0.03640** | -0.054046*** |
| | | (0.01576) | (0.01313) |
| Water Pressure | 75% of your needs | -0.03670*** | -0.075608*** |
| | | (0.01328) | (0.01434) |
| Connection Fee | 100,000 Kyat | 0.05593*** | 0.081779*** |
| | | (0.01540) | (0.01679) |
| | 0 Kyat | 0.12740*** | 0.196313*** |
| | | (0.01846) | (0.01707) |
| Installment of connection fee payment | 20 monthly installments | 0.05956*** | 0.106066*** |
| | | (0.01406) | (0.01380) |
| Wastewater | With clean treated water to river/lake | 0.03367** | 0.006286 |
| | | (0.01416) | (0.01274) |
| Water Tariff (per person per month) | 800 Kyat | -0.05428*** | -0.050581** |
| | | (0.01800) | (0.02001) |
| | 1,200 Kyat | -0.12004*** | -0.129818*** |
| | | (0.02118) | (0.01994) |
| | 1,600 Kyat | -0.13419*** | -0.181898*** |
| | | (0.01936) | (0.02190) |
| Constant | | 0.63850*** | 0.598402*** |
| | | (0.02707) | (0.02305) |
| Observation | | 6,000 | 6,000 |
| Adjusted R-squared | | 0.03834 | 0.0999 |

*Note:* Robust standard errors are in parenthesis.
Although overall R2 is low in the conjoint analysis, the interest of this study are the coefficients for each level of attribute as the casual estimate, which are unbiased and consistent due to the randomization of attributes and levels in the experiment.
**p<0.05
***p<0.01

**Table 2:** Estimated effects on the external and internal probabilities for all respondents

While the overall trends in external choice probability and internal choice probability look the same, the magnitude of impact of each attribute is different. What does the difference between external choice probability and internal choice probability imply? External choice probability means people choose between the status quo and the new policy and internal choice probability means that choice is only between the new policies. Therefore, it can be interpreted that the difference is based on the preference for the status quo as perceived by consumers. The impact of attributes (except wastewater and the 800 Kyat water tariff) on their acceptance under external choice probability is smaller than that under internal choice probability, which means less sensitivity on the acceptance of the external choice probability and implies that there are households who will never accept any new policy as well as those who will accept any new policy. Figure 7 show the distribution of the acceptance ratio by respondents on 10 new policies which were shown to them at the time of household survey. It shows that there is considerable ratio at '0' that means "no acceptance on any new policy." This seems to be consistent with the answers

to questions under the second survey, where over 70% of respondents answered “Satisfactory” or “somewhat satisfactory” about the present water supply. Even with a connection fee of 0 and 1,600 Kyat/person/month payments, the estimated connection ratio remains about 66.5% for municipal water services of drinkable water, 24 hour distribution, enough water pressure, and clean treated wastewater. This implies that it is necessary to take other measures to promote water supply connections.

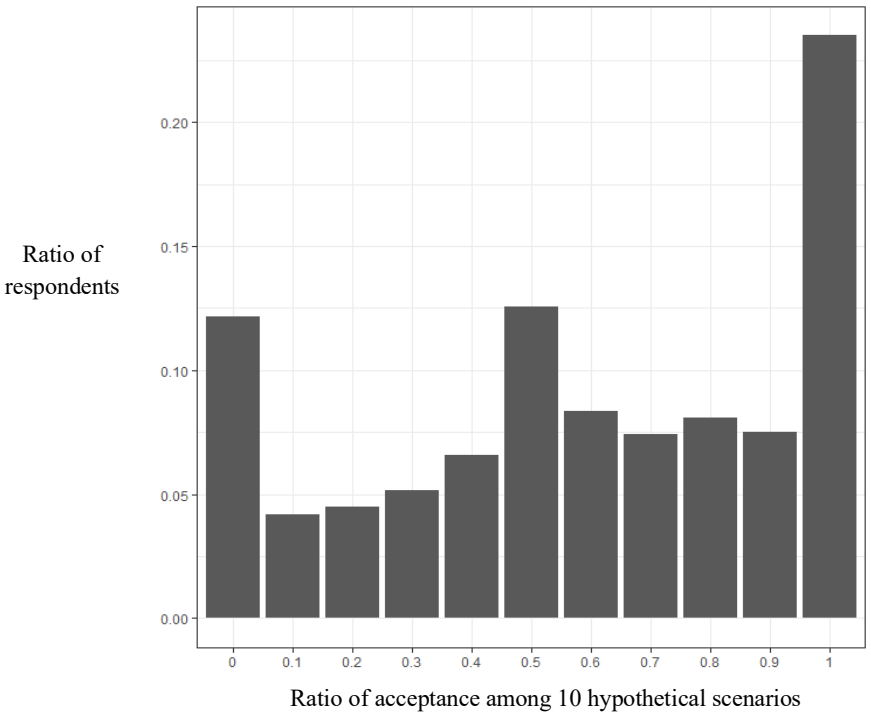



**Figure 7:** Distribution of acceptance ratio on new policy by household

### 4.2 Analysis of the differences between respondents’ characteristics

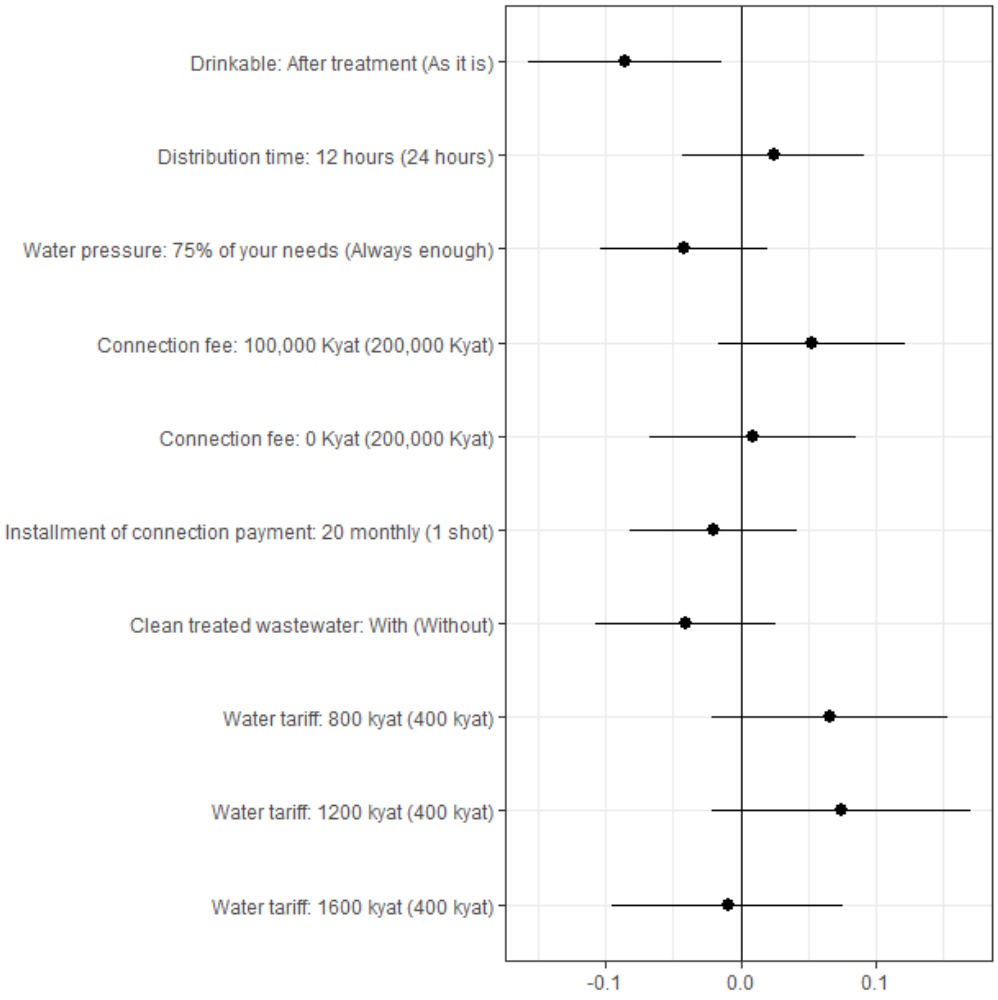
We estimated the difference of personal preference based on respondents’ characteristics of education level, residents in a block with partial municipal water supply, gender, income level, and households with child under 5 years old, respectively, from the point of promoting the connection (external choice probability).

Among these characteristics, we find that education level, residents in a block with partial municipal water supply, and gender have significant differences at the 95% confidence interval. For education level, the acquisition of drinkable water increases the support of new policies by respondents with secondary school or higher education compared to those with primary school or lower by about 8% points (Figure 8). While respondents show their satisfaction or are somewhat satisfied with the present water supply and recognize that water borne diseases are rare, which

may lead to no significant difference from respondents with children under 5 years old, those who have secondary or higher education have more concerns about issues of water quality.

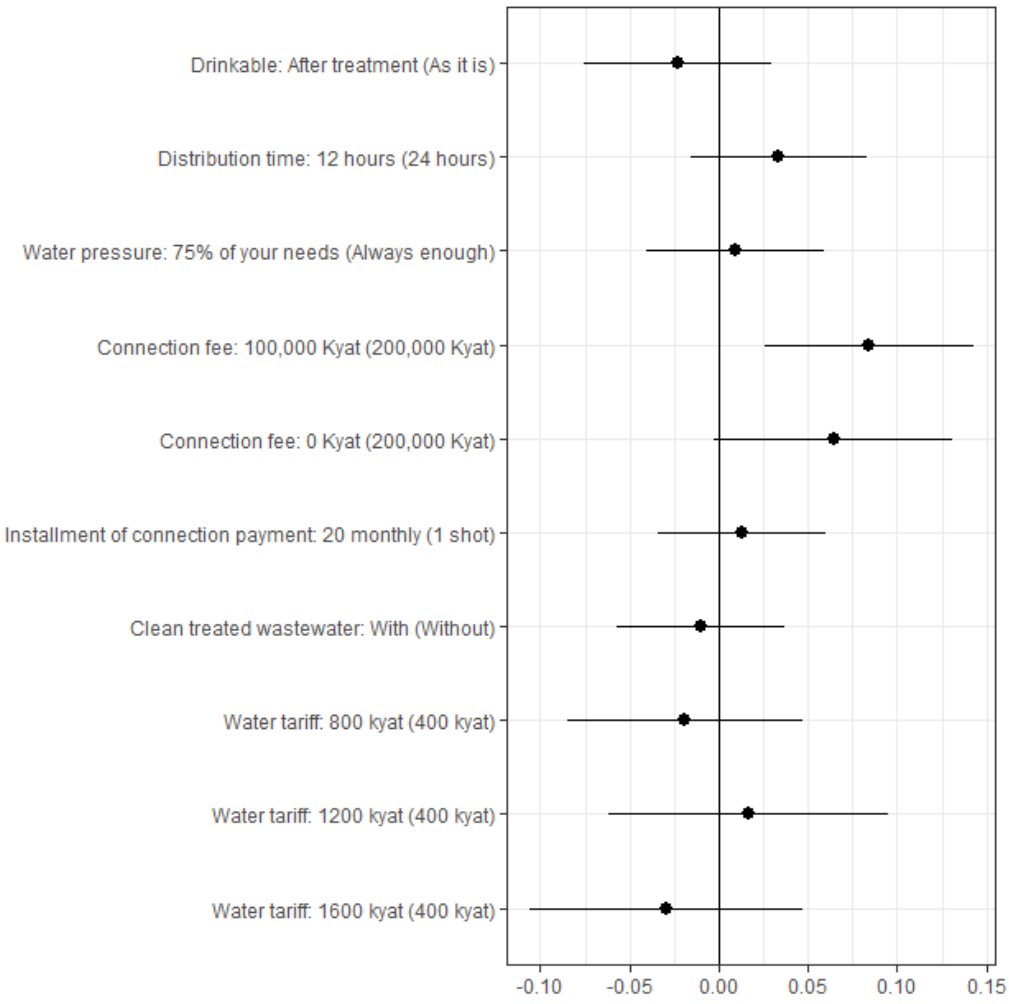
Figure 9 shows that there are differences between respondents who live in a block with partial municipal water supply and those with no municipal water supply. Among the attributes, a connection fee produces significant differences and increases the support of respondents who live in a block with no municipal water supply by around 7 to 8% points. It may possible that these people are aware of the present service level of water supply (that is, several hours on a couple of days a week), which may give a negative impression, but further study is necessary.

Females show higher support for new policies involving clean treated water and changes in water tariffs than males (Figure 10). Clean treated water increases their support for new policies and an increase in water tariffs has lower support from males. Females are the main user of water for tasks such as cooking and washing, and they care about family health. This implies that females have a higher awareness of convenience and quality of water services (water from a tap) in hygiene environments.



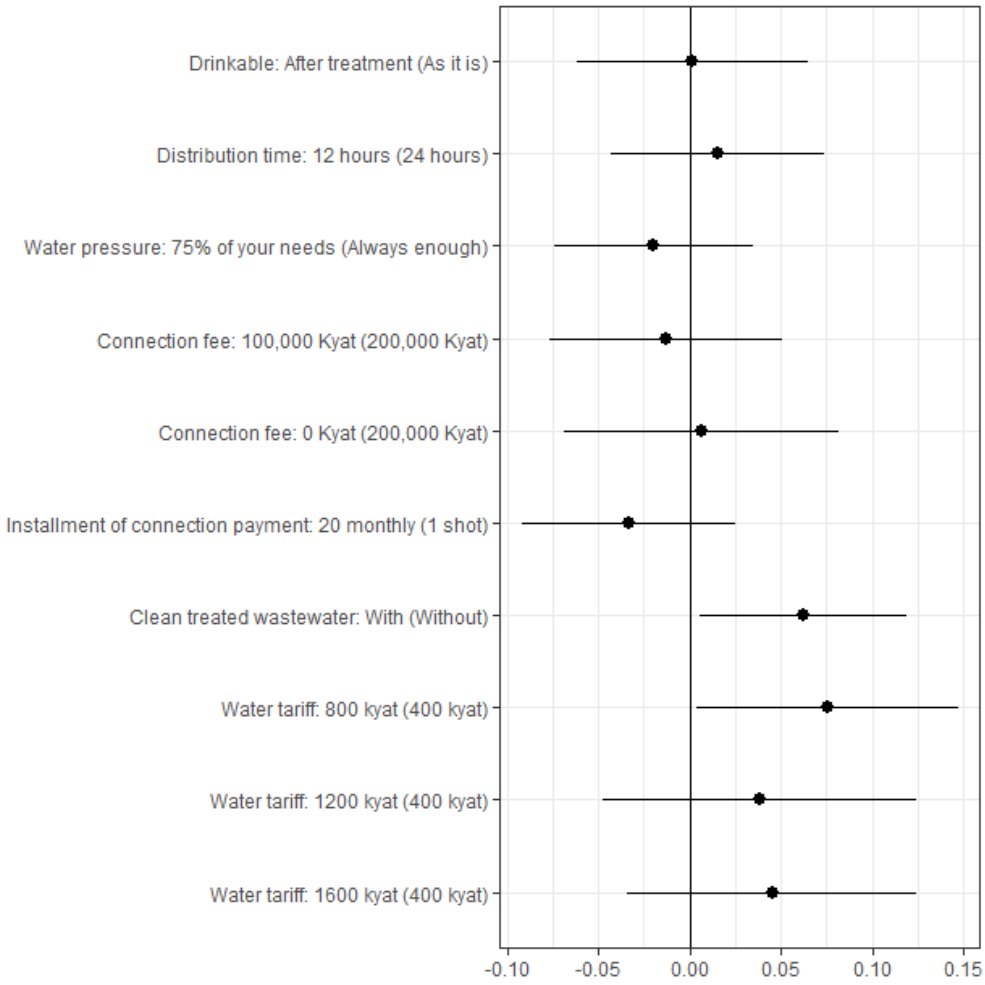

*Note:* respondents with secondary school or more education are the benchmark.
Horizontal bars represent 95% confidence intervals.

**Figure 8:** Interaction of casual effects on external choice probability with differences in education level




*Note:* respondents who live in blocks with partial municipal water supplies are the benchmark.
Horizontal bars represent 95% confidence intervals.

**Figure 9:** Interaction of casual effects on external choice probability with differences in blocks




*Note:* Male is benchmark.
Horizontal bars represent 95% confidence intervals.

**Figure 10:** Interaction of casual effects on external choice probability by gender

### 4.3 Welfare gain

Figure 11 shows the distribution of WTP for proposed water service policy on municipal water supply from the aspect of water tariffs revealed by adopting the randomized conjoint experiment. We find that the majority of respondents have a higher willingness to pay compared to the present water tariff of 400 Kyat per person per month.

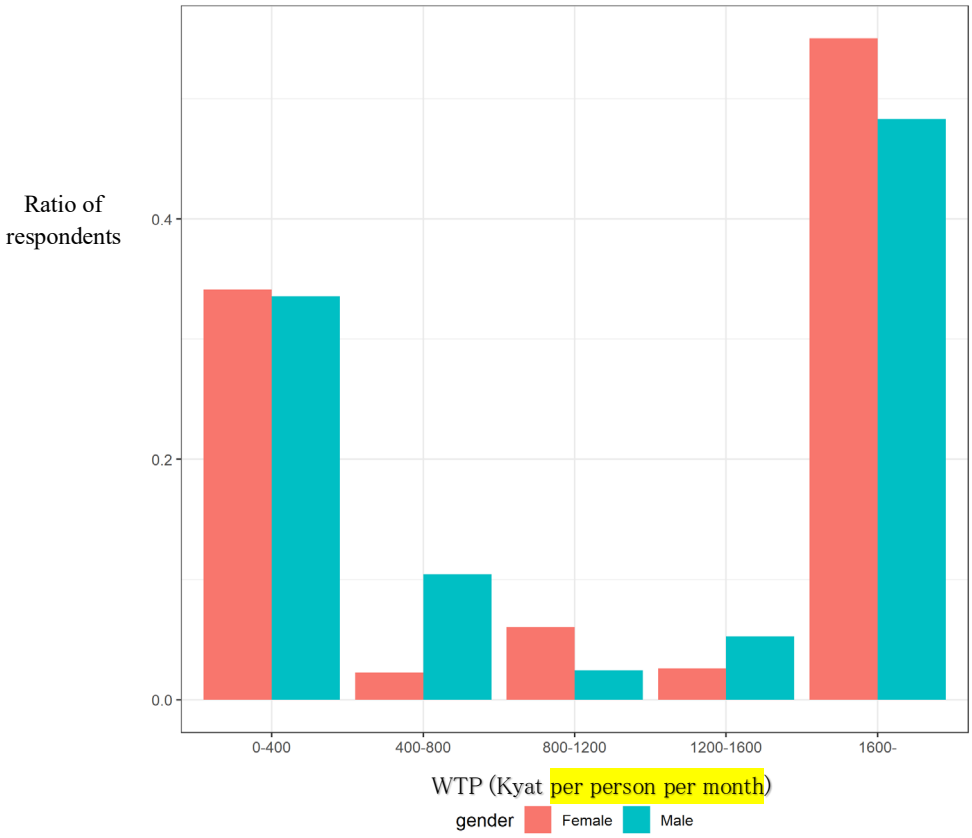



**Figure 11:** Density of WTP distribution for the acceptance of new water service policies

Then, we estimate the lower bound of the marginal average welfare gain from policy implementation by using equation (1) from Section 3.3 Estimation Strategy. The result of this estimation is 906 Kyat by male respondents, 974 Kyat by female respondents and 942 Kyat by all respondents, respectively. These results are more than double the present YCDC water tariff of 400 Kyat per person per month. When 942 Kyat is examined under the condition of 4.7 persons per household, the monthly payment becomes 4,427 Kyat. With 3% of income being the affordable price of water suggested by UNDP (OHCHR et al. 2010), monthly income is calculated to be 147,567 Kyat, which is smaller than the majority of monthly incomes found in our survey. This means that there is space for an increase of water tariff with the introduction of a new water supply policy.

## 5. Discussion and Conclusions

Yangon City, the largest city in Myanmar, does not presently have sufficient municipal water services, so people have to find their own water sources, including private wells. In addition, the population in Yangon city is increasing and Yangon City Municipality plans to expand municipal water services to cope with this. The present study examined the impact of consumer preferences on the new policy for water services covering measures to promote connection to municipal water by adopting a randomized conjoint experiment in Dagon South Township.

This research has revealed that decreases in connection fees and the improvement of water quality largely increases consumer acceptance of new policies of water services when analyzed using the attributes set in this research, while wastewater treatment has little impact. The results also imply that people are satisfied with the present quality and supply of water to some extent. In addition, we found significant differences when analyzing the characteristics of education level, residents or not in a block with only partial municipal water supplies, and gender. This implies that it is necessary to communicate with people considering the above situations and to take measures to promote the connection of municipal water services in the future. At the same time, sustainable water services should be considered in the light of increases in water tariffs since people may accept improved but more costly water services.

One other possible way to promote connections is to show good practices in water services to people since they (even overall in Myanmar) have not experienced better water services. When people clearly realize the characteristics of the new water services that is to come, this may have an influence on their acceptance and WTP. In addition, it is necessary to advertise the necessity for smooth flows and treatment of wastewater and enhance awareness since an increase in water produces an increase in wastewater, which affects living and natural environments if not dealt with effectively.

This research is based on a study carried out during the COVID-19 pandemic, thus this event may have changed people's preferences. Nevertheless, it is considered that the importance of communicating with people about essential services remains unchanged. To demonstrate good practice and enhance consumer awareness, and to listen to their needs for better service is critically important. At the time of the field study, we had an opportunity to join a meeting with township and block leaders. The block leaders delivered information on people's needs such as improvements in water services and decreases in connection fees for low income households. Such activities are important and also useful when seeking to increase better municipal services corresponding to the people's voice.

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## Abstract (in Japanese)

## 要　約

ミャンマー最大の都市であるヤンゴン市では、市営上水道が十分に整備されていないため、多くの人が私用井戸をはじめとした水源を利用している。この状況を改善するために、ヤンゴン市は既存の市営上水道サービスを、水道が通っていない人々にも拡大することを提案している。本研究は、市営水道の新しい政策シナリオに関する選好を調査し、現在私用水源を活用している消費者が市営上水道に接続するための要因を特定することを目的とするものである。この研究では、ヤンゴン市内で 2 番目に人口が多い、南ダゴンタウンシップを対象とし、コンジョイント実験を用いて実施した。その結果、水道接続料金の引き下げや水質の改善は政策に対する受容度を大きく高めるが、下水処理の改善はほとんど影響を及ぼさないことが分かった。また、人々は現在の水源にある程度満足しており、接続促進のためのさらなる施策の必要性が示唆された。さらに、教育レベル、市営上水道が一部整備されているブロックの居住者か否か、また、性別によって、その選好に有意のある違いが見られた。これらの結果から、今後、市営上水道の接続を促進するためには、上記の状況を勘案しつつ人々とコミュニケーションを図ること、また、それを踏まえた効果的な対策を講じる必要があることが示された。同時に、人々は水道サービスの改善による、より高い水料金を受け入れる可能性があり、水道料金の値上げも含め、水道サービスの持続可能性について検討すべきである点が示された。

キーワード:都市給水，コンジョイント実験，ミャンマー