Performance Preferences and Policies in Urban Water Supply – Yogyakarta, Indonesia

YOHANNES KINSKIJ BOEDIHARDJA
ENSCHEDE, THE NETHERLANDS, FEBRUARY, 2016

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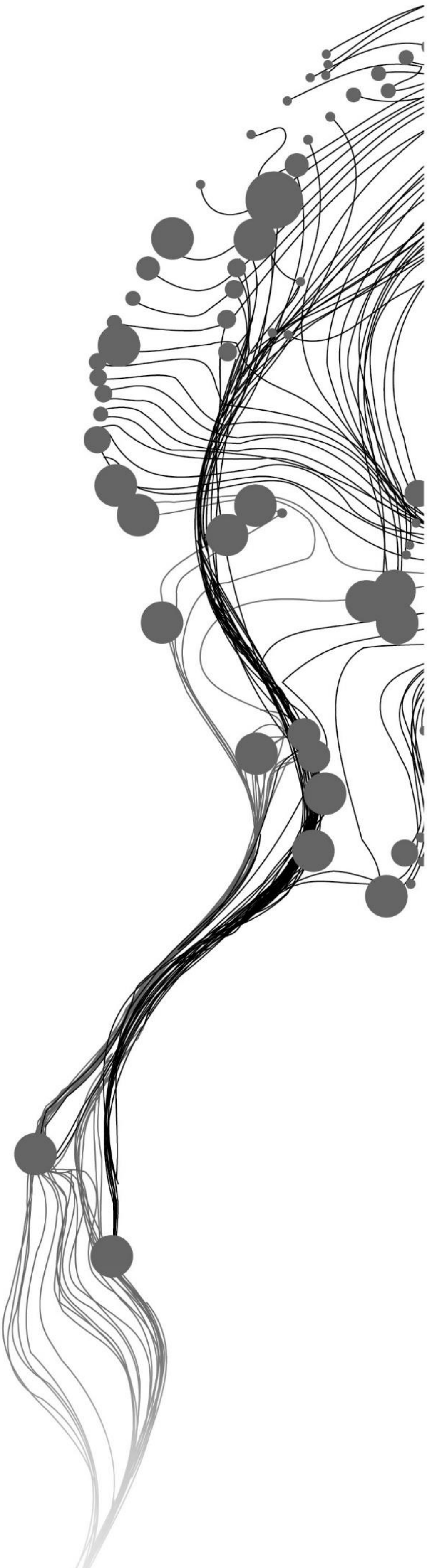

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Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation.
Specialization: Urban Planning and Management

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ABSTRACT

In urban areas, people can get water supply from various sources. Piped water is commonly used in the developed countries. In the developing countries piped water is not always available and when it is, problems in quality and continuity may arise. Groundwater well water is then one of the options of water provision. However, the continuous use of groundwater can have various consequences, such the decrease of the groundwater table. This is observed in this study for Indonesia, in the city of Yogyakarta. To prevent this situation from worsening, the Government of Indonesia have plans to improve current piped water supply. This way, people are expected to be willing to switch from groundwater well to piped water supply.

With the end goal of deriving policy recommendations in order to attract well water users to piped water, this research proposes a method based on four main elements. The first element was towards the better understanding of the water users' characteristics and behaviours in choosing water provision. The second element was the assessment of the system performance of piped water supply, by comparing piped water and groundwater well. The variables that were used to analyse are affordability, quantity, quality and continuity. The third element aims to connect the first and second elements by exploring which are the factors that determine the individual choice of water provision. For this purpose, a stated choice experiment was conducted, where three attributes (price, quality and continuity) were used for the comparison between the two types of water provision (pipe and well). After analysing the connection, the fourth element was establishing policy recommendations. The policy recommendations were derived based on the results of the stated choice experiment, by calculating probabilities of choice of water provision, using real condition scenarios.

The result of the first element shows that private well is the most used water supply in the study area. Another result indicates that piped users tend to have higher socio-economic status compared to other sources. Results from the spatial analysis show that are clear clusters in the study area. In addition, results of the second element show that in general, groundwater well is perceived as better than piped water.

Regarding the choice experiment, two models were developed. The first model is a main-effects only for the sample as a whole. And the second model is also a main-effects only model, however, it controls for education levels. Overall, results show that quality is the most important variable in the choice of water provision source, followed by continuity and price. Finally, the policy recommendations that were derived from this study aiming to attract users to piped water supply are: enhancing the performance of piped water, increasing the cost of the permit for digging wells and extracting groundwater, and subsidizing low-income people. This study has some limitations, mostly explained by the specificity of this area, and the data collection strategy.

Keywords: water provision choice, stated choice experiment, spatial analysis, policy.

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LIST OF ABBREVIATIONS

BPN	*Badan Pertanahan Nasional* (National Land Agency)
BPS	*Badan Pusat Statistik* (Statistics Bureau)
EPA	Environmental Protection Agency
ESDM	*Energi dan Sumber Daya Mineral* (Ministry of Energy and Mineral Resources)
GPS	Global Positioning System
PDAM	*Perusahaan Daerah Air Minum* (Piped Water Service Company)
PLN	*Perusahaan Listrik Negara* (National Electricity Company)
PU-ESDM	*Pekerjaan Umum – Energi Sumber Daya Mineral* (Public Works - Energy and Mineral Resources Department)
PUSTRAL	*Pusat Transportasi dan Logistik* (The Centre of Transportation and Logistic)
SPSS	Statistical Package for Social Science
USGS	United States Geological Survey

1. INTRODUCTION

1.1. Background

Water is one of the basic needs in human life. Water is usually used for drinking, for washing and for irrigation. In order to get water, people have to get it from some water sources. Some of them get water from surface water such as river, lake or spring. However, some of them get the water from ground or from piped water (Ratnayaka & Brandt, 2009).

Among those water sources, piped water is known as safe and reliable water provision. Piped water is mostly operated by government, although some piped waters are operated by private companies (WHO and UNICEF, 2010). Besides its perks, piped water supply has their own challenges. These challenges are: providing water for all population within a city; minimizing gap between coverage and service; enhancing water quality; preserving water for current and new water network (Alegre et al., 2006). If they cannot overcome these challenges, some problems will appear. According to Whittington, Pattanayak, Yang, & Kumar (2002), these problems are ineffective network (leaking), safeguarding the continuity of water distribution, and bad quality of water. Moreover, in developing countries, some people cannot access water from piped water because they are poor. They do not have the ability to pay the cost for installation of pipes, for the water itself and for maintenance of pipes (UN-HABITAT, 2003). It is for these reasons that people try to find alternative ways to get water.

There are several ways to get water other than piped water in urban area. People can get water from private water services. Usually these services distribute water by using water containers from one neighbourhood to other neighbourhoods. The other water provision other than piped water is by extracting water from the ground. People build private wells or communal wells and use water pump to get water from the ground. Since people cannot afford to pay for piped water from piped water supply or water from private water services, extracting water from ground becomes common for people in developing countries. Unfortunately, this type of water provision has a number of side effects. The water that has been extracted from the ground sometimes gets polluted by some dangerous materials such as human faecal material (Pang et al., 2004). This is particularly the case in high density urban areas. Besides that, if people keep extracting water from the ground continually, then the groundwater levels and the quantity that can be extracted will reduce gradually below renewable levels.

Indonesia, as a developing country, faces all the above problems. In many cities, more people use groundwater than use piped water that is normally provided by the local PDAM (*Perusahaan Daerah Air Minum*) or Piped Water Service Company. This situation has resulted in large impacts on ground water levels. The city of Yogyakarta experiences a water table decrease between 20 to 30 centimetres annually (Jakarta Post, 2014). If this condition continues, Yogyakarta will run out of groundwater and may face other consequences, such as land subsidence. One of the main reasons why this situation has occurred is because majority people living in 20 out of total 45 urban villages use well to fulfil their daily need and only nine urban villages use PDAM which is provided by PDAM in Yogyakarta area known as PDAM Tirtamarta (BPS *Republik Indonesia*, 2011).

Lately, the Indonesian Government tried to remedy this situation by cancelling the 2004 Law on Water Resource that allowed private participation in order to provide water for people. The reason is that the 2004 law was not compliant with the National Statue of 1945, where all national resources should be managed only by the state. As a result of this, the water distribution and revenue collection should only be conducted by PDAM (Jakarta Post, 2015). Since this policy is newly assigned, first step to apply this policy is that PDAM will cooperate with ESDM (Ministry of Energy and Mineral) in provincial level to apply the new policy in regard to building groundwater wells and try to enhance current piped water supply. In the future, it is expected that people using wells will be decreasing; instead, they will use PDAM water network.

1.2. Justification of the Research

WHO and UNICEF (2010) stated that in 2008, only 37% of population living in urban area in Indonesia used improved piped water and for the rest, they used wells, tanker-truck, etc. These different water provisions depend on different socio-economic characteristics and spatial locations of the area. They also stated that if people continue using other water resource than piped water, it will affect their health and well-being. Furthermore, it will also affect to the decrease of groundwater table. Thus, enhancing current piped water supply in order to attract groundwater users to switch to piped water supply has become one of solutions to stop decreasing groundwater table.

However, enhancing current piped water supply is not as simple as it seems. There are many different variables that need to be taken care of. According to Alegre et al. (2006), the variables are affordability, continuity, quantity, quality. In order to determine which variable that can be improved, they state that potential users need to be involved in the assessment of current piped water service. These potential users are known also as entities or stakeholders. The most important stakeholders are the water undertakings and the consumers. In this research, the water undertakings is PDAM who manage the water supply system. The consumers are people that use piped water supply for their daily needs. Besides those two, other water supply users, such as groundwater well users, are important as well. These users are also important despite they do not have direct connection to the system. The reason is that because they still get affected by they system. For instance, they use groundwater wells, maybe because piped water supply is not affordable by them, etc.

In her research, Salendu (2010) used users' perception to analyse quality assessment of PDAM and its relation with sanitation. On the other hand, Ndungu (2011) used PDAM's perception for policy analysis in relation to spatial variation of groundwater in urban settlements. Meanwhile, this research tries to look into broader variables other than quality and coverage. It is because there is a possibility that the assessment of the system can affect more variables than those two variables. Furthermore, to make the assessment of the system, perspectives from users are needed. As the users, they face some issues related to the piped water. On the other hand, PDAM as provider of piped water has to be taken into account since they play a big role in managing piped water. At the end of the day, there is a need to link users and PDAM. It is because users' needs have to meet with PDAM's capabilities. It can be found out then which variables that need to be improved based on people's point of view and which variables can be improved by PDAM's capabilities. To find a solution for this issue, this research produces advices for PDAM in form of policy recommendations. Based on that, therefore, it is important to use people's perception and translate it into policy recommendations to help PDAM enhance current piped water supply and attract more users.

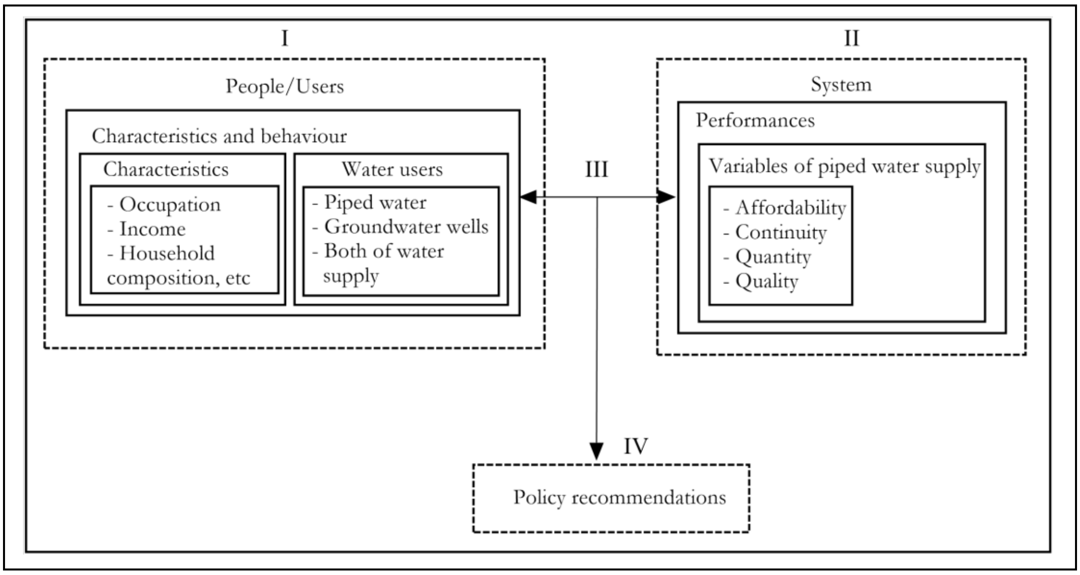
1.3. Research Problem

The provision of safe and reliable water supply like piped water is a basic need for people. However, there are some people that still use other water provision than piped water in Yogyakarta. According to BPS Republik Indonesia (2011), out of total 45 urban villages in the city of Yogyakarta, majority population in 20 urban villages use groundwater wells, majority population in 16 urban villages use hand pumped water, and majority population in 9 urban villages use water from PDAM. Furthermore, as mentioned earlier in Section 1.1, groundwater extraction is not preferred from a policy and environmental effects point of view. In terms of policy, all water resources should be managed only by state; whereas in term of environmental point of view, extracting groundwater can decrease the groundwater table that will lead to land subsidence. Because of those reasons, piped water supply need to be enhanced to attract groundwater users to switch to piped water supply.

To enhance piped water supply, the current piped water supply has to be assessed so that the users gain a good service. Moreover, a good service from piped water supply will also attract groundwater users to switch and at the end, help to preserve groundwater table. For that reason, there is a need to develop a method to evaluate current piped water supply. To develop a method, there are three elements that need to be looked into. According to Desalegn (2005), Alegre et al. (2006), Salendu (2010), Ndungu (2011), and Pun (2011), the three elements are stakeholders (users and provider), variables (performance of system), and policy. These three elements have to be looked as a unit. It is because, based on previous studies, these elements are related and affect each other. Therefore, this research is going to develop a method by looking on the three elements and how they influences each other.

1.4. Conceptual Framework

Conceptual framework in this research is built based on the relationship of stakeholders, variables and policy (Alegre et al., 2006; Desalegn, 2005; Ndungu, 2011; Pun, 2011; Salendu, 2010) (see section1.3). For further explanation, it can be seen as follows (Figure 1-1).



Note: I, II, III, and IV are specific objectives.
Figure 1-1 Conceptual Framework

There are three main elements in this conceptual framework, people/users, system and policy. People/users are defined based on their socio-economic characteristics and their behaviour in choosing water provision. Socio-economic characteristics of people are occupation, income, household composition, etc. (See Figure 1-1). According to Rahut, Behera, and Ali (2015), different socio-economic characteristics will have different behaviour in choosing water provision. For instance, people with high income tend to choose safer water supply, such as piped water, compared to people with lower income.

System in this conceptual framework is about piped water supply. The reason why different water provisions, other than piped water supply, occur is that because of ineffectiveness and inefficiency in piped water performance. Piped water performance is measured based on variables. The variables are affordability, continuity, quantity, and quality.

Those two elements can affect each other in both directions. For instance, system can affect people’s behaviour. If PDAM sets high price for piped water supply, people will choose other water supply that cheaper than piped water supply, in this case is groundwater well. Another instance is that people’s characteristics can also affect the system. If people have less income, then they will choose piped water supply with poorer quality as long as they can afford it. With the fact, therefore, this research is also conducted to find and understand the connection between those two elements.

To find and understand the connection of the elements, it is important to understand each element (people/users and system). That is why this research has four specific objectives. The first specific objective is about people/users. The second specific objective is about system. The third specific objective is about the connection between people/users and system. As the result of understanding the connection (third specific objective), fourth specific objective is policy recommendations. The policy recommendations are related with the outcome of third specific objective e.g. if based on understanding of connection, price is variable that affect people's behaviour in choosing water provision, then subsidy can be one of the recommendations. Afterwards, the policy recommendations need to be compared with current situation and current practice in the field.

1.5. Research Objectives

Based on the current situation and condition stated in section 1.1, this research determines research objectives to be achieved. The general objective of this research is to develop a method for establishing policy recommendations by evaluating performance of the current piped water supply in Yogyakarta City and understanding the link between characteristics, behaviour and performance. The general objective is divided into four specific objectives as follows:

1. To identify water users' characteristics and behaviour in choosing water provision.
2. To analyse system performance in piped water supply.
3. To analyse the connection between characteristics, behaviour and performance.
4. To generate policy recommendations that attract groundwater well users to use piped water supply.

1.6. Research Questions

In order to achieve the research objectives, research questions have been constructed as shown below.

I. To identify water users' characteristics and behaviour in choosing water provision.
   1. What are the characteristics of water users in study area?
   2. How do people get the water in study area?
   3. Why do people choose different water provision in study area?
   4. Where are people with different water provision clustering?

II. To analyse system performance in piped water supply.
   1. Which concepts/methods are suitable to describe system performance in piped water supply?
   2. Which variables are important to describe system performance?

III. To analyse the connection between characteristics, behaviour and performance.
   1. What is the connection between characteristics, behaviour and performance?
   2. Which variables are important in determining behaviour of people?

IV. To generate policy recommendations that attract groundwater well users to use piped water supply.
   1. What do the current policies state about key variables that have been identified in research objective number 3?
   2. What are the policy recommendations that can be generated?

1.7. Methodological Framework

Methodological framework for this research is shown on Figure 1-2. It gives an overview of how this research is operationalised. There are three phases of this research. The first phase, the identification of research problems, research objectives and questions are based on combination of societal problem that exist in study area and literature review. The second phase is about data required and data collection. This phase explains how the data that are needed for this research are obtained from fieldwork. The third phase is about data analysis. After obtaining the data from the fieldwork, the data are analysed. Then, based on all those analysis, the results and findings, discussions, conclusions are presented and recommendations are proposed.

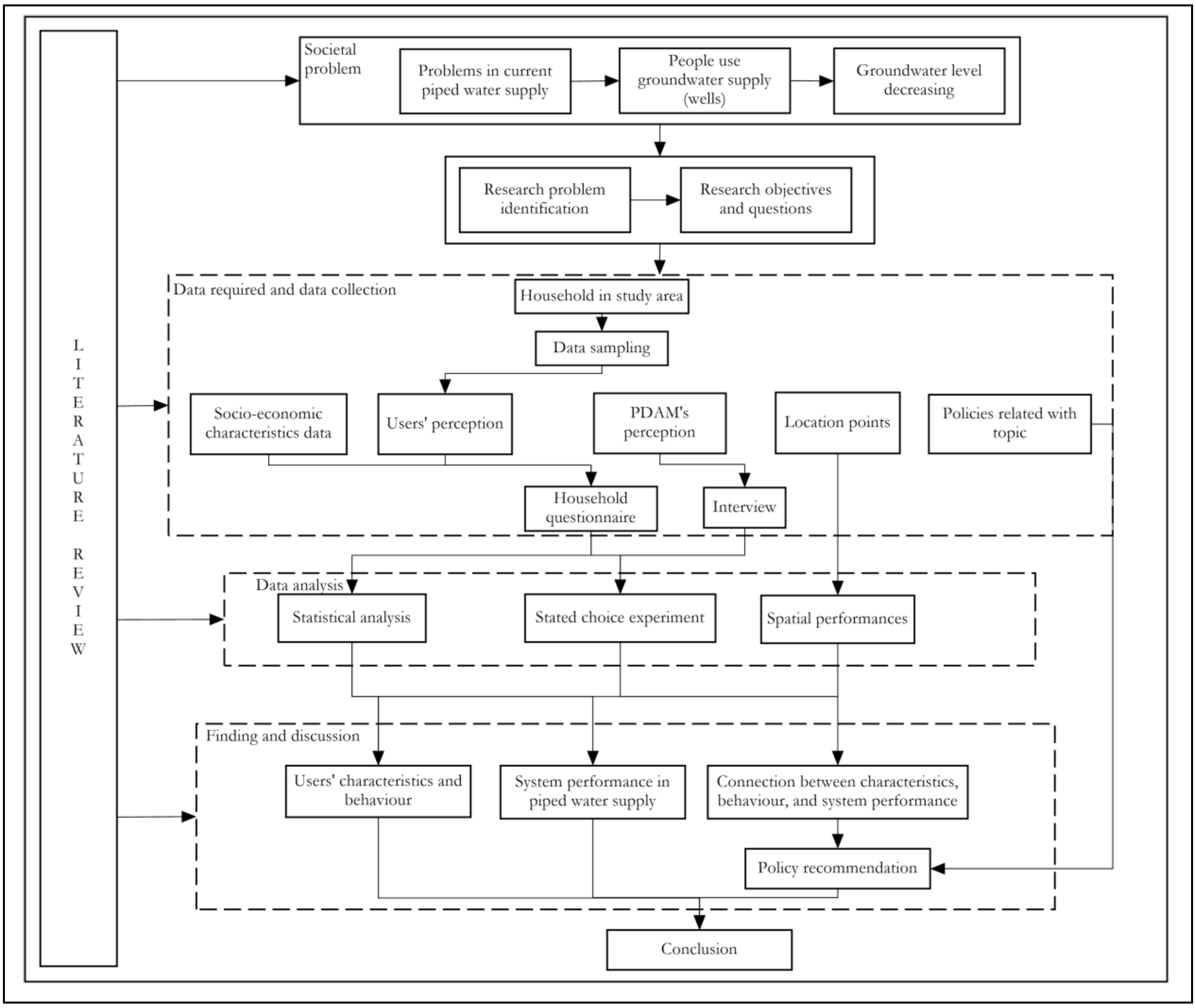


Figure 1-2 Methodological Framework

1.8. Research Design Matrix

Table 1-1 shows research design matrix which explains data requirement, data source and technique of analysis that used for answering research questions. For further detail, it can be seen in Table 1-1.

Table 1-1 Research Design Matrix

No	Research Questions	Data Required	Data Type	Techniques of Analysis
1.	What are the characteristics of water users in study area?	Socio-economic characteristics of water users	Primary	Statistical analysis
2.	How do people get the water in study area?	Water supply provision of water users	Primary	Statistical analysis
3.	Why do people choose different water provision in study area?	Users' perception	Primary	Statistical analysis
4.	Where are people with different water provision clustering?	Location points	Primary	Spatial performance

No	Research Questions	Data Required	Data Type	Techniques of Analysis
5.	Which concepts/methods are suitable to describe system performance in piped water supply?	Relevant literature on concepts	Secondary	Literature review
6.	Which variables are important to describe system performance?	Relevant literature and users' perception	Secondary and primary	Literature review and statistical analysis
7.	What is the connection between characteristics, behaviour and performance?	Relevant literature	Secondary	Literature review
8.	Which variables are important in determining behaviour of people?	Users' perception in stated choice questionnaire	Secondary	Stated choice experiment
9.	What do the current policies state about key variables that have been identified in research objective number 3?	Current policies that have relation with key variables from research objective number 3.	Secondary	Literature review
10.	What are the policy recommendations that can be generated?	Current policies that have relation with key variables from research objective number 3 and PDAM's perception	Secondary	Literature review

1.9. Organization of the Thesis

Chapter 1 – *Introduction*

This chapter presents the background and justification of the study that lead to the research problem. Research objectives, specific objectives, research questions, and general overview about this research are presented in this chapter.

Chapter 2 – *Literature Review*

This chapter is about literature review. It explains and defines accessibility to the different water provisions. Furthermore, this chapter also provide theoretical concept of perception and behaviour, stated choice experiment, experimental design and multinomial logit model.

Chapter 3 – *Study area*

This chapter introduces Yogyakarta City based on geographic, demographic and socio-economic characteristics conditions. In addition to that, this chapter also gives general overview of water supply in Yogyakarta. This overview of water supply is divided into two. The first is piped water supply which is managed by PDAM Tirtamarta and the second is groundwater well.

Chapter 4 – *Methodology*

This chapter describes the methodology which are used in this research. This chapter gives detail information about survey design, execution of survey and data processing that was conducted in advance.

Chapter 5 – *Results and Findings*

This chapter shows the results of analysis and the findings of analysis. The detailed results and findings mainly about the characteristics of the sample, distribution of water users, clusters of water users, piped water performances, behaviour of water users in purchasing bottled water, stated choice analysis and policy recommendations.

Chapter 6 – *Discussion of the Findings*

This chapter discuss the findings from previous chapter and give reflections about those findings. These reflections are arranged based on all research questions.

Chapter 7 – *Conclusions and Recommendations*

This chapter summarize the findings, presents them and provides some recommendations for further study based on this research's limitations.

2. LITERATURE REVIEW

This chapter explains about water provisions which focus only in piped water and groundwater well, since these two water provision are the main concern of this research. Furthermore, this chapter also provide theoretical concept of perception that can lead to behaviour of choosing water supply. This chapter also provide literature review about stated choice experiment that plays an important role for this research. This section of stated choice experiment is divided into two sub-sections which are experimental design and multinomial logit model. At the end of this chapter, a summarized section is explained in brief about this chapter.

2.1. Water Supply Provision

This section aims to give a general overview about piped water and groundwater well. Despite there are many types of water supplies, this research only focusses in two water supplies as stated before in Chapter 1. Moreover, the general overview in this section is mainly based on advantages, disadvantages and characteristics of each water supply.

Piped water supply is mostly organised by government, but sometimes, private organisation also organise piped water supply (Alegre et al., 2006). Piped water supply is also considered as the best water supply provision compared to others (G. Howard et al., 2006). The reasons that piped water is considered as best water supply are: less time to collect water; quantity of water are plenty; continuity of water is reliable (Hutton & Haller, 2004). Ideally, piped water has no bacterial disease that cause diarrhoea (coliforms) and less dissolved solids that will affect quality of water and health (Hutton & Haller, 2004; Salendu, 2010). However, the water quality of piped water supply, actually, depends on systems and how the systems works (Doria, Pidgeon, & Hunter, 2009; Salendu, 2010). Besides that, in developing countries, the lack of access to piped water because of limited piped connection and high price for installation and revenue make piped water only accessible for high income group (Akbar, Minnery, van Horen, & Smith, 2007). This situation can lead people with low income to find other sources of water such as pond/river or unsafe sources (Akbar et al., 2007). They tend to find other sources of water based on availability of water rather than the safety of water that they used (Salendu, 2010). Other disadvantages of piped water are: water leaking that can affect quantity and continuity of the water (Pun, 2011); and poor water processing that can affect the quality of water (Salendu, 2010).

Besides piped water supply, another water source that people mostly used is groundwater well. According to Cairncross & Valdmanis (2006), groundwater well is usually used by low income group because groundwater well requires less cost than piped water supply. However, groundwater well comes with disadvantages as well. Mostly, disadvantages of groundwater wells are related with quality, quantity, continuity and sustainability (EPA, n.d.). Poor quality of construction, depth of well, untighten casing of pump line, heavy rainfall that bring polluting material can affect the quality of groundwater well (Salvato, Nemerow, & Agardy, 2003). This condition is aggravated with the density of urban environments (Foster, 2001). He mentions that dense urban environment can lead to unprotected sewerage and sanitation. The water from the unprotected sewerage and sanitation can be absorbed by soil and can affect the quality of groundwater. On the other hand, not only water quality that become a disadvantage of groundwater well, but also quantity, continuity and sustainability. Based on Ponce (2006), quantity, continuity and sustainability of groundwater well are mostly influenced by season. There will be plenty of water in rainy season, but in the dry season, quantity and continuity of water will become less. As the result of using groundwater continuously, it can affect the sustainability of groundwater in the surrounding area.

2.2. Perception and Behaviour of Water Users

Perception of water users is an important thing that affect people's choice of water supply and behaviour towards it. The perception of water users is affected by several factors. These factors are explained as follows.

1. Rahut et al. (2015) in their research mentioned that affordability is an important that affect people's choice and behaviour. Their research says that wealthier households tend to have access to piped water, than poorer households. This situation occurs because wealthy households can afford the installation of piped water and monthly fare for piped water. As the results, poor households tend to find another water sources that do not require payment for installation and monthly fare. Usually, they choose well or other natural sources, i.e. pond, river, lake, etc.
2. Besides affordability, quantity and continuity are factors that can affect people's choice and behaviour. Based on research by Guy Howard and Bartram (2003), quantity of water is affected by continuity of water to the people's house. When the water that are distributed is less, then people could not meet their requirement for water. As the results, this condition could affects people's health condition. Afterwards, people do not tend to choose a water supply which supply less water to their house. For consumption, people living high temperatures area need to consume water, at least, 4.5 litres/day (Guy Howard & Bartram, 2003). For hygiene (drinking and cooking) and amenity use (basic needs for personal and domestic cleanliness), Guy Howard and Bartram (2003) wrote that there are no information about how much amount of water that are needed.
3. The next factor that affect people's choice and behaviour is water quality. According to Doria, Pidgeon, and Hunter (2009), water quality plays a major factor in affecting their choice. They states that perception of water quality, especially for drinking water, is influenced by colour, odour and flavour. Flavour is the main variable that can affect people's perception towards water supply among those variables. Furthermore, perceptions of chemical (lead, chlorine and hardness) is a major variable to determine water safety. By considering perceptions of chemical, people will consider that their water supply is safety to be consumed or not. As the result, the lack of water quality in flavour and safety affect people's behaviour (Doria et al., 2009). People will prefer to find another water sources because there is no trust in water quality. The alternative to get a good water quality can come from many sources. The most chosen water source for drinking and cooking is bottled water (Jorgensen, Graymore, & O'Toole, 2009).
4. Besides the main factors mention above, previous experience can be added as an additional factor that influence people's perception. Doria (2010) wrote that prior experience can affect the interpretation of new information and the perception of water source in the future. As the result, people prefer the water that they have been used to especially in term of quality. For example, people from certain part of area where the drinking water is usually yellowish may consider it is strange to have a bluish water. As the result, they can feel dissatisfaction about it and find other water sources (Doria, 2010).

2.3. Stated Choice Experiment

To analyse the connection between characteristics and behaviour of water users to the choices of water supply, in this research a stated choice experiment was conducted. According to Hensher (1994), stated choice experiment, part of stated preference methods, is generally known as behavioural research aiming to identify respondents' behaviour towards their choice of combinations of attributes. Stated choice experiment has several advantages, such as: respondents consider trade-off between variables; enable price as one of variables; multiple scenarios can be used; can estimate non-monetary variables to find level of customers demand; and the result more objective based on respondent's perspective (Centre for International Economic, 2001). Meanwhile, its drawback is that this type of experiment is known for its complexity, and sometimes not realistic if choice sets are not comprehensive and exhaustive enough.

Stated choice experiment is originated from economics discipline, but it is also used for transport modelling. However, recently, stated choice experiment is also applied on water research. One of researches comes from MacDonald et al. (2005). This research measured customer service standards in urban water. Their study area was in Australia. In their experiment, attributes used were continuity, connection interruption per month, information about connection interruption, alternatives for water supply, and annual water bill. It was known that price sensitivity was an important component based on users' perception. Users tend to choose a combination that has benefit for them based on their annual water bill.

Another research about water came from Brouwer et al. (2014). This research compared respondents' willingness to pay for improved drinking-water quality in rural and urban area. Their study area was in Kenya. For this research, they used four attributes, which were flow rate, storage capacity, diarrhoea prevalence and price. Respondents from urban and rural areas were compared. The results of this research indicate that both of respondents in urban and rural were concerned more about diarrhoea. This was the main driver for their choice behaviour. Besides that, still willingness to pay was also the main driver. Respondents living in urban area have more willingness to pay compared with respondents living in rural area. Respondents living in rural area are more price-sensitive, explained mainly due to their reduced household income.

In the next section, the experimental design process will be described. This is followed by a description of the main theoretical considerations about the Multinomial Logit model (MNL), the mainstream model within choice modelling theory.

2.3.1. Experimental Design

According to Hensher, Rose, and Greene (2007), there are eight stages to design a stated choice experiment: problem refinement; stimuli refinement; experimental design consideration; generate experimental design; allocate attributes to design columns, generate choice sets; randomize choice sets; and construct survey instrument. Figure 2-1 gives an overview, and its relations, of these eight stages.

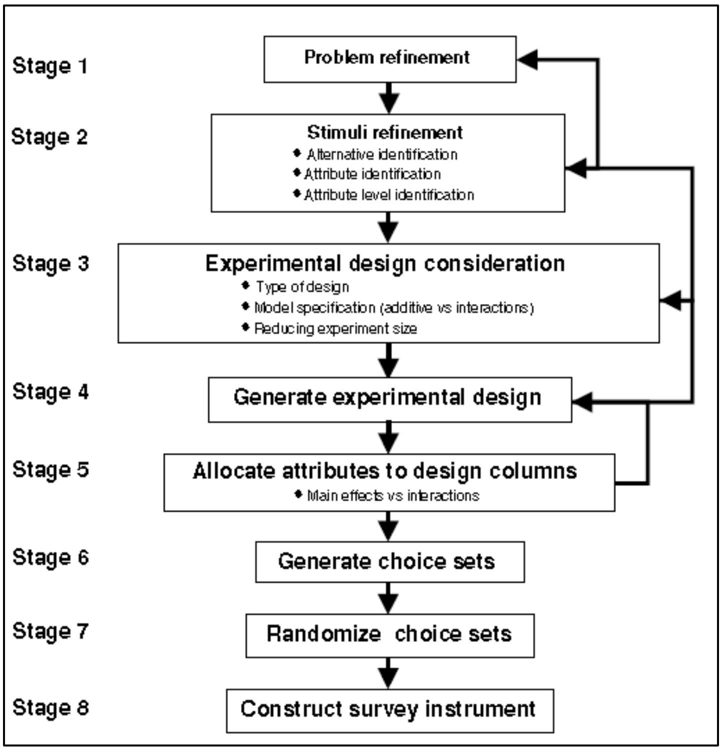


Figure 2-1. The Experimental Design Process
Source: (Hensher et al., 2007)

The first stage, problem refinement, aims to attain more understanding about the problem by eliciting the research problem and listing some questions related to the problem. This stage is also meant to help the researcher to draft only important questions that can lead to generating hypothesis (Hensher et al., 2007).

Stimuli refinement is divided into three steps: alternative identification, attribute identification, and attribute level identification. Alternative identification means that the analyst needs to list all possible alternatives that are available within the context of study. Meanwhile, the analyst needs to eliminate alternatives which are not significant. Furthermore, the analyst needs to define attributes and attribute level for alternatives that were determined in the previous step. According to Hensher et al. (2007), the first step is making attributes for each alternatives. Next step is that the analyst needs to define attribute levels and attribute level labels. Attribute level labels can be shown as quantitative (number) or qualitative (words).

Experimental design consideration mostly discuss about type of design, model specification and alternatives for reducing experiment size. There are two types of design: full fractional design and fractional factorial design (see Figure 2-2). In full fractional design, all the possible combination of alternatives and levels are presented to respondents. However, when the number of possible combinations is too high, an orthogonal fractional factorial design is then constructed, in order to avoid respondent burden, and respondents are presented only with a fraction of the full factorial design.

Example of Experimental Designs

	Factor 1	*Factor 2*	*Factor 3*
(i) ***Full Factorial Design***			
Alternative 1	1	1	1
Alternative 2	1	1	2
Alternative 3	1	2	1
Alternative 4	1	2	2
Alternative 5	2	1	1
Alternative 6	2	1	2
Alternative 7	2	2	1
Alternative 8	2	2	2
(ii) ***Fractional Factorial Design***			
Alternative 1	1	1	1
Alternative 2	1	2	2
Alternative 3	2	1	2
Alternative 4	2	2	1

Figure 2-2 Example of Full Factorial Design and Fractional Factorial Design
Source: (Kroes & Sheldon, 1988)

On the next step, attribute levels need to be coded. There are two types of coding: effect coding and dummy coding. Figure 2-3 shows an example of effect coding. The first attribute level (high) is coded as (1, 0). The second attribute level (medium) is coded as (0, 1) and the third attribute level is coded as (-1, -1). This means that the estimated utilities for each attribute sum to zero across the levels of that attribute, and that the t-statistics of each part-worth utility indicate any significant differences against the overall mean utility of that attribute. Figure 2-4 shows the example of dummy coding. The first attribute level (high) is coded as (1, 0). The second attribute level (medium) is coded as (0, 1) and the third attribute level is coded as (0, 0). When dummy coding is used, the estimated utility for each attribute is equal to the difference between the mean of the attribute and the mean of the reference level (assigned as 0's on all attribute vectors). T-tests could be used to compare each attribute's mean with the mean of the reference level.

Attribute level \ Variable	*comfort1*	*comfort2*
High	1	0
Medium	0	1
Low	−1	−1

Figure 2-3 Example of Effect Coding
Source: (Hensher et al., 2007)

Attribute level \ Variable	*comfort1*	*comfort2*
High	1	0
Medium	0	1
Low	0	0

Figure 2-4 Example of Dummy Coding
Source: (Hensher et al., 2007)

The next step is generating the choice sets and randomizing choice sets that will be used in the survey. The aim of randomize choice sets is to prevent bias respond from the respondents (Hensher et al., 2007). Hensher et al. (2007) give an example, if one respondent is presented a large number of choice sets, then the respondent will get bored and it may affect the responses. Therefore, randomize the choice sets is needed. Furthermore, Hensher et al. (2007) states that by randomizing the choice sets, it can help the researcher to test for order effect in model estimation.

The next step is generating the choice sets and randomizing choice sets that will be used in the survey. The aim of randomizing choice sets is to prevent bias responses from the respondents that could be due to the order that choice sets are presented.

Hensher et al. (2007) mentioned that there is no formal study about how to do randomization of choice sets, although it is advisable. It means that randomized choice sets will be presented to respondents. By using Computer Aided Personal Interviews or known as CAPI, the researcher will be able to generate a randomize survey automatically. The problem is that for paper and pencil survey, logistical problems may arise. However, Hensher et al. (2007) suggested to generate additional blocking variables within an experimental design as alternative way. The perk of generating additional blocking variables is that it can help to reduce logistical problem in paper and pencil survey. It is because the design attributes will be orthogonal with the order of presentation.

The last stage of experimental design is constructing the survey. For doing that the analyst needs to arrange the choice sets in appropriate way. It is suggested by Hensher et al. (2007) to insert clear instructions about it. Thus, the respondent will understand what they have to do and consequently minimize the bias.

2.3.2. Multinomial Logit Model (MNL)

In order to analyse the result from stated choice experiment, discrete choice model is used. It is because the respondents must select a best choice among other set of choices (Nkurunziza, 2008). Furthermore, discrete choice models figure that "the probability of individuals choosing a given option is a function of their socioeconomic characteristics and the relative attractiveness of the option" (Ortúzar & Willumsen, 2011, p.227). Ortúzar and Willumsen (2011) also stated that the relative attractiveness can be represented using the concept of utility. The concept of utility gives an illustration about what the individuals wants to maximize. They also stated that the utility can be used to predict probability of an alternative to be chosen, as long as the value must be contrasted. Later, it can be converted into probability with a value between 0 and 1.

According to Hensher et al. (2007), there are three main ways to estimate discrete choice models. There are nested logit, mixed logit, and multinomial logit. Ortúzar and Willumsen (2011) wrote that the most popular discrete choice models are multinomial logit and nested logit. The advantages of MNL is that it treats responses from the same respondents as independent observations in the estimation (Hensher et al., 2007) and it is known as the simplest discrete choice model (Nkurunziza, 2008).

As mentioned before, discrete choice models figure about choice probabilities, thus, coefficients estimated by MNL can be used calculate probabilities that a choice can be chosen by individuals using an equation (Ortúzar & Willumsen, 2011). This equation can be seen as follows (Equation 2-1).

$$\mathrm{Prob}_i = \frac{\exp V_i}{\sum_{j=1}^{J} \exp V_j}; \qquad \mathrm{j} = 1, \ldots, \mathrm{i}, \ldots, \mathrm{J} \quad \mathrm{i} \neq \mathrm{j}$$

Equation 2-1 Probabilities Function
Source: (Hensher et al., 2007)

Hensher et al. (2007, p.86) describe the Equation 2-1 as:

> "The probability of an individual choosing alternative *i* out of the set *J* alternatives is equal to the ratio (the exponential of the) observed utility index for alternative *i* to the sum of the exponentials of the observed utility indices for all *J* alternatives, including the *i* th alternative."

Meanwhile, *Vi* is explained in Equation 2-2 as follows.

$$V_i = \beta_{0i} + \beta_{1i} f(X_{1i}) + \beta_{2i} f(X_{2i}) + \beta_{3i} f(X_{3i}) + \cdots + \beta_{Ki} f(X_{Ki})$$

Equation 2-2 Utility Function
Source: (Hensher et al., 2007)

Where

> "β_{1i} is the weight (or parameter) associated with attribute X_1 and alternative *i*
> β_{0i} is a parameter not associated with any of the observed and measured attributes, called the alternative-specific constant" (Hensher et al., 2007, p.76).

Hensher et al. (2007) also describe *k* as the number of attributes between 1 until *K*. To measure the goodness-of-fit of the MNL model, the McFadden's ρ^2 (Rho-square) index is usually used. This index is commonly referred to as the likelihood – ratio model.

2.4. Summary of Literature Review

This chapter presents a detailed understanding of water supply provision, perception and behaviour of water users and stated choice experiment. The section of water supply provision (Section 2.1) focussed on two types of water supplies (piped water and well) that are the main concern of this research. The section gives an overview about the characteristics, the advantages and disadvantages of both water supplies. Meanwhile, the section of perception and behaviour of water users (Section 2.2) explains about factors (affordability, quantity, continuity, and quality) which affect people's perception, choice and behaviour. Afterwards, in Chapter 4, these factors will be used to measure performance of piped water supply.

The next section is about stated choice experiment (Section 2.3). It is explained to analyse the connection of characteristics (Section 2.1) and behaviour of water users (Section 2.2). To do the stated choice experiment, developing experiment design is the first step. There are eight stages which are needed to design a stated choice experiment. After designing the experiment and conducting the survey, the data from survey need to be analysed. For analysing the data, MNL will be used because in the survey, respondents are expected to choose a best choice among other set of choices. Furthermore, MNL will be used to calculate utilities and probabilities of choice of water provision.

3. STUDY AREA

This chapter describes study area, which is Yogyakarta City, based on geographic conditions, demographic conditions and socio-economic characteristics. In addition to that, this chapter also gives general overview about water supply conditions in Yogyakarta city especially piped water, which is managed by PDAM Tirtamarta, and groundwater well.

3.1. General Description of Study Area

Yogyakarta City is part of Java Island, Indonesia (Figure 3-1). This city is known as a main capital of D.I Yogyakarta Province which famous with tourism and education. Yogyakarta city is located on the heart of D.I. Yogyakarta Province. The coordinate of Yogyakarta City lies between 110º24’19” - 110º28’53” East Longitude and 07º15’24” - 07º49’26” South Latitude. The city of Yogyakarta has boundaries as seen below:

- North: Sleman County.
- South: Bantul County.
- West: Bantul County and Sleman County.
- East: Bantul County and Sleman County.

Yogyakarta City has 14 districts (see Figure 3-1) and 45 urban villages with 32.5 km² of land area that are dispersed within the city. Furthermore, that land area of Yogyakarta City is equal to 1.02% of D.I Yogyakarta Province land area. The largest district in Yogyakarta City is Umbulharjo district with 8.12 Km² and the smallest district is Pakualaman district with 0.63 Km².

Figure 3-1 Map of Districts in Yogyakarta City

3.2. Population and Density

According to the data of BPS Kota Yogyakarta (2009), in 2008, there were 456,915 inhabitants living in Yogyakarta City with combination 51.14% was female and 48.86% was male. Moreover, population density in 2008 was 14,059 inhabitants per Km^2. This population density increased 1,831 inhabitants per Km^2 compared to the population density in 2000. More explanation about population and density can be seen as follows (Table 3-1).

Table 3-1 Population and Density in Yogyakarta City (2008)

District	Area (Km^2)	Male (People)	Female (People)	Total (People)	Density (People/Km^2)
Mantrijeron	2.61	18,398	19,044	37,442	14,346
Kraton	1.40	10,612	11,908	22,520	16,086
Mergangsan	2.31	17,352	18,569	35,921	15,550
Umbulharjo	8.12	39,191	40,129	79,320	9,768
Kotagedhe	3.07	16,097	16,207	32,304	10,522
Gondokusuman	3.99	27,062	28,648	55,710	13,962
Danurejan	1.10	10,999	11,683	22,682	20,620
Pakualaman	0.63	5,754	5,014	11,768	18,679
Gondomanan	1.12	7,398	8,595	15,993	14,279
Ngampilan	0.82	9,537	10,695	20,232	24,673
Wirobrajan	1.76	15,856	15,248	31,104	17,673
Gedongtengen	0.96	9,708	10,714	20,422	21,273
Jetis	1.70	15,019	15,442	30,461	17,918
Tegalrejo	2.91	20,244	20,792	41,036	14,102
Total	3.25	223,227	233,688	456,915	14,059

Source: (BPS Kota Yogyakarta, 2009)

3.3. Education and Occupation

Generally, education in Yogyakarta City are divided into several level. The basic level is primary school and the highest level is post graduate. Based on BPS Kota Yogyakarta (2009), people in Yogyakarta City were mostly senior high graduate with 31.12% of population. Meanwhile, the least level of education were post graduate level with 0.94% of population. Meanwhile, occupation in Yogyakarta City are categorised into several types as well. The categorization was based on type of business. According to data from BPS Kota Yogyakarta (2009), majority people in Yogyakarta City worked in service business area with 108,660 inhabitants in total. On the other hand, type of business with less people worked in was farm business with only 32 inhabitants in total.

3.4. Water Supply

The purpose of this section is to give an illustration about water supply provision in Yogyakarta City. There are four water supply provisions in Yogyakarta City (BPS Kota Yogyakarta, 2009). However, this research only focuses on two water supplies: piped water supply and well (Figure 3-2). Piped water in Yogyakarta City is managed by PDAM. PDAM in Yogyakarta is known with PDAM Tirtamarta. Data from BPS Kota Yogyakarta (2009) showed that PDAM Tirtamarta had 25,562 households as their customers. These numbers were still less compared to the well users. The data showed that well/spring were used by 102,739 households and known as the most used water supply in Yogyakarta City. Those numbers were number of households with well permit. If the households without well permit were included then the numbers will be more than that. Moreover, to give deeper information about both water supplies, Sub-Section 3.4.1 and 3.4.2 were constructed below.

Figure 3-2 Photos of Type of Water Source in the Study Area

3.4.1. Piped Water Supply

According to data from Pemkot Yogyakarta (2001), PDAM Tirtamarta produced 17,800,000 m^3/year to serve their customers. Although PDAM Tirtamarta produced 17,800,000 m^3/year, they only distributed 15,600,000 m^3/year and sold 10,900,000 m^3/year. For the rest of 2,200,000 m^3 was saved for reserve. Based on that information, PDAM Tirtamarta lost 30% of water due to leaking.

In order to fulfil the water production per year, PDAM Tirtamarta uses water from four water sources. Based on Pemkot Yogyakarta (2001), these four water sources are taken from spring, shallow well, deep well, and surface water. Spring waters are taken from Umbul Wadon spring and Kali Kuning spring. For shallow wells, the water is taken from 8 different shallow wells in Karang Wuni, Besi I, Besi II, Gemawang, Bulusan, Kentungan and Jongkang. Furthermore, water from deep wells comes from 28 deep wells. These wells are located in Kota Gede, Ngaglik and Bedog. For surface water, PDAM Tirtamarta takes water from Padasan River. Water from Padasan River is not taken directly from the river, but it is through some treatment to keep the quality of the water. That is why Padasan River is equipped with water treatment plant. Meanwhile, to keep its quality, water that comes from other sources than Padasan River is treated using other methods. Water from Umbul Wadon is treated using chlorination to reach good quality of drinking water standard. Water from Kali Kuning is filtered and processed using sedimentation process to prevent unwanted particles in the water. Water from all wells are treated with aeration, coagulation, flocculation, filtration and chlorination to get good quality before it is distributed. Furthermore, all the water is distributed using pipe network to area in Yogyakarta City. This pipe network can be seen on Figure 3-3.

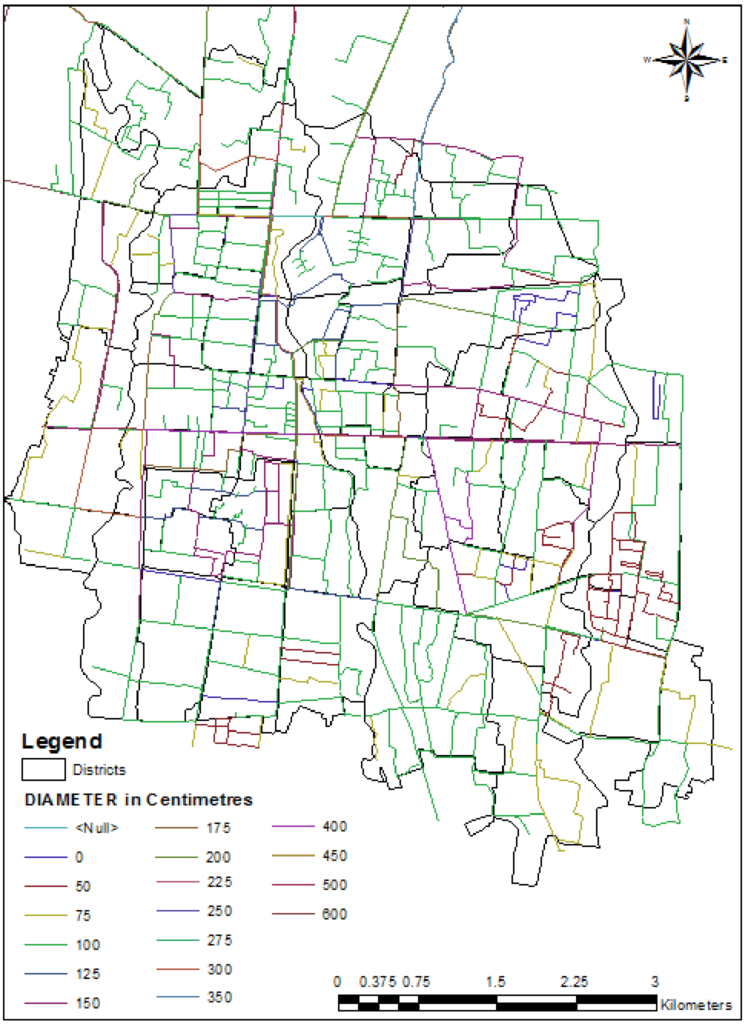


Figure 3-3 Map of PDAM Tirtamarta's Pipe Network

For operational needs, PDAM Tirtamarta gives prices for water to their customers. Different fare applies for different type of building use. According PDAM Tirtamarta (2014), these type of building use are classified into five main groups. There are social use, non-commercial use, commercial use, industrial use, and special use. Moreover, the water price also will be different based on water consumption. However, this research only focusses in non-commercial use that shows on Table 3-2.

Table 3-2 Price for Water Consumption per Type of Building Use

Type of Building Use	Water Consumption			
	0-10	11-20	21-30	>30
	Water Price per m³			
Non-Commercial Use	Rp			
Household type A1	2,500	3,800	5,700	9,500
Household type A2	3,400	4,200	5,700	9,500
Household type A3	4,000	4,500	6,500	9,500
Household type B	4,000	4,500	6,500	9,500

Source: (PDAM Tirtamarta, 2014)

As mentioned before that water price per m^3 depends on type of non-commercial use. For further explanation about criteria for each type of users can be seen as follows.

- Household A1: house with road width and drainage between 0 to 3.99 meters.
- Household A2: house with road width and drainage between 4 to 6.99 meters.
- Household A3: house with road width and drainage between 7 meters and above.

- Household B/Government building: house with or without a business license, government agencies and foreign representative offices.

Furthermore, to measure how much the PDAM users must pay, PDAM employee check the water gauge for PDAM that installed in each users' house. Usually they check at the end of month. Afterwards, they record the amount of the water and calculate it into amount of money that the PDAM users have to pay (see Figure 3-4).

Figure 3-4 Photos of Water Gauge in the Study Area

3.4.2. Groundwater Well

After giving general overview about piped water supply, this section gives a general overview about groundwater well in Yogyakarta City. To build a well in Yogyakarta City, the well users need a well permit. The procedures of well permit application is administered in Regulation no. 28 Year 2013. According to Pemkot Yogyakarta (2013), all activities that need to extract groundwater must have a permit without any exception. This regulation not only gives information how to apply for well permit, but also gives information about the drilling and monitoring procedure (Figure 3-5).

To apply a well permit, the applicant must submits a form to the Environmental Bureau. Afterwards, Environmental Bureau will check the form and all requirements. If it is complete, then The Environmental Bureau will give a recommendation to the Governor of D.I.Yogyakarta Province. The governor has a right to reject the application although the form and requirements are complete. The rejection is depended on the water debit in that area. If it is approved, then the governor will give a recommendation that need to be signed by Major of Yogyakarta City. This signed form will be received by Licensing Bureau to give a permit to the applicant. Meanwhile, for drilling procedure, field survey needs to be conducted by licensing bureau. If the location is good, then licensed driller will build the well based on instruction of Licensing Bureau. Meanwhile for monitoring procedure, Licensing Bureau with Environmental Bureau will do a monthly checking. This checking is to see whether or not well users extract more water and endanger the environment near them. Thus, they will check water debit, water quality and building quality. For further illustration, it can be seen on Figure 3-5.

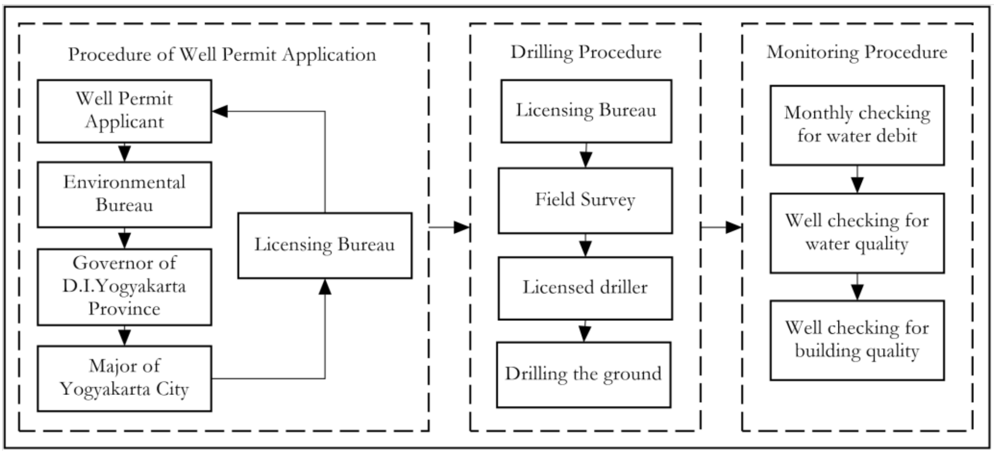


Figure 3-5 Procedures of Extracting Groundwater
Source: (Pemkot Yogyakarta, 2013)

4. METHODOLOGY

This chapter describes the methodology that was used in this research. This chapter is divided into three main sections. The first section gives information about the survey design. It explains about questionnaire design, design of stated choice experiment, selection of urban villages and sampling design. The second section shows how the survey was conducted. For the last section, data processing and data analysis for all the data that were retrieved from survey is explained.

4.1. Survey Design

4.1.1. Questionnaire Design

To retrieve information about household data, water supply provision and stated choice, a questionnaire was performed during a fieldwork. However, questionnaire design had to be done in advance. Therefore, this section was written based on the preparation of questionnaire design.

At the beginning, some variables that needed for the questionnaire were selected based on discussion with supervisors and literature review. Before going to the field, some choices for existing conditions of water supply were changed after a discussion with PUSTRAL (*Pusat Studi Transport dan Logistik*), part of Gadjah Mada University in Yogyakarta. This changing was intended to help respondent to easily understand the questions.

There are three parts in the questionnaires (See Appendix 4, 5 and 6). The first part looked at the household data. The purposes of the first part were to look into socio-economic characteristics of respondents and to identify different social classes within the study area. To fulfil these purposes, several questions related to household data were asked, for instance: number of persons in the household, occupation, level of education, house type, and possession of property (motorcycle, house, telephone, electricity, etc.). The second part of the questionnaire aimed to identify existing condition of water supply. This questionnaire only focused on four type of water supply. There were PDAM, private well, communal well, and bottled water. The respondent could choose one of them or combining two or more water supply based on their situation. Furthermore, the conditions of water supply were mostly related with the price spent for water in a month, how much water they use (quantity), continuity of its service, and quality of water, for what purpose they use water and specific questions regarding well water provision. For example, type of well, distance of the well, etc. The third part contains the stated choice experiment, which will be detailed in the next section.

4.1.2. Design of Stated Choice Experiment

In order to design the stated choice experiment, according to the literature review, some steps need to be taken. The steps are explained as follows.

1. The first step was determining the variables. This research explores two types of water provision (pipe and well). The attributes were price, quality, and continuity.
2. The second step was defining the attribute levels. Each attribute varied within 3 levels. The reason for choosing 3 levels for each of the 3 attributes was twofold: to keep the orthogonality in the design and to avoid having a complex experimental task. Each attribute and their levels are explained on Table 4-1.
3. The next step involved creating the full factorial experimental design. There are 2 variables (pipe and well), 3 attributes (price, quality, continuity) each varying within 3 attribute levels (high, medium, low), resulting in a $(2x3)^3$ full factorial design. It yields to a total of 216 combinations. In this case, the number of combination is too high. Therefore, fractional factorial design was used. The fractional factorial design was generated using SAS software(The University of Iowa, 2015). The resulted fractional factorial design generated 18 choice sets.

4. These 18 choice sets were randomized by the addition of 1 extra variable for blocking the design. Thus, the choice sets were blocked into two blocks (see Appendix 5 and 6). Each block contains 9 choice sets. Each block had their own combination of choices (see Appendix 5 and 6). Each block was printed and copied 250 times. Hence, in the total, this research had 500 copies of both blocks.
5. The last step was constructing the questionnaire. Clear instructions were given about how to perform the choice experiment, and surveyors were also instructed to help on the understanding of the experimental task.

The questionnaire was tested through a pilot study, and some adjustments were made, especially on the collection of the revealed data.

Table 4-1 Attribute Levels

Variable	Piped Water	Ground Water Well
Price	(1) More than you pay now for piped water	(1) More than you pay now for ground water
	(2) Same as you pay now for piped water	(2) Same as you pay now for ground water
	(3) Less than you pay now for piped water	(3) Less than you pay now for ground water
Quality	(1) Drinkable	(1) Better than now, but not drinkable
	(2) Same as now	(2) Same as now
	(3) Worse than now	(3) Worse than now
Continuity	(1) available the whole day;	(1) available the whole day;
	(2) difficulties on peak hours (06.00 -09.00 and 17.00-21.00);	(2) difficulties on peak hours (06.00 -09.00 and 17.00-21.00);
	(3) only available 2 hours in the day	(3) only available 2 hours in the day

Note: (1) high; (2) medium; (3) low

4.1.3. Selection of Urban Villages

Based on explanation in Chapter 3 Study Area, Yogyakarta City can be concluded as a large city. By looking to this fact, it is impossible to take the whole area in Yogyakarta City as study area. Therefore, there was a need to do a selection of urban villages. The aims of this selection was to help this research to finish on time with given time and fund, but still can answer the research questions properly.

Furthermore, the selection of urban villages was based on different socio-economic characteristics of water users and discussion with PUSTRAL. Household characteristics and different socio-economic factors will lead to different behaviour (see section 1.4). Based on BPS *Republik Indonesia* (2011), one of district in the city of Yogyakarta that has several urban villages with different socio-economic characteristics is Tegalrejo. This district has four urban villages named Bener, Kricak, Karangwaru and Tegalrejo (see Figure 3-1).

Table 4-2 Data about Urban Villages in Tegalrejo District

Urban Village	People	HH	Poor People	% Poor People	Energy for Cooking	Drinking Water	Water Supply	Electricity PLN	Electricity Non-PLN
Bener	4942	1681	514	10.4%	LPG	Without bottled water	Well	1261	420
Kricak	12518	4291	1163	9.3%	LPG	bottled water	PDAM	2461	1830
Tegalrejo	8292	2139	687	8.3%	LPG	Without bottled water	Well	1957	182
Karangwaru	9375	3241	762	8.1%	LPG	bottled water	PDAM	2050	1191

Source: (BPS Republik Indonesia, 2011)

According to Table 4-2, three out of four urban villages were chosen. It was because Tegalrejo and Karangwaru have similar percentage of poor people (8.3 % and 8.1%). Furthermore, Bener, Kricak and Karangwaru are located side by side and it can save time and fund for this research. Meanwhile, Tegalrejo was not chosen because it is not located side by side compare with others and based on condition in the field, it will take more time to explore that urban village (see Figure 4-1).

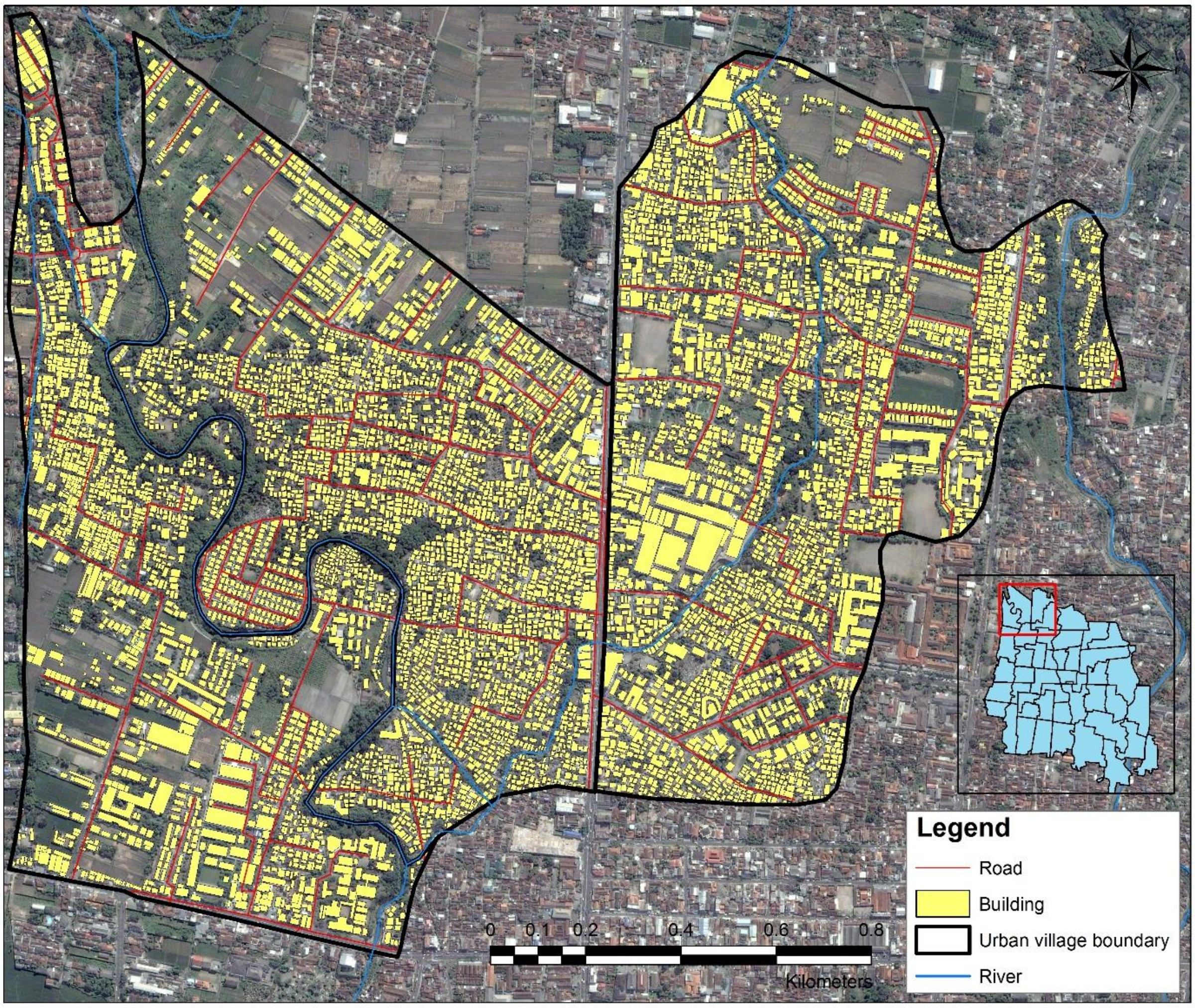


Figure 4-1 Map of the Study Area

4.1.4. Sampling Design

Sampling design that was used in this research was cluster sampling. Cluster sampling is one of sub-sampling from random/probability sampling (Kumar, 2005). Random/probability sampling means that the choice of one respondent within the sample is not influenced other respondents, since they are considered to be independent. Moreover, Kumar (2005) mentions that random/probability has advantages compare to others such as: the samples can represent total sampling population and the collected random sample can be tested using statistical tests. This testing is impotant to see its correlation.

According to Martinez (2015), generally, the steps for doing cluster sampling using satellite images are divided into different steps. First step is dividing satellite images into grids. These grids can be selected using simple random or systematic sample of grids. Second step is number all dwelling within those grids and select random dwelling. Moreover, the last step is selecting individual/household from each dwelling unit.

In the survey, this research did cluster sampling using satellite images. The images of the study area were taken from satellite imagery. All buildings within three selected urban villages were included for sampling of household survey (Figure 4-2). It means that all buildings had opportunity to be chosen as part of sampling frame for household survey. This research took household as their sampling unit. It is because if this research took people as its sampling unit, then the probability for people in the same household to be interviewed will be high. People in the same household tend to give same information or maybe contradictory information. It will give bias for this research.

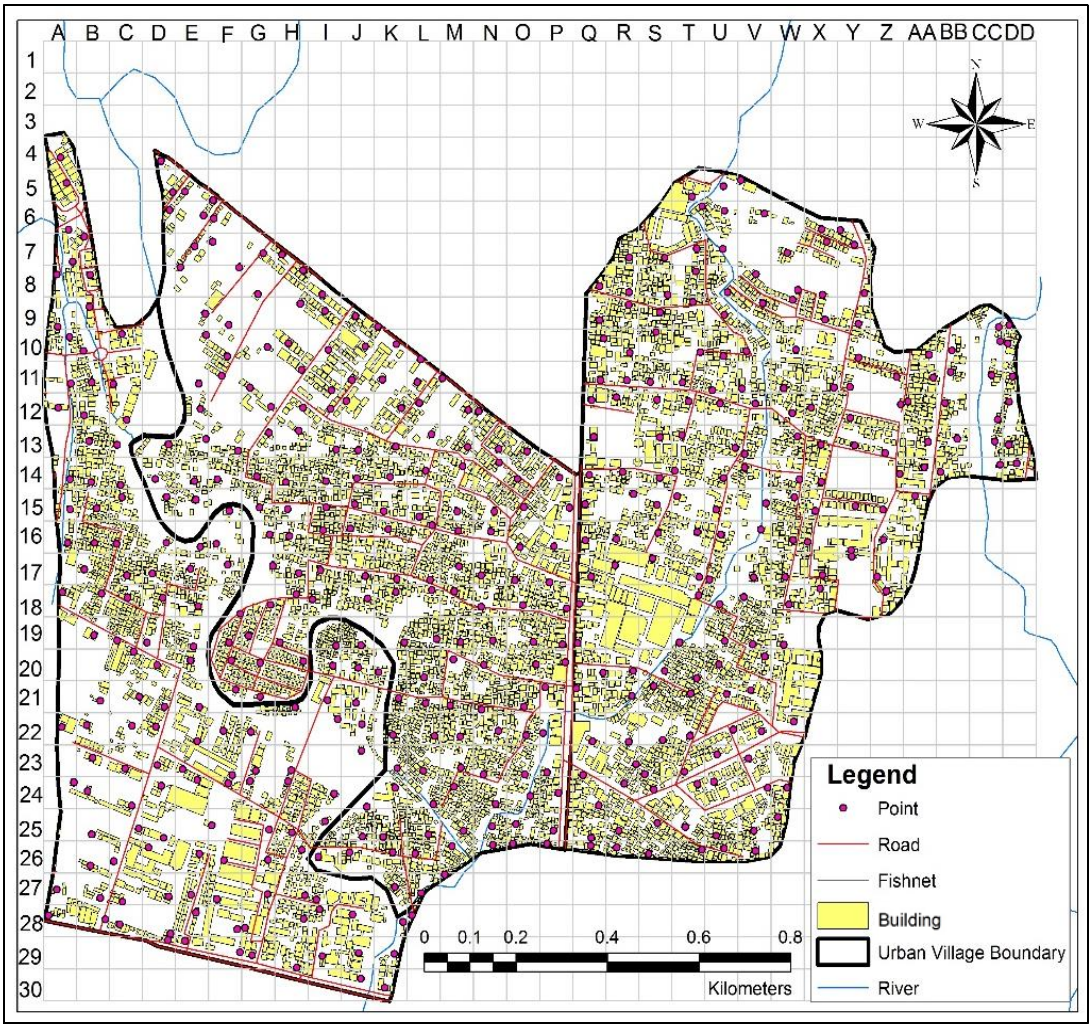


Figure 4-2 Cluster Sampling in the Study Area

4.2. Execution of Survey

The fieldwork started from Tuesday, 15 September 2015 and ended on Saturday, 3 October 2015. The fieldwork were opened by discussing about fieldwork with PUSTRAL. The discussion was mostly about how the household survey will be conducted during three weeks of fieldwork, how many respondents, where the sufficient area for the survey is and who need to be contacted for interview and also contacted surveyors. That first week spent for making survey permit and waiting for it. Meanwhile, second and third week were spent for household survey (section 4.2.1), interview (section 4.2.2), and secondary data collection (section 4.2.3).

4.2.1. Household Survey

Household survey aimed to extract information from the household about three parts that are shown in Section 4.1.1. The household survey became the most important part of this research that is why it was prepared carefully. The preparation of household survey was started by discussing the questionnaire and selecting the surveyors. Five persons were selected as surveyors. Each surveyor handled 100 respondents within 10 days. Hence, one surveyor interviewed 10 respondents per day. After making an agreement about survey, all the surveyors came for a discussion about the questionnaire. They read the questionnaire and interviewed each other to get feeling about the questions. More time were spent to explain and discuss the stated choice experiment, how they supposed to do it, since that part need more explanation. They suggested to change some questions in first and second part of questionnaire, because it was hard to understand for them. They also suggested to fix the map, because there were double points in one grid.

After some upgrade on questionnaires and maps, on Monday 21 September 2015, with all surveyors, the pilot survey was conducted. The purpose of doing pilot survey was to know which part of the questionnaire that still need to be improve. The other purposes of doing pilot survey were to know how much time was spent for one questionnaire and to give the surveyors an illustration how to conduct the survey. There were 15 questionnaires for pilot survey. One surveyor interviewed three respondents. These respondents were not the same with respondents for main survey. Mostly respondents lived near Gadjah Mada University. According to discussion with PUSTRAL on previous week, the surveyors interviewed only head of household or his wife. It was because only head of household or wife know about situation in their house. Besides that, only they can make decision to choose between PDAM or well or none of those in stated choice. From the pilot survey, it was known that one questionnaire needed 15-30 minutes including introduction and small chatting. This time depended on how the respondents understand the questions. They mostly spent more time to give data about quantity of water from private or communal well.

On the next day, the surveyors took the fixed questionnaire after some upgrading on it based on the pilot survey. They took questionnaires in the morning and gave those back on the evening. Then, the returned questionnaire needed to be recheck whether or not some questions were empty. If that so, they need to explain and fix it. To locate the households, surveyors used maps. Because they are from the area of survey, they did not find it difficult. To give illustration of household survey, it can be seen on Figure 4-3 and Figure 4-4.

Figure 4-3 Photos of Household Survey in the Study Area

Figure 4-4 Photos of Housing Conditions in the Study Area

4.2.2. Interview

The purpose of doing interview was to retrieve a deeper information and insight from government's institution regarding the research problem. Hence, PDAM Tirtamarta, KIMPRASWIL, and PU-ESDM which have a concern to the problem were chosen as respondents. PDAM Tirtamarta was chosen because they play a major project as a piped water provider. Meanwhile, KIMPRASWIL (Settlements and Regional Infrastructure Department) was chosen because they made some policies regarding water supply to the different types of buildings. PU-ESDM (Public Works - Energy and Mineral Resources Department) was chosen because they made regulation and restriction to extract groundwater. Unfortunately, after discussing with Licensing Bureau which gave the permit for this interview, it was known that PU-ESDM is under provincial jurisdiction. Licensing Bureau could not give the permit for higher jurisdiction and it will take more time. After discussing with PUSTRAL, the interview was conducted only for PDAM and KIMPRASWIL. All the questions that were asked in the interview can be seen on Appendix 7.

4.2.3. Secondary Data Collection

Secondary data collection were done to support this research. It was conducted by requesting data from some departments in Yogyakarta City. Unfortunately, PDAM Tirtamarta as water provider did not want to give their data due to confidentiality issue. The data about PDAM Tirtamarta were collected from PUSTRAL. For detailed explanation, it can be seen on Table 4-3 below.

Table 4-3 Collected Data

Collected Data	Sources	Year
Demographic data	BPS Yogyakarta City	2009
Policies, laws and regulations in housing and water provision	KIMPRASWIL	2012 and above
Maps of Yogyakarta City and data about PDAM Tirtamarta	PUSTRAL	2013
PDAM Tirtamarta's pipe network	ITC	2012
Satellite Imagery of Yogyakarta City	Yogyakarta Marhensa	2013
Regulation to extract groundwater	Government of Yogyakarta City	2013

4.3. Data Processing

Data processing was conducted to prepare the data for further analysis. However, before doing the data processing, the data need to be rechecked in order to preserve its quality. The author rechecked all the questionnaires while inputting the answer into excel. Afterwards, the excel data were converted into SPSS. In SPSS, some codes and labels were added for statistical analysis. New and shifted location points were fixed using ArcGIS, based on information given by surveyors. Each household has some unique ID that can be joined with household code in SPSS. The author rechecked the questionnaires, SPSS data and asked the surveyors to avoid errors. Meanwhile, all notes from interview were transcribed using MS. Words. If there was some unclearly statements, the author contacted the respondent directly using email. Later, this data, along with the data from questionnaires and maps, were ready to be used for further analysis.

4.4. Data Analysis

Data analysis was performed to produce results that can be used for this research to answer the research questions. Generally, this research used SPSS as the main tool for producing results. Cross tabulation in SPSS is used for revealing social-economic characteristics, assessment of system performance in piped water supply, and behaviour of water users in purchasing bottled water. For detailed steps can be seen below.

- For socio-economic characteristics, water source for each respondents were crossed tabulation with some variables (number of persons in household, house type, motorcycle, etc.). The output can be seen on Table 5-1.
- For assessment of system performance used cross tabulation by inputting variables of system performance (affordability, continuity, quality and quantity) as the input data. The results of this data analysis can be seen in Section 5.4.
- For behaviour of water users in purchasing bottled water source, variable for with/without purchasing bottled water were used as input data. Afterwards, the output of this data analysis were transformed into graph that can be seen on Figure 5-14.

This research used other tools to answer the research questions which require different analysis. These tools were ArcGIS and BIOGEME. For detailed analysis are described in Section 4.4.1 and 4.4.2 as follows.

4.4.1. Clusters Analysis

The purpose of doing clusters analysis of water users was to analyse whether or not each water users make clusters and where the clusters are. Clusters of water users were done in ArcGIS using point density tool.

This tool produces a neighbourhood around each raster cell centre. Afterwards, total raster cells for some neighbourhoods which overlay one to another are calculated. At the end, the total points from that calculation will be divided by the area of the neighbourhood (Silverman, 1986). As the results, there will be a cold and hot area of clusters. Blue colour indicates cold area and red colour indicates hot area, a location where most of similar water users are grouped together. The value that shows in the maps representing outcome value from the calculation of point density. The results of this clusters analysis are shown on Figure 5-3 until Figure 5-7. For further explanation of the steps can be seen on Figure 4-5.

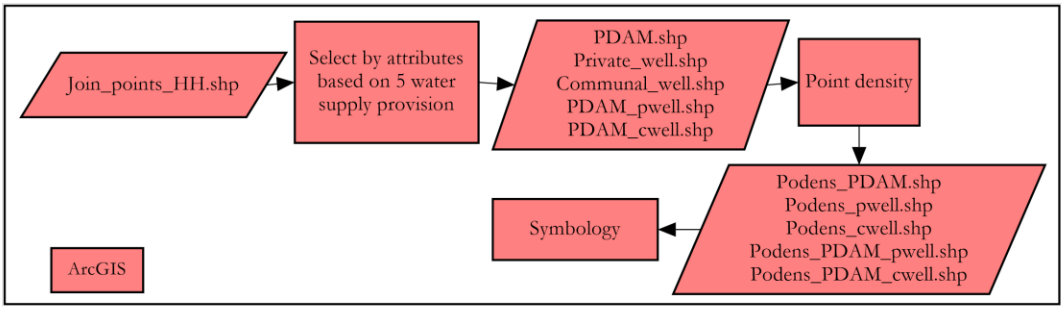


Figure 4-5 Flowchart of Clusters Analysis

4.4.2. Stated Choice Analysis

In order to identify which variables that can attract well users to change to PDAM, stated choice analysis was carried out. In this research, stated choice analysis was used twice. The first time was to estimate parameters in general. The second time was to estimate parameters with relation to education level. To do those two analysis, the result from stated choice experiment (taken from households' survey) was used.

For estimating parameters model 1, this results needed to be rearranged from horizontal into vertical in Excel. Thus, it showed that one respondent made nine choices in vertical (in one column named choice). Afterwards, effect coding was used to code each choice. Effect coding was used to represent the variables. The first attribute level (high) were coded as (1, 0). The second attribute level (medium) were coded as (0, 1) and the third attribute level were coded as (-1, -1) in order to get sum of zero for across level of that attribute. This coding was for all three variables (price, continuity and quality). This excel file was the based for stated choice analysis. For more detail steps, it can be seen on Appendix 1.

For estimating parameters model 2, the steps mainly the same with estimating parameters model 1. The difference is that this research added three education level (high, medium, low). The results contains five level of education. Thus, this research need to make three group of them. The high level is for university degree. The medium level is for senior and junior high school. Meanwhile, the low level is for elementary school or no formal education. Afterwards, this level need to be coded also. High level were coded as (1, 0), Medium coded as (0, 1) and low level were coded as (-1,-1). These levels were multiplied with coded variables and attribute levels. After that, this excel file was used for the base of stated choice analysis to estimate parameters with relation to education level. For more detail steps, it can be seen on Appendix 2.

Furthermore, because in this research, stated choice analysis used Multinomial Logit (MNL), thus, BIOGEME was used as software to do MNL. Based on Bierlaire (2003), BIOGEME (*BIerlaire's Optimization package for GEV Models Estimation*) is an open source that is used to estimate random utility. This estimation is based on optimization algorithms. For further steps of this analysis can be seen on Appendix 3 and the final results of this analysis can be seen in Section 5.6.

5. RESULTS AND FINDINGS

This chapter mainly shows the results of analysis and findings from the results. These results are divided into several sections. In the beginning, the discussion focuses on the characteristics of the sample, distribution of water users, clusters of water users. In the second part, piped water performances is explained. This piped water performance is based on its affordability, quality, quantity and continuity. Afterwards, behaviour of water users in purchasing bottled water is also explained in this chapter. Furthermore, last part or section about stated choice analysis are explained. The results from stated choice analysis are used to establish policy recommendations. These policy recommendations were produced to help policy makers to attract more groundwater well users to use piped water.

5.1. Sample Characteristics

Characteristics of households sample in the study area are presented in Table 5-1. Most of households sample (39%) in study area contain of four persons. Usually, it is a family with one husband, one wife and two children. Moreover, at least one person within the household (46.28%) has an occupation and mostly are head of household. Table 5-1 shows that majority of head of the household (46.6%) work as self-employed even though most of them have university degree (47%). Turning to other variables, most of households own a permanent house (98.39%), two motorcycles (47.53%), and mobile phone (80.92%). All households use electricity from public company for electricity known as PLN (*Perusahaan Listrik Negara*) and use LPG (Liquid Petroleum Gas) for cooking. For further information, it can be seen on Table 5-1 below.

Table 5-1 Sample Characteristics

Variables	Classes	Percentage (%)
Number of persons in household	1	1.2
	2	7.6
	3	19.8
	4	39
	More than 4	32.4
Number of persons with occupation in household	1	46.28
	2	38.43
	More than 2	15.29
Head of Household's Occupation	No occupation	3.4
	Self employed	46.6
	Military/police	3.6
	Government Officer	20.2
	Others	26.2
Head of Household's Education Level	No formal education	0.8
	Primary school	3
	Junior High School	10.2
	Senior High School	39
	University	47
Own/rent house	Own	91.6
	Rent	6.4
	Other	2
Type of house	Temporary	0.60
	Semi-permanent	1.00
	Permanent	98.39
Own motor cycle	Yes	98
	No	2
Number of motorcycle	1	22.04
	2	47.35
	3	24.08

Variables	Classes	Percentage (%)
	>3	6.53
Own telephone	Yes	99.6
	No	0.4
Type of telephone	Home line	1.00
	Mobile phone	80.92
	Both	18.07
Electricity	PLN	100
Energy Cooking	LPG	100

Based on socio-economic data for Yogyakarta City in Section 3.3, the most of inhabitants in Yogyakarta City are senior high school graduate. However, Table 5-1 shows differently. It shows that majority head of households have university degree. In the common sense, it is expected that people with high education level tend to have better income than people with lower education level. Yogyakarta City in general tend to be represented as city with majority of medium income level people, because majority of inhabitants are senior high school graduate. On the other hand, the sample from three urban villages have higher education level. Those three urban villages tend to be represented as area with majority of high income area. Thus, because of those reasons, the sample taken for this research cannot represent Yogyakarta City in general, but it only represents three urban villages.

5.2. Distribution of Water Users

Figure 5-1 shows the distribution of water users in the study area. The water users in the study area are divided into five water supply provisions. These five types of water supply in the study area are PDAM; private well; communal well; PDAM and private well; PDAM and communal well. Based on Figure 5-1, it is known that more than half of households in the study area use private well. Followed by PDAM users with 32.6%. Combination between PDAM and private well users is in the third place with 14%. Meanwhile, communal well users are only 1.6% from the total respondents. It is slightly higher than users of combination between PDAM and communal well. PDAM and communal well users in the study area are 1.4% from the total respondents. It makes combination between PDAM and communal well as the least water users in the study area. This combination is an unusual combination. The reason behind this is that the users want to lower their cost. By using communal well, they do not need to pay for constructing cost.

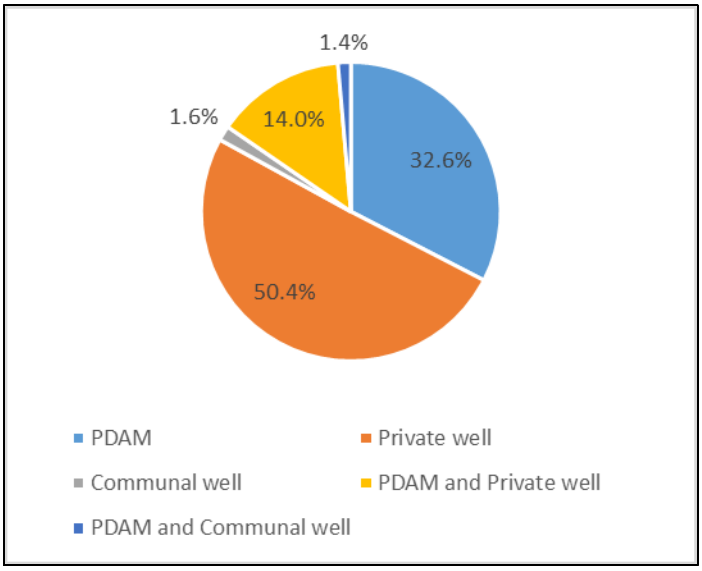


Figure 5-1 Water Users in the Study Area

Figure 5-2 presents the distribution of various types of water users in the study area. To show it, household's points from the survey were used for mapping. In total, there are 500 household's points that were generated randomly. Majority of those points consist of 163 households that use PDAM and 260 households that extract water from ground. Meanwhile, the rest are 77 households that use both PDAM and groundwater well. By showing this figure, it can give a general illustration about the distribution of water users in the study area.

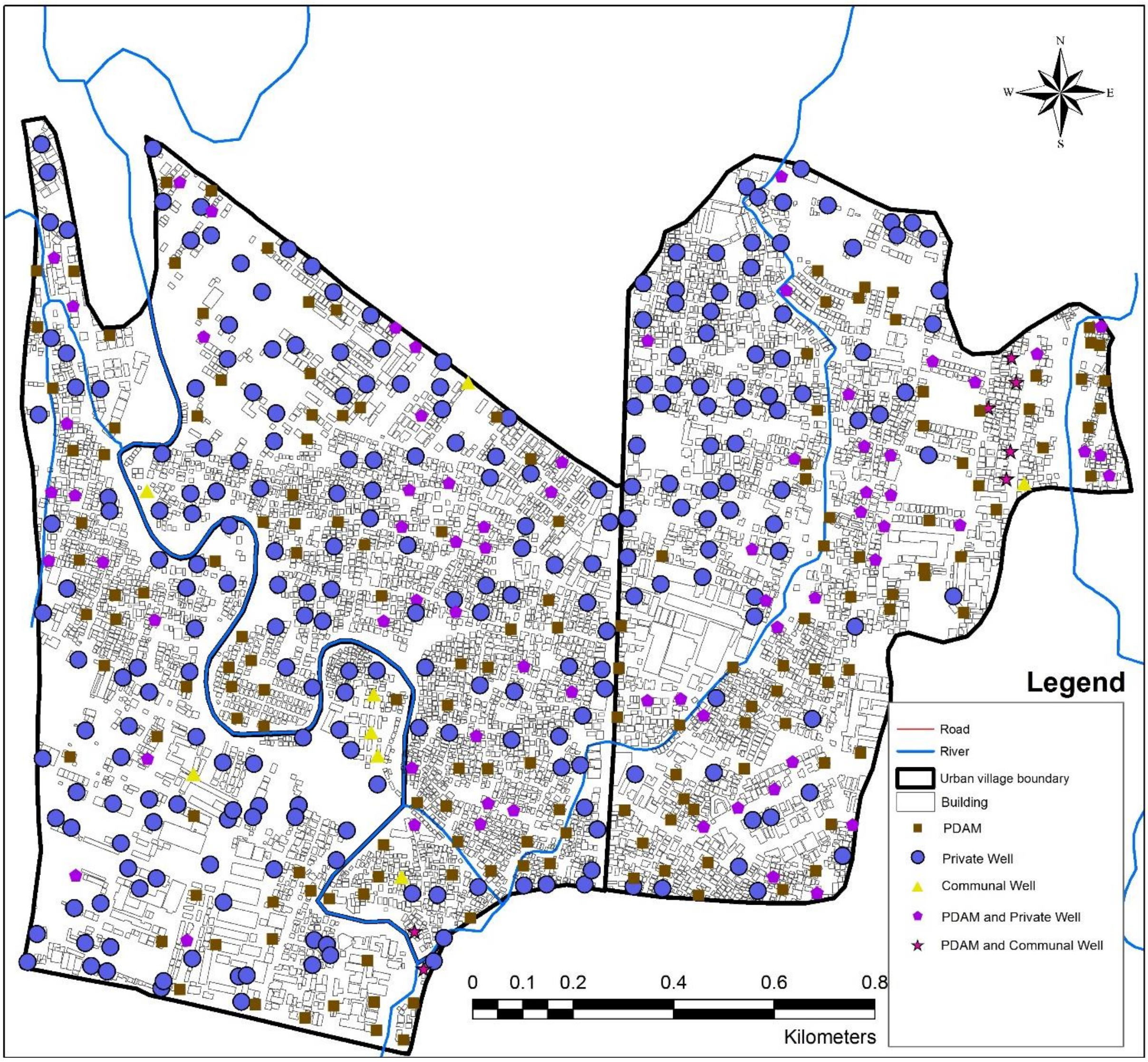


Figure 5-2 Distribution of Water Users in the Study Area

5.3. Clusters of Water Users

This section shows the outputs of clusters analysis in Section 4.4.1. The purpose of this analysis is to see whether or not there are any clusters of certain water supply in the study area. The clusters analysis also can be useful to determine the characteristics of each cluster. These characteristics are shown on Table 5-2. To get these clusters characteristics, some clusters in every water users were selected in Arc GIS. In their attribute table, some information was retrieved based on the same variables on the Table 5-1 except electricity and energy for cooking. It is because all sample households use the same electricity from PLN and energy from LPG (see section 5.1). For further explanation, the results can be seen on Table 5-2 and Figure 5-3 until Figure 5-7.

Table 5-2 Clusters Characteristics

Variables	Clusters				
	PDAM	**Private well**	**Communal Well**	**PDAM and Private Well**	**PDAM and Communal Well**
Number of persons in household	4 persons	4 persons	More than 4 persons	4 persons	4 persons
Number of persons with occupation in household	One person with occupation.	One person with occupation.	Three persons with occupation.	Two persons with occupation.	Two persons with occupation.
Head of household's occupation	Government officer.	Others.	Self-employed.	Self-employed.	Self-employed.
Head of household's education level	University.	Junior high school.	Elementary school.	Senior high school.	Senior high school.
Own/rent house	Own.	Own.	Own.	Own.	Own.
Type of house	Permanent.	Permanent.	Permanent.	Permanent.	Permanent.
Own motor cycle	Yes.	Yes.	Yes.	Yes.	Yes.
Number of motorcycle	3 motorcycles.	2 motorcycles.	2 motorcycles.	1 motorcycles.	1 motorcycles.
Own telephone	Yes.	Yes.	Yes.	Yes.	Yes.
Type of telephone	Mobile phone.	Mobile phone.	Mobile phone.	Mobile phone.	Mobile phone.

Based on Table 5-2, characteristics of each cluster can be described. The description of each cluster's characteristics is presented as follows:

1. PDAM
   Head of households that use PDAM tend to have highly education level with university degree. With high education level, they can achieve a stable occupation as government officer. With certain monthly salary from government, they can own permanent house. Most of them also own three motor cycles and mobile phone.
2. Private well
   Head of households that use private well tend to have lower education level than PDAM users. They have a junior high school degree. With lower education level, it seems that they have an unstable occupation in other area which does not require high education level. However, despite the fact that they probably receive lower salary than PDAM users, they still own permanent house with two motorcycles and mobile phone.
3. Communal well
   Head of households of communal well users tend to have the lowest education level among others. With only elementary school degree, it is hard to find a stable occupation. They prefer to work as self-employed. To cover their need, three persons within the household need to work. It is because that the households most likely contain five persons. This amount is considered as the largest among others. That is why three persons out of five persons need to work. By looking to those conditions, using communal well is more preferable for them than using PDAM or private well which requires more money for instalment, maintenance and monthly expenses. Although, they own permanent house with two motorcycles and mobile phone.
4. PDAM and private well
   Head of households using both PDAM and private well tend to have higher education level (senior high school graduate) than private and communal well users. However, they prefer to work as self-employed. To support their daily need, the households do not depend on only one person. That is

why at least two persons within the household are working. They also own permanent house, although, they have less motorcycles compare to three previous water users.

5. PDAM and communal well
   Head of households using both PDAM and communal well tend to have senior high school degree. To support this household's daily needs, two persons within the household have to work. The Head of households are mostly working as self-employed. They also own permanent house, one motor cycle and mobile phone. This condition is similar with PDAM and private well users.

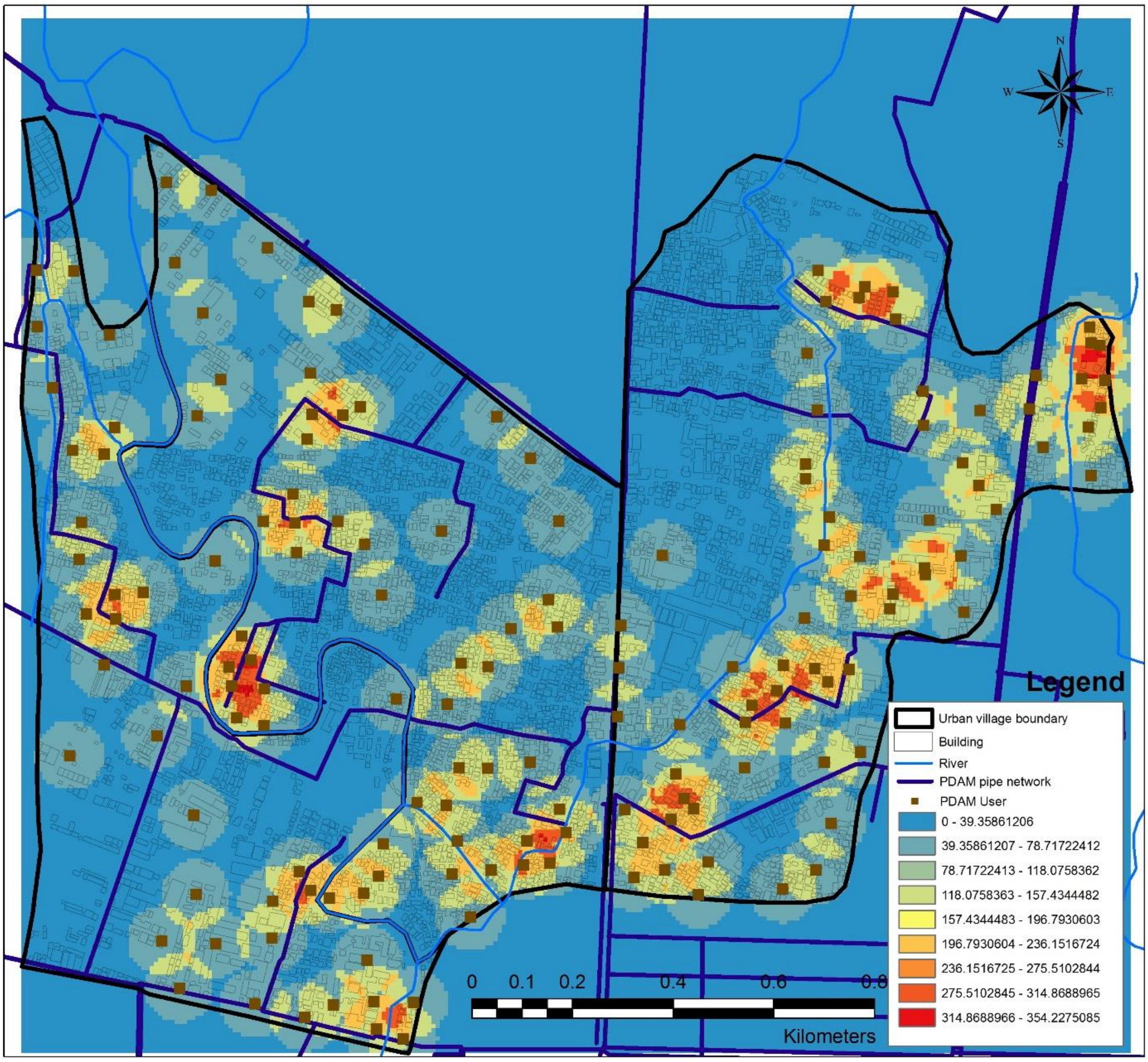


Figure 5-3 Clusters of PDAM Users in the Study Area

The first result is presented on Figure 5-3. The values in the Figure 5-3 are retrieved from the calculation of overlaid neighbourhoods (See Section 4.4.1). Based on that, if more neighbourhoods are overlaid, then the values will become higher and the colour will become redder. This condition does not apply only for Figure 5-3, but also Figure 5-4 until Figure 5-7.

On Figure 5-3, it is indicated that from 163 PDAM users, some clusters are occurred in some part of the study area. The Most of them are clustered in west part of Kricak Urban Village, near Winongo River. Some of them make a cluster in east part of Karangwaru Urban Village and for the rest are scattered in some part of the study area. By looking on PDAM pipe network, it is believed that the clusters are following PDAM pipe network.

Furthermore, Figure 4-1 section 4.1.3 gives a more detailed illustration that both clusters in Kricak and Karangwaru are occurred in planned residential. In Indonesia, planned residential is built by residential developer. Usually, residential developer contacts PDAM to provide water supply for that housing. It is a must for them to provide housing with PDAM as stated in Public Law No.2 about building in article 36 and 37 (Pemkot Yogyakarta, 2012). One of the reasons why the price for planned residential is higher than unplanned residential is because of this law. The owner must have a stable occupation to pay the house. This condition is aligned with the characteristics of PDAM cluster area in Table 5-1. It shows that PDAM users tend to have high income.

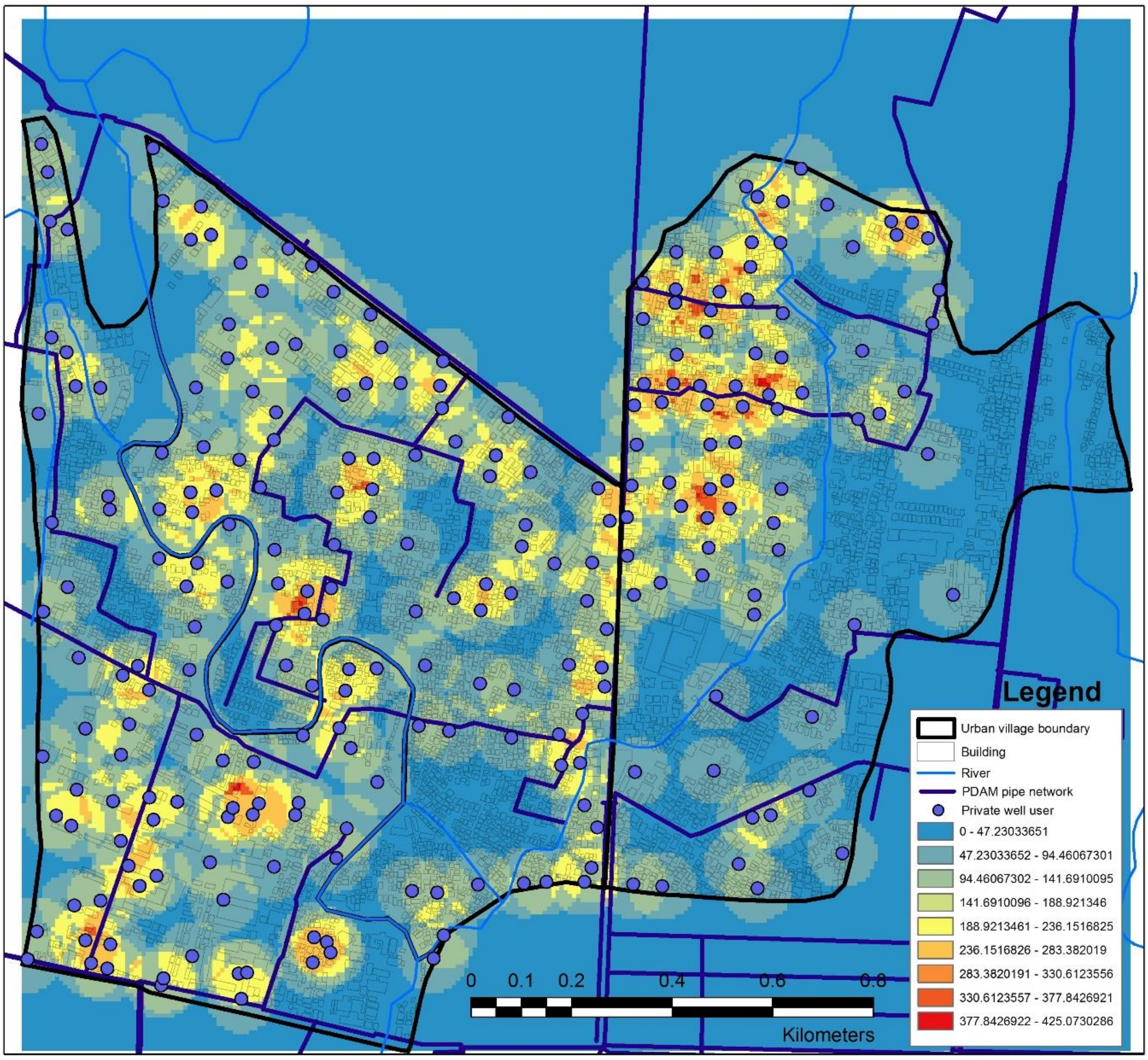


Figure 5-4 Clusters of Private Well Users in the Study Area

Figure 5-4 shows clusters of private well users that occur in the study area. Those clusters are mostly grouped in top left part of Karangwaru Urban Village. There are some other clusters such as in the centre of Bener and Kricak Urban Village, but they are smaller than clusters in Karangwaru. Surprisingly, those clusters in three urban villages are occurred near PDAM pipe network. Thus, it can be indicated that lack of pipe connection is not a primary reason why people use private well. Meanwhile, for other points are scattered in some part of the study area.

Based on Figure 4-1 section 4.1.3, the clusters are occurred in high density neighbourhood. High density neighbourhood, according to Hopkins (2010), is one of indicators that people with low income live in this neighbourhood. They prefer to find other water source than pay for PDAM's monthly expense. They tend to save their money for other needs.

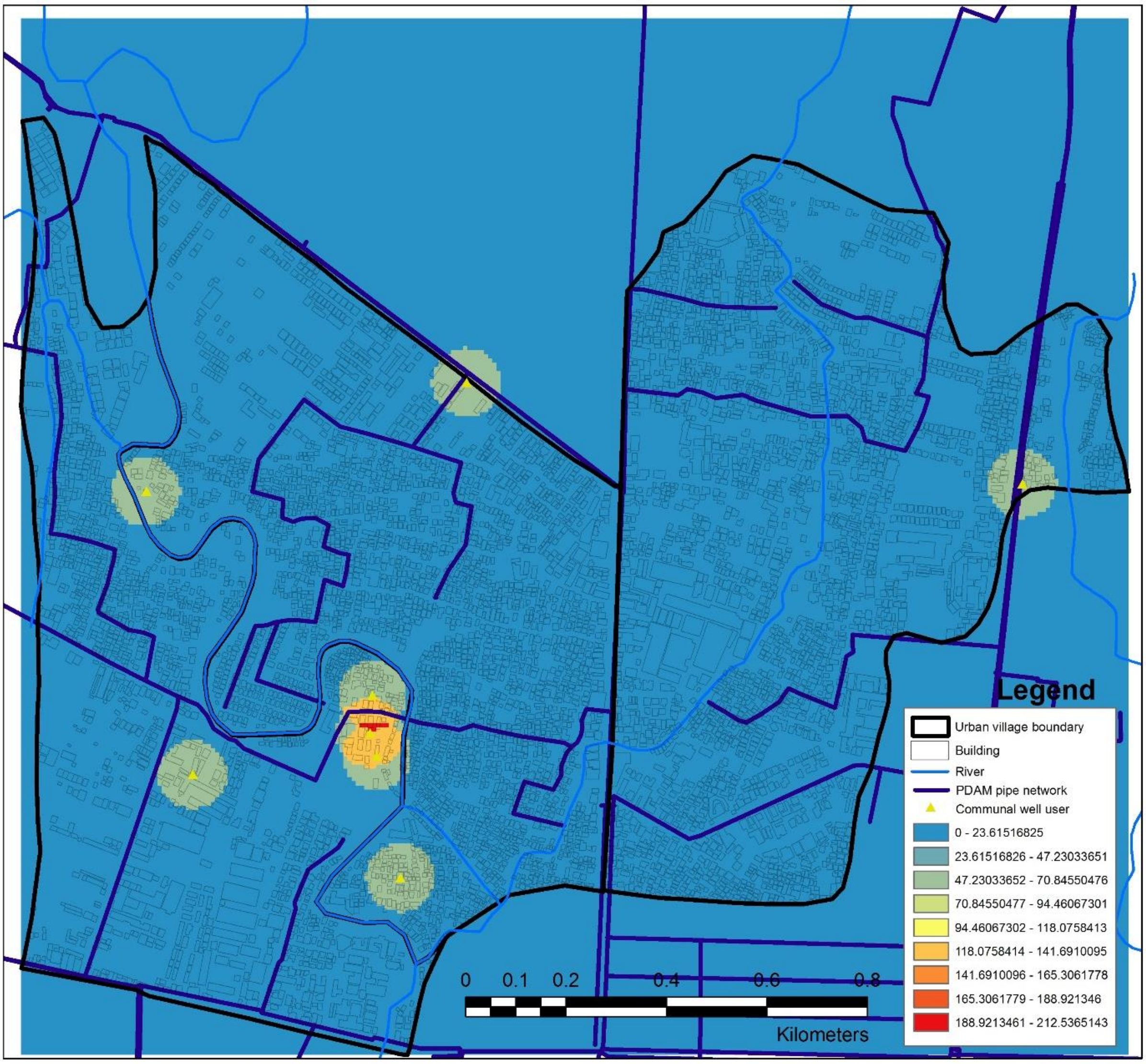


Figure 5-5 Clusters of Communal Well Users in the Study Area

Unlike two previous water users, communal well users are clustered in one place and for the rest, they are dispersed in some part of the study area. This cluster is taken place in Bener Urban Village, near the Winongo River. According to Figure 5-5, six of them are located near PDAM pipe network. Thus, it is a possibility that they can access PDAM. However, they still prefer to use communal well which is low in cost compared to others. For example, Figure 5-3 shows cluster near Winongo River. Both clusters are located side by side and covered by pipe network, but they still prefer to use communal well. Moreover, data from Figure 4-1 section 4.1.3 shows that this cluster occurs in high density area with unplanned resident which can be associated with low income neighbourhood (Hopkins, 2010). This is matched with cluster characteristics for this water supply users. They tend to have low income compared to others. Thus, it can be indicated that the lack of pipe network is not the reason for them to choose communal well.

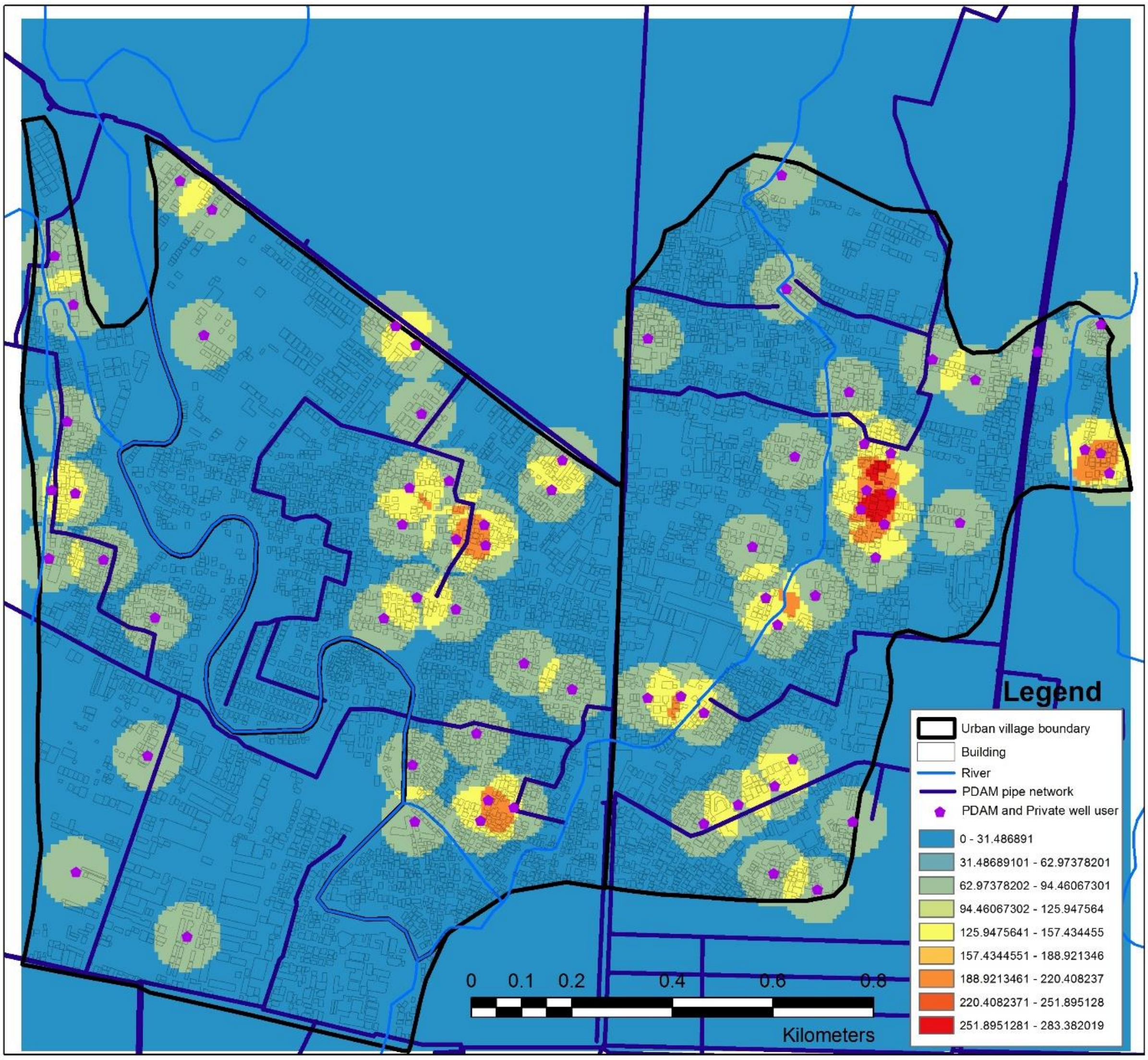


Figure 5-6 Clusters of PDAM and Private Well Users in the Study Area

Figure 5-6 shows that there is one big cluster which occurs in the study area for PDAM and private well users. This cluster occurs in the centre part of Karangwaru Urban Village. By exploring on Figure 4-1 section 4.1.3, it is known that this cluster is taken place in high density area near industrial area. This may explain why they used both water supplies. Foster (2001) states that the users of groundwater well come not only from private domestic, but also from industrial uses. The reason is that groundwater is relative low cost. Furthermore, industrial area tend to consume more water than private. By consuming more water, it can affect the water debit in that area. As the result, private well users was looking for other alternative since they can get stable quantity of water. One of solution is using PDAM. Thus, they prefer to use both of water supply. They will use PDAM only if there is low debit of groundwater. It is to keep PDAM bill as low as possible.

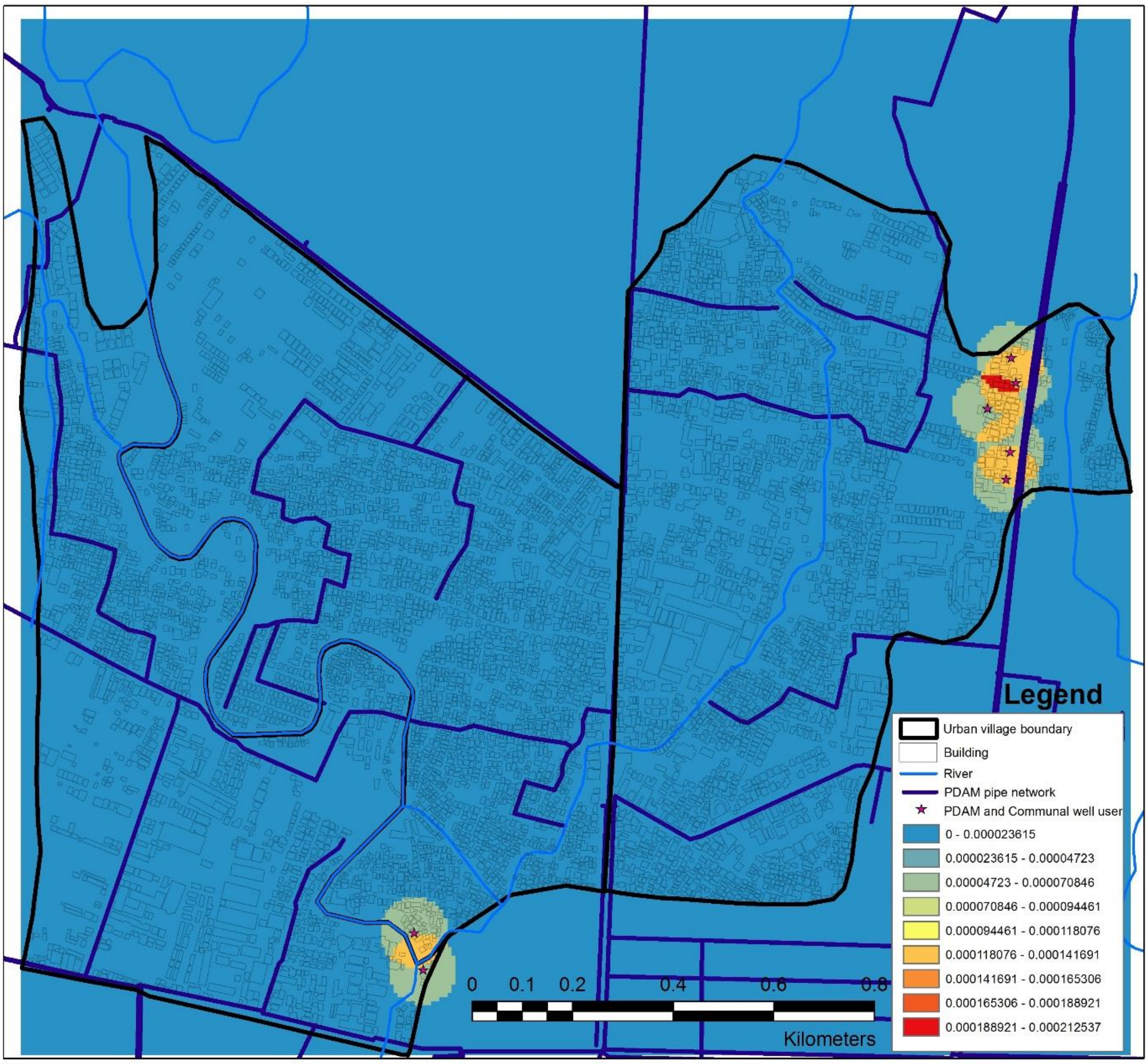


Figure 5-7 Clusters of PDAM and Communal Well Users in the Study Area

Similar with communal well users, users for both PDAM and communal well have one cluster. According to Figure 5-7, the cluster is located in the east part of Karangwaru Urban Village. This cluster is located in an unplanned residential area near the main road to Sleman County (see Figure 4-1). Communal wells are used together with other users. However, because they used together, the debit water of communal well is unstable for the users. According to the survey, most of them spend time between 5-10 minutes to reach it. It does not include time to fill the buckets and energy to bring the buckets back to their home. To solve this situation, they prefer to use both PDAM and communal well. The primary water supply is communal well and PDAM as the backup. Similar with PDAM and private well, they want to keep the water bill as low as possible.

5.4. Piped Water Performances

This section focuses in analysing the performance of piped water in the study area. The analysis was based on four variables: affordability, quantity, quality, and continuity. In the household survey, every respondent gave their information and perception about four variables. Indicator for affordability was based on money that they spent every month. Indicator for quantity was according to water consumption per household. For PDAM which give monthly report, the quantity was shown in meter^3/month. Meanwhile, other water supplies which did not have monthly report, the quantity was shown in meter^3/day, based on information from respondents. Meanwhile, indicators for the water quality of water supplies were retrieved based on respondents' perception. The indicators for quality were focused on smell, taste, and colour. For further explanation, it can be seen on sub-sections below.

5.4.1. Affordability

Affordability of piped water supply was measured by comparing monthly spending (in Indonesian Rupiahs/IDR) for each water supply. This research wants to see whether or not each water supply users spent differently based on that comparison. However, the choices were too high for water supply users to choose. Hence, as the results, most of choices for all water supplies are grouped in the choice of below 300,000 IDR as seen on Table 5-3. Only few users spent between 300,000-600,000 IDR and above 600,000 IDR compared to users who spent less than 300,000 IDR.

Table 5-3 Monthly Spending for Water

Water Supply	Monthly Spending for Water (In IDR)			Total
	<300,000	300,000-600,000	>600,000	
PDAM	157	6	0	163
Private well	239	12	1	252
Communal well	8	0	0	8
PDAM and private well	63	5	2	70
PDAM and communal well	6	1	0	7

5.4.2. Quantity

Majority of PDAM users (51.7%) used 21-30 m^3 water per month (Figure 5-8). In average per day, they used 0.7-1 m^3 water per day. Meanwhile, private well users, on average, used approximately 2.91 m^3 water per day and communal well users, in average, used 14.26 m^3 water per day (Table 5-4). However, these numbers were based on rough calculation of the users. Hence, there might be a bias in their calculation because there was no an accurate tool to measure the water that they used. If the amount of used water are correct, then based on the data, the private and communal well users tend to use more water than PDAM users, because they did not have to pay a certain of money for the water that they used. This condition did not apply for PDAM users. They have to use water very carefully, because the amount of used water affect the water bill that they have to pay at the beginning of the next month.

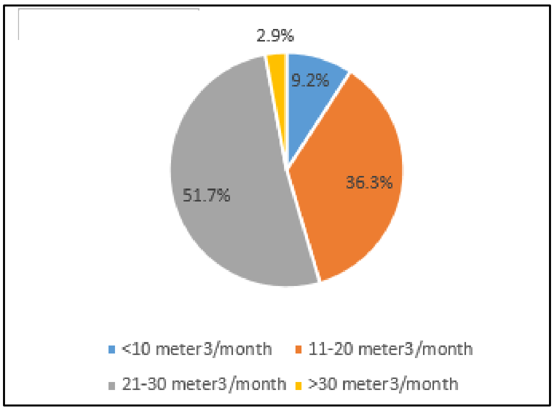


Figure 5-8 Amount of Water that Used per Month by PDAM Users

Table 5-4 Quantity of Water that Used per Day by Private Well and Communal Well

Water Supply	Quantity of Water in m^3/day		
	Minimum	Maximum	Average Use
Private Well	0.25	16	2.91
Communal Well	2	45	14.26

5.4.3. Quality

- Smell

Smell quality of water was taken from household questionnaires. It came not only from PDAM but also from private well and community well. Figure 5-9 shows that about 67.5% from PDAM, 99.7% from private well, and 100% from communal well had no smell. Meanwhile, 32.5% from PDAM and 0.3% were reported to be had smelly water. That smell came from smell of chlorine for PDAM and smell of mud for private well. The smell of chlorine occurred because of disinfectant process (See Section 3.4.1). On the other hand, smell of mud was reported that it came from rain water that dropped in land and infiltrated respondent well.

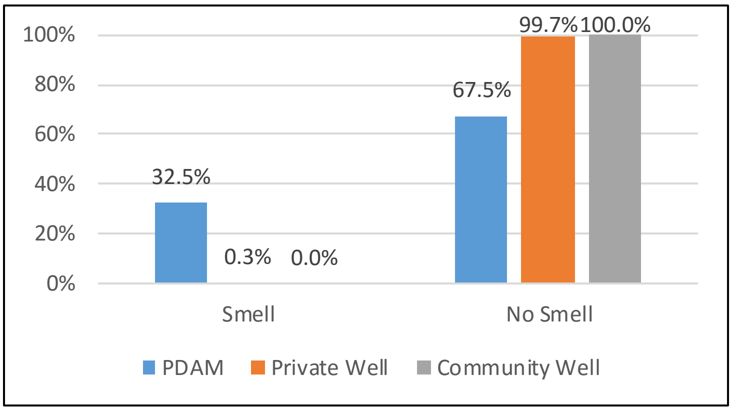


Figure 5-9 Smell Quality of Water

- Taste

Next variable of quality is taste quality of water. It was observed using the same previous household questionnaires and also from other water sources than PDAM. Based on Figure 5-10, private well and communal well had no taste at all (100%). Contrary with that result, 32.5% of PDAM users reported that the water had chlorine taste and the rest reported that there was no taste.

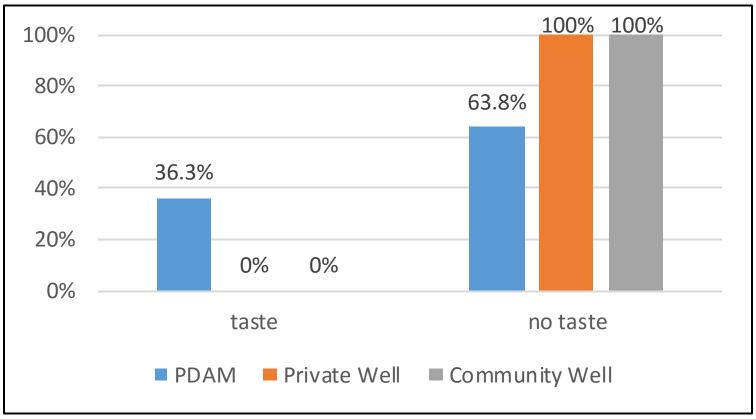


Figure 5-10 Taste Quality of Water

- Colour

Another variable of quality is colour. According to Figure 5-11, percentage of respondent with coloured water were 20.5% for PDAM and 1.6% for private well. The water reported to be had brownish colour. Figure 5-11 also shows that 79.5% users of PDAM, 98.4% users of private well, and all users of communal well had colourless water.

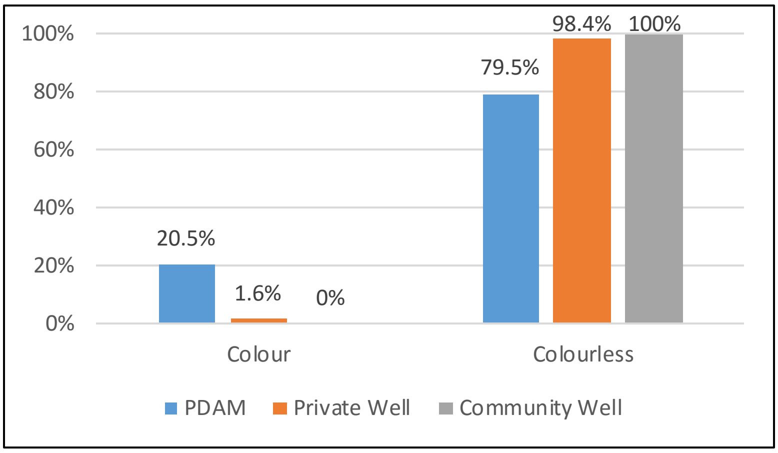


Figure 5-11 Colour Quality of Water

5.4.4. Continuity

Continuity of water supply service was measured based on respondents' perception through daily service of water supply. First water supply is PDAM. According to Figure 5-12, mostly respondents (62.1%) did not have problem with the continuity of PDAM service. However, there were some respondents that had difficulties on peak hour 06.00-09.00 (10.8%), not everyday service (21.7%), only in some hours (4.2%) and difficulties on the evening 17.00-21.00 (1.3 %). The causes of this situation were leaking in the piped water and water lost (see Section 3.4.1).

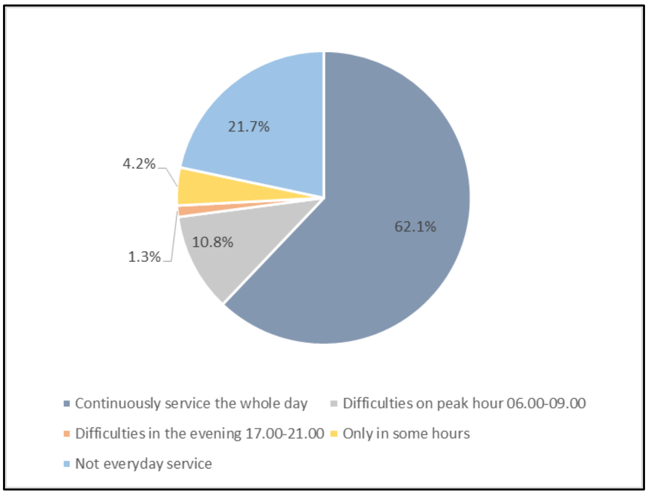


Figure 5-12 Continuity Based on PDAM Users

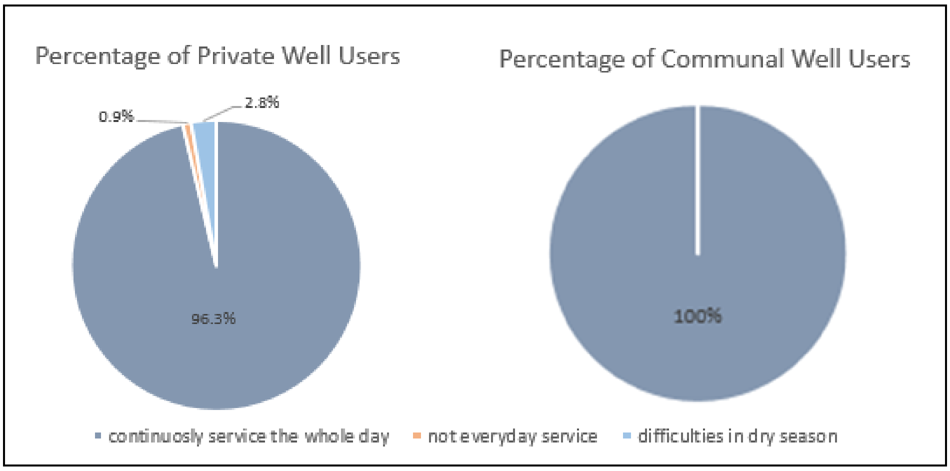


Figure 5-13 Continuity Based on Private and Communal Well Users

For both private well and communal well (Figure 5-13), their users mostly did not have problem with continuity (96.3% for private well and 100% for communal well). Their service continues the whole day. Although they mostly had continuously service, some private well users said that they had problem in continuity especially in dry season (2.8%) and not everyday service (0.9%). In dry season, the water debit seems too low because of high evaporation and unlike in rainy season, there was no water that replace the water that was taken before.

5.5. Behaviour of Water Users in Purchasing Bottled Water

Figure 5-14 below shows that most of PDAM users purchase bottled water for drinking and cooking with 64.4% from the total PDAM users. Meanwhile, most of private well users did not purchase bottled water (67.5%). They used water from private wells for drinking by cooking it first. This condition applies also for both PDAM and communal well users. They prefer to cook the water first than purchase the bottled water.

As mentioned before in Chapter 2. Literature Review that people's perception towards water quality can affect people's behaviour in purchasing bottled water. This situation explains what happened in the study area. In section 5.4.2, based on people's perception, water quality is not safe for drinking water due to colour, taste and smell. Thus, they tend to find another alternative (bottled water) to fulfil their need for drinking water. Despite the fact that PDAM's water was treated very carefully (see section 3.4.1). It is indicated that there is no trust from the users to PDAM in processing the water and its output. The reasons behind that, based on literature review, may come from the lack of information about PDAM and quality process.

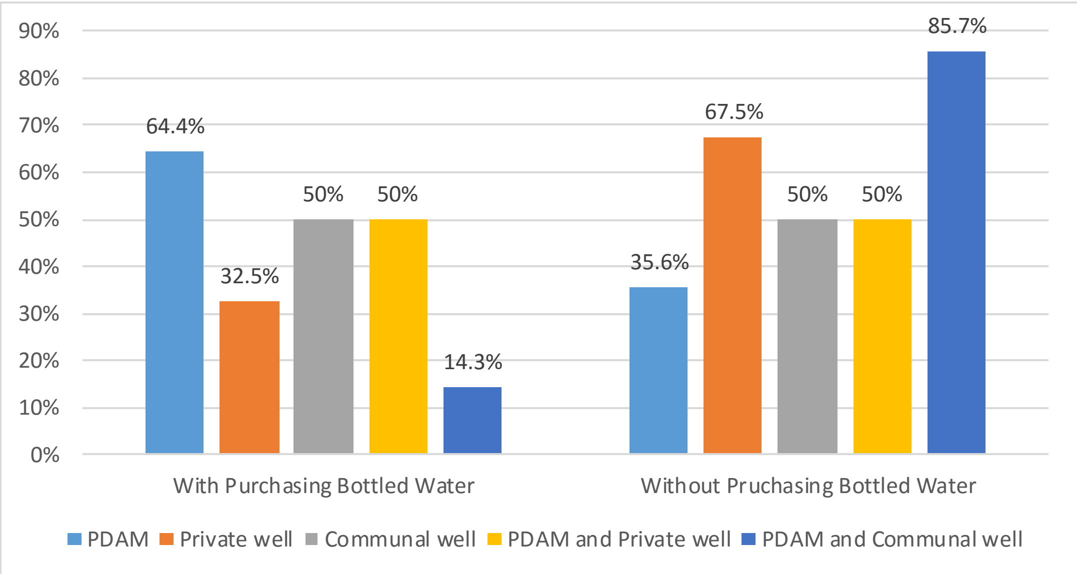


Figure 5-14 Water Supply and Purchase of Bottled Water

5.6. Multinomial Logit Models for Water Provision Choice

The results reported in this section are based on a multinomial logit model (MNL) for water provision choice, originated from the stated choice experiment that was conducted. Two different models were estimated: the first model (Section 5.6.1) estimates the parameters in relation to the overall sample, whereas the second model (Section 5.6.3) controls for education levels. Maximum likelihood was used to estimate the parameters of the model, using the software BIOGEME (Bierlaire, 2003). After estimating the parameters, the coefficients of the each model were used to calculate choice probabilities in order to make predictions for real condition scenarios in the study area. At the end, policy recommendations were elaborated with the purpose of attracting groundwater well users to change into using piped water.

5.6.1. Estimated Parameters for Model 1

Model 1 was estimated using the responses from the overall sample. Model coefficients are shown on Table 5-5. McFadden's Rho Square value is the indicative of model performance and it ranges from 0 to 1. According to Louviere, Hensher, and Swait (2000), Rho-square values between 0.2 and 0.4 are indicative of good model fit. The present model has a McFadden's Rho Square value is 0.389. Therefore, the model performed well with most of the estimated coefficients being statistically significant.

Table 5-5 Utility Parameters

Attributes and Levels	Coefficient	T-Test	P-Value
Constant PDAM (α)	-1.768	-32.04	0
Constant Well (α)	-2.122	-32.82	0
PDAM Price High	-0.310	-4.75	0
PDAM Price Medium	0.026	0.41	0.68
PDAM Price Low*	0.283		
PDAM Quality High	0.797	12.63	0
PDAM Quality Medium	0.222	3.49	0
PDAM Quality Low*	-1.019		
PDAM Continuity High	1.100	18.12	0
PDAM Continuity Medium	-0.438	-6.18	0
PDAM Continuity Low*	-0.662		
Well Price High	-0.535	-6.76	0
Well Price Medium	0.046	0.61	0.54
Well Price Low*	0.488		
Well Quality High	-0.649	-7.46	0
Well Quality Medium	1.360	19.76	0
Well Quality Low*	-0.711		
Well Continuity High	1.320	18.95	0
Well Continuity Medium	-0.745	-8.64	0
Well Continuity Low*	-0.575		

Note: *: base level.

Table 5-5 shows the estimated coefficients for the variables (PDAM (piped water), well (ground water)), attributes (price, quality, continuity) and levels (high, medium, low). Regarding the coefficients for the constants, because the choice of "none of these" was used as a reference, thus the coefficient is zero, the high and negative coefficients estimated for PDAM and well indicate a deviation from this reference. This means that "none" was the most chosen, followed by pipe and well, which is confirmed by the descriptive analysis.

Moreover, P-value column shows whether each choice is significant with level of significant 95% ($P<0.05$). According to P-value, almost all coefficients are significant. Meanwhile, in coefficient column, positive sign of coefficient indicates a higher preference whereas the negative coefficient means that respondents in the sample do not have a preference for this level. For instance, in PDAM price, respondent indicated a higher preference in low price and do not have a preference for high price, which is an expected finding.

Table 5-5 indicates that coefficients for PDAM, PDAM with low price, high quality and high continuity were the most chosen. On the other hand, the least chosen was PDAM with high price, low quality and high continuity. These findings may reflect that the respondents prefer an ideal condition of piped water supply which is best service in quality, continuity and with low cost.

As for choice of well, the respondents indicated a higher preference for the attributes low cost, medium quality and high continuity. It would be expected, however, that people would prefer well with high quality. The reason behind this is that the respondents could not imagine a better quality for groundwater well, therefore, as a result, they could not trade-off about well water quality very well.

Another interesting analysis is the importance of each attribute to the overall utility. The importance of each attribute can be indicated by the percentage from relative ranges (range between the highest and the lowest utility of the attribute), as Figure 5-15 shows. It indicates the extent to which each attribute contributes to the total utility. Figure 5-15 shows that quality has a higher importance in the total utility for piped water, followed by continuity and price. Meanwhile, continuity has a higher importance in the total utility than price for well water followed by quality and price.

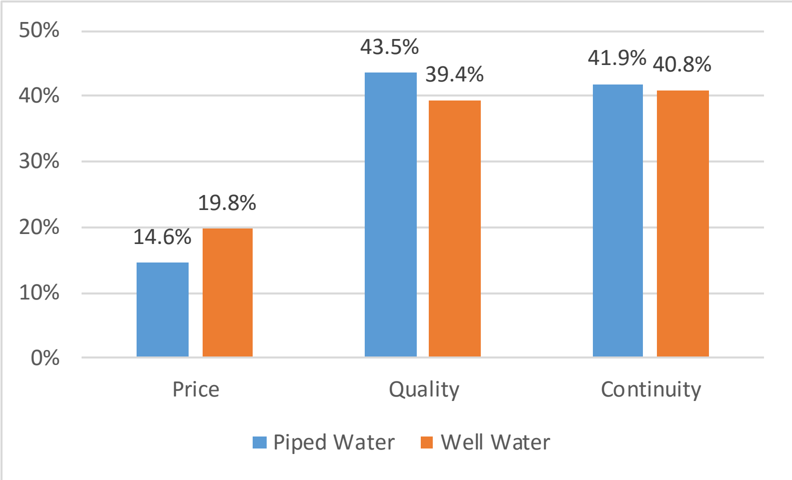


Figure 5-15 Importance of Each Attribute

5.6.2. Probabilities Based On Model 1

Probabilities based on model 1 is based on three variables: pipe, well, and none. These probabilities were calculated based on the exponential of utility divided by sum of all exponential utilities (see Equation 2-1 in Section 2.3.2). For instance, to calculate probability of pipe, then exponential of pipe's utility divide by sum from all exponential utilities (exponential of pipe + exponential of well + exponential of none). Furthermore, these probabilities mean that a person from the sample would choose pipe, well or none, given variation in price, quality and continuity, regardless their education level, type users, etc.

In order to get probabilities of pipe, well and none, the utility was calculated for each of the types by using the estimated coefficient of each attributes and constants. However, before calculating the utility, a scenario was built. This scenario is meant to be realistic and representative of the study area. The reason why real condition scenario was chosen is that the output of this model (policy recommendations) must be applicable in the field. Therefore, based on real condition in the study area, PDAM was simulated with high price, high quality and high continuity. Meanwhile, well was given the scenario with high price, low quality, and low continuity. The flowchart of the process can be seen on Figure 5-16. Meanwhile, the reason for each variable's scenario can be seen on Table 5-6 as follows.

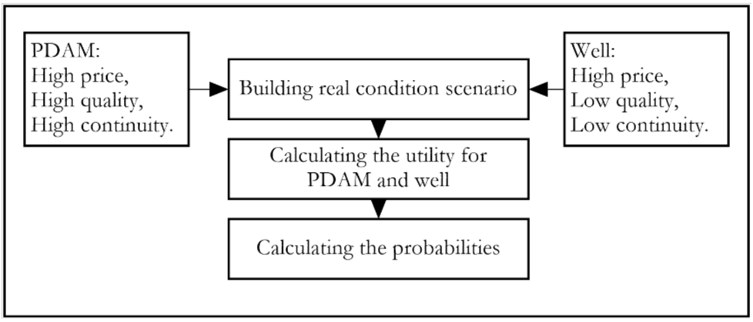


Figure 5-16 Flowchart of the Process to calculating the Probabilities

Table 5-6 Scenario from Real Condition in the Study Area

Variable	Description
PDAM	In terms of quality, it is known from section 5.4.3 that some of the respondents perceived PDAM's water as water with smell, taste and colour. In terms of continuity, section 3.4.1 shows that PDAM suffered 30% of water lost that lead to problem in its continuity for some respondents. In order to get high quality and high continuity, that is assumed to be what the respondents would prefer, PDAM needs to increase the price, for instance, by adding more machines to treat the water and removing old pipes for better connection.
Well	Because the government wants to limit the permit for extracting groundwater, an increase in price is needed to get a new permit and tax for extracting groundwater (see section 1.1). Furthermore, based on Table 3-1, Yogyakarta City had 14,059 inhabitants per Km^2 in 2008. Now, Yogyakarta is growing as a highest density city in D.I. Yogyakarta Province. This situation can originate problems. The first problem is related to quality of groundwater. According to Salendu (2010), Yogyakarta City faces decreasing quality of groundwater due to contamination from unprotected sanitation and sewerage. Another problem is related to continuity of groundwater. The decreasing groundwater table can affect this continuity. Based on these two problems, the scenario for well is assumed as low quality and low continuity.

After knowing the scenario, the next step is calculating the utility for the choice of pipe, and well water (see Figure 5.16). Each vector representing the attributes levels were multiplied by 1 or 0 based on the scenario that was built. For instance, the vector of high quality of pipe water was assumed as 1, because this is the level that considered in the scenario. The vectors for medium and low quality for water pipe were assumed as zero, as they are not accounted in the scenario. Therefore, only the coefficient for high quality pipe water would be considered in the utility of choosing pipe water. The utility functions for pipe and well water can be seen on Equation 5-1.

$$U_{Pipe} = \beta_{0pipe} + \beta_{High\ price} \times 1 + \beta_{High\ quality} \times 1 + \beta_{High\ continuity} \times 1$$

$$U_{Well} = \beta_{0Well} + \beta_{High\ price} \times 1 + \beta_{Low\ quality} \times 1 + \beta_{Low\ continuity} \times 1$$

Equation 5-1 Utility of Pipe and Well Using Real Condition Scenario

After calculating utility of pipe and utility of well, the next step is calculating probabilities by using Equation 2-1 for each variable. The results are shown on Table 5-7 below.

Table 5-7 Result of Probabilities Based on Model 1

Probability	Percentage
Pipe	44.93%
Well	1.11%
None	53.95%
Total	100.00%

Table 5-7 shows, based on the already described scenarios, that the probability of a respondent choosing pipe is 44.93%. Meanwhile, probability of a respondent choosing well is 1.11%. Furthermore, 53.95% of respondents would not choose any of the options. Although most of respondents tend to choose none with this scenario, it also indicates that respondents tend to choose piped water than well water. It is probably because the respondents may think that they will gain more benefits by choosing piped water provision than well water provision, in this hypothetical scenario.

5.6.3. Estimated Parameters Based on Model 2

This section explains the estimated parameters based on model 2. Generally, the steps that were taken to estimate parameters with model 2 are still the same with previous section (section 5.6.1). The difference is that education levels were used to see whether certain education levels give different perceptions to the choices (see Appendix 2). Education levels were chosen because it is assumed that people with higher education can achieve higher income. Hence, indirectly, education levels can give an illustration about income levels of the respondents.

The model used maximum likelihood and BIOGEME. The result shows that the McFadden Rho Square value is 0.338. Hence, it is considered that the model performed well, although McFadden Rho Square from previous section (0.389) is better. Moreover, it can be seen on Table 5-8 that most of the estimated coefficients being statistically significant.

Table 5-8 Utility Parameters Based on Model 2

Attributes and Levels	Coefficient Education Level High	P-Value	Coefficient Education Level Medium	P-Value	Coefficient Education Level Low	P-Value
Constant PDAM (α)	-1.610	0				
Constant Well (α)	-1.890	0				
PDAM Price High	-0.234	0.01	0.004	0.96	0.230	0.05
PDAM Price Medium	0.049	0.57	-0.174	0.04	0.125	0.28
PDAM Price Low*	0.185		0.170		-0.355	
PDAM Quality High	0.384	0	0.623	0	-1.007	0
PDAM Quality Medium	0.120	0.15	0.076	0.36	-0.196	0.08
PDAM Quality Low*	-0.504		-0.699		1.203	
PDAM Continuity High	0.816	0	0.886	0	-1.702	0
PDAM Continuity Medium	-0.381	0	-0.179	0.04	0.560	0
PDAM Continuity Low*	-0.435		-0.707		1.142	
Well Price High	-0.485	0	-0.585	0	1.070	0
Well Price Medium	0.032	0.73	0.214	0.02	-0.246	0.05
Well Price Low*	0.453		0.371		-0.824	
Well Quality High	-0.534	0	-0.289	0	0.823	0
Well Quality Medium	0.975	0	0.969	0	-1.944	0
Well Quality Low*	-0.441		-0.680		1.121	
Well Continuity High	1.090	0	1.050	0	-2.140	0
Well Continuity Medium	-0.641	0	-0.594	0	1.235	0
Well Continuity Low*	-0.449		-0.456		0.905	

Note: *: base level.

Table 5-8 shows the estimate coefficients for the variables (PDAM (piped water), well (groundwater)), attributes (price, quality, continuity) and levels (high, medium, low). Regarding the coefficients for the constants, the choice of "none of these" was used as a reference, thus the coefficient is zero, the high and negative coefficients estimated for PDAM and well indicate a deviation from this reference. This means that "none" was the most chosen, followed by pipe and well, which is confirmed by the descriptive analysis. This condition is the same with Table 5-5.

Moreover, in P-value columns show whether each choice is significant with level of significant 95% ($P<0.05$). According to P-value columns, almost all choices are significant. Meanwhile, in coefficient column, positive sign of coefficient means that respondents indicated a higher preference for this level. On the contrary, the negative coefficient means that respondents in the sample do not have a preference for this level. For instance, in PDAM price for education level high, respondent indicated a higher preference in low price and do not have a preference for high price.

Table 5-8 indicates that respondents with education level high and education level medium have a high preference in PDAM with low price, high quality and high continuity. However, respondents with education low have a high preference in PDAM with high price, low quality and low continuity. It is an unusual finding. Usually, people have same preference with high educated and medium educated respondents. This finding may reflects that the low educated respondents might not understand the instructions very well. Therefore, they could not tradeoff between the choices.

As for variable of well, both of respondents with high and medium education level prefer well with low cost, medium quality and high continuity. It is an unusual preference for quality. Generally, people have a higher preference to high quality compare to medium quality. The reason is that because the respondent could not imagine a better quality for groundwater well. They know that groundwater cannot be improved. Therefore, as the result, they could not tradeoff between those two levels very well. On the other hand, low educated respondents have a high preference in well with high price, low quality, and medium continuity. The reason for this unusual preference is the same with what occurs in PDAM for low educated respondents. The low educated respondents might not understand the instructions very well. As the results, they could not tradeoff between choices appropriately.

Another interesting analysis is the importance of each attribute to the overall utility. Figure 5-17 until Figure 5-19 show the importance of each attribute on respondents' choice in percentage from relative ranges (range between the highest and the lowest utility of the attribute). Figure 5-17 shows that in the interaction with education level high, continuity has a higher importance for piped water, followed by quality and price. The same situation applies for well. Continuity also has a higher importance in the total utility than price for well water, followed by quality and price. Figure 5-18 shows that in the interaction with education level medium, continuity has a higher importance for piped water, followed by quality and price. Meanwhile, in total utility for well water, quality has a higher importance, followed by continuity and price. Quality and continuity also have little differences in total utility for well water. Figure 5-19 shows that in the interaction with education level low, it is the same with interaction with education level high. In the both utility for piped water and well water, continuity has a higher importance, followed by quality and price.

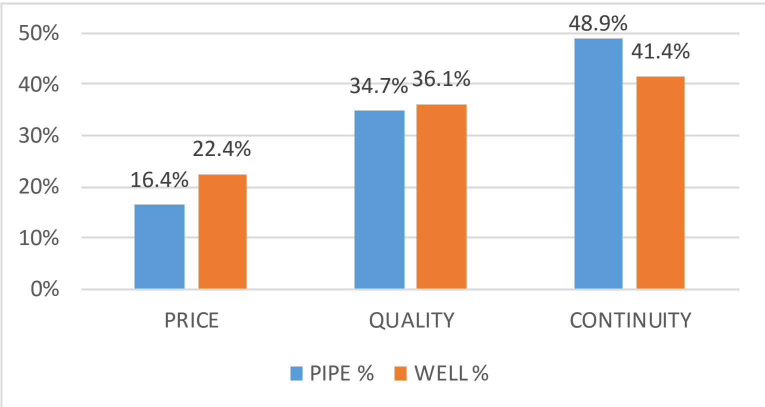


Figure 5-17 Importance of Each Attribute in Interaction with Education Level High

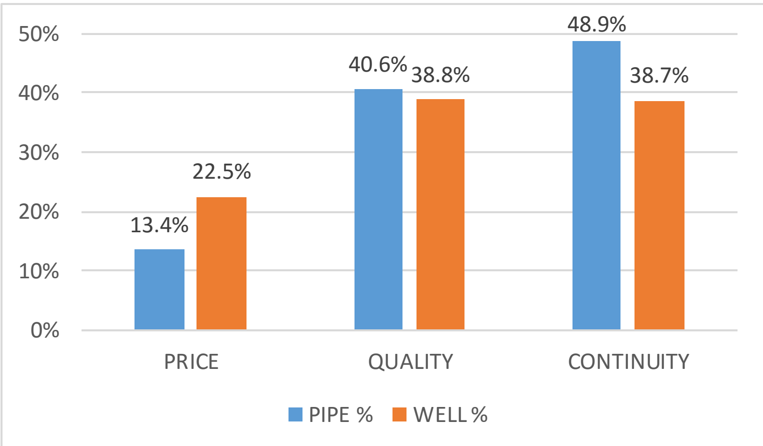


Figure 5-18 Importance of Each Attribute in Interaction with Education Level Medium

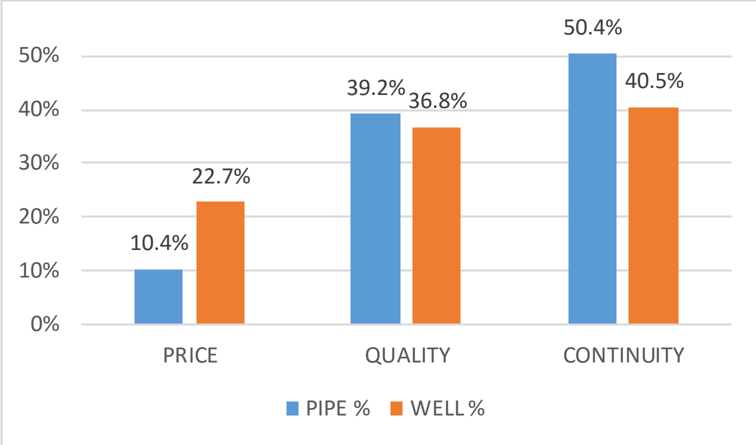


Figure 5-19 Importance of Each Attribute in Interaction with Education Level Low

5.6.4. Probabilities Based on Model 2

Unlike probabilities in section 5.6.2, this section shows probabilities that a person from the sample would choose pipe, well, or none, given variation in price, quality and continuity by considering their education level. The first step to calculate probabilities was similar with calculating probabilities in previous section which is calculating utility for each water provisions by using coefficient of each attributes and constants. The next step used the same scenario from real condition in the study area (Table 5-6). Afterwards, in formula of utility, the steps were the same with section 5.6.2. The difference is that the utility formula (Equation 5-1) for pipe water and well were used three times to calculate three education levels (high, medium, and low). After calculating utility of pipe and well, probability for each choices were needed to be calculated. This probability was calculated based on three different education levels as well using Equation 2-1. Furthermore, the result of probability calculation can be seen on Table 5-9.

Table 5-9 Result of Probabilities Based on Model 2

Probability	Education Level		
	High	Medium	Low
Pipe	33.59%	46.92%	0.38%
Well	2.44%	1.40%	76.66%
None	63.96%	51.68%	22.95%
Total	100.00%	100.00%	100.00%

Table 5-9 shows, based on the already described scenarios, that high and medium education level tend to choose none other than other choices. It is because the respondents can trade-off between pipe and well. Furthermore, by neglecting probability of none, it is clear that the respondents tend to choose pipe other than well for these two education level. Meanwhile, for low education level, the respondents with low education level tend to choose well other than other choices. It is probably because they think that they cannot afford pipe water because of high price. Furthermore, as mentioned in section 5.6.3, the low educated respondents could not trade-off properly. That is why the choice of none is the lowest compared to others.

5.6.5. Policy Recommendations

This section describes policy recommendations that can be retrieved from the results of section 5.6.2 and 5.6.3, as stated in section 1.4. Moreover, this research built policy recommendations based on information on current situation and based on analysis on this research. It is because these recommendations have to be applicable on the study area and have valid analysis to support it. According to probabilities in previous section, these are the policy recommendations.

1. Enhancing performance of PDAM.
   Based on the scenario and probabilities (section 5.6.2), a respondent tend to choose PDAM if PDAM makes some improvement in quality and continuity. By increasing the price, PDAM can cover their cost to enhance quality and continuity of their service. For instance, adding machines to treat the water, adding a water source to increase the debit, and improving old pipe connections can be a way to enhance performance of PDAM. As the results, people will switch to piped water as shown on Table 5-7.

2. Increasing price for permit of well and extracting groundwater
   This policy recommendation is suggested based on the scenario and probabilities (section 5.6.2). By increasing price for permit of well and extracting groundwater, they will think twice to use groundwater. As the results, with the same price, but higher quality and continuity, people tend to choose PDAM (Table 5-7).

3. Subsidy for low income people
   Based on Table 5-9, the respondents with low education level tend to choose well than pipe. Because the respondents with low education level tend to have less income compare with other education levels, they will have a hard time to pay for high price of pipe water. Thus, according to this situation, to attract respondents with low education level to choose pipe, subsidy from government for them can be a solution. By giving a subsidy for them, they will be able to pay for pipe water. They will think that with less price, they can get better water supply to their house.

6. DISCUSSION OF THE FINDINGS

This chapter discuss the findings that are taken from results and findings' chapter and give reflections about those findings. In general, these reflections are arranged based on research objectives and research questions that need to be answered. The first section discusses about water users' characteristics and their behaviour in choosing water supply. The second section discusses performance of piped water supply compare to others water supply. The third section on this chapter is discussing about the connection between first section and second section of this chapter. The last section discusses about policy recommendations that were retrieved from chapter of the results.

6.1. Water Users' Characteristics and Behaviour in Choosing Water Supply

Exploring data that were retrieved from household questionnaires, it is known that there are five types of water supply that have been used in the study area. Mainly, they are divided into three water supplies which are PDAM, private well, and communal well. The other two are just combination between PDAM and private well or PDAM and communal well. Based on the analysis, private well has the highest users in the study area compare to others. Meanwhile, water supply with the least users is PDAM and communal well. This combination is very unusual, because usually the combination is between PDAM and private well.

From the analysis, it is indicated that each waters supply has their own socio-economic characteristics. Socio-economic characteristics in this research was analysed based on available variables. These variables are mentioned in the Table 5-2. According to the results, these variables need to be explored more, especially the variables that explain about possession of property such as: house, motorcycle and telephone. As mentioned in Chapter 4 Methodology, these results were retrieved from household survey. The questions in the questionnaires might not contain deeper question about possession of property that can lead to inaccurate information. For instance, if a surveyor asked, "Do you own this house?" and then the respondent answered, "Yes, I own it." If the question stopped in that point, then it will become inaccurate. Because there are two possibilities about that house ownership. First, the respondent bought it with their own money or second, they got it from their family (inheritance from their family). Another example, if a surveyor asked, "Do you own motorcycles?" then the respondent answered," Yes, I do." If it stopped in that point, then it will be lead to inaccuracy. Because, there are also possibility that they bought the motor cycle in cash or they bought it via Credit Company. They have to pay per month according to the contract. The last example is related with house type. Based on the questionnaire, the respondents answered that they have a permanent house. However, the house may be permanent, but it may has different size, building quality and amenities than another house. These kind of further questions did not ask in the survey. Therefore, by looking to those examples, it is important to give questions as detail as possible to gain accurate data for further research.

Furthermore, as the results of analysis in the characteristics, PDAM users tend to have the highest socio-economic level compared to others. It is corresponded with PDAM characteristics in the literature review (Section 2.1). To use PDAM, the users need to pay cost for installing and maintenance. They need to pay monthly expense as well for the water that they used. Based on this condition, they need to have a stable occupation that can give a stable income as well. Meanwhile, communal well users tend to have the lowest socio-economic level. They prefer to use communal well, because unlike private well users who need to pay for building the well, communal well users do not need to pay anything. It is because usually communal well is built by government. Compared to PDAM and communal well users, the other three water users tend to have medium socio-economic level.

Besides characteristics, clusters of each water supply also analysed in the previous chapter. The analysis show that each water supply has cluster within the study area. PDAM users are clustered in west part of Kricak Urban Village and east part of Karangwaru Urban Village. For private well users, they clustered in top left part of Karangwaru Urban Village. Meanwhile, users for combination of PDAM and private well are clustered in the centre part of Karangwaru Urban Village. For the rest two water supplies, despite the fact that they only have few users, they still clustered as well. Communal well users are clustered in Bener Urban Village, near the Winongo River. Meanwhile, users for combination of PDAM and communal well are clustered in the east part of Karangwaru Urban Village.

Cluster analysis did not only indicate the location of clusters, but also can indicate the reason why some water supplies are clustered in certain area. It indicated three reasons by overlaying pipe network with clusters area. The first reason is that the lack of PDAM pipe network. As expected before, people who located far from pipe network will choose other water supplies. However, the result from the analysis showed that lack of PDAM pipe network is not the main reason. Most of the water supply's clusters are located near PDAM pipe network, but they still prefer to use other water supply. Even, the map of pipe network is from 2011 data. If the latest data are used, then more area will be covered by pipe network in 2015. The second reason is location. Location also did not come as the main reason. Some area are located in planned residential that must be supplied by PDAM. But, some area also use PDAM, in spite of their location in unplanned residential. The location can affect behaviour people to choose secondary water supply. For instance, users of combination between PDAM and private wells are clustered near industrial area. Industrial can affect the water debit, because they might be used the groundwater as well. Due to this situation, people in that area use PDAM as their backup. If their well are run out of water, then they will use PDAM. The last reason and also might be the main reason come from their ability to pay. Various socio-economic levels of each water supply users that mentioned in the beginning of this section can lead to choosing different water supply. For instance, high socio-economic level tend to choose PDAM. Meanwhile, lower socio-economic level tend to find other sources such as groundwater well that can be cheaper than PDAM. Although they are located near the pipe network.

6.2. Performance of Piped Water Supply

To measure performance of piped water supply, there are some variables that can be looked for. This research only focused on four variables. The variables are affordability, quantity, quality and continuity. Comparison between piped water supply and groundwater well users were used. The results are based on the water users' perceptions toward those variables.

The first variable is affordability. The variable of affordability was measured based on the money that the respondents spend every month. The results show that most of the respondents from each water supply spend less than 300,000 IDR. However, this result could not be taken for granted. The results might be indicated that the range of money was not properly set. It might true that in other area than the study area that people will spend money according to the range of choices. But, it need to be rechecked. Therefore, it is suggested to set range of choices according to the situation in that area.

The next variable is quantity. According to the results, in quantity, groundwater well users tend to use more water than PDAM users. The reason behind this is that they do not need to pay for the water. Meanwhile, PDAM tends to limit their use of water due to water bill. The more they use water, the more they need to pay for it. These two differences in using water showed that overused of groundwater is occurred in the study area. However, the results need to be rechecked. The reason is because, in the survey, the respondents seemed not sure about how much water that spent per day. Furthermore, unlike the PDAM users, well users do not have a receipt that indicates how much they used. The amount of well water that used was came from rough calculations. Therefore, further checking is needed in the further research.

In variable of quality, the performance of piped water supply was measured based on three sub-variables: smell, taste, and colour. In those three sub variables, less than half of PDAM users perceived that PDAM's water was having chlorine smell, taste and colour compare to others. According to water treatment on section 3.4.1, PDAM's water is supposed to have a better quality compare to the groundwater which is not treated at all. Moreover, the literature review (section 2.2) also states that based on their experience, people tend to picture PDAM's water as high quality water with no smell, no taste and no colour. However, in reality, it is totally different with in their imagination. The water has smell, taste and colour. The cause of this situation might come from the disinfectant and distribution process. For instance, by using too much disinfectant, it can help to kill the bacteria, but it can cause smell of chlorine as well. Furthermore, old pipe connection and leaking can be other examples. Rust that occurred in old pipe connection can change the colour and the taste of the water. Meanwhile, hole in the pipe can be infiltrated by the soil that can change the colour and the taste of the water as well.

The bad perception of water users towards water quality affect people's behaviour in purchasing bottled water especially PDAM users. From the analysis, it is known that more than half of PDAM users purchased bottled water. They tend to find other water source that can be used for drinking, because they are afraid to use PDAM's water. Despite the fact that PDAM's water was treated very carefully (see section 3.4.1). There is no trust from PDAM users about the process and the quality of the water due to lack of information about it. As written by Doria (2010) and Jorgensen et al. (2009) that lack of information can affect people's trust. Afterwards, Lack of trust can affect their behaviour.

In terms of continuity, most of PDAM users picture PDAM as a reliable water source. However, there is a problem with their service. Some of PDAM users complained about the service especially when it is on peak hours (morning and evening). They also complained that the service was not working in some days. Based on Section 3.4.1, it was occurred because of leaking and water lost. That table also explains that PDAM lost 30% of distributed water. It means that only 70% of distributed water that can reach the users. Furthermore, this situation can influence PDAM users to use other water supplies, one of them is groundwater well. It is because from the results, it is known that groundwater well barely has a problem with its continuity. People will find that groundwater well is a good alternative as long as PDAM do not improve its connection.

6.3. Connection Between Characteristics, Behaviour and Performance

To analyse connection between characteristics, behaviour and performance in this research, stated choice experiment was used. However, this stated choice experiment is hard to be understood by the respondents. One of indicator is that the respondents could not trade-off very well between choices as seen in section 5.6.1. Section 5.6.1 shows that none of these was the most chosen compare to pipe or well.

The reasons why stated choice experiment is hard to be understood are varied. The first reason is that the respondents got bored and wanted to finish the survey as quickly as possible by choosing none of these. In the literature review, Hensher et al. (2007) also mentioned about this, because the respondents need to choose between a lot of combination, it can make them bored. The used of paper and pencil based survey might add their boredom. They looked the thickness of the questionnaire and they think that the survey will take their time. As the results, they tend to finish it quickly. The second reason is that the respondents could not understand the instruction and the explanation of each combination very clearly, especially respondents with low education level (Section 5.6.3). Actually, the respondents can ask directly to the surveyors if they do not understand. However, by looking to the first reason, the respondents preferred not to. By looking to these reasons, using computer based survey can be a solution. By using computer based survey, the respondents can feel more attractive and the surveyors can insert some detail information in it.

In the results, PDAM's utility of model 1, quality has a higher importance followed by continuity and price. Meanwhile, in well's utility of model 1, continuity has as a higher importance followed by quality and price. The same situation occurred in PDAM's and well's utility of model 2. Based on the results on section 5.6.3, all respondents from three education levels picture quality and continuity as a higher importance in utility compared to price. However, the results are difference for what it was expected. Usually, price has a higher importance compared to others. By looking to the Table 5-1, the characteristics of the respondents tend to have a good socio-economic level. Therefore, it can be the reason why the price does not has a higher importance in the utility compare to others.

6.4. Policy Recommendations

The purpose of the policy recommendations is to attract people to use piped water. The policy recommendations of this research are built based on analysis of connection between characteristics, behaviour and performance. There are three policy recommendations that came up from the analysis. The first is enhancing performance of PDAM especially in quality and continuity. The second is increasing price for permit of well and extracting groundwater. The third is giving subsidy for low income people.

To see whether or not these policy recommendations are applicable, this research needs to check current policy or practice about the policy recommendations. For enhancing performance of PDAM, according to Antara News Yogyakarta (2013), PDAM has started to renew old pipe connection since the beginning of 2014. The aim of renewing old pipe connection is to improve the quality and to check the leaking spot. However, renewing old pipe connection cannot be done at once due to limited fund. Every year, each urban village's connection will be renewed. Besides renewing old pipe connection, recently, PDAM Tirtamarta (2016) announce that they will buy a water compressor. The water compressor will help PDAM to pump water from the water depot to the households.

Meanwhile, for increasing price for permit of well and extracting groundwater, this policy recommendation is in accordance with what the Indonesian Government want to do in the future (See Section 1.1). However, increasing price for well permit needs a strict monitoring from the Government. As mentioned by Ndungu (2011), one of the cause of illegal wells in Yogyakarta City is the lack of groundwater monitoring. Actually, the Government has a regulation about this as seen in Section 3.4.2, but it is different in the field because of limited personnel and failure in the management (Ndungu, 2011). Hence, in addition to increasing price for well permit, The Government needs to improve the management of well licensing.

For giving subsidy to low income people, PDAM has to tackle this issue carefully. PDAM and the Government, most likely, give the subsidy based on price table created by PDAM (Table 3-2). This table gives an explanation about price table for different type of households. The table indicates that the different type of households represents different type of economic status. The higher the type, the more expensive the households have to pay. That is why The Government tend to give subsidy based on that explanation. However, as seen in Section 3.4.1, the measurement of households' type is according to the road width and drainage size. These measurements will create a bias in the future. For instance, a non-permanent house with road width and drainage size higher than 7metres will pay more expensive than a permanent house with less road width and drainage. Therefore, PDAM has to include house type and other criteria related to economic status as their measurements. Furthermore, this will help Government to give a right subsidy for right people.

7. CONCLUSIONS AND RECOMMENDATIONS

This chapter conclude the key findings from previous chapters. It follows with explanation about limitation that this research face during its process. At the end, some recommendations for possible future research are given in the last section based on limitations which occurred during the research.

7.1. Conclusions

This study primarily develops a method that can help to produce policy recommendations by identifying water users' characteristics and behaviour, evaluating the performance of piped water supply, and understanding link between characteristics, behaviour and performance. To achieve that main objective, four specific objectives were proposed. The key findings from each specific objective are presented in subsection below to answer the research questions.

7.1.1. Key Findings from Specific Objective 1

Waters users' characteristics and behaviour in choosing water provision have been assessed. The findings are shown as follows.

1. The characteristics of water users in the study area are indicated as more high socio-economic level compared to the overall characteristics of inhabitants in Yogyakarta City. Hence, the results are fit only for the sample area (three urban villages). Furthermore, according to the results of household surveys, PDAM users tend to have highest socio-economic level compared to others.
2. People can get water from three main water supplies: piped water supply that is provided by PDAM, private well and communal well. Besides that, there is also combination between PDAM and private well, PDAM and communal well.
3. People choose different water provision based on its affordability, quantity, continuity, and quality.
4. Each water supply tend to make clusters in certain part of the study area. PDAM users are clustered in west part of Kricak and east part of Karangwaru. For private well users, they clustered in top left part of Karangwaru. Meanwhile, users for combination of PDAM and private well are clustered in the centre part of Karangwaru. For the rest two water supplies, despite the fact that they only have few users, they still clustered as well. Communal well users are clustered in Bener, near the Winongo River. Meanwhile, users for combination of PDAM and communal well are clustered in the east part of Karangwaru. The reason that they clustered in certain area is not only because of the availability of pipe connection, but also location. The choosing of location for their house can affect their behaviour. Their house's location tend to be determined by their socio-economic level. I.e. PDAM users mostly clustered in planned residential which is expensive.

7.1.2. Key Findings from Specific Objective 2

After assessing water users' characteristics and behaviour, next specific objective is analysing the system performance in piped water supply. The following findings were made from that analysis.

1. The method to describe system performance in piped water supply is based on comparison of piped water supply and groundwater well. The comparison is based on variables: affordability, quantity, continuity and quality.
2. System performance are described based on four variables mentioned before. The findings of each variable are: (1.) According to the variable of affordability, most of the respondents from each water user spend the same amount of money which is less than 300,000 IDR. However, this result still need to be checked due to different range of choices. (2) The variable of quantity shows that

groundwater users tend to use more water than PDAM users. It is because they do not have to pay for the water that they used. However, this variable face the same issue with the variable of affordability. The result still needs to be checked because it is indicated that the respondents using well did not give valid amount of used water. (3) For the variable of quality, based on water users' perception, PDAM has low quality of water compare to ground water users by measuring its smell, taste and colour. This bad perception of PDAM users lead to their behaviour in purchasing bottled water. Because of this mistrust, most of PDAM users in the study area prefer to buy bottled water for drinking and cooking. (4) PDAM tend to have more problems in its continuity compare to groundwater well. Some of PDAM users complained about problem in its continuity especially in peak hours and in some days as well.

7.1.3. Key Findings from Specific Objective 3

The findings from analysing the connection between characteristics, behaviour and performance are presented as follows.

1. Stated choice was used for analysis. The choice of none became the most chosen choice compared to other choices. Two reasons behind this, the first one, they felt bored and tend to choose none. The second one, they could not trade-off between choices very well. Furthermore, the used of paper and pencil based survey may cause the boredom because the respondents looked to the thickness of the questionnaire that they need to fill.
2. There are two models which were produced in this research. The first model was estimated parameter in general. Meanwhile, the second model was estimated parameter with considering the respondents' level of education. The first model shows that quality has a higher importance followed by continuity and price in PDAM's utility. Furthermore, the first model also shows that continuity has a higher importance followed by quality and price in well's utility. For second model, both utilities of PDAM and well show that quality and continuity as a higher importance compare to price.

7.1.4. Key Findings from Specific Objective 4

Policy recommendations were retrieved from the results of three previous specific objectives. These were the main findings.

1. The current policies about quality and continuity of PDAM show that PDAM has started to renew old pipe connection since the beginning of 2014 to improve the quality and to check the leaking spot. However, due to limited fund, the renewing can be done at least one urban village per year. Besides renewing old pipe connection, PDAM will buy a water compressor in 2016 to improve debit water.
2. There are three policy recommendations that were produced in this research. They are enhancing performance of PDAM; increasing price for permit of well and extracting groundwater; and subsidy for low income people.

7.2. Limitations and Recommendations

This section explains limitations in this research that will lead to the recommendations for further research. For further explanation, the limitations and recommendations of this research are explained as follows.

1. The groundwater well users were focused only for household use without including commercial use, hotel use or industrial use.

2. The questionnaire needs deeper questions to get more accurate data and minimize the bias. For instance, in socio-economic questions (house type, motorcycle, etc.) and system performance questions (quantity and affordability).
3. The data that was used for selection of the three urban villages, pipe connection map and description of the study area was not the latest data.
4. The system performance of piped water supply was analysed only based on affordability, quantity, quality and continuity despite there are more variables that can be used to analyse the system performance.
5. The system performance was conducted based on comparison between piped water and other water supplies. This comparison was based on perceptions of each water supply users. However, the perceptions, sometimes, were not accurate. For instance, in terms of quality, the respondents gave the quality of well water based on their perceptions. As the results, the water from PDAM tend to be lower in quality.
6. This research used paper and pencil based survey due to limitation in gadget. However, based on experience in this research, the paper and pencil based survey can lead to long process of experimental design, requires more explanation to the surveyors, and costly survey. Furthermore, the paper and pencil based survey is less attractive that will make the respondents bored (Hensher et al., 2007).

Considering the limitations of this research, there are several recommendations for further research.

1. The further research can includes commercial, hotel and industrial as their respondents because they might use more groundwater compared to households as stated in Jakarta Post (2014).
2. The further research must spends more time to create solid questionnaire with paying attention to the deeper questions in some parts of questionnaire as mentioned before in the limitations.
3. In order to analyse the system performance of piped water, the further research can add more variables such as: service coverage, quality of service, transmission and distribution (Alegre et al., 2006).
4. Further research needs to analyse system performance not only using the perceptions but also using other methods that are more accurate. For example, like in the research of Ndungu (2011) and Salendu (2010), the quality of water was measured not only based on the perceptions, but also based on evidence from the laboratory that is more accurate.
5. Finally, further research can use computer based survey because it has more advantages compare to pencil and paper based survey (Hensher et al., 2007).

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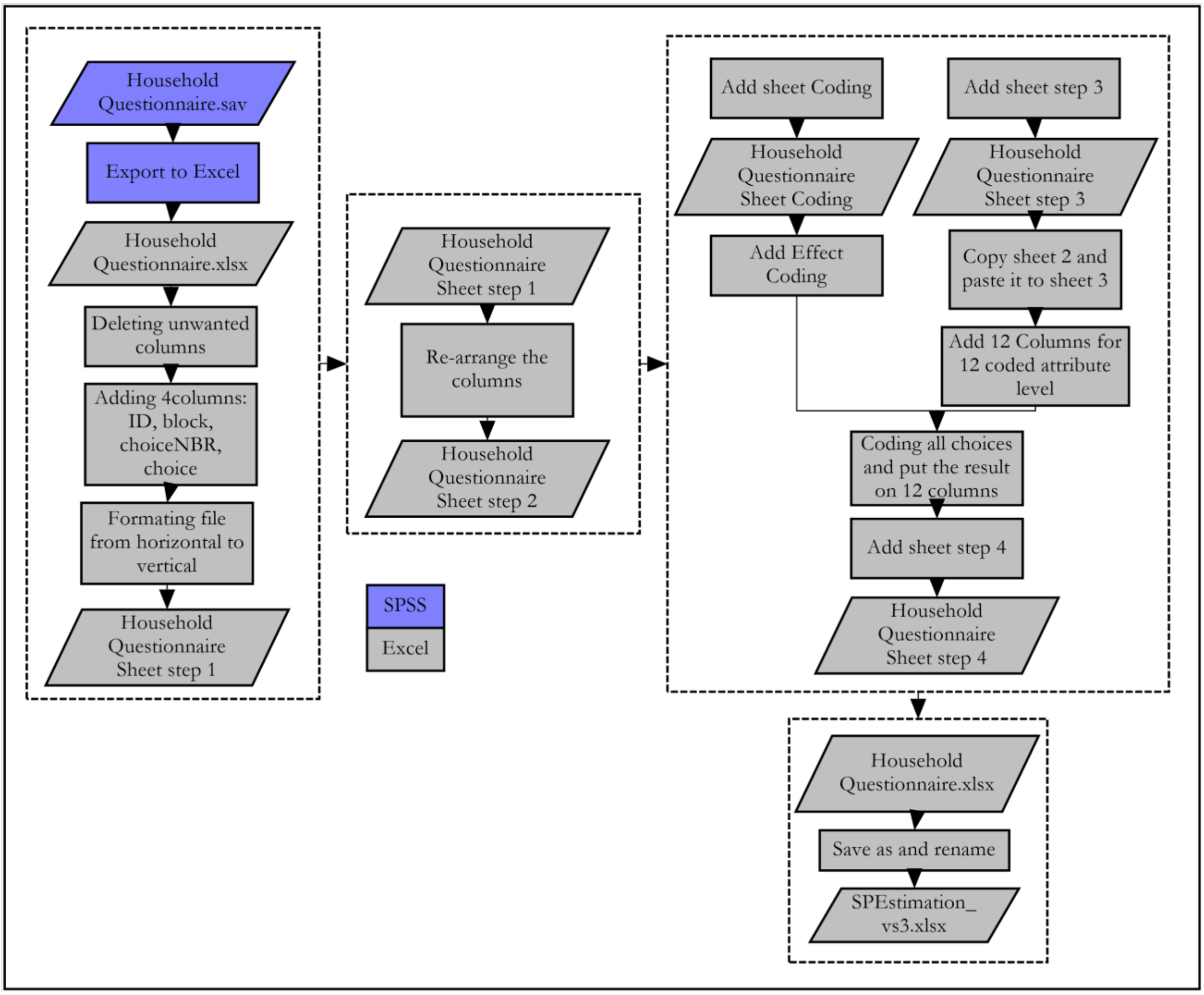
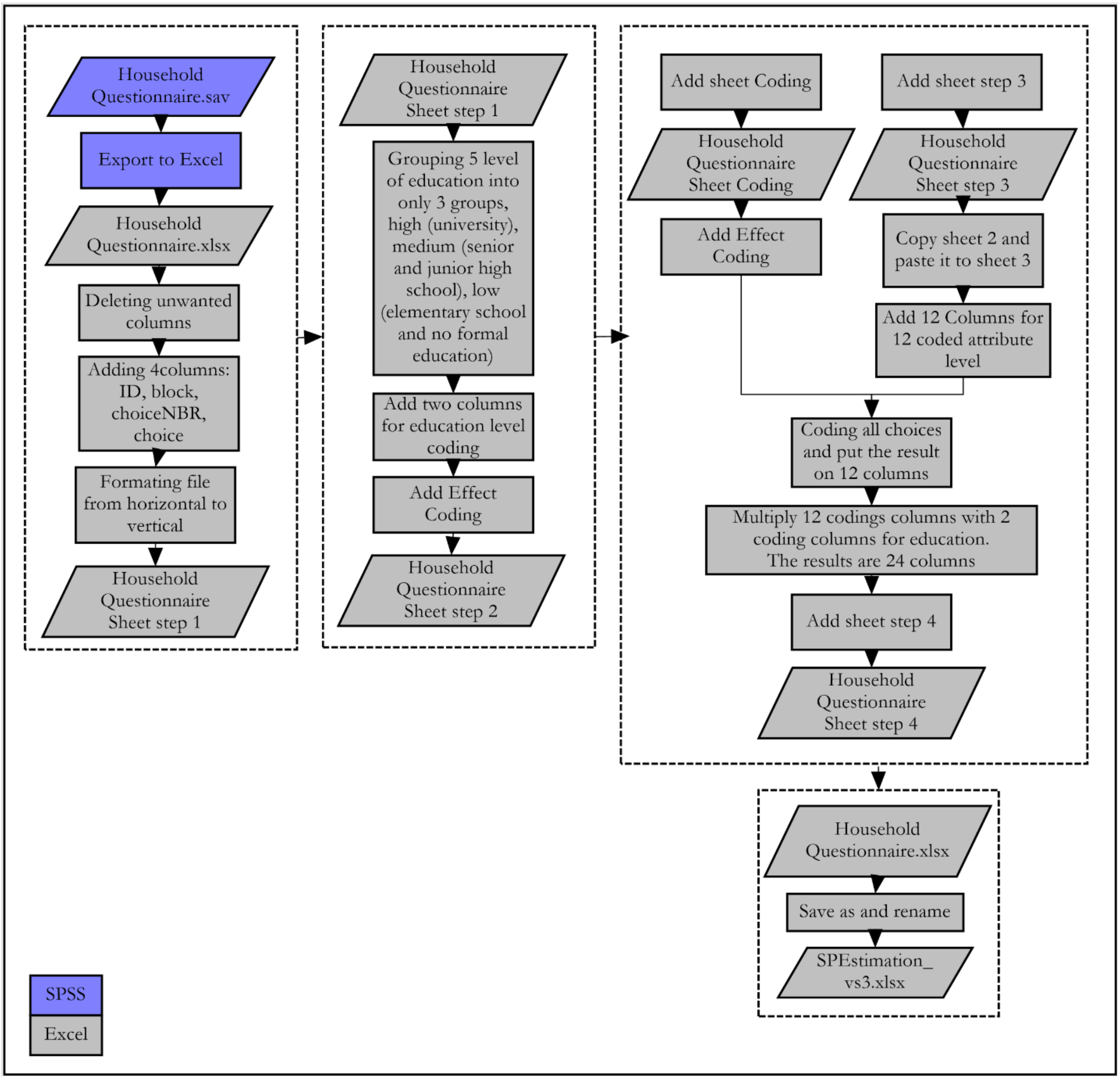
APPENDIX 1. FLOWCHART FOR ESTIMATING PARAMETERS MODEL 1

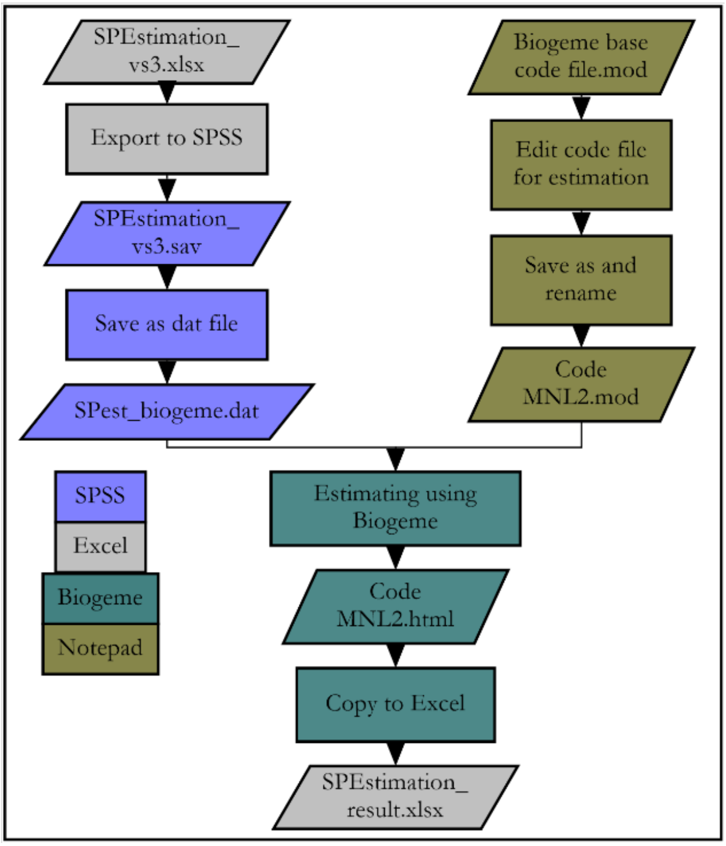


APPENDIX 2. FLOWCHART FOR ESTIMATING PARAMETERS MODEL 2



APPENDIX 3. FLOWCHART OF STATED CHOICE ANALYSIS

This appendix gives a detail information about stated choice analysis (Section 4.4.2). After doing preparation in excel. Both excel files, output from steps in Section 4.4.2 were prepared. These excel files was converted into .dat file for input data using SPSS. BIOGEME needs not only .dat file but also coded file as the formula. Thus, coded file was created in notepad. Next step, both .dat file and coded file were used in estimating utility parameters. The results were html files and needed to be transformed into excel format to make better interpretation. Furthermore, for more detail of the steps that were taken, it can be seen on figure below.



APPENDIX 4. HOUSEHOLD QUESTIONNAIRE

Date:
Surveyor:
Village name:
Household number:

Household Data

1. Number of persons in this household:
   a. 1 b.2 c.3 d.4 e.>4, specify:_____________________________

2. How many persons have occupation within this household?
   a. 1 b.2 c. >2, specify:_____________________________

3. What is the occupation of the head of this household?
   a. No occupation b. Self-employed c. Military/Police d. Government officer
   e. Others, specify________________________

4. level of education
   a. No formal education b. Elementary c. Junior high school d. Senior High School
   e. Undergraduate/Master/Doctoral

5. Own/rent this house:
   a. Own b. Rent c. Other, specify: ___________________________

6. House type:
   a. Temporary b. Semi-permanent c. Permanent

7. Does this household has motor cycle? Y/N
   How many motor cycle this household has?
   a. 1 b. 2 c. 3 d.>3

8. Type of telephone:
   a. Home line b. Mobile phone c. Both

9. Electricity:
   a. PLN b. Private generator c. Public generator

10. Energy for cooking:
    a. LPG b. kerosene c. firewood d. charcoal

Water Supply Provision

1. How much does this household spend for water supply per month in total?
   If you know exact amount, please, write down the amount______________________

   a. <Rp.300,000
   b. Rp.300,000 - Rp.600,000
   c. >Rp.600,000

Attributes	**Water Provision**			
	PDAM	**Private Well**	**Communal Well**	**Bottled Water**
Quantity	a. <10 metre³/month b. 11 – 20 metre³ /month c. 21 – 30 metre³/month d. >30 metre³/month	____metre x____ metre x_____ metre (size of their tub that they fill with well water per day) How many times do you fill it per day? ___	____metre x____ metre x_____ metre (size of their tub that they fill with well water per day) How many times do you fill it per day? ___	a. <5 gallons of mineral water/month b. 6 – 10 gallons of mineral water/month c. >10 gallons of mineral water/month
Continuity	a. Continuously service the whole day b. Difficulties on peak hour 06.00-09.00 c. Difficulties in the evening 17.00-21.00 d. Only in some hours e. Not everyday service	a. Continuously service the whole day b. Not everyday service c. Difficulties in dry season	a. Continuously service the whole day b. Not everyday service c. Difficulties in dry season	**NOT APPLICABLE**
Quality	a. Smell b. No Smell a. No taste b. Chlorine a. Colour b. Colourless	a. Smell b. No Smell a. No taste b. Chlorine a. Colour b. Colourless	a. Smell b. No Smell a. No taste b. Chlorine a. Colour b. Colourless	a. Smell b. No Smell a. No taste b. Chlorine a. Colour b. Colourless
Water Uses	a. For cooking b. For drinking c. For washing cooking ware d. For washing motor e. For gardening	a. For cooking b. For drinking c. For washing cooking ware d. For washing motor e. For gardening	a. For cooking b. For drinking c. For washing cooking ware d. For washing motor e. For gardening	a. For cooking b. For drinking
Type of Well	**NOT APPLICABLE**	a. Dug well (shallow well) b. Drilled well (hundred meters deep)	a. Dug well (shallow well) b. Drilled well (hundred meters deep)	**NOT APPLICABLE**
Get Water from Well	**NOT APPLICABLE**	a. Manually/Hand pump b. Machine/Jet-pump	a. Pipe connection b. Taking from the source	**NOT APPLICABLE**
Distance from Communal Well	**NOT APPLICABLE**	**NOT APPLICABLE**	a. <5 minutes b. 6-10 minutes c. >15 minutes	**NOT APPLICABLE**

APPENDIX 5. STATED CHOICE EXPERIMENT BLOCK 1

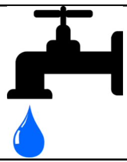
In this part of the survey you will be asked to choose between piped or ground water, in relation to some variables:

Quality:
Piped water: ranges from drinkable; same as today and worse than today
Ground water: ranges from better than today; better, but not drinkable; same as today; worse than today

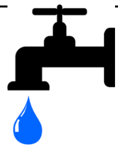
Continuity:
Piped and Ground water: ranges from available the whole day; difficulties on peak hours (06.00 -09.00 and 17.00-21.00); only available 2 hours in the day

Price:
Piped water: Prices will be relative to the monthly bill paid to the water provider. It will vary between: more expensive than now; same as now; cheaper than now.
Ground water: Price includes the electricity to pump the water, and any other costs that may occur to get water from the ground. It will vary between: more expensive than now; same as now; cheaper than now.

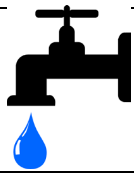
You are also allowed to choose the "none of these" option.

			
Quality	Drinkable	Better than now, but not drinkable	
Continuity	Only available for 2 hours	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	More than you pay now	More than you pay now	
Choice	◯	◯	◯ None of these

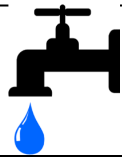
1)

			
Quality	Drinkable	Better than now, but not drinkable	
Continuity	Available the whole day	Available the whole day	
Price	More than you pay now	More than you pay now	
Choice	◯	◯	◯ None of these

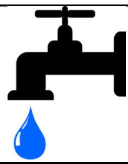
2)

			
Quality	Same as now	Worse than now	
Continuity	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	More than you pay now	Less than you pay now	
Choice	◯	◯	◯ None of these

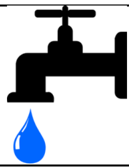
3)

			
Quality	Worse than now	Same as now	
Continuity	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	Available the whole day	
Price	More than you pay now	Less than you pay now	
Choice	◯	◯	◯ None of these

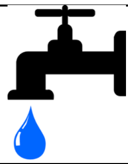
4)

			
Quality	Drinkable	Worse than now	
Continuity	Only available for 2 hours	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	Same as you pay now	More than you pay now	
Choice	◯	◯	◯ None of these

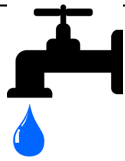
5)

			
Quality	Same as now	Same as now	
Continuity	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	Same as you pay now	Same as you pay now	
Choice	◯	◯	◯ None of these

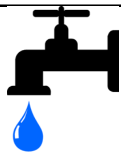
6)

			
Quality	Worse than now	Better than now, but not drinkable	
Continuity	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	Only available for 2 hours	
Price	Same as you pay now	Less than you pay now	
Choice	◯	◯	◯ None of these

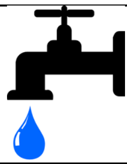
7)

			
Quality	Drinkable	Same as now	
Continuity	Only available for 2 hours	Available the whole day	
Price	Less than you pay now	Same as you pay now	
Choice	◯	◯	◯ None of these

8)

			
Quality	Same as now	Better than now, but not drinkable	
Continuity	Available the whole day	Only available for 2 hours	
Price	Less than you pay now	Same as you pay now	
Choice	◯	◯	◯ None of these

9)

			
Quality	Worse than now	Worse than now	
Continuity	Only available for 2 hours	Only available for 2 hours	
Price	Less than you pay now	Less than you pay now	
Choice	◯	◯	◯ None of these

APPENDIX 6. STATED CHOICE EXPERIMENT BLOCK 2

In this part of the survey you will be asked to choose between piped or ground water, in relation to some variables:

Quality:
Piped water: ranges from drinkable; same as today and worse than today
Ground water: ranges from better than today; better, but not drinkable; same as today; worse than today

Continuity:
Piped and Ground water: ranges from available the whole day; difficulties on peak hours (06.00 -09.00 and 17.00-21.00); only available 2 hours in the day

Price:
Piped water: Prices will be relative to the monthly bill paid to the water provider. It will vary between: more expensive than now; same as now; cheaper than now.
Ground water: Price includes the electricity to pump the water, and any other costs that may occur to get water from the ground. It will vary between: more expensive than now; same as now; cheaper than now.

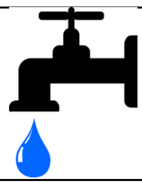
You are also allowed to choose the “none of these” option.

			
Quality	Drinkable	Better than now, but not drinkable	
Continuity	Only available for 2 hours	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	More than you pay now	More than you pay now	
Choice	◯	◯	◯ None of these

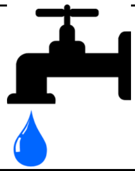
1)

			
Quality	Drinkable	Worse than now	
Continuity	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	Only available for 2 hours	
Price	More than you pay now	Same as you pay now	
Choice	◯	◯	◯ None of these

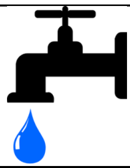
2)

			
Quality	Same as now	Same as now	
Continuity	Only available for 2 hours	Only available for 2 hours	
Price	More than you pay now	More than you pay now	
Choice	◯	◯	◯ None of these

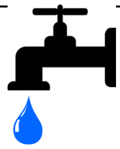
3)

			
Quality	Worse than now	Better than now, but not drinkable	
Continuity	Only available for 2 hours	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	More than you pay now	Same as you pay now	
Choice	◯	◯	◯ None of these

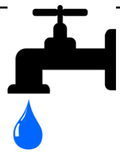
4)

			
Quality	Drinkable	Same as now	
Continuity	Available the whole day	Only available for 2 hours	
Price	Same as you pay now	Less than you pay now	
Choice	◯	◯	◯ None of these

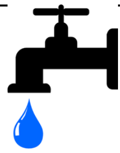
5)

			
Quality	Same as now	Better than now, but not drinkable	
Continuity	Only available for 2 hours	Available the whole day	
Price	Same as you pay now	Less than you pay now	
Choice	◯	◯	◯ None of these

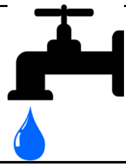
6)

			
Quality	Worse than now	Worse than now	
Continuity	Available the whole day	Available the whole day	
Price	Same as you pay now	Same as you pay now	
Choice	◯	◯	◯ None of these

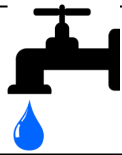
7)

			
Quality	Drinkable	Drinkable	
Continuity	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	Less than you pay now	Less than you pay now	
Choice	◯	◯	◯ None of these

8)

			
Quality	Same as now	Worse than now	
Continuity	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	Available the whole day	
Price	Less than you pay now	More than you pay now	
Choice	◯	◯	◯ None of these

9)

			
Quality	Worse than now	Same as now	
Continuity	Available the whole day	Difficulties on peak hours (06.00 -09.00 and 17.00-21.00)	
Price	Less than you pay now	More than you pay now	
Choice	◯	◯	◯ None of these

APPENDIX 7. INTERVIEW QUESTIONS

Questions will be asked in the interview with KIMPRASWIL (Settlements and Regional Infrastructure Department).

1. Is there any policy about how water supply network is built in different type of settlements?
2. How does water supply network build in formal settlement?
3. How does water supply network build in informal settlement?
4. How do people in informal settlement get water supply?
5. Is KIMPRASWIL coordinated about water supply network in informal settlement with PDAM or PU-ESDM?
6. Does KIMPRASWIL has a plan to make policy about how water supply network should be built in informal settlement?

Questions will be asked in the interview with PDAM.

1. Where does PDAM get water source from?
2. How many hours per day does PDAM supply water to each village?
3. How many water is produced by PDAM daily?
4. How does PDAM keep the quality of its water supply?
5. What is the average revenue collected per unit of water sold?
6. What is the main challenge(s) of PDAM right now?
7. How does PDAM handle that challenge(s)?
8. Do you aware about policy that will limit license for well users due to drought in Yogyakarta?
9. In PDAM's perspective, what are the strategies to overcome this situation?
10. Is there any plan to improve PDAM's service to attract more customers? In which variables?