DOCTORAL DISSERTATION

Incorporating Users' Preferences to Develop Improvement Strategies on the Domestic Water Fulfillment in Indonesia

September 2021

Sugiyono

Graduate School of Environmental Engineering

Dewancker Bart Lab

The University of Kitakyushu, Japan

Abstract

Aside from the availability of the abundant water resources, the domestic water fulfillment in Indonesia has not achieved a fully satisfying level. The UN water (2017) recorded that only 54% of the Indonesian population are served by water on premise. Admittedly, providing a reliable public water service is not an easy task, but requires huge efforts. In the context of Indonesia, the local governments have more burden on this issue due to the changes in the political and administrative system, which is from centralized to decentralized system. Then, the problem becomes more complicated for a small city because its limited resources must be spent for a variety of sectors. In this case, the domestic water sector is frequently overlooked and not prioritized.

This research specifically discusses the issue of the domestic water fulfillment in the Indonesian small city. Kota Metro in Lampung Province is taken as the case study area due to its low percentage of the public water service coverage. The main objective is to propose development scenarios to improve the current situation by considering the constraints belong to the city as well as the public preference. The study starts with the elaboration on the current status of the domestic water fulfillment in this city. Then, it is continued with elaborating the public preference on the domestic water utilization, which is conducted through an online and a household survey.

This research found that in Kota Metro the preferable domestic water sources are attached to certain reasons namely reliable quantity, good quality, easy access, and affordable price. Moreover, the individual groundwater users also admitted that the choose this water source because they do not have other choices. Besides, the selection of the preferable domestic water sources is also influenced by several factors such as the respondent's socioeconomic background. Surprisingly, the availability of the pipe water network does not give a significant influence on the community to choose the public water service although the aye positively correlated. This propensity is also strengthened by the satisfaction level of the respondents to their current main water source. The result shows that the pipe water users have the most dispersed opinion to show their satisfaction level compared to the other.

The results of these two stages are then used as inputs to formulate the development scenarios. The scenarios are developed under three conditions, which are applying doing business as usual, accelerating pipeline-based water service, and combining pipeline-based and communal-based water service. In the end of the discussion, lessons from other strategies from other places are drawn through a systematic literature review. Eventually. The proposed strategies are reflected to the findings resulted from the lessons drawing process.

Acknowledgement

All praises and gratitude to Allah for all of His graces so that this thesis can be finished properly. I would also like to express my gratitude toward several people who significantly contributed to my study in the University of Kitakyushu, Japan.

First of all, I sincerely thank to Prof. Bart Dewancker for supervising my work and for all priceless helps given to me during my study. Also, my deepest appreciation for all professors in the Graduate School of Environmental Engineering, the University of Kitakyushu, especially Prof. Koji Takasu, Prof. Shohei Nishihama, and Assoc. Prof. Masao Kido for all comments and advice to improve my work.

Secondly, I would thank to the Ministry of Development Planning (BAPPENAS) for giving me the opportunity to pursue the doctoral program in the University of Kitakyushu government of Kota Metro and the government of Kota Metro for facilitating the survey that was conducted for this research. Besides, my appreciation is also for the surveyors and respondents for participating on the survey.

Thirdly, thanks to all my friends in Bart Lab (Dadang Hartabela, Athina Ardhianto, David Christian, Siswanti Zuraida, Adessarman, Yurika Mori, and Yuling Tsai) for all supports and helps. Besides, I would also thank to Indonesian community in Kitakyushu (Rendy Perdana Khidmat, Dimas Herjuno, Trezza Chandra Julian, and Munawir) and all people that I cannot mention one by one. There is not enough space in this page to write your names but there is always a dedicated space in my memory to remember all your kindness.

Last but not least, my deepest appreciation to all my families especially my wife (Murtiana) and my sons (Akmal, Ahsan, Arfan) for all prays and supports during my study. Thank you for always being my source of motivation to reach this goal.

Table of Contents

List of Figures

List of Tables

Chapter 1
Introduction

1.1. Background

1.1.1. Currently Global Trend on Domestic Water Issues

Access to drinking water is becoming a critical global issue recently. Combined with the current dynamics of the climate change, increasing population growth impend the water sources since the increasing water demand is far exceeding the limited freshwater availability[1]. It is reported that 844 million people lack a basic water service and 2.1 billion lack safely managed water source [2]. To elaborate, the WHO defines basic water service as drinking water from an improved source that can be collected less than 30 minutes for roundtrip including queuing while safely managed water source is drinking water from an improved water source which is located on premises, available when needed, and free from fecal and priority contamination [3]. The report [2] also noted that more than 2 billion people live in countries encountering severe water stress. To define, a country is categorized as water-stressed if the availability of the water resource per capita is less than 1,000 m^3 in a year [4]. Unsurprisingly, the United Nations targeted universal access to water by 2030 as one of the targets of the Sustainable Development Goals (SDGs), which is a continuation of the Millennium Development Goals (MDGs) due to the nature of water as a non-substitutable substance for human's live as well as ecology.

Besides domestic uses, various sectors such as agriculture, mining, industry, etc. rapidly increase the water demand and exacerbate imbalance supply-demand mechanism. The competing interests between those commercial and non-commercial uses or localities could also trigger severe conflicts [5][6]. Besides, those activities evidently contaminate the water sources and decrease the water quality [7]. Hence, the water source can be viewed as a valuable resource that is prone to be polluted. Therefore, it is supposed to be well managed to prevent more serious conflict as well as to fulfil human basic need sustainably.

Moreover, discussing domestic water issues is not merely about its physical scarcity but also its efficient governance [8], economic valuation and ecological conservation [9], and political setting [10]. Subsequently, concern about water scarcity results in various approaches in water resource management. The paradigm evolves from dominant water management, integrated water management, ecosystem management, and collaborative decision making [11]. Afterward, water security paradigm emerges to broaden the discussion of water resource management. Regarding this issue, scholars have various perspectives to define water security and do and assessment on it [12]. The traditional definition of the water security is closely related to the resource requisition and its utilization to ensure the needs of people inside a certain authority [13]. Then, the geographical-entity-based definition was getting fuzzy since the existence of water source sometimes is located on cross-boundaries area and the perspective of the water security is constructed and influenced by dispersed contexts such as socioeconomic background, cultural values, political setting, and technological advancement [14]. Furthermore, in their review, Cook and Bakker [15] stated that the water security approach could be viewed as a complementary paradigm of Integrated Water Resource Management (IWRM). In more explicit definition, the Sustainable Water Partnership (SWP) emphasizes five essential dimensions of the water security namely health, livelihood, productive economies, ecosystems, disaster risk reduction [16]. By considering these five elements to manage the water resource, availability access, and safe use of the water are expectantly achieved as the outcomes of the implemented measures.

Another important issue in domestic water provision is competing interests to other sectors [17]. Besides its characteristic as human basic need, water is an essential element in food production and energy generation, which are important to develop or maintain economic growth. Indeed, the water quality for power plant or agricultural use does not need to be as high as for drinking water but those sectors are far more consumptive compared to the domestic water uses in terms of the water quantity. It then brings a dilemma for policy makers to suffice all needs within finite resources. Nevertheless, this phenomenon can also be viewed in reverse angle. The nexus approach has been introduced to view bidirectional relationship between water and other sectors i.e., food and energy rather than see water as the main important input. To explain, the relationship can be illustrated as follows.

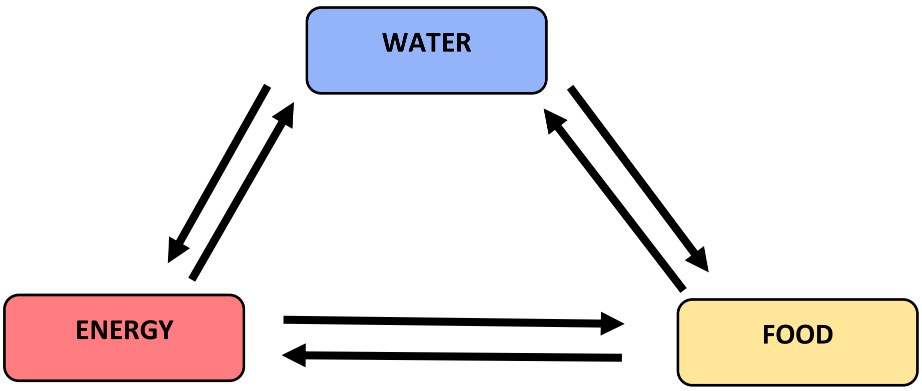
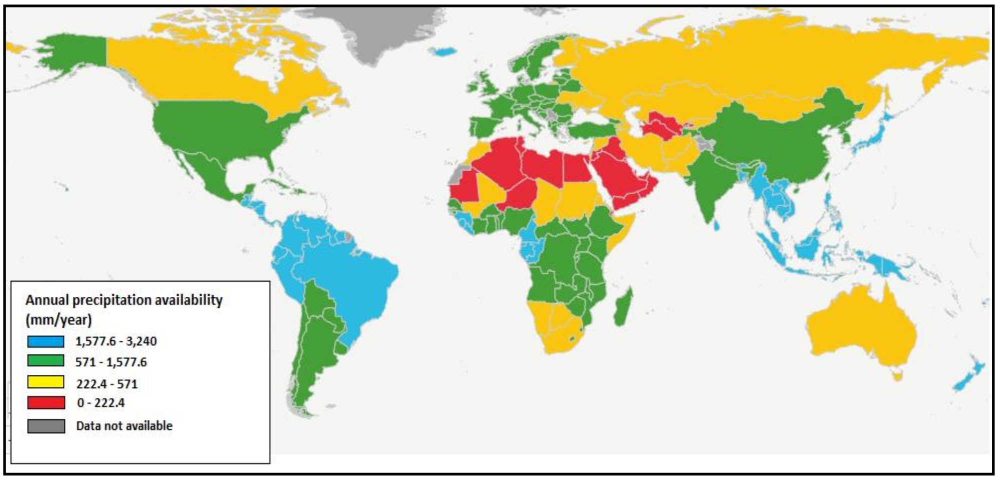


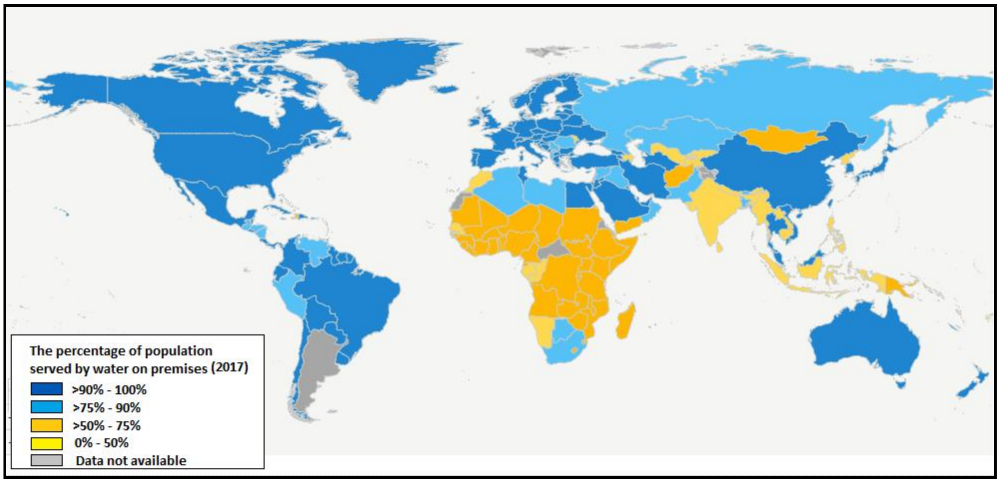
Figure 1.1 Schematic diagram of water-energy-food nexus

Figure 1.1 shows a schematic diagram illustrating water-energy-food nexus. The three sectors are inter-dependent and can be viewed as input or output of each other [18]. For instance, water can be used as a main input for energy generation e.g., hydropower, power plant cooler, etc. On the other hand, energy is needed in the whole process of drinking water production and distribution e.g., groundwater abstraction, pumping system. In the case of energy-food nexus, energy is required for food production either in the crop cultivating stage (e.g., pumping system for irrigation) or in the post-harvesting phase (e.g., storage, food processing industries, etc.). Meanwhile, the agricultural sector has an important role as the supplier of the raw materials for biofuel industries. Furthermore, water-food nexus is more obvious. Water is absolutely required for agricultural activities (e.g., irrigation, fishery, livestock, etc.). On the other hand, agricultural land, which is characterized as permeable surface, enables rainwater to be more infiltrated, which is a beneficial condition in the groundwater discharge-recharge mechanism. Considering their inextricable linkages, the three sectors are supposed to be synergized and well managed. Otherwise, they affect each other negatively. Hence, more holistic approaches are required. Proctor et al [19] summarized five critical perspectives that are supposed to be involved to synergize water-energy-food nexus. They are the perspective ecosystem, waste management, institutional change, trust, and learning process. Moreover, the water-energy-food nexus should also be understood within various disciplines since connecting those sectors requires not advanced technical measures but also suitable governance approaches [20].

Moreover, the discussion of domestic water fulfillment cannot be separated from the issue of the water resource availability. These following figures illustrate the relationship between them.



(a)



(b)

Figure 1.2. (a) The average annual precipitation availability,

(b) The Percentage of population served by water on premise (2017) (source: [21])

Figure 1.2 illustrates a contradictory situation between the availability of water source (e.g., rainwater) and the level of water service. To specify, figure 1.2.a shows the annual precipitation that is abundantly available in tropical countries, which is supposed to be a big potential to suffice water needs. By contrast, figure 1.2.b indicates that most of those tropical countries achieved less than 75% in providing water on premises. The rainwater rate, which can be interpreted positively corelates to the availability of water resource, does not guarantee the level of domestic water fulfillment.

Indonesia, specifically, is categorized as a country with high annual rainfall rate but its achievement on domestic water provision is clustered below 50% of population. It seems in line to Tortajada and Biswas [22] that emphasize current debates on the water management should give more attention on the discussion of managing water through a good governance rather than be stuck on the issue of the water physical scarcity [22]. This statement strengthens the evidence that abundant water source does not fully guarantee the service reliability, but many factors involved. In more detail, the discussion of the recent Indonesian domestic water situation is presented in the following section.

1.1.2. Domestic Water Service Provision in Indonesia: Paradox of Abundant Water Resources

Regarding domestic water fulfillment, Indonesia also ratified the SDG's agenda by issuing a development plan stated in Presidential Decree Number 59/2017 about the achievement of the Sustainable Development Goals. Two goals related to water provision are accommodated by this presidential decree: (1) increasing access to drinking water to 100% of the population by 2019, and (2) increasing drinking water production capacity to 118.6 m3 per second by 2019. Actually, these are reasonable goals considering the report released by WHO and UNICEF in 2015 stating that Indonesia is one of the countries that have met the targets set in the Millennium Development Goals [23] while statistical data show that 72.99% of households in Indonesia already have access to drinking water [24]. Despite this positive trend, some problems appear when the data is broken down into a more specific issue on how people have access to their domestic water source. As a matter of fact, water source utilization in Indonesia is still dominated by individual groundwater exploitation instead of public water service utilization. This is actually an alarming situation in the perspective of water resource sustainability considering the negative consequences of excessive groundwater exploitation revealed by many studies [25]–[27]. To be more specific, [28] recorded that only 10.29% of households in Indonesia utilize tap water as their main drinking water source, while 36.28% of households rely on bottled water for drinking and the rest choose to exploit groundwater individually.

Furthermore, current situation of domestic water sector in Indonesia is an accumulative result of former policies and regulations that were not free from political setting. Water service providers, for instance, now are expected to be more independent managerially and financially as a consequence of decentralization concept that was highly promoted after the termination of the centralized regime in 1998. The decentralized system expectantly could give more power to local authorities to manage basic public services including domestic water. Hence, domestic water service is supposed to be better developed as both communities and water companies have a shorter bureaucracy to deal with. Nevertheless, this assumption does not fully match with empirical reality. The data shows the domestic water use in Indonesia is still dominated by individual groundwater abstraction rather than reliable public water service. BPS[1] noted that only 10.08% of households in Indonesia utilize tap water for potable use while the rest relies on other sources [24]. Briefly, current situation of domestic water fulfillment is summarized in table 1.1.

Table 1.1 The source of the domestic water fulfillment in Indonesia (2019) (Source: [24])

Domestic Water Fulfillment	Achievement (%)		
	Urban Areas	Rural Areas	Average
Water source for potable uses:			
- Bottled water	52.16	20.54	38.25
- Tap water	12.71	6.73	10.08
- Borehole well	16.34	16.39	16.36
- Protected dug well	12.31	22.76	16.91
- Unprotected dug well	1.56	7.24	4.06
- Spring	3.86	19.78	10.86
- Surface water	0.16	2.53	1.20
- Rainwater	0.83	3.98	2.22
- Other	0.06	0.05	0.05
Water source for non-potable uses:			
- Bottled water	0.29	0.11	0.21
- Tap water	26.41	8.15	16.38
- Borehole well	43.04	24.85	35.04
- Protected or unprotected dug well	24.26	37.60	30.13
- Spring	4.10	19.78	10.99
- Surface water or rainwater	1.74	9.37	5.10
- Other	0.16	0.15	0.16

This table shows domestic water sources utilized in Indonesia and their proportion for both potable and non-potable uses. Firstly, public water service (tap water) just takes a small portion of domestic water fulfillment. For potable uses (drinking, cooking, etc.), the water source is dominated by bottled water, especially in the urban areas. Meanwhile, borehole and dug well are the most preferable over other types of domestic water sources. Secondly, there is a significant disparity between urban and rural areas in the case of the tap water utilization. It implies the development of pipeline network and other supporting infrastructures between urban and rural areas still remain a wide gap. It might also be interpreted that public water service providers prefer serving urban areas, which is more economically beneficial for them. It causes the service has not reached optimal coverage and the performance of the providers is questionable. In its report, the Ministry of Public Works stated that only 55% of public water service providers are labelled as "in good condition" while the rests are

[1] BPS stands for Badan Pusat Statistik (Central Bureau of Statistics)

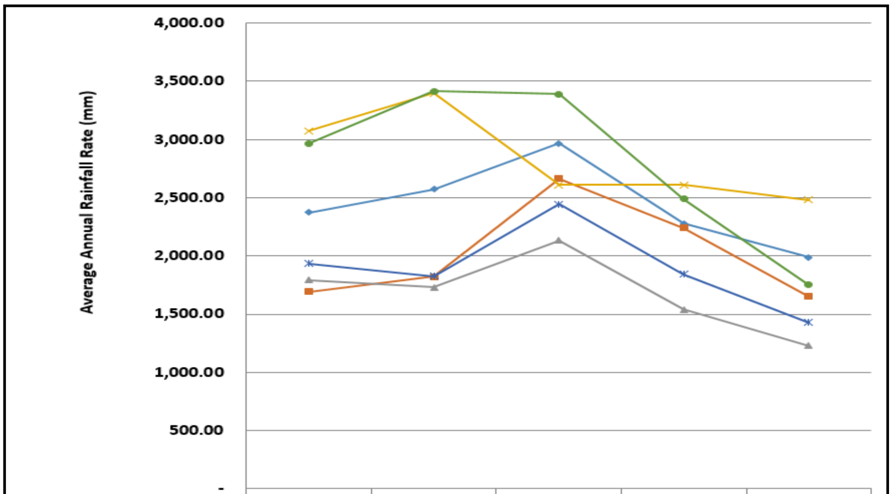
categorized as “in bad condition” or “in very bad condition”. To specify, the data on the performance of the public water service providers is summarized in the following table.

Table 1.2 Assessment on the performance of public water service providers (source: [29])

Year	Number of Assessed Companies	the company’s performance category					
		GOOD		BAD		VERY BAD	
		Number of Companies	Percentage (%)	Number of Companies	Percentage (%)	Number of Companies	Percentage (%)
2017	378	209	55.3	103	27.2	66	17.5
2016	371	198	53.4	108	29.1	65	17.5
2015	368	196	53.2	100	27.2	72	19.6

Table 1.2 can actually be used to confirm the reason why pipeline-based water service is less preferable. As a matter of fact, people prefer bottled water to tap water even though it is much more expensive. A similar case is also applied for the choice of individual borehole well. To illustrate, consumers have to pay around ten million rupiahs (around USD 680) to construct a borehole well while initial fee for pipe water installation costs around three million rupiahs (around USD 200). In the case of bottled water, the price for 20 Liters of bottled water is around fifteen thousand rupiahs (USD 1) while the pipeline-based water tariff is around five thousand rupiah (USD 0.3) per m^3. Thus, consumers’ preference and satisfaction play an important role, instead of merely price consideration, in choosing a method to fulfill water needs. This is in line with the findings by Roekmi et al [30], which assessed four indicators of pipeline-based water consumers’ satisfaction in Cikarang, Indonesia. They found that water continuity is the most expected service provided by company. Based on this fact, water service providers can actually reformulate their water price to a certain level, which is economically profitable, but it has to be followed by satisfying service.

Aside from pipeline-based water service, it is also interesting to elaborate other potentials to fulfill domestic water needs. As a tropical country, the rainwater availability in Indonesia is abundant. Paradoxically, this type of water resource has not been optimally utilized for domestic water fulfillment. This is probably because the availability of rainwater is seasonal dependent, and its distribution is also spatially unequal. Besides, in Indonesia, the rainwater is traditionally used for agricultural purposes but is rarely used for fulfilling potable needs. Aside from these premises, rainwater can be seen as the most promising water resource to be exploited sustainably [31]. Rainwater harvesting, can also be an alternative to deal with water shortage and play an important role to provide access to water in remote or isolated areas[32]. BPS [33] noted that minimum average of annual rainfall rate, which was gauged in 34 observation stations, is 1806.97 mm and the minimum number of days with rainfall occurrence is around 145 days a year. In more detail, data on the average rainfall rate is illustrated by figure 1.3.



	2011	2012	2013	2014	2015
Sumatera	2,373.13	2,570.60	2,967.57	2,278.83	1,987.19
Jawa	1,693.00	1,821.33	2,664.43	2,241.85	1,651.97
Bali & Nusa tenggara	1,794.50	1,732.33	2,134.00	1,540.03	1,229.23
Kalimantan	3,076.00	3,399.25	2,609.27	2,611.38	2,479.32
Sulawesi	1,934.33	1,825.60	2,445.75	1,840.63	1,426.33
Maluku & Papua	2,964.25	3,415.67	3,388.33	2,489.90	1,752.78

Figure 1.3 Average annual rainfall rate in Indonesia (2011 – 2015) categorized by island

Despite its big potential, rainwater has not been widely used in Indonesia, which is confirmed by table 1.1. Indeed, rainwater harvesting system involves several variables to be successfully implemented although it is recently getting more popular worldwide [34]. Study by Semaan et al [35] suggested cost, reliability, and the performance of rainwater tanks as the variables influencing optimal size of rainwater harvesting facilities for domestic use. Moreover, rainwater infiltration, which is vital for rainwater harvesting, requires pervious surface bringing consequences in broader issues such as building and spatial arrangement, road material, and so forth [36].

Another potential to accelerate the development of the domestic water sector is the commitment from Indonesian government, which is articulated by programs and financial support. In 2008 the government of Indonesia started a program called as PAMSIMAS[2]. This program accentuates cooperation between communities' initiatives and government support. In PAMSIMAS, communities have an important role in deciding the proposed plan. Then, they are also responsible for handling the operational and maintenance phase. To formulate the proposal, communities are given technical assistances by personnel hired by the government. In this stage, the government facilitates financial support to provide training for communities so that they have sufficient capability to formulate and execute a proposed plan. Moreover, government is responsible for the construction cost while communities are responsible for operational and maintenance cost in the post-construction phase.

[2] PAMSIMAS stands for Penyediaan Air Minum dan Sanitasi Berbasis Masyarakat (Community-Based Sanitation and Drinking Water Provision)

Through this approach, it is expected that built facilities would be more durably utilized since communities have more sense of belonging to their works.

To elaborate, PAMSIMAS has been conducted in three phases. This categorization aimed to ease target setting in accordance with government financial capacity. PAMSIMAS I was conducted in 2008 – 2012 and PAMSIMAS II were conducted in 2013 – 2017. PAMSIMAS I resulted in the addition of facilities related to drinking water and sanitation in 7.000 villages within 15 provinces. PAMSIMAS II enlarged covered program up to 12.000 villages within 33 provinces. PAMSIMAS III has been launched in 2018 and was planned for the next five years. This program targeted 100% access to water and sanitation would be achieved in 2019. The World Bank report shows the significant improvement in access to water for low-income communities and in the community empowerment to improve the health [37]. Lessons learned from PAMSIMAS is how significant communities' involvement to determine the output of the program. Besides, this participatory program also has a significant role in determining the sustainability of built infrastructures. Referring to Yalegama et al [38], accurate project prioritization, transparency, and implementation support are determinant factors to encourage communities to involve actively. A similar situation likely appears in the implementation of PAMSIMAS.

1.1.3. The Need for Innovative Alternatives to Overcome the Problems of the Domestic Water Service Provision

Aside from notable results of PAMSIMAS, the program only prioritizes rural areas, which are considered as areas with limited or no access to drinking water and sanitation. Meanwhile, urban areas are unable to access this scheme to develop their domestic water sector. It is understandable since the achievement on access to water in rural areas are still far below urban areas. Nevertheless, the big proportion of population living in urban areas cannot be overlooked. The BPS noted that 56.7% of Indonesia population lives in urban areas and it is projected to 66.6% in 2035 [39]. Subsequently, the issue of increasing demand for basic need such as drinking water in urban areas needs more attention due to this demographic trend. Otherwise, it can generate catastrophic occurrences ranging from personal health deficiency to environmental deterioration.

Furthermore, PAMSIMAS scheme cannot be applied in urban areas because Indonesian administration system recognizes two types of administrative territories namely kabupaten (regency) and kota (city). The former refers to the area dominated by rural characteristics while the latter refers to urban area. While the rural areas are supported by the PAMSIMAS program, the urban areas are expected to be able to suffice domestic water needs through another approach i.e., pipeline-based water service. To inform, there are 416 kabupaten and 98 kota in Indonesia. Regarding pipeline-based water service, there are three types of the provision systems. The first type is operated by a private enterprise.

The second type is operated by local government-owned company (called as PDAM[3]), which is not a part of the city governmental structure. The third type is operated by the institution that is attached to the city governmental structure. In some cases, several cities are served by two providers such as a private enterprise and a local government-owned company. Besides, there are also cities that join with their neighbor city to have domestic water service. In detail, the pipeline-based water provider of the 98 cities in Indonesia is presented in the following figure.

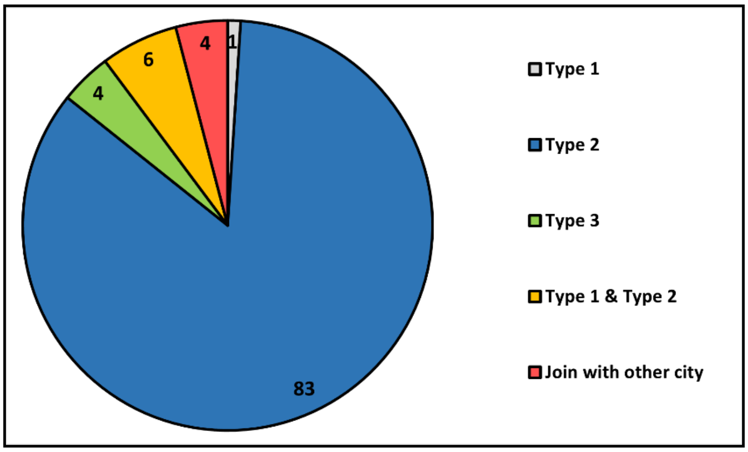


Figure 1.4 Various types of domestic water providers in Indonesian cities
(data source: compiled from [40])

Figure 1.4 shows the majority of Indonesian cities provide domestic water service through the local government-owned company (type 2) while only one city (i.e., Kota Batam), which is specially dedicated as a center of industrial estates, served by a private company. Indeed, a private company naturally seeks economic benefits to run their business and Kota Batam offers this opportunity due to its status as the center of the industrial zone in Indonesia. Another type of business scheme in the domestic water provision is collaboration between PDAM and private companies. In this case, they usually share the service zones. This type mostly appears in big cities such as Jakarta and Manado. It is understandable since big cities offer potential market for private companies and are more attractive to run their business.

Furthermore, the third type of the domestic water service is conducted by the organization that is under the city governmental structure. There are four cities (i.e., Kota Subulussalam, Kota Pariaman, Kota Pagar Alam, and Kota Metro) that perform this type in delivering domestic water service. Through this scheme, financial supports and the appointment of personnel are fully belonged to the authority of the local government. The third type is commonly applied in the cities that do not have capability to establish the local government-owned company or the economy of scale is too small to

[3] PDAM stands for Perusahaan Daerah Air Minum (The Local Government-owned Drinking Water Company)

run profit-oriented organization such as PDAM. On the one hand, this scheme enables to give the subscribers cheaper price since its nature of nonprofit oriented organization. However, expanding the service, which is delivered through pipe network, is a big challenge because limited financial capacity belonged to the local government cannot support high investment required. Besides, the domestic water provision must compete with other sectors to be financed and it frequently is less prioritized. As a result, the service coverage is slowly developed, and the service performance is poor. The following table is to illustrate the situation of domestic water service in the cities that apply the third type of domestic water service.

Table 1.3. The overview of the water service coverage in the cities performing the third type of the domestic water service

City's Name	Area (km^2)	Population in 2019 (people)	Density (people/km2)	Numbers of Households in 2019	Water Service Subscribers in 2019	
					Numbers	%
Kota Subulussalam	1,391.00	81,417	59	17,432	3,428	19.66
Kota Pariaman	73.36	88,501	1,206	18,977	5,528	29.13
Kota Pagar Alam	633.66	146,128	231	34,161	4,029	11.79
Kota Metro	68.74	167,411	2,435	42,925	2,205	5.14

Table 1.3 compares the size of the cities as well as their water service coverage. Generally, all cities have small percentage of pipe water customers. In more detail, Kota Metro has the smallest percentage even though this city is the most populous and the densest compared to other cities. It also implies that the city residents, who are not the customers of the service provided by the city government, exploit other sources to fulfill their daily needs. Following the data summarized in table 1.1, bottled water is the most preferable for potable uses and groundwater (i.e., boreholes or dug wells) is mostly used for non-potable uses. Evidently, groundwater abstraction is done through individual exploitation, which is environmentally harmful. Besides, individual groundwater abstraction will cause worse impacts in the long run if the trend continuously happens. Therefore, research on this issue needs to be conducted to elaborate alternatives for improvement. To specify, this research elaborates the issue of domestic water issue to formulate improvement strategies. Kota Metro, which has the smallest percentage of public water subscribers, is chosen as the case study area to represent the most challenging situation to develop domestic water service. Then, several research questions are derived to direct this research.

1.2. Research Questions

The main questions to be addressed in this research are:

1. What is the current situation of the domestic water fulfillment in the selected case study area?
2. What factors influence public preference on the domestic water fulfillment?

3. What alternatives can be proposed to improve the current situation of domestic water fulfilment considering strengths and weaknesses belonged to the case study area?
4. What strategies have been conducted in other places and what lessons can be drawn from them?

1.3. Research Objectives

Based on the research questions listed above, the objectives to be achieved in this study are:

1. To explore the current status of domestic water provision in the case study area.
2. To investigate factors influencing public preference on the domestic water source.
3. To formulate proposed strategies to improve domestic water provision.
4. To draw lessons from various attempts that have been applied to improve domestic water provision.

1.4. Research Contribution

The contribution that is offered by this study are:

1. Wider perspectives on the discussion of determinant factors motivating community to choose a preferable domestic water source.
2. Approaches in providing domestic water service to deal with dilemma of the limited resources to gain optimum outputs.

1.5. Thesis Structure

This thesis consists of eight chapters that respectively represent the sequential phase of the study. They are:

Chapter 1

This chapter contains current issues on the domestic water fulfillment from the global to the local context. The current trend shows that many countries face a dilemma and are struggling to provide reliable water service. In the case of Indonesia, the local government takes a big portion of this responsibility due to administration paradigm shifting. Hence, the need for improvement strategies in domestic water provision in the local context is a crucial aspect to discuss. From this premise, the research questions and research objectives are formulated. Furthermore, research contribution and the outline of the discussion are also stated in this chapter.

Chapter 2

This chapter explored novel discussion on the domestic water issues. Literatures related to domestic water fulfillment are elaborated to understand the most current issues. Then, factors influencing public preferences for domestic water fulfillment are also elaborated to view the issue of the water provision from the perspective of the users. The discussion also includes methods that were applied to justify the preferences. Furthermore, various approaches to deal with dilemma in domestic water provision is explored to widen the perspective in formulating improvement strategies.

Chapter 3:

This chapter explains the methodology applied in this research. It also includes method to select the case study area. Method for data collection, which are online and household survey, is also discussed in this chapter besides statistical techniques to analyze the data. Moreover, method for improvement strategy formulation and lesson drawing process is reviewed in this chapter.

Chapter 4

This chapter explores preliminary study on the community preferences for domestic water fulfillment in Kota Metro. The study is conducted by spreading online questionnaire to the residents of Kota Metro through e-mail and social media. This chapter also discusses the relationship between the socioeconomic background and the community preferences for domestic water uses. Besides, the accessibility to pipe network in Kota Metro is assessed whether it significantly influences the community preferences.

Chapter 5:

This chapter validates the preliminary study with the field survey. This chapter also adds the discussion of the respondent's satisfaction level to their current domestic water use and whether they have water shortage experience. Furthermore, we analyze whether respondent's satisfaction level and water shortage experience can motivate the community to shift their current domestic water source.

Chapter 6:

This chapter elaborate development planning scenarios that are possibly proposed to improve domestic water sector in Kota Metro. Findings resulted from the online and household survey are combined with potentials belonged to Kota Metro to formulate scenarios. Three approaches are suggested. They are doing business as usual approach, pipeline-based approach, and a combination between pipeline-based and community-based water service. Moreover, the scenario is also simulated for 5-year and 10-year development plan.

Chapter 7:

In this chapter, literatures related to improvement strategies that have been conducted all over the globe are elaborated. The case study areas are selected considering the similarity, in terms of climate and economic capacity, with Indonesia in order to provide fair comparison. Then, the determinants factor succeeding the implementation of the development strategies are listed and lessons from them drawn. In the last part of this chapter, proposed alternatives are recalled and reflected to the implemented strategies.

Chapter 8:

This chapter wraps the whole discussion by summarizing the discussion of the previous chapters. Results obtained in respective chapter are listed and summarized in this chapter. Specifically, this chapter would confirm the whole discussion with the research questions and intended objectives that are previously mentioned in chapter 1.

Furthermore, the thesis structure is illustrated by the following figure.

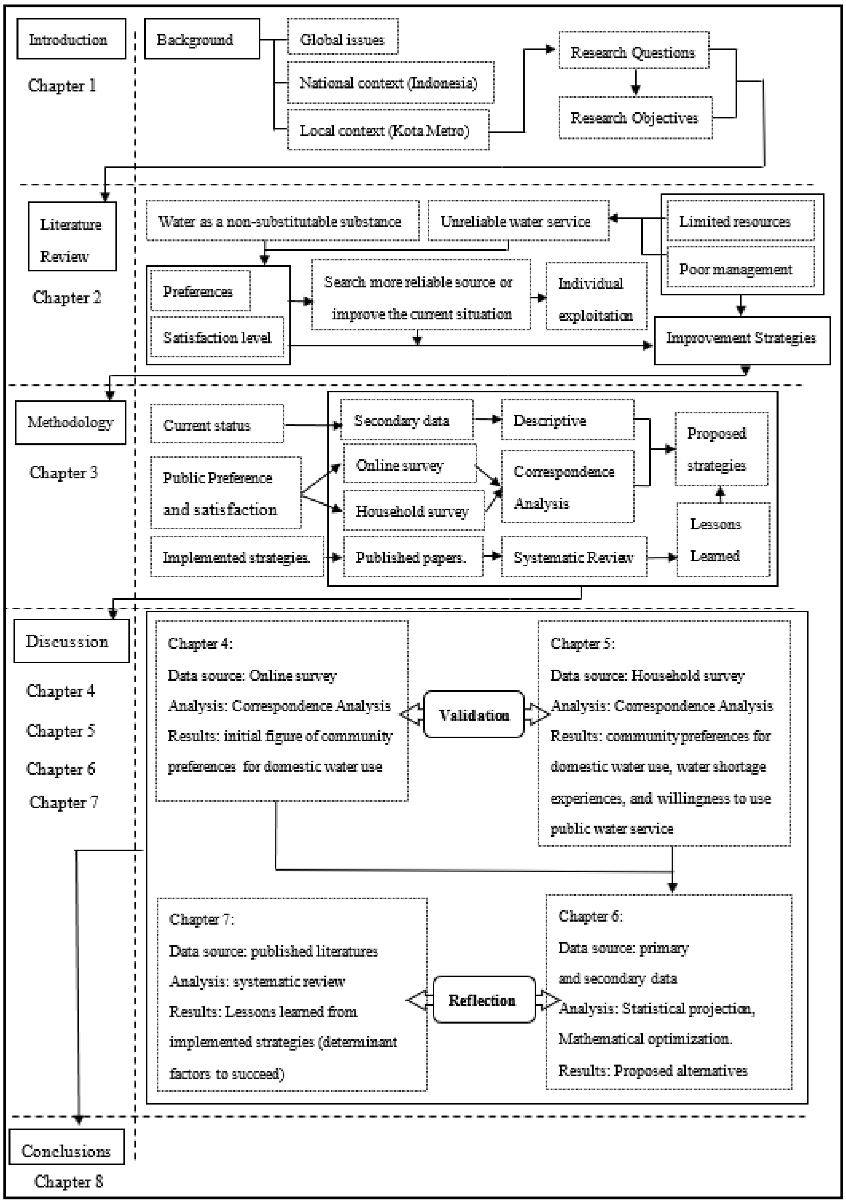


Figure 1.5 Research flowchart

To summarize, the chapters in this thesis are divided as is illustrated in figure 1.5. They are inseparable and inter-correlated one to another. Chapter 1 can be said as the stage of the problem formulation in this research that is followed by the formulation of the research objectives. Subsequently, current debates on the domestic water fulfillment are explored in chapter 2 to encapsulate the study with theoretical framework. Besides, this stage is essential to find the novelty as well as the contribution of this research to the current debate on domestic water issue. To achieve the research objectives, several steps were conducted that is elaborated in chapter 3. This is the stage to set suitable methods for this study. Afterward, the results of this study were discussed in chapter 4, 5, 6, and 7. In this stage, the results were thoroughly analyzed and were confirmed to the initial objectives. Eventually, chapter 8 wrapped all discussion with some concluding remarks and recommendations for further research.

References

[1] UN Water, "The United Nations World Water Development Report 2015: Water for a Sustainable World," Paris, 2015.

[2] UN Water, "Sustainable Development Goal 6: Synthesis Report 2018 on Water and Sanitation," New York, 2018.

[3] WHO, "Safely Managed Drinking Water: Thematic Report on Drinking Water 2017," Geneva, 2017.

[4] S. Damkjaer and R. Taylor, "The measurement of water scarcity: Defining a meaningful indicator," *Ambio*, vol. 46, no. 5, pp. 513–531, 2017, doi: 10.1007/s13280-017-0912-z.

[5] F. von Benda-Beckmann, "Contestations over a life-giving force: Water rights and conflicts, with special reference to Indonesia," in *A World of Water: Rain, Rivers, Seas in Southeast Asian Histories*, P. Boomgaard, Ed. Leiden: BRILL, 2007, pp. 259–277.

[6] T. Böhmelt, T. Bernauer, H. Buhaug, N. P. Gleditsch, T. Tribaldos, and G. Wischnath, "Demand, supply, and restraint: Determinants of domestic water conflict and cooperation," *Glob. Environ. Chang.*, vol. 29, pp. 337–348, 2014, doi: 10.1016/j.gloenvcha.2013.11.018.

[7] C. A. Grady, S. C. Weng, and E. R. Blatchley, "Global potable water: Current status, critical problems, and future perspectives," in *Handbook of Environmental Chemistry*, D. Barcelo and A. G. Kostianoy, Eds. Springer, 2014.

[8] B. Benito, Ú. Faura, M. D. Guillamón, and A. M. Ríos, "The efficiency of public services in small municipalities: The case of drinking water supply," *Cities*, vol. 93, pp. 95–103, 2019, doi: 10.1016/j.cities.2019.04.016.

[9] B. B. Ashagre *et al.*, "Integrated modelling for economic valuation of the role of forests and woodlands in drinking water provision to two African cities," *Ecosyst. Serv.*, vol. 32, pp. 50–61, 2018, doi: 10.1016/j.ecoser.2018.05.004.

[10] M. Rusca, A. S. Boakye-Ansah, A. Loftus, G. Ferrero, and P. van der Zaag, "An interdisciplinary political ecology of drinking water quality. Exploring socio-ecological inequalities in Lilongwe's water supply network," *Geoforum*, vol. 84, pp. 138–146, 2017, doi: 10.1016/j.geoforum.2017.06.013.

[11] C. Pahl-Wostl, P. Jeffrey, N. Isendahl, and M. Brugnach, “Maturing the New Water Management Paradigm: Progressing from Aspiration to Practice,” *Water Resour. Manag.*, vol. 25, no. 3, pp. 837–856, 2011, doi: 10.1007/s11269-010-9729-2.

[12] H. T. Aboelnga, L. Ribbe, F. B. Frechen, and J. Saghir, “Urban water security: Definition and assessment framework,” *Resources*, vol. 8, no. 4, pp. 1–19, 2019, doi: 10.3390/resources8040178.

[13] A. Jägerskog, A. Swain, and J. Őjendal, “Introduction: Water Security – Origin and Foundations,” *Water Secur.*, vol. 1, pp. 1–18, 2014.

[14] C. Cook and K. Bakker, “Water security: Debating an emerging paradigm,” *Glob. Environ. Chang.*, vol. 22, no. 1, pp. 94–102, 2012, doi: 10.1016/j.gloenvcha.2011.10.011.

[15] K. Bakker, “Water security: Research challenges and opportunities,” *Science (80-.).*, vol. 337, pp. 914–915, 2012.

[16] SWP, “What is Water Security?” https://www.swpwater.org/what-is-water-security/ (accessed Feb. 09, 2021).

[17] M. Falkemark, “Learning to balance competing water interests,” *www.waterworld.com*, 2002. https://www.waterworld.com/drinking-water/article/16201434/learning-to-balance-competing-water-interests (accessed Feb. 09, 2021).

[18] G. B. Simpson and G. P. W. Jewitt, “The development of the water-energy-food nexus as a framework for achieving resource security: A review,” *Front. Environ. Sci.*, vol. 7, pp. 1–9, 2019, doi: 10.3389/fenvs.2019.00008.

[19] K. Proctor, S. M. H. Tabatabaie, and G. S. Murthy, “Gateway to the perspectives of the Food-Energy-Water nexus,” *Sci. Total Environ.*, vol. 764, p. 142852, 2021, doi: 10.1016/j.scitotenv.2020.142852.

[20] M. Dalla Fontana, F. de A. Moreira, G. M. Di Giulio, and T. F. Malheiros, “The water-energy-food nexus research in the Brazilian context: What are we missing?,” *Environ. Sci. Policy*, vol. 112, pp. 172–180, 2020, doi: 10.1016/j.envsci.2020.06.021.

[21] UN Water, “SDGs Interactive Map,” 2017. https://sdg6data.org/maps (accessed Feb. 09, 2021).

[22] C. Tortajada and A. K. Biswas, “Achieving universal access to clean water and sanitation in an era of water scarcity: strengthening contributions from academia,” *Curr. Opin. Environ. Sustain.*, vol. 34, pp. 21–25, 2018, doi: 10.1016/j.cosust.2018.08.001.

[23] WHO; UNICEF, “Progress on Sanitation and Drinking Water: 2015 Update and MDG Assessment,” Geneva, 2015. doi: 10.1007/s13398-014-0173-7.2.

[24] BPS, “Statistik Kesejahteraan Rakyat 2019 (Welfare Statistics 2019),” Jakarta, 2019. [Online]. Available: https://www.bps.go.id/publication/2019/11/22/1dfd4ad6cb598cd011b500f7/statistik-kesejahteraan-rakyat-2019.html.

[25] R. N. Gejl, M. Rygaard, H. J. Henriksen, J. Rasmussen, and P. L. Bjerg, “Understanding the impacts of groundwater abstraction trough long-term trends in water quality,” *Water Res.*, vol. 156, no. 2019, pp. 241–251, 2019.

[26] A. Menció and J. Mas-Pla, “Influence of groundwater exploitation on the ecological status of streams in a Mediterranean system (Selva Basin, NE Spain),” *Ecol. Indic.*, vol. 10, no. 2010, pp. 915–926, 2010.

[27] S. S. Sayre and V. Taraz, “Groundwater depletion in India: Social losses from costly well deepening,” *J. Environ. Econ. Manage.*, vol. 93, no. 2019, pp. 85–100, 2019.

[28] BPS, “Statistik Kesejahteraan Rakyat 2018 (Welfare Statistics 2018),” Jakarta, 2018.

[29] BPPSPAM, “Buku Kinerja PDAM 2017 (the performance report of the public water service providers in 2017),” Jakarta, 2017. [Online]. Available: http://sim.ciptakarya.pu.go.id/bppspam/assets/assets/upload/BUKU_Lap_Kinerja_PDAM_2017_FA.pdf.

[30] R. A. K. Roekmi, L. H. Chua, and K. Baskaran, “Analysing piped water service provider performance based on consumer perceptions,” *Util. Policy*, vol. 55, pp. 79–89, 2018, doi: 10.1016/j.jup.2018.09.011.

[31] M. R. Karim, M. Z. I. Bashar, and M. A. Imteaz, “Reliability and economic analysis of urban rainwater harvesting in a megacity in Bangladesh,” *Resour. Conserv. Recycl.*, vol. 104, pp. 61–67, 2015, doi: 10.1016/j.resconrec.2015.09.010.

[32] J. Song, M. Han, T. il Kim, and J. eun Song, “Rainwater harvesting as a sustainable water supply option in Banda Aceh,” *Desalination*, vol. 248, pp. 233–240, 2009, doi: 10.1016/j.desal.2008.05.060.

[33] BPS, “Statistik Lingkungan Hidup Indonesia 2017 (Statistics of Environmental 2017),” Jakarta, 2017. [Online]. Available: https://www.bps.go.id/publication/2017/12/21/4acfbaac0328ddfcf8250475/statistik-lingkungan-hidup-indonesia-2017.html.

[34] N. J. Kolavani and N. J. Kolavani, “Technical feasibility analysis of rainwater harvesting system implementation for domestic use,” *Sustain. Cities Soc.*, vol. 62, p. 102340, 2020, doi: 10.1016/j.scs.2020.102340.

[35] M. Semaan, S. D. Day, M. Garvin, N. Ramakrishnan, and A. Pearce, “Optimal sizing of rainwater harvesting systems for domestic water usages: A systematic literature review,” *Resour. Conserv. Recycl. X*, vol. 6, p. 100033, 2020, doi: 10.1016/j.rcrx.2020.100033.

[36] U. Nachshon, L. Netzer, and Y. Livshitz, “Land cover properties and rain water harvesting in urban environments,” *Sustain. Cities Soc.*, vol. 27, pp. 398–406, 2016, doi: 10.1016/j.scs.2016.08.008.

[37] The World Bank, “PAMSIMAS : Responding to the Water and Sanitation Challenges in Rural Indonesia,” Jakarta, 2014. [Online]. Available: http://documents1.worldbank.org/curated/en/938961468195535278/pdf/101178-WP-P085375-PUBLIC-Box393259B-PAMSIMAS.pdf.

[38] S. Yalegama, N. Chileshe, and T. Ma, “Critical success factors for community-driven development projects: A Sri Lankan community perspective,” *Int. J. Proj. Manag.*, vol. 34, no. 4, pp. 643–659, 2016, doi: 10.1016/j.ijproman.2016.02.006.

[39] BPS, “The Percentage of Population Living in Urban Areas by Provinces (2010-2035),” 2020. https://www.bps.go.id/statictable/2014/02/18/1276/persentase-penduduk-daerah-perkotaan-hasil-proyeksi-penduduk-menurut-provinsi-2015---2035.html (accessed Feb. 15, 2021).

[40] PERPAMSI, “Daftar Anggota PERPAMSI (The Member of Indonesian Drinking Water Company Association),” 2018. https://perpamsi.or.id/page/view/8/anggota-biasa1 (accessed Feb. 22, 2021).

Chapter 2

Literature Review

2.1. Current Issues in the Domestic Water Provision

2.1.1. Limited Resources for Continuously Growing Demands

Imbalance situation between supply and demand side in the domestic water provision is currently becoming a global concern [1]. To specify, in 2018 the United Nation reported that three out of ten of global population lack access to safely managed drinking water service [2]. Besides, it is reported that 844 million people lack a basic water service and 2.1 billion lack safely managed water source [3]. Indeed, increasing population growth is suspiciously subjected as the main cause of this situation since water is the absolute needs that is irreplaceable while the availability of fresh water is theoretically considered as a limited substance [4]. Then, this situation is also worsened by the exacerbating events such as climate changes, natural disasters, sociopolitical conflicts, etc.

Furthermore, in the regional context (southeast and east Asia), WHO noted that more than half of the people who are not using improved drinking water facilities live in China followed by Indonesia (26%) [5] as is illustrated by figure 2.1. To define, the improved drinking water sources are those which by nature of their design or construction have the potential to deliver safe water. In detail, the improved drinking water facility is classified into three categories, which are safely managed, basic, and limited. The safely managed water service should be accessible on premises, available when needed, and contamination free. If the improved source does not meet these criteria but needs 30 minutes or less to collect water, it is categorized as a basic service. If the water collection time exceeds 30 minutes, it is categorized as limited service [6].

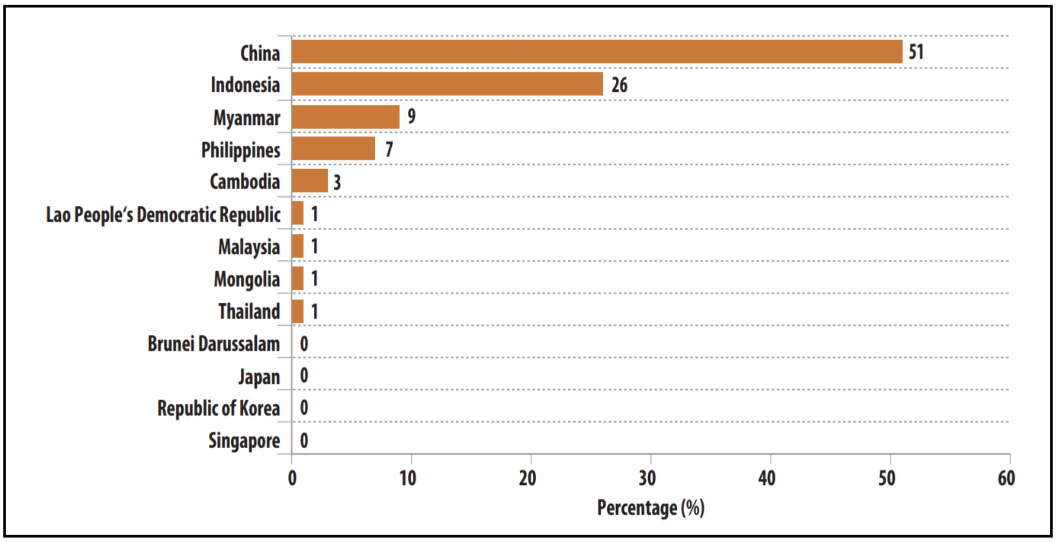


Figure 2.1 Distribution of population in the Southeast and East Asian countries who are not using improved drinking water sources in 2015 [Source: [5]]

Indeed, providing a reliable public water service is a big challenge especially in terms of technical and institutional arrangement. The core problem from the technical perspective is providing daily water need sufficiently for continuously growing population while the consumable water source is considered as a finite substance. Figure 2.1, for instance, reflects that countries with big population (e.g., China and Indonesia) must struggle to provide this basic need. This is the consequence of the nature of water need fulfillment that should be provided for every person per day. Thus, bigger population means bigger effort should be paid. Moreover, the report [5] also highlighted the wide disparity between rural and urban areas in the issue of pipe water service coverage along with the issue of economic and social inequality that appears in the societies.

Moreover, the supply of water essentially depends on the natural events that cannot simply separated from hydrology cycle [7]. In this regard, climatic situation and geomorphological characteristics of a certain location play an important role to determine the availability of the water sources. Nevertheless, the existence of huge water resources does not fully guarantee the water service provider give a reliable service. Indonesia, for instance, is gifted with abundant rainfall rate throughout a year due to its geographical location on the tropical region but is struggling to provide a reliable domestic water service. To illustrate, Samekto and Winata [8] described that annual freshwater availability in Indonesia is around 694 billion m^3 but only 23 percent is utilized to fulfill daily domestic needs, which is far less than the actual demand. Despite its huge quantity, the quality of water resources, especially surface water is also a crucial issue to be managed. Regarding this issue, BPS [9] reported that the Water Quality Index (WQI) in 2018 is 51.01, which slightly decrease compared to the WQI in 2017 (53.20). This score is categorized as the water with marginal quality [10]. Since the surface water is the main source of public water service, the issue the low quality makes the public water service providers must do more efforts to process the raw water source into safely consumable water.

Although its availability is theoretically considered constant, changes in urban landscape caused by human activities might threaten the water sources in terms of quantity and quality. From the perspective of development planning, there is a little intervention could be done for the embedded characteristics to ensure the availability of the water source lasts sustainably. Therefore, this finite water deposits have to be carefully managed to fulfill the demand that naturally keeps increasing as the population grows. On the other hand, more intervention can still be given to the demand side. It can be done by shaping people's behavior toward water consumption through clear regulation or other approaches.

Furthermore, water demand is defined as the total volume of water that would be expected to be used in the city with no supply limitation while water supply is considered as the total volume of formally registered water supplied to cities [11]. However, this literature does not classify informal connections as a part of water supply system.

Subsequently, Akpabio [12] emphasized that subjectivity is often attached in formulating the definition of the domestic water consumption. It depends on personal perception and cultural tradition attached to individuals or societies. Furthermore, many factors such as socioeconomic background, cultural habits, and so forth are highlighted as influential element determining the water consumption pattern [13][14]. Thus, it can be concluded that water demand does not entirely reflect the actual consumption pattern. Nevertheless, calculating current demand and future projection is still needed in the context of development planning. Otherwise, a misleading calculation causes under estimation implicating insufficient water provision or over estimation that requires inefficient budget allocation. In the operational definition, some literatures express the water demand using the term minimum water requirement. Table 2.1 summarized several definitions of the minimum water requirement that are suggested by literatures. Besides, the minimum water requirement standardized by some institutions in Indonesia are also listed in the table.

Table 2.1 The minimum water requirement suggested by literatures

Literature, year	Suggested amount of minimum water requirement (Liters per person per day)	Remarks
Gleick (1996) [15]	50	The literature suggested 50 Liter of water to fulfill human's basic needs which consist of 5 Liters for drinking, 10 Liters for cooking and 15 Liters for bathing, and 20 Liters for sanitation uses.
BSN[4] (2002) [16]	100 or 150 or 250	The suggested amount of minimum water requirement is classified into three categories based on the spatial characteristics: • 100 Liters per person per day for the rural areas. • 150 Liters per person per day for the city with less than one million population. • 250 Liters per person per day for the city with one million population or more.
Howard and Bartram (2003) [17]	5 to 100	The literature classified the domestic water fulfillment per person per day as follows: • Below 5 Liters is categorized as no access. • 20 Liters is categorized as basic access.

[4] BSN stands for Badan Standarisasi Nasional (National Standardization Board)

		• 50 Liters is categorized as intermediate access. • 100 Liters is categorized as optimal access.
Kemendagri[5] (2006) [18]	60 (or 10 m^3 per household per month)	The minimum water consumption that is suggested for setting the block tariff concept. The progressive tariff will be applied for the consumers who exceed the suggested amount of water consumption.
Kemen PU[6] (2007) [19]	144	The literature reported the average domestic water consumption resulted from the household survey that was conducted in 8 provinces in Indonesia (i.e., Sumatera Utara, Bengkulu, Jakarta, Jawa Tengah, Jawa Timur, Kalimantan Timur, Nusa Tenggara Timur, and Papua).
Reed and Reed (2013) [20]	70	The literature suggested the minimum water requirement in emergencies. It classified the water need based on the utilization: • 10 Liters for drinking • 20 Liters for cooking • 30 Liters for personal washing • 40 Liters for washing clothes • 50 Liters for cleaning home • 60 Liters for growing food • 70 Liters for sanitation
Singh and Turkiya (2013) [21]	117	The average minimum amount of water requirement in rural area India resulted from the household survey.

Although the actual water demand of a certain community subjectively depends on various variables (e.g., habit, culture wealth, etc.), table 2.1 is useful to roughly estimate the supply. Practically, the supply can be estimated by multiplying this suggested volume with the population. Then, the data on the existing population trend can be projected to estimate the minimum water requirement in the future. In this regard, the availability of the population data is essential to project the future trend. Indeed, the longer recorded period will generate the better projection implicating on the more precise estimation one the minimum water requirement. The following section will elaborate the methods to estimate the population projection.

[5] Kemendagri stand for Kementerian Dalam Negeri (The Ministry of Internal Affair)
[6] Kemen PU stands for Kementerian Pekerjaan Umum (The Ministry of Public Works)

2.1.2. Determining the Minimum Water Requirement

Population projection is traditionally defined as an extrapolation of historical data on population into the future trend. Regarding this issue, Wang and vom Hofe [22] identified that there are generally three types of population projection methods. They are trend extrapolation, cohort-component, and structural method. The trend extrapolation method starts with observing the existing trend then projects the future trend by following the graphical tendency whether the pattern is linear, geometric, parabolic, logistic, and so forth. Therefore, this method relies very much on the historical data and is suitable for the case of small areas where disaggregated population statistics are not always available. On the other hand, the cohort-component method requires population data in more detail aspects such as age, gender, population distribution, and others since this method aims to elaborate whether natality or migration is more influential to the population growth [23]. Different from the two aforementioned methods, the structural methods evolved when non-demographic factors such as employment, income, land use, mobility, and so forth were supposed to involved in population projection to respond to the nature of complexity and uncertainty.

Furthermore, population projection takes an important role in the perspective of the development planning process. This is because planning always deals with the future implications of the present actions [24]. Planning does not only anticipate future demand but also manages the issue of resource scarcity. In its relationship with the domestic water issues, the population projection is also an essential element in managing water provision as well as water-related infrastructure planning [25], [26], [27]. Moreover, the issue of the domestic water provision becomes more complex and challenging because of its multi-dimensional involvement such as economic inequality [28][29], spatial entity [30][31], and climate change [32].

In the context of Indonesia, the issues related to population projection officially belongs to the government domain, which is managed by the government statistics agency (BPS). Specifically, BPS [33] recognized two types of projection calculation, which are mathematical and component projection method. The mathematical projection method is estimating the population projection assuming the population growth rate is constant. There are three types of the mathematical projection method. They are arithmetic, geometric, and exponential method. The formula of the arithmetic method is presented in the equation 2.1 while the formula of geometric and exponential methods is respectively presented in the equation 2.2 and equation 2.3.

$$P_t = P_0(1 + rt) \text{ ; and } r = \frac{1}{t}(\frac{P_t}{P_0} - 1) \quad \text{(eq. 2.1)}$$

$$P_t = P_0(1 + r)^t \text{; and } r = \left(\frac{P_t}{P_0}\right)^{\frac{1}{t}} - 1 \quad \text{(eq. 2.2)}$$

$$P_t = P_0 e^{rt} \text{; and } r = \frac{1}{t} ln\left(\frac{P_t}{P_0}\right) \quad \text{(eq. 2.3)}$$

Where, Pt = Projected population at year

P_0 = Population in the initial year as a basis of projection

r = population growth rate

t = period of the projection (in years)

e = the basis of the natural logarithm (2.7182828)

Meanwhile, component method refers to the understanding that the population change in a certain area is the accumulation of the natural population growth (natality and mortality) and the population changes due to migration. Indeed, this method can reflect the demographic trend more realistically, but this method requires more detail data explaining the occurrence. The component method is basically expressed by equation 2.4.

$$P_t = P_0 + (N - M) + (Mig_{in} - Mig_{out}) \qquad \text{(eq. 2.4)}$$

Where, Pt = Projected population at year

P_0 = Population in the initial year as a basis of projection

N = Natality

M = Mortality

Mig_{in} = In-migration

Mig_{out} = Out-migration

Despite benefits and drawbacks offered by respective projection method, this research employed the mathematical method instead of the component method due to data availability. The annual statistical report launched by the government does not explicitly publish data required by the component method. That is why the mathematical method was chosen. Furthermore, the population projection would be utilized to set the estimated domestic water requirement. We set the estimated water requirements by multiplying the population projection with the suggested amount of daily water requirement as are listed in table 2.1.

2.1.3. Public Preferences in the Domestic Water Utilization

Current dynamics of supply-demand mechanism in the domestic water fulfillment cannot be simply divorced from the issue of the public preference. The public preference as well as satisfaction plays an important role in the issue of the domestic water provision. For example, if people do not prefer using public water service provided by the government, a big investment to develop the domestic water infrastructures will be less useful. By contrast, if all residents demand public water service, the government must develop more reliable water service provision system, which requires a huge investment. Indeed, this phenomenon rarely appear in the countries whose domestic water provision system have been settled and able to give a reliable service with a high satisfaction level.

Furthermore, people develop their preference for a certain product or service because of various factors, which can come from internal or external triggers. Many studies have been done to investigate the factors that influence people's preference related to drinking water. For instance, Abubakar [34] assessed whether variables such as place of residence, geopolitical zone, household wealth and education level affect their preference for drinking water fulfillment, especially related to public standpipe facilities. This research was conducted in Nigeria using the chi-square and logistic regression methods. This study found that the distance to public water standpipes strongly affected the utilization of this facility and the community's willingness to pay for water. However, the respondents' education level did not really affect the choice of their drinking water source while poverty significantly correlated to unimproved drinking water. A similar tendency also occurred in Accra, Ghana, which was studied by Vasquez and Adams [35]. Different from the previous study, this research found that the respondents were not sensitive to the distance of standpipes to their house but to the time spent for queuing. Although having similarity in the absence of piped water networks, household preferences in the Mekong Delta, Vietnam were strongly determined by season [36] . This is plausible because they rely very much on rainwater to fulfill their water needs.

Furthermore, Li, et al. [37] took Singapore as a case study to explore factors driving household drinking water choice. They used multivariable regression analysis to assess household social-economic characteristics and their relation to drinking water preference. The study showed that bottled water is less preferred among respondents with non-professional and self-employment backgrounds. Nevertheless, the awareness that bottled water is more expensive and causes greater environmental damage was only found among respondents who had a higher education level and smaller family size. For further exploration, we listed more studies in the issue of the public preferences of domestic water utilization in table 2.2.

Table 2.2 Literatures discussing the issue of factors determining public preferences in the domestic water fulfillment

Author(s), Year	Study Area	Applied Methods	Assessed Factors	Results
Abubakar (2019) [34]	Nigeria	Descriptive and inferential statistics (n=38,459)	Socioeconomic, location, and demographic factors.	The borehole is the most utilized water source that equally split between rural and urban areas. Poorer households tend to use surface water while richest households mostly use borehole.
Vasquez and Adams (2019) [35]	Urban settlement in Accra, Ghana	Generalized multinomial logistic model (n=344)	Water price, public water service, household socio-demographic background.	Respondent has the willingness to pay in a certain amount of water price that is directly proportional to their

				income. However, the willingness to pay varied following accessibility, availability, and quality of water service.
Li et al (2016) [36]	Rural areas of the Mekong Delta, Vietnam	Descriptive statistics and regression analysis (n=384)	Demographics, socioeconomics, preferred water source, willingness to pay on the consumed water source.	Household's willingness to pay is highly influenced by the season. The respondents tend to have more willingness to pay on the dry season since they prefer to use private water sources or surface water in the rain season.
Li et al, (2019) [37]	Singapore	Principle Component Analysis (n=1000)	Household demographic, social, and economic characteristics. Household knowledge of water bills, water conservation, and perception of the existing water service.	Respondents who have higher income with smaller family sizes less believe that bottled water is safer than tap water. Meanwhile, more educated respondents have more concerned about environmental issues related to bottled water consumption.
Gross and Elshiewy (2019) [38]	Rural areas of Benin	Discrete choice model (n=1988)	Water price, distance to the water source, subjective water quality, household wealth, household size, education, and gender of the household head.	Water price, distance to the water source, and the subjective water quality are relevant for the water source choice. Price is negatively correlated to the quantity demand.
Rahut et al (2015) [39]	Bhutan	Assessing secondary data from Bhutan Living Standard Survey 2003 (n=4,007), 2007 (n=9,798) and 2012 (n=9,998) using multinomial logistic model	Demographics, consumption expenditure, housing, employment, health status, fertility, education, access to public facilities and services, price of commodities, and ownership of assets.	Older people tend to choose pipe in their dwelling while younger ones' preference is using public tap as their water resource. The level of education correlates positively with the tendency of using private pipe water and household head gender has no significant influence on the choice of water source.

Generally, these aforementioned studies found that the public preferences are triggered by two factors, which are internal and external factors. Internal factors are related to the individual's background such as socioeconomic background. On the other hand, external factors are elements beyond the individuals such as the availability of supporting facility, service quality, laws regulating the water utilization, etc. Following this theoretical framework, we defined the internal and external factor that could significantly influence the public preference in our case study area. We relate the internal factor with the respondent's education, occupation, family size and monthly income. Presumably, education and occupation represent the respondent's knowledge and awareness on the current issue of domestic water provision. Meanwhile, the family size could represent the respondent's water requirement and income could represent the respondent's ability to pay on the domestic water service. Furthermore, the existence of the piped water network is assessed as an external factor that potentially directs the respondent's opinion on their current domestic water fulfillment. Furthermore, to differentiate with the studies listed in table 2.2, we employ the Correspondence Analysis to investigate factors influencing the respondent's domestic water choice in our case study area. Further discussion on this issue will be presented in the methodology chapter.

2.2. The Paradigm-Shifting in Urban Water Management

2.2.1. From Supply-side to Demand-side Management Approaches

Various strategies have been developed to ensure sufficient water provision by managing the supply-demand interaction of this basic need. Previously, strategies that were developed were dominated by the supply-side management approach, which focused on increasing the efficiency of water supply in the production, transportation, and distribution stages [40]. The amount of required water is usually estimated by projecting future needs using statistical calculation techniques. Subsequently, water service providers produce the required quantity and manage the distribution of the water. This requires advanced technology, implying large investments [41]. Regarding the financial issue, some water development projects show a huge investment required to deliver drinking water service on premise. For example, Nepal required USD 11.684 million to develop infrastructures and supporting facilities to provide basic water supply service for 90,397 households in 2012 [42]. The Indonesian government, in particular, allocated IDR 950 billion (approximately equal to USD 63.780 million) to expand the water pipelines targeting for 290,000 households in 2018 [43]. Not only is a big investment required, but also the issue of domestic water provision becomes more complicated when the big investment appears along with various interests [44].

Moreover, supply-side management is also vulnerably dependent on variables such as climate change, which is now becoming increasingly unpredictable [45]. The nature of the supply-side management approach, which concentrates more on ensuring the sufficient supply, urge the water service providers to seek reliable water sources in terms of their quality and quantity. Unfortunately, current trend on the water-related climate events such as precipitation rate and frequency, sea level rise, etc. degrade the availability and the quality of the water sources. Then, it is worsened by the anthropogenic causes such as conflicting interests on the water resources, pollution, land use changes, and so forth.

On the other hand, the demand-side management approach was developed after the supply-side management approach turned out to be unable to comprehensively respond to the current dynamics. Unlike the supply-side management, demand-side management prefers intervening in people's consumption behavior to optimize available water sources rather than increasing production capacity to maximize water supply [46]. This intervention can be done through various instruments, such as education campaigns, block tariffs, water reuse, and so forth [47]. On top of that, clear guidance and firm regulations are required to ensure the methods are well applied.

Furthermore, the demand-side management approach also considered multi-stakeholder participation rather than one directional relationship between the water service provider and the users. Akhmouch and Correia [48], for instance, emphasize the importance of various stakeholders' involvement through the 3P (places-peoples-policies) approach in water resource management. This approach is proposed by OECD (The Organization for Economic Co-operation and Development) and is considered as a framework to respond to current challenges in the public water provision [49],[50]. Integrating the three mentioned elements in the public water provision is the keyword in this framework. The three factors are important since policy, people, and places are interlinked and are not mutually exclusive. To describe their interlinked correlation, the domestic water provision aims to fulfill people's basic needs by providing sufficient infrastructure, which is encapsulated by public policy and is installed on people's place of living. Essentially, this approach is based on the principle that no one best solution to deal with water-related issues exists but context-dependent alternatives must be formulated. This concept promises a better approach in managing water issues, even though at the implementation stage the issue becomes more complicated.

In the implementation level, one of the models that is in line with the 3P concept has been proposed by Leigh and Lee [51]. They suggest a triangular model of urban water sustainability. Through this model, three important elements, namely infrastructure, users, and provider, are integrated to manage urban water more sustainably. Referring to the 3P approach, these three elements can be associated with places, people, and policies, respectively. Furthermore, the triangular model of urban water sustainability sets the ultimate goals for the development of each element. For example, the development of infrastructure specifically has the ultimate goal of providing equitable access and cost of water service while increasing the users' awareness is expected to increase supply efficiency. On the other hand, strengthening the service provider is expected to make it possible to help solve water resource conservation issues.

Moreover, supply-side and demand-side management should not be seen as mutually exclusive although a study by Katz [52] has shown that there is a negative correlation between supply-side and demand-side management when they are concurrently applied. Both supply-side and demand-side management approaches can be integrated when their respective portions are properly designated. The supply side of the domestic water provision can be strengthened by developing facilities that enable to fully suffice the public needs. Simultaneously, programs to educate the users as well as to raise their awareness should not be overlooked.

2.2.2. From Centralized to Decentralized Water Service

Domestic water provision is a sector that was previously dominated by the centralized approach. This is understandable since the water source is traditionally recognized as the public good. Nevertheless, this categorization is shifting along with the extension of the criteria to classify a certain good rather than merely a dichotomy between public and private goods. The current classification of the goods is defined into four criteria based on the characteristics of the rivalry and excludability to consume a certain good. Then, the classification is arranged in a matrix as is illustrated by the following figure.

	Excludability	Non-Excludability
Rivalry	Private goods	Common-pool resources
Non-Rivalry	Club goods	Public goods

Figure 2.2. The classification of the goods (modified from : [53])

Figure 2.2 illustrates the classification of the goods based on their characteristics of rivalry and excludability when they are consumed. For example, public goods are characterized by non-rivalry and non-excludable. Non-rivalry means that more than one person can consume the good (either at the same or different time) without diminishing others' ability to use it. Meanwhile, non-excludable means the provider of the good is unable to restrict other consumers to use the good. Streetlamps is one of the examples that can explain this definition more clearly. Thus, everybody can consume the streetlamps without disturbing anybody else's opportunity to consume the same lamps at the same time. On the opposite quadrant, there are private goods, which are characterized by rivalry and excludable. It means that once a person consumes his or her private goods (e.g., clothes, foods, private vehicles, private house, etc.), nobody can consume the same goods at the same time.

Furthermore, between the two extreme poles (i.e., public, and private goods), there are club goods and common-pool resources. The former refers to the good that are non-rivalry but excludable. Movie cinemas and cable TV can be categorized in this group since the customers can enjoy the products without diminishing other consumer's opportunity to access the same products. However, the producers can exclude a person who do not subscribe or pay for the products. Public transport can also be classified into club good in spite of the word "public" as an adjective. On the other hand, common pool resources are the goods that are rivalry but non-excludable. Natural resources such as fish stocks or and water resources can be taken as an example of this type of good since once those resources are consumed by a person, nobody else can consume them but the nature cannot exclude the unintended consumers. Up to this point, former assumption that categorize water resources (including groundwater sources underneath the private property) as the public good (or the private good) is supposed to be revisited.

Moreover, the new perspective to classify the water resource will affect to the paradigm-shifting to manage this natural resource. Managing water resources under the perspective of the public good is likely no more relevant. This is true that the water sources are provided by nature and nobody can be excluded to consume. Nevertheless, once a person individually exploits the water resource, he or she will reduce somebody else's opportunity to consume water at equal level of quantity and quality as well as at the same time. Therefore, it must be regulated by authorized bodies i.e., government organizations. In this case, the centralized approach is considered as an effective way to manage the water source as well as to provide public water service. However, its efficiency is getting questionable due to the issue of a big investment required. Besides, as the complexity in the societies tends to increase, the centralized approach is becoming less efficient to be implemented.

The emergence of the decentralized approach in the domestic water sector is an alternative to overcome problems that cannot be managed by the centralized approach. Currently, the centralized approach, which is commonly delivered by supply-side management, is likely unable to respond the dynamics in the domestic water issues that are more complicated involving various interests. Therefore, involving communities is important instead of state-centered decision-making process. This alternative can be more efficient to be formulated if there is responsibility sharing that defines 'who is doing what' in the water resource management. From this point of view, the decentralized approach is promising due to its smaller scale of the problem and complexity.

2.2.3. Introducing the Circular Economic Concept in the Domestic Water Provision

Along with the introduction of the decentralized approach, it is also important to involve local context to formulate improvement strategies in domestic water sector [54]. Global phenomena that currently appear can be taken as an insight to be scaled down and suited to the local issue. Then, the approach can even be taken from other fields beyond water-related discipline such as the circular economy concepts. To elaborate, the circular economy concept has been well promoted in industrial sectors. The rising awareness on limited resources to respond increasing demand has shifted the paradigm from linear, which apply exploit-produce-dispose model, to circular model, which is more restorative and regenerative [55]. Therefore, circular economy concept strongly emphasizes on the efficiency of the resource utilization to overcome the problem of limited resource and growing demand [56]. In the circular economy concept, environmental or resource problems can be managed not only by technological advancement but also trough efficient allocation [57]. Besides, studies exploring the role of public sectors in the circular economy focused on regulating the transition while few of them discuss the issue in the context of the organizational level [58]. Meanwhile, Scarpellini et al. [59] suggested that the economic and social benefits gained from the circular economy activities are more effective when it is implemented at the regional level.

Moreover, the emergence of the circular economy concepts is caused by raising awareness on imbalance supply-demand mechanism in various sectors that is exacerbated by unpredicted events such as climate change. The essential characteristic of the circular economy that keeps products and materials within productive use as long as possible. When they reach end of use, they are cycled back into the system [60]. To apply this approach, [55] suggested three main steps. They are justifying the starting point and focus, assessing opportunities, and analyzing the implications.

In spite of the fact that many studies reporting the merits of the circular economy concept in the field of the commercial enterprises [61] [62], the concept is rarely discussed for the nonprofit public sector such as public water service and faced big challenges to be implemented in this sector [63]. A study by Merli et al. [64], for example, concludes the circular economy is a subject that is a rapid development. Their finding shows industrial waste management and metallurgy are two sectors that are dominantly studied while water sector is far less dominant compared to them. Moreover, a structured review by Morceletto [65] recognized that existing targets of the circular economy, which were documented by worldwide publications, are concentrated on the aspect of recycling, recovery, and resource efficiency. Paradoxically, the tendency of limited resources and continuously increasing demand in domestic water sector is something obvious but few studies discussing the potential of the circular economy concept implementation to overcome the dilemma in domestic water provision. Besides, the targets [65] are very useful to be utilized as a benchmark of the satisfying water provision as well as of the sustainable water management.

2.3. The Domestic Water Provision in the Context of Indonesia

2.3.1. Current Achievement on the Domestic Water Provision

In 2019 the Badan Pusat Statistik (Central Bureau of Statistics—BPS) recorded that 89.27% of households in Indonesia have already had access to decent drinking water [66]. Not only that, but Indonesia has been noticed by WHO and UNICEF as a country that successfully achieved 90 percent of accessing drinking water at the basic level [67]. Moreover, the World Bank also reported a significant improvement in the Indonesian domestic water sector. In 2018, It is recorded that 73% of households have access to decent water sources while in 1994 the percentage is only 34% [68]. However, this report also suggested that Indonesia's current achievement is the lowest compared to other countries in Southeast Asia such as the Philippines, Vietnam, Malaysia, and Thailand, which achieve more than 90% in the case of access to water.

Admittedly, the data shows a significant improvement in the Indonesian domestic water sector. However, a critical review can be posed to the data if they are broken down into more specific issue on the types of domestic water sources. The data [66] shows that the domestic water consumption is still dominated by the individual groundwater use i.e., individual dug wells or boreholes while public water service provided by the government only share a small percentage (in more detail, the data is presented in table 1.1 on chapter 1).

Moreover, there has been a significant change in the type of water source to fulfill the potable needs. Figure 2.3 illustrates changes in the composition of domestic water source utilization recorded by BPS from 2000 to 2016. In the 2000, most of households relied on individual groundwater sources to fulfill their potable needs such as drinking and cooking. It was recorded that the dug well utilization (both protected and unprotected) reached about 50% and the use of individual boreholes was nearly 15%. At the same period, the households who utilize pipe water service was around 20%. Besides, the bottled water consumption for potable purposes was still invisible in this period. Nevertheless, the composition of the domestic water utilization drastically changes since 2006, especially for the bottled water consumption. In 2016, bottled water use for potable purposes shares the highest percentage over other types of domestic water sources. It was recorded that more than 30% of households consumed bottled water for potable uses in this period. Meanwhile, decreasing trend occurs in the case of protected and unprotected dug well and tap water whereas the percentage of households who use individual boreholes undergoes a fluctuating trend.

On one hand, the decreasing trend on the individual groundwater use is exhilarating. On the other hand, the same tendency on the tap water utilization remains questions regarding the development of the public water service as well as the public preferences for domestic water use. First, the development of the public water service through pipeline-based is probably unable to balance the population growth so that the percentage is getting less as time goes by. Second, the households that formerly subscribed the pipe water service and consumed it for potable uses shift to other drinking water source because they were no longer satisfied by the public water service or individual groundwater abstraction. This assumption is likely in line with the fact that the bottled water consumption drastically increases during the recorded period. Thus, the individual groundwater users change their drinking water source into bottled water instead of public water service.

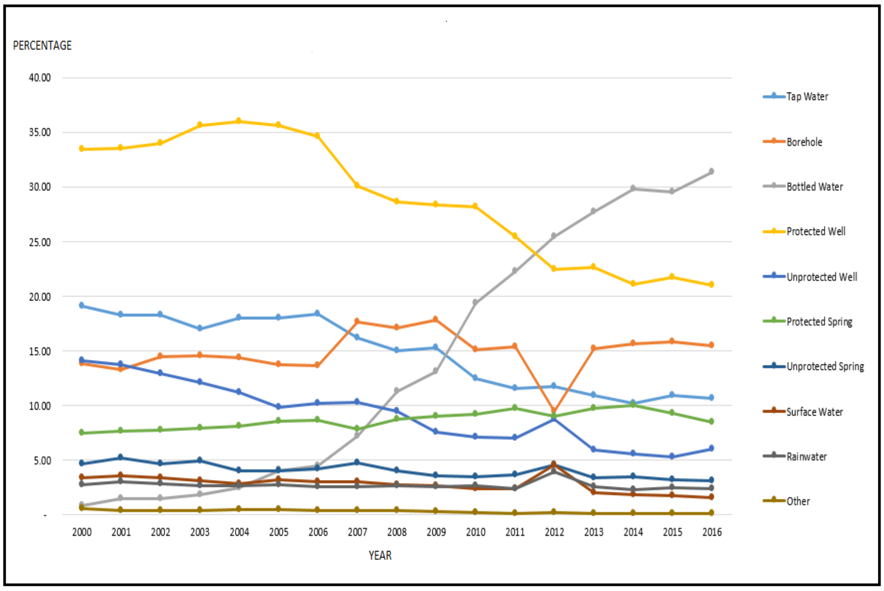


Figure 2.3. Percentage of households in Indonesia and their drinking water sources (2000-2016) (Source: modified from [69])

Furthermore, the shifting of the household's choice on the drinking water source can also be viewed from various perspectives. The existing water sources might be unable to meet the users' expectation, but they are doubting the quality offered by the public water service. From the perspective of the public preference, the good side is that it indicates the appearance of the improvement in the community's socioeconomic background since the bottled water is the most expensive drinking water source compared to the other. Besides, it also implies that people's awareness on the quality of water to drink is increasing. Nevertheless, this alteration might also be viewed as the degradation of the groundwater quality so that the users do not prefer using it anymore.

2.3.2. Challenges and Opportunities to Achieve Universal Access to Safely Managed Water Sources

Big population scattered in thousands of islands is the most challenging situation in dealing with public water service provision in Indonesia. This situation is exacerbated by its unequal distribution. The data [70] shows that the population is concentrated in Jakarta with the density of 15,900 people per square kilometer while the least densely province is West Papua within only 9 people pes square kilometer. Both situations are equally dilemmatic. The highest density certainly demands more supply, which requires more investment. Besides, it also technically difficult to install or expand the pipe network in the crowded areas. On the contrary, the least density areas do not offer economic benefits so that are not attractive to invest even though the technical constraints are not as big as in the densely populated areas.

Aside from the technical constraints, the institutional issue is also dilemmatic in dealing with domestic water provision. While the technical issue deals with technically tangible matters such as accelerating supply-side to equilibrate demand-side or maintaining the quality of the water, the institutional issue has to deal with intangible matters such as managing a reliable service within effective organization or educating people to use the water wisely. The institutional arrangements, which can be articulated in the forms of regulations or organizations, are frequently overlooked despite their importance for ensuring a reliable service more sustainably. Regarding this issue, institutional theorists such as [71] suggested that institutions are designed to shape collective actions based on formal and informal rules, norms, and shared strategies. Besides, the nature of water source management, which is commonly categorized as a common pool resource, requires actors who hold various roles and interests to get involved [72]. Furthermore, the shift from large and centralized into small scale and distributed technologies is supposed to be equipped with socio-institutional arrangement for enabling more sustainable water management [73].

Regarding the institutional issues, in Indonesia, the national government still has an important role even though decentralized system is highly promoted since 1998. Regarding drinking water and sanitation, in 2014 the national government has launched the presidential regulation number 185 to accelerate the development of sanitation and drinking water sector. In this regulation, the authority and responsibility to develop sanitation and drinking water sector are distributed to the national, provincial, and local government to accelerate and synchronize the development programs. For the drinking water sector, the ultimate goal to achieve universal access, in terms of quantity, quality, continuity, and accessibility, can be accelerated significantly [74]. Indeed, this rule does not regulate specifically technical matters but general guidance. Because of that, it is essential to follow it up with the more technical plans which can start with understanding supply-demand mechanism in domestic water sector.

2.4. Contextualizing Global and National Issues into the Case Study Area

In the context of Kota Metro, similar tendency that occurs globally and nationally also appears in the local scale. The current data shows that only about 5% of its population utilizes public water service provided by the government of Kota Metro. By contrast, the rest of the population exploit individual groundwater source in their properties. The low service quality performed by the service provider might be subjected as the cause of this occurrence. Therefore, it does not meet the public's expectation and discourage their preference for the public water service. Consequently, people seek other alternatives to fulfill their daily domestic water need instead of public water service delivered by the local government. Combined with the absence of the rules regulating groundwater protection in Kota Metro, this situation leads people to individually exploit groundwater source on their property. Indeed, this is not a pleasant fact in the context of sustainable urban water management and should be well anticipated to prevent worse situation in the future.

Undoubtedly, to increase the service performance requires a big investment that is not affordable for a small city such as Kota Metro. Nevertheless, letting the tendency of individual groundwater exploitation keeps going on can also generate another problem. Environmental degradation is one of the most obvious impacts resulted from the individual groundwater exploitation. Many studies have empirically confirmed the negative impacts of the excessive groundwater abstraction especially for the environmental. Besides, the absence of regular inspection and monitoring on the individual groundwater wells might also threaten the user's health due to pollutants resulted from domestic activities such as wastewater and fecal pollution. That is why, a study related to improvement strategies formulation in dealing with the dilemma in the domestic water fulfillment is required. Kota Metro is one of the examples of the small cities in Indonesia struggling to provide reliable public water service and dealing with the mentioned dilemma. Thus, it is expected that improvement strategies formulation conducted in this research can be replicated on the other locations with necessary contextual adjustments.

In formulating the improvement strategies, we are inspired by the concept of the circular economy, which are intensively proposed for commercial business but have not been widely discussed in the field of the public sector such as domestic water provision. To apply the concept, we followed the stages suggested by Ellen Mac Arthur [55], which are justifying the starting point and focus, assessing opportunities, and analyzing the implications, to generate alternatives of improvement strategies.

Essentially, the current status of domestic water fulfillment in Kota Metro can be set as a starting point while the universal access in domestic water sector [74] [75] can be considered as a target to focus on. Moreover, identified potentials are assessed as opportunities to be exploit as well as a consideration in formulating proposed alternatives. In this regard, identified potentials were synthesized with the desirable targets in the strategy formulation. Afterwards, the implications of the respective alternatives would be analyzed within the point of view of applicability and elements required. To specify, the conceptual framework is illustrated by figure 2.4. The figure schematically illustrates the stages conducted in formulating improvement strategies. The current achievement of domestic water fulfillment in Kota Metro is essential element to be identified to set a benchmark. Besides, public preferences for domestic water utilization, which are discussed in chapter 4 and 5, would also be included as a consideration. Furthermore, universal access to domestic water is set as an ultimate goal to achieve and projected water demand is the instrument enabling to analyze the gap between the current fact and the desirable achievement. Besides, the tendency of individual groundwater exploitation was also considered to be reduced due to environmental conservation.

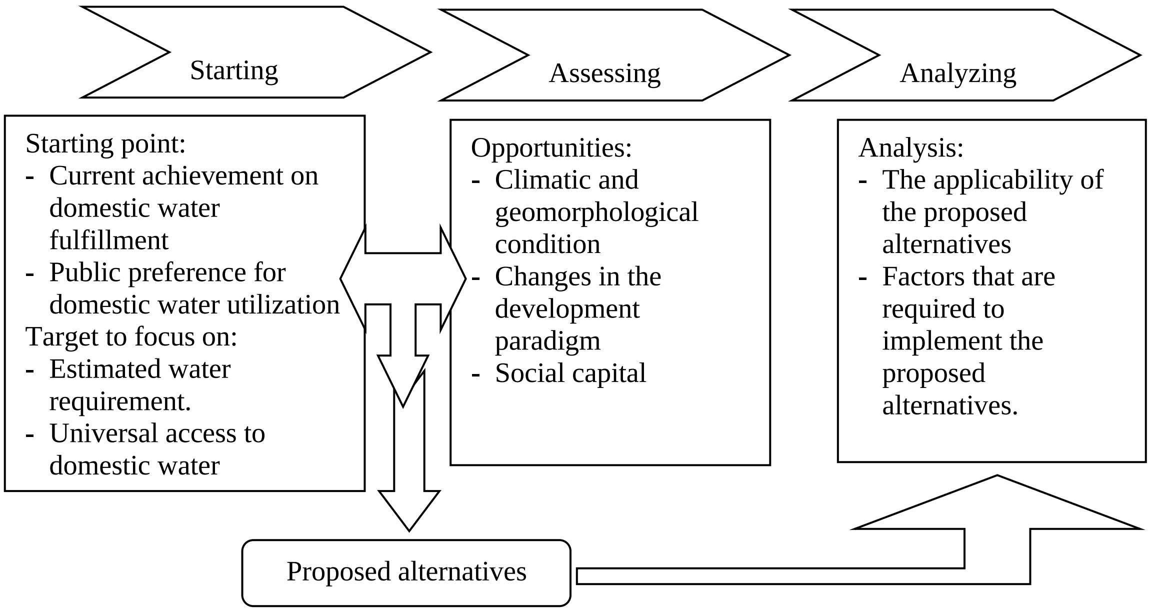


Figure 2.4. The conceptual framework to formulate improvement strategies

Combined with identified opportunities, the starting point and desirable goals are synthesized to formulate suggested alternatives. To specify, the opportunities would be elaborated within various dimensions climatic and physical attributes of Kota Metro as well as the paradigm-shifting of the development regime. In the strategy formulation, these potentials would be utilized to fill the gap between the existing situation and the desired goals. Three approaches are applied in formulating improvement scenarios. They are doing business as usual approach, accelerating pipeline-based water service, and mixing pipeline-based and community-based water service. Those three scenarios are assessed by involving two variables, which are the desirable output and required funding. This is because the trade-off that frequently appears when the two variables involved. A higher expected output certainly requires higher funding. In this research, the optimization model is proposed to set a desirable output within a reasonable funding. Afterwards, exploration to the implemented strategies from other places are also conducted to gain the lessons learning process from them. Besides, this stage is also to elaborate the determinant factors causing such strategies are successful or failed. In the strategy formulation, this stage is important to prevent factors that possibly discourage the implementation of the proposed strategies.

References

[1] UN Water, "The United Nations World Water Development Report 2015: Water for a Sustainable World," Paris, 2015.

[2] United Nations, "The Sustainable Development Goals Report 2018," New York, 2018.

[3] UN Water, "Sustainable Development Goal 6: Synthesis Report 2018 on Water and Sanitation," New York, 2018.

[4] A. Distanont, O. Khongmalai, and R. Rassameethes, "Collaborative triangle for effective community water resource management in Thailand," *Kasetsart J. Soc. Sci.*, vol. 39, no. 2018, pp. 374–380, 2018.

[5] WHO Western Pasific Region, "Sanitation, drinking-water and health: Achievements and challenges ahead," Manila, 2017.

[6] WHO and UNICEF, "The new JMP ladder for drinking water," 2017. https://washdata.org/monitoring/drinking-water (accessed Nov. 11, 2020).

[7] T. Böhmelt, T. Bernauer, H. Buhaug, N. P. Gleditsch, T. Tribaldos, and G. Wischnath, "Demand, supply, and restraint: Determinants of domestic water conflict and cooperation," *Glob. Environ. Chang.*, vol. 29, pp. 337–348, 2014, doi: 10.1016/j.gloenvcha.2013.11.018.

[8] C. Samekto and E. S. Winata, "Potensi Sumber daya Air di Indonesia (Indonesian Water Resource Potentials)," in *Aplikasi Teknologi Air Bersih untuk Kabupaten/Kota di Indonesia*, 2010, pp. 1–20.

[9] BPS, "Statistik Lingkungan Hidup Indonesia 2019: Hutan dan Perubahan Iklim (Environment Statistics of Indonesia 2019: Forests and Climate Change," Jakarta, 2019.

[10] C. Rickwood and G. M. Carr, "Global Drinking Water Quality Index Development and Sesitivity Analysis Report," Ontario, 2007.

[11] M. S. Ahmadi, J. Sušnik, W. Veerbeek, and C. Zevenbergen, "Towards a global day zero? Assessment of current and future water supply and demand in 12 rapidly developing megacities," *Sustain. Cities Soc.*, vol. 61, no. June, 2020, doi: 10.1016/j.scs.2020.102295.

[12] E. M. Akpabio, "Water and People: Perception and Management Practice in Akwa Ibom State, Nigeria," *Soc. Nat. Resour.*, vol. 24, pp. 584–596, 2011.

[13] V. K. Mehta, R. Goswami, E. Kemp-Benedict, S. Muddu, and D. Malghan, "Social Ecology of Domestic Water Use in Bangalore," *Econ. Polit. Wkly.*, vol. 48, no. 15, pp. 40–50, 2013.

[14] L. W. House and J. D. House, "Shifting the timing of customer water consumption," *J. Am. Water Work. Assoc.*, vol. 104, no. 2, pp. E82–E92, 2010.

[15] P. H. Gleick, "Basic Water Requirements for Human Activities: Meeting Basic Needs," *Water Int.*, vol. 21, no. 1996, pp. 81–92, 1996.

[16] BSN, *SNI 19-6728.1-2002 Penyusunan Neraca Sumber Daya Air (Water Balance Arrangement)*. Indonesia, 2002.

[17] G. Howard and J. Bartram, "Domestic Water Quantity, Servive Level and Health," Geneva,

2003.

[18] Kemendagri, *Peraturan Menteri Dalam Negeri Nomor 23 Tahun 2006 tentang Pedoman Teknis dan Tata Cara Pengaturan Tarif Air Minum pada Perusahaan Daerah Air Minum*. Indonesia, 2006.

[19] www.pu.go.id, “Pemakaian Air Rumah Tangga Perkotaan 144 Liter per Hari (Domestic water consumption in urban areas is 144 Liters per person per day),” 2007. https://pu.go.id/berita/view/4175/pemaiaian-air-rumah-tangga (accessed Dec. 13, 2019).

[20] B. Reed and B. Reed, “How much water is needed in emergencies: Technical notes on drinking water, sanitation and hygiene in emergencies,” Geneva, 2013.

[21] O. Singh and S. Turkiya, “A survey of household domestic water consumption patterns in rural semi-arid village, India,” *GeoJournal*, vol. 78, no. 5, pp. 777–790, 2013.

[22] X. Wang and R. vom Hofe, *Research Methods in Urban and Regional Planning*. New York: Springer, 2007.

[23] B. C. O’Neill, D. Balk, M. Brickman, and M. Ezra, “A Guide to Global Population Projections,” *Demogr. Res.*, vol. 4, pp. 203–288, 2001, doi: 10.4054/demres.2001.4.8.

[24] R. E. Klosterman, K. Brooks, E. Feser, and H. Renski, *Planning Support Methods: Urban and Regional Analysis and Projection*. Lanham: Bowman & Littlefield, 2018.

[25] D. B. Moalafhi, B. Parida, and K. P. Kenabatho, “New Population Forecasting Techniques for Realistic Water Demand Management in Urban Centres of Bostwana,” in *Proceeding of the International Conference Modelling and Simulation*, 2012, pp. 191–197.

[26] A. K. Nigam and D. C. Rahi, “Estimating Water Demand for Year 2041 Jabalpur City,” *Int. J. Innov. s Eng. Technol.*, vol. 7, no. 2, pp. 14–21, 2016.

[27] Y. A. Mekonnen, “Population Forecasting for Design of Water Supply System in Injibara Town, Amhara Region, Ethiopia,” *Civ. Environ. Res.*, vol. 10, no. 10, pp. 54–65, 2018.

[28] S. Frankhauser and S. Tepic, “Can Poor Consumers Pay for Energy and Water? An Affordability Analysis for Transition Countries,” *Energy Policy*, vol. 35, no. 2007, pp. 1038–1049, 2007.

[29] S. Bhattacharya, S. Saha, and S. Banerjee, “Income inequality and the quality of public services: A developing country perspective,” *J. Dev. Econ.*, vol. 123, pp. 1–17, 2016, doi: 10.1016/j.jdeveco.2016.07.003.

[30] K. . Manez, S. Husain, S. C. . Ferse, and M. M. Costa, “Water Scarcity in the Spermonde Archipelago, Sulawesi, Indonesia: Past, Present, and Future,” *Environ. Sci. Policy*, vol. 23, no. 2012, pp. 74–84, 2012.

[31] A. J. Hargreaves, R. Farmani, S. Ward, and D. Butler, “Modelling the Future Impacts of Urban Spatial Planning on the Viability of Alternative Water Supply,” *Water Res.*, vol. 162, no. 2019, pp. 200–213, 2019.

[32] P. Khirshen *et al.*, “Integrated Urban Water Management Applied to Adaptation to Climate Change,” *Urban Clim.*, vol. 24, no. 2018, pp. 247–263, 2018.

[33] BPS, "Pedoman Penghitungan Proyeksi Penduduk dan Angkatan Kerja (Guidence for Calculating Population and Workforce Projection)," Jakarta, 2010.

[34] I. R. Abubakar, "Factors influencing household access to drinking water in Nigeria," *Util. Policy*, vol. 58, pp. 40–51, 2019, doi: https://doi.org/10.1016/j.jup.2019.03.005.

[35] W. F. Vasquez and E. A. Adams, "Climbing the water ladder in poor urban areas: Preferences for 'limited' and 'basic' water services in Accra, Ghana," *Sci. Total Environ.*, vol. 673, pp. 605–612, 2019, doi: https://doi.org/10.1016/j.scitotenv.2019.04.073.

[36] L. Li, C. S. Li, and D. Wichelns, "Assessing household willingness to pay for bottled water in rural areas of the Mekong Delta, Vietnam," *Water Resour. Rural Dev.*, vol. 7, pp. 36–49, 2016, doi: https://doi.org/10.1016/j.wrr.2016.03.001.

[37] L. Li, E. Araral, and M. Jeuland, "The drivers of household drinking water choices in Singapore: Evidence from multivariable regression analysis of perceptions and household characteristics," *Sci. Total Environ.*, vol. 671, pp. 1116–1124, 2019, doi: https://doi.org/10.1016/j.scitotenv.2019.03.351.

[38] E. Gross and O. Elshiewy, "Choice and quantity demand for improved and unimproved public water sources in rural areas: Evidence from Benin," *J. Rural Stud.*, vol. 69, pp. 186–194, 2019, doi: https://doi.org/10.1016/j.jrurstud.2019.02.021.

[39] D. B. Rahut, B. Behera, and A. Ali, "Household access to water and choice of treatment methods: Empirical evidence from Bhutan," *Water Resour. Rural Dev.*, vol. 5, pp. 1–16, 2015, doi: https://doi.org/10.1016/j.wrr.2014.09.003.

[40] J. M. Dalhuisen, H. L. F. de Groot, and C. A. Rodenburg, "The Economics of Urban Drinking Water Use," *Bulit Environ.*, vol. 28, no. 2, pp. 111–123, 2002.

[41] C. Tortajada, "Policy dimensions of development and financing of water infrastructure: The cases of China and India," *Environ. Sci. Policy*, vol. 64, pp. 177–187, 2016, doi: 10.1016/j.envsci.2016.07.001.

[42] Asian Development Bank, "Nepal: Community-Based Water Supply and Sanitation Project," Mandaluyong, Philippines, 2012.

[43] The Ministry of Public Works, "Program Hibah Air Minum Kementerian PUPR Berikan Akses Bagi 4,5 Juta MBR (The Ministry of Public Work Grant Program Enables 4.5 Million of Low Income People to Have Access to Drinking Water)," 2017. https://www.pu.go.id/berita/view/18/program-hibah-air-minum-kementerian-pupr-berikan-akses-air-bagi-4-5-juta-jiwa-mbr (accessed Aug. 20, 2020).

[44] OECD, "Financing water: Investing in sustainable growth," 2018.

[45] O. Romano and A. Akhmouch, "Water Governance in Cities: Current Trends and Future Challenges," *Water*, vol. 11, no. 2019, pp. 1–9, 2019.

[46] D. Lavee, Y. Danieli, G. Beniad, T. Shvartzman, and T. Ash, "Examining the Efectiveness of Water Demand-side Management Policies in Israel," *Water Policy*, vol. 15, no. 2013, pp. 585–597, 2013.

[47] WMO, "Tools for Water Use and Demand Management in South Africa," Geneva, 2001.

[48] A. Akhmouch and F. N. Correia, “The 12 OECD Principles on Water Governance: When Science Meets Policy,” *Util. Policy*, vol. 43, no. 2016, pp. 14–21, 2016.

[49] A. Akhmouch and F. N. Correia, “The 12 OECD principles on water governance-When science meets policy,” *Util. Policy*, vol. 43, pp. 14–20, 2016, doi: https://doi.org/10.1016/j.jup.2016.06.004.

[50] O. Romano and A. Akhmouch, “Water governance in cities: Current trends and future challenges,” *Water*, vol. 11, pp. 1–9, 2019.

[51] N. G. Leigh and H. Lee, “Sustainable and Resilient Urban Water System: The Role of Decentralization and Planning,” *Sustainability*, vol. 11, no. 3, pp. 1–17, 2019.

[52] D. Katz, “Undermining Demand Management with Supply Management: Moral Hazard in Israeli Water Policies,” *Water*, vol. 8, no. 2016, pp. 1–13, 2016.

[53] A. C. Steinemann, H. J. Brown, and W. C. Apgar, *Microeconomics for Public Policy Analysis*. Boston: South-Western College Publishing, 2003.

[54] M. M. P. Rana and A. Piracha, “Supplying water to the urban poor: Government’s roles and challenges of participatory water governance,” *Cities*, vol. 106, no. August, p. 102881, 2020, doi: 10.1016/j.cities.2020.102881.

[55] Ellen Macarthur Foundation, *Delivering the Circular Economy: A toolkit for Policymakers*. Cowes, UK: Ellen Macarthur Foundation, 2015.

[56] A. Heshmati, “A Review of the Circular Economy and Its Implementation,” Bonn, 2015.

[57] C. Fogarassy and D. Finger, “Theoretical and Practical Approaches of Circular Economy for Business Models and Technological Solutions,” *Resources*, vol. 9, no. 76, pp. 1–9, 2020.

[58] N. Klein, T. B. Ramos, and P. Deutz, “Circular Economy Practices and Strategies in Public Sector Organizations: An Integrative Review,” *Sustainability*, vol. 12, no. 2020, pp. 1–24, 2020.

[59] S. Scarpellini, P. Portillo-Tarragona, A. Aranda-Uson, and F. Llena-Macarulla, “Definition and measurement of the circular economy’s regional impact,” *J. Environ. Plan. Manag.*, vol. 62, no. 13, pp. 2211–2237, 2019.

[60] P. Lacy, J. Long, and W. Spindler, *The Circular Economy Handbook: Realizing the Circular Advantage*. London: Palgrave MacMillan, 2020.

[61] T. Lahti, J. Wincent, and V. Parida, “A Definition and Theoretical Review of the Circular Economy, Value Creation, and Sustainable Business Models: Where Are We Now and Where Should Research Move in the Future,” *Sustainability*, vol. 10, no. 2018, pp. 1–19, 2018.

[62] L. T. Peiro, D. Polverini, F. Ardente, and F. Mathieux, “Advance towards circular economy policies in the EU: The new Ecodesign regulation of enterprise servers,” *Resour. Coservation Recycl.*, vol. 154, no. 2020, pp. 1–11, 2020.

[63] N. S. Kakwani and P. P. Kalbar, “Review of Circular Economy in urban water sector: Challenges and opportunities in India,” *J. Environ. Manage.*, vol. 271, no. July, p. 111010, 2020, doi: 10.1016/j.jenvman.2020.111010.

[64] R. Merli, M. Preziosi, and A. Acampora, “How do scholars approach the circular economy? A

systematic literature review," *J. Clean. Prod.*, vol. 178, pp. 703–722, 2018, doi: 10.1016/j.jclepro.2017.12.112.

[65] P. Morseletto, "Targets for a circular economy," *Resour. Conserv. Recycl.*, vol. 153, no. November 2019, p. 104553, 2020, doi: 10.1016/j.resconrec.2019.104553.

[66] BPS, "Statistik Kesejahtraan Rakyat 2019 (Welfare Statistics 2019)," Jakarta, 2019.

[67] WHO; UNICEF, "Progress on Sanitation and Drinking Water: 2015 Update and MDG Assessment," Geneva, 2015. doi: 10.1007/s13398-014-0173-7.2.

[68] World Bank, "Indonesia Public Expenditure Review: Spending for Better Results," Jakarta, 2020.

[69] BPS, "The Percentage of Households and the Domestic Water Sources (2000-2016)," 2016. https://www.bps.go.id/statictable/2014/09/10/1361/persentase-rumah-tangga-menurut-provinsi-dan-sumber-air-minum-2000-2016.html. (accessed Oct. 13, 2018).

[70] BPS, "Data Kepadatan Penduduk Menurut Provinsi 2015-2019 (Population Density by Province from 2015 to 2019)," Jakarta, 2020. [Online]. Available: https://www.bps.go.id/indicator/12/141/1/kepadatan-penduduk-menurut-provinsi.html.

[71] E. Ostrom, "Polycentric systems for coping with collective action and global environmental change," *Glob. Environ. Chang.*, vol. 20, no. 2010, pp. 550–557, 2010.

[72] A. Agrawal, D. G. Brown, G. Rao, R. Riolo, D. T. Robinson, and M. Bommarito II, "Interactions between organizations and networks in common-pool resource governance," *Environ. Sci. Policy*, vol. 25, no. 2013, pp. 138–146, 2013.

[73] S. J. Van de Meene, R. R. Brown, and M. A. Farrelly, "Towards understanding governance for sustainable urban water management," *Glob. Environ. Chang.*, vol. 21, no. 3, pp. 1117–1127, 2011, doi: 10.1016/j.gloenvcha.2011.04.003.

[74] Perpres 185/2014, *Peraturan Presiden Republik Indonesia Nomor 185 tahun 2014 Tentang Percepatan Penyediaan Air Minum dan Sanitasi (Indonesia Presidential Regulation Number 185 Year 2014 about Accelerating Drinking Water Provision and Sanitation)*. Indonesia, 2014.

[75] C. Tortajada and A. K. Biswas, "Achieving universal access to clean water and sanitation in an era of water scarcity: strengthening contributions from academia," *Curr. Opin. Environ. Sustain.*, vol. 34, pp. 21–25, 2018, doi: 10.1016/j.cosust.2018.08.001.

Chapter 3
Methodology

3.1. Selecting the Case Study Area

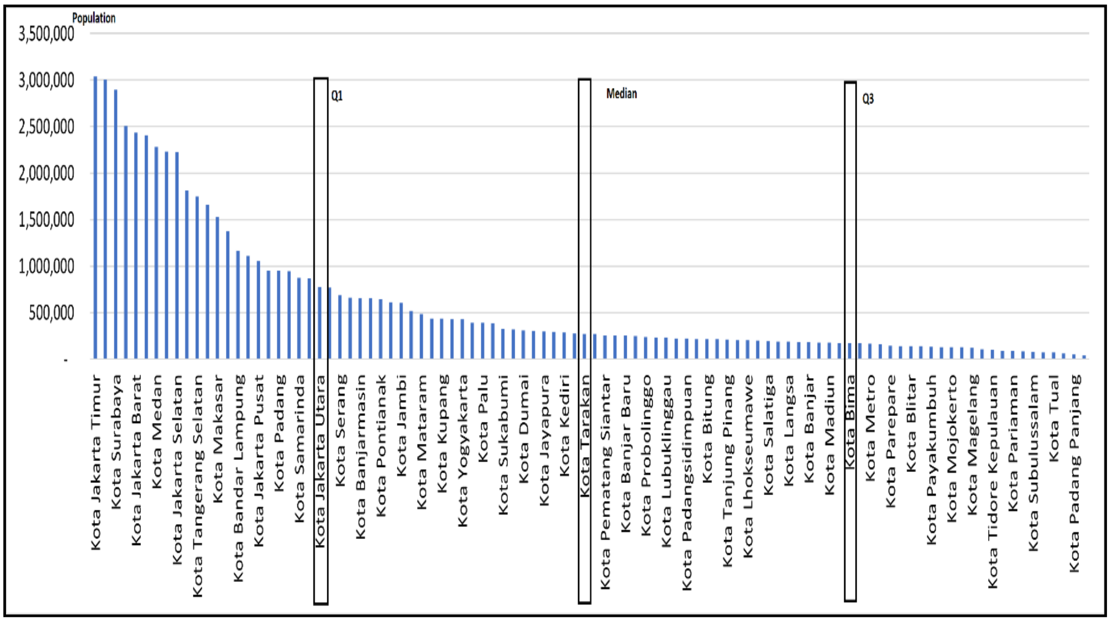
This research focuses to discuss the issue of the domestic water fulfillment in the Indonesian small city. To select a city as the case study area, several stages are conducted. To begin with, we overview the governmental administration system in Indonesia, which recognizes two types of administrative territories namely kabupaten (regency) and kota (city). The former is characterized by a large area that is dominated by rural landscapes. Meanwhile, the latter is characterized by a small area that is dominated by urban landscapes. Moreover, the kabupaten usually has and is less densely populated compared to the kota. In the case of public water service provision, the kabupaten is considered as less developed than the kota. Unsurprisingly, the Indonesian government established the community-based sanitation and drinking water service provision to accelerate the development in the kabupaten. Nevertheless, the assumption that considered the kota is more advanced in the water service provision is not fully true. In fact, many kota are struggling to provide public services including drinking water. The change in the political and administration systems in Indonesia, which is from centralized to decentralized system, gives the local authorities more rights and responsibilities to provide necessary public services. It might not be a big problem for local authorities that have a strong financial capacity yet small cities face a dilemmatic situation to deal with the problem of the public water provision.

Furthermore, to simplify, we use the term regency and city to indicate kabupaten and kota rather than using the term in the Indonesian language. In total, there are 416 regencies and 98 cities in Indonesia [1]. In this research, we focused the discussion for the cities, especially the small ones because of challenging situation belonged to them. To select a case study representing the Indonesian small cities, we conducted several selection stages. Firstly, we listed 98 local territories that are stated as cities in the Indonesian administrative system and defined the city size. The formal definition of the city size in Indonesia refers to the law number 26/2007 about the spatial planning [2]. In this regulation, the city size is formally classified based on only its population. The definition is listed in the following table.

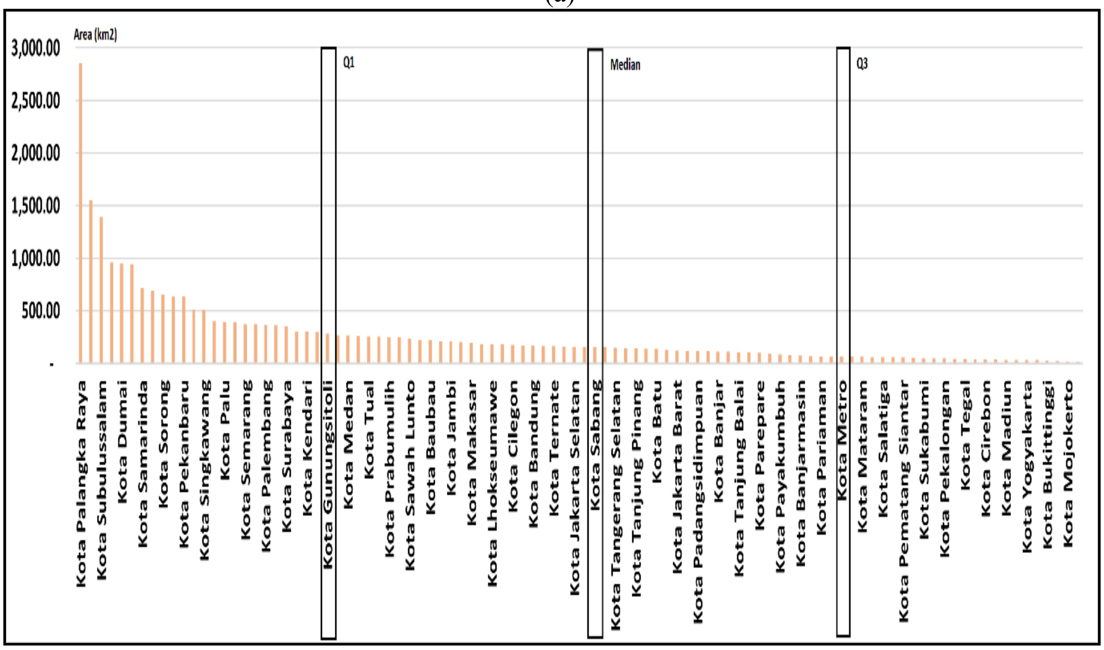
Table 3.1. The classification of the city in Indonesia

The classification of the city size	Population
Small city	< 100,000
Medium size city	100,000 – 500,000
Big city	500,000 – 1,000,000
Metropolitan	> 1,000,000

Aside from its simplicity, this classification does not consider the area even though they are important to define the city size. Besides, the area will automatically affect the population density, where the small area makes a city is more densely populated. For the sake of the statistical representativeness, in this research we listed the population and the area of the 98 cities to define a small city instead of excluding the element of the area. To select the case study area, the list is ordered from the biggest to the smallest. Afterward, the case study area is chosen from the last quartile. The list of the cities in Indonesia is presented by the following figures.



(a)



(b)

Figure 3.1 (a) the list of the Indonesian cities ordered by the population; (b) the list of the Indonesian cities ordered by the area

The figures show a wide gap among the Indonesian cities in terms of their populations and areas. This research is designed to discuss the issue of the domestic water provision of the small city, which is listed in the last quartile. Furthermore, we identified the city that matches to the definition of the small city in both categories (population and area). The intersection of those categories resulted in 9 cities that meet both criteria. They are Kota Metro, Kota Tebing Tinggi, Kota Blitar, Kota Mojokerto, Kota Bukittinggi, Kota Magelang, Kota Sibolga, Kota Solok, and Kota Padang Panjang.

Furthermore, we explored the issues of the public water service in the selected cities. Two aspects are elaborated to grasp the initial figure of the public water service in the selected cities. They are the percentage of service coverage and the organizational arrangement of the public water service provision. The data is summarized in the following table.

Table 3.2. The percentage of the public water service subscribers of the selected cities

The name of the city	Population	The numbers of public water subscribers	Percentage (%)
Kota Metro [3]	165,193	2,205	1,33
Kota Tebing Tinggi [4]	164,402	10,516	6.42
Kota Blitar [5]	157,909	12,576	7.95
Kota Mojokerto [6]	139,423	5,289	3.79
Kota Bukittinggi [7]	123,296	10,093	8.19
Kota Magelang [8]	122,111	27,665	22.65
Kota Sibolga [9]	87,626	15,207	17.35
Kota Solok [10]	74,271	15,232	20.51
Kota Padang Panjang [11]	53,693	8,715	16.23

The table compares the ratio between the public water service and the population among the nine small cities selected in the previous stage. The data is collected form the annual statistical report that is officially published by the respective city government. It can be seen that Kota Metro (in Lampung province) has the largest population but the number of the public water service subscribers in this city is the lowest compared to the other cities. It can be interpreted that Kota Metro faces the most challenging situation in developing its domestic water sector or is unable to encourage the residents using public water service to fulfill their daily needs. Therefore, this city is selected as the case study area to conduct further investigation in the issues of the domestic water fulfillment in the Indonesian small cities.

3.2. Operationalizing the Research to Achieve Expected Objectives

After obtaining determining the case study area, the methods to operationalize the research are designed. To formulate the research methodology, we refer to the expected objectives that have been mentioned in chapter 1. To recall, there are four objectives to be achieved in this research. The first is to understand the current status of the domestic water issue in the case study area while the second is related to the public preferences on the domestic water utilization. The third is formulating alternatives based on findings found in the first and the second objectives. Subsequently, the fourth objective is exploring strategies that have been implemented on the other places to be referred as the lessons learning process for the case study area.

Furthermore, several operational stages are designed achieve the objectives mentioned above. The stages are illustrated by figure 3.2. Different with the research flowchart illustrated in figure 1.5, which outlined the discussion of the research and the connection among chapters, figure 3.1 illustrates the research flow in more technical steps. It includes the required data as well as relevant analytical tools employed to grab the conclusions.

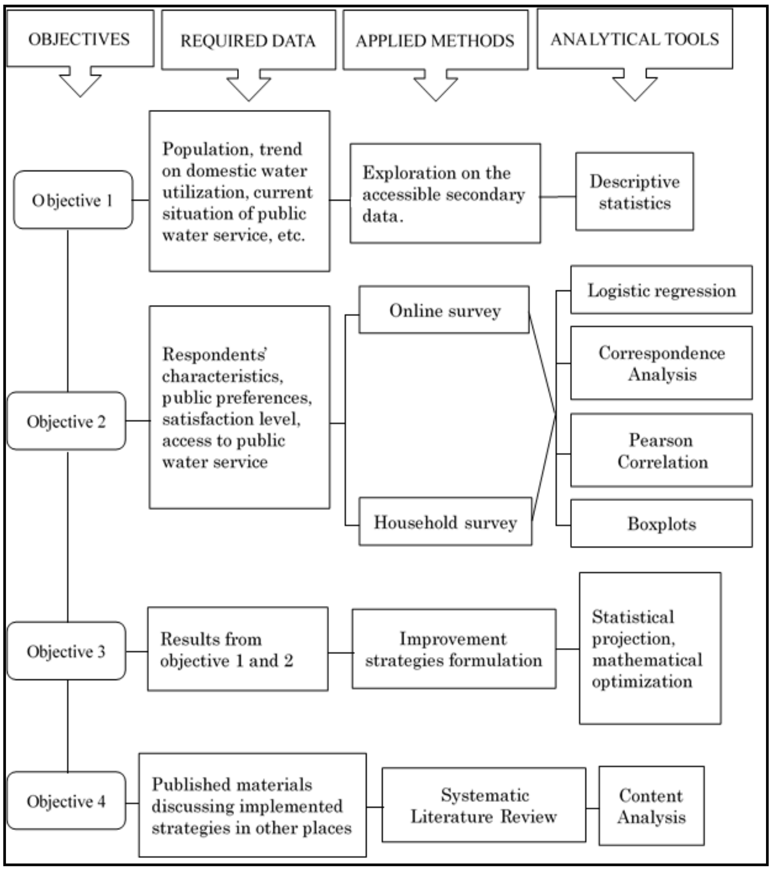


Figure 3.2. The schematic diagram of the research methodology

This figure shows the schematic diagram of the methods conducted in this research to achieve targeted objectives. The first objective can be achieved by investigating the current of the domestic water fulfillment in Kota Metro through the exploration on the accessible secondary data. The descriptive statistics is highly employed in this stage. Moreover, the second objective requires primary data that is collected through online and household survey. In this stage, several analytical tools such as logistic regression, correspondence analysis, Pearson correlation, and boxplots are performed for both online and household survey dataset. Then, findings resulted from the first and the second objective are used as inputs to formulate development scenarios for improvement. On the other side, developments strategies that have been successfully implemented in other places are valuable information to be learned. Through a systematic literature review, determinant factors to succeed the development of the domestic water are investigated. Indeed, the selected case studies have to fit to the context of Indonesia. Therefore, we selected the case studies that come from the places that have similar climatic and economic situation with Indonesia. To conduct this stage, we employed the content analysis. In more detail, the data collection process and analytical tools are discussed in the following sections.

3.3. Data Collection

3.3.1. Collecting Data through An Online Survey

Besides exploring the secondary data, the initial stage to investigate the issue of the domestic water provision in Kota Metro is conducting a preliminary study through an online survey. This stage aims to grasp the initial figures of the domestic water service provision in Kota Metro as well as the community preference in using preferable domestic water source. The online survey is conducted by spreading an online questionnaire through e-mail and social media to the targeted respondents who reside in Kota Metro. This survey targeted 165 respondents based on the assumption of one respondent is representing 1,000 population of Kota Metro. However, we could not set the number of replies but expect the target would be achieved. We were expecting a snowball effect occurred when the online questionnaire submitted to the potential respondents. Therefore, the number of the collected samples would be getting bigger as the questionnaire spreads and would be considered as statistically significant.

Furthermore, we outlined the questionnaire into four main parts. The first part is related to the respondent's basic information such as gender, age, and address to briefly recognize the respondent's figure and to map their spatial distribution. The second part of the questionnaire is questioning the information related to the respondent's socioeconomic background such as education, occupation, family size, and income for further elaboration on the respondent's characteristics. Then, the issue of the respondent's domestic water utilization is questioned in the third part of the questionnaire. In this part, we asked the respondents about their types of domestic water sources that are currently used to suffice their daily needs and the reason why those utilized water sources are preferable for them. Besides, we also asked the respondents about the availability of the pipe network (access to public water service) surrounding their residences to investigate whether this factor is influential to the respondent's decision in choosing preferable domestic water sources. Finally, we asked the respondents to express their satisfaction level in consuming their current water sources. Three issues (i.e., quantity, quality, and price) are asked to the respondents to measures their satisfaction level. We provided one-to-ten interval to the respondents to express their satisfaction level. In the case of quantity and quality, the respondent can give the score one to show that they are extremely dissatisfied while ten is for the extremely satisfied. Meanwhile, in the case of the water price, the respondents can give score one if they feel the water price is extremely cheap or ten if they feel it is extremely expensive.

3.3.2. Collecting Data through Household Survey

After conducting the online survey, we did the household survey for the sake of validating the initial findings that were previously found. Unlike the online survey, in the household survey we could set the number of respondents to be targeted. In this regard, we set the number of the targeted respondent following the statistical formula to the sample size for a random survey. The sample size is determined by the following formula [12].

$$n = \frac{\frac{z^2 p(1-p)}{e^2}}{1 + \frac{z^2 p(1-p)}{e^2 N}} \qquad \text{(Eq.3.1)}$$

Where: *n* is the sample size,

z is the z-score associated with a level of confidence,

p is the sample proportion expressed in decimal,

e is the margin of error expressed in decimal,

N is the population size.

In this survey, we set the confidence level at 95%, which corresponds to the *z* score of 1.96. The sample proportion (*p*) was defined at 50% and the margin of error (*e)* was desired at 4%. The population size that we used as the basis of the calculation is the population data of the Kota Metro, which is 165,193 (2018). The calculation results in the number of targeted samples 599 respondents. Subsequently, the 599 targeted respondents were proportionally distributed to all villages in Kota Metro in accordance with their proportion the total population of Kota Metro.

Furthermore, the household survey enabled us to ask questions that are impractical to be asked through the online survey. Hence, we extended the questionnaire to the several issues. They included the respondent's experience of the water shortage and how they handled this problem. Moreover, the respondent's opinions on the current situation of the domestic water services provided by the city government were also asked. Combining these two aspects (the water shortage experience and the quality of the public water service), we then asked the respondent's about altering the individual groundwater exploitation, which is currently practiced, to the public water service provided by the city government.

3.4. Analytical Tools

3.4.1. Descriptive Statistics

In the beginning stage, we collected secondary data such as population, geographical condition, the existing public water provision, etc., to obtain the initial figures of the domestic water issues in Kota Metro. The data is then analyzed using descriptive statistics such as the central tendency of the data as well as the dispersion. Indeed, it is not aimed to draw a conclusion but merely to describe the existing phenomena. Besides, the descriptive statistics is also important to conduct using data summary or graphical illustration so that the data would be more easily understood.

Besides for the secondary data, the descriptive statistics was also used to summarize the respondent's information gained from either online or household survey. This elementary statistical tool enabled us to grasp initial figures on the respondent's composition and characteristics. In the numerical presentation, the data is expressed by its average, clusters, compositions, and so forth. Besides, it can also be graphically illustrated using bar charts, pie charts, or other graphical means. Then, the descriptive statistics would be followed by other analyses to reveal deeper meanings as well as to draw conclusions in this research.

3.4.2. Multinomial Logistic Regression Analysis

Multinomial logistic regression is used to predict categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables. This type of regression technique can solve the problem where the expected outcomes are not dichotomous or binary [13][14]. The multinomial logistic regression uses maximum likelihood estimation to evaluate the probability of categorical membership. Thus, multinomial logistic regression can be used to predict which of two or more categories a person (or a case) is likely to belong to, compared to a baseline (or reference) category and given certain other information [15], [16]. Due to its ability to examine categorical data, this method is a powerful alternative to analyze influential (non-numerical) factors to a certain trend or respondent's choice. For instance, [17] examined factor influencing high school students' choice in continuing their study to university.

Furthermore, multinomial logistic regression is widely used in various fields. Some of studies discussing the topic of the public preference employed multinomial logistic regression as a tool to analyze the dataset and explore the correlation between the respondent's choice and factors influencing the choice. In this research, we elaborated the issue of the respondent's reasoning to utilize their preferable domestic water sources. To classify, the reasons are clustered into five groups. They are related to the issue of quantity, quality, affordability, and accessibility. Besides, in the survey we accommodated the respondents' answers that do not relate to these categories under the category of others.

In the computation, the pipe water is set as the referent category when the multinomial logistic analysis was performed. Therefore, the likelihood of the respondents' reasons to use other domestic water sources (besides the pipe water) is assessed by referring to the reasons of the pipe water users. In more detail illustration, the computation is presented in table 3.3.

Table 3.3. The illustration of the Multinomial Logistic Regression Analysis

The Respondent's water source	The respondent' reasons	The MLR coefficient
Water source 1	Reason 1	$C_{1,1}$
	Reason 2	$C_{1,2}$
	Reason 3	$C_{1,3}$
	Reason 4	$C_{1,4}$
Water source 2	Reason 1	$C_{2,1}$
	Reason 2	$C_{2,2}$
	Reason 3	$C_{2,3}$
	Reason 4	$C_{2,4}$

As an illustration, let us say that water source 1 is individual dug well and reason1 is the quantity. Thus, the coefficient on the first row ($C_{1,1}$) explain the likelihood between the respondents who use their individual dug wells (due to the water quantity) and the respondents who use the pipe water with the same reason. The coefficient is marked with the positive or negative sign. The positive sign means that they share a similarity, but the negative sign shows their oppositeness. Besides, the value of the coefficient indicates the level of the likelihood, where the bigger value means the stronger likelihood. In the analysis, the computation, which was assisted by SPSS version 23, was conducted for all types of the domestic water source and all reasons admitted by the respondents.

3.4.3. Correspondence Analysis

Correspondence Analysis (CA) is widely utilized to uncover the relationship among categorical variables [18]. The basic concept of the CA is transferring a contingency table, which consists of numerical respondent's information, into a two-dimensional graph. Geometrically, individuals are indicated by spots scattering one to another and the distance between two spots shows how close the similarity between two individuals. In the case of data gathered from the questionnaire, a closer distance between two spots indicates that two individuals share a higher level of similarity by giving relatively similar answers. In its development, the CA is extended to a more complex relationship, which is called the Multiple Correspondence Analysis (MCA). Similar to the CA, the MCA is also used to describe the relationships among categorical variables and to characterize the individuals using the variables visualized in the graphical illustrations [19].

The MCA's ability to analyze an individual's characterization and contribution to the whole collected sample is MCA's strong feature making it preferable [20]. Not only that, but MCA also enables to quantify respondent's preference leading to a meaningful interpretation [21]. Furthermore, visual illustrations derived from the calculation in MCA facilitate readers to understand data features more easily. Due to its applicability to assess the association between categories, this method has been widely employed in diverse fields either natural or social sciences. [22], for instance, used MCA to analyze constituent's political preference in the Canadian national election. Moreover, behavioral issues are also elaborated by many types of research through various fields including marketing [23][24], tourism [25], social behavior [26], education [27], public health [28][29], and so forth. Not only that, but MCA is also utilized to explore survey data at the national level [30].

Nevertheless, MCA has not been widely applied to assess user's behaviors in public service sectors such as domestic water provision. Referring to previous studies listed in table 2.2, none of them employed MCA in the revealing influential factors in determining people's choice of domestic water utilization. It is understandable since the nature of domestic water provision, which is supposed to be uniformly provided for all communities [31], leads to the assumption that there will be no variance in the user's preference. However, this assumption does not appear in our case study area and people can freely choose their preferable water source.

Considering the benefits offered by the correspondence analysis, it utilized to explore the relationship between the respondent's characteristics such as the socioeconomic background and their choice of domestic water use. The information given by the respondents in the interviews initially is summarized into a contingency table as illustrated by table 3.4.

Table 3.4 The illustration of the contingency table for the correspondence analysis

The respondent's characteristics	The Respondent's domestic water source				
	Source 1	Source 2	Source 3	Source 4	Source 5
Gender	$n_{1,1}$	$n_{1,2}$	$n_{1,3}$	$n_{1,4}$	$n_{1,5}$
Age	$n_{2,1}$				
Education	$n_{3,1}$				
Occupation	$n_{4,1}$				
Income	$n_{5,1}$				
…………….	$n_{6,1}$				
…………….	$n_{7,1}$				
Etc.					$n_{i,j}$

After collected information is transformed into the contingency table, the correspondence analysis is performed by the assistance of the computer statistics software (SPSS version 23) so that the graphs illustrating the relationship between assessed variables can be automatically created and further interpretation on the dataset can be conducted.

3.4.4. Pearson Correlation Analysis

The Pearson Correlation Analysis is commonly used to illustrate how strong the linear correlation between the two assessed variables. In other word, how significant the change would happen to the dependent variable if there were a single change in the independent variable. In this research, we used the Pearson Correlation Analysis to explore the relationship between the availability of the pipe network and the respondent's choice of the domestic water sources. We set our assumption on the traditional thought that the availability of the pipe network and other supporting facilities might significantly influence the decision to choose a preferable domestic water source. Thus, the availability of the pipe network is treated as the independent variable while the respondent's choice is the dependent variable.

Similar with the previous analysis, the SPSS version 23 is still used to compute the Pearson correlation coefficient. The coefficient is usually expressed by the score ranging from -1 to +1. To specify, the sign indicates the type of the correlation. The negative sign shows that the assessed variables have a contrary correlation while the positive sign indicates that they are mutually correlated. In addition, the value of the coefficient shows the significance. The perfect correlation is expressed by 1, and no correlation is symbolized by 0.

3.4.5. Boxplots

The boxplots are utilized to elaborate the issue of the respondent's satisfaction level as is illustrated by figure 3.3. One of the advantages using the boxplots is the rich information given by the simple figure. It can compare several groups that existed in the survey. Moreover, the statistical parameters such as minimum and maximum range, quartiles, and median are simply represented by the boxplots. In addition, the data that is statistically considered as outlier data can also be easily recognized in the boxplots.

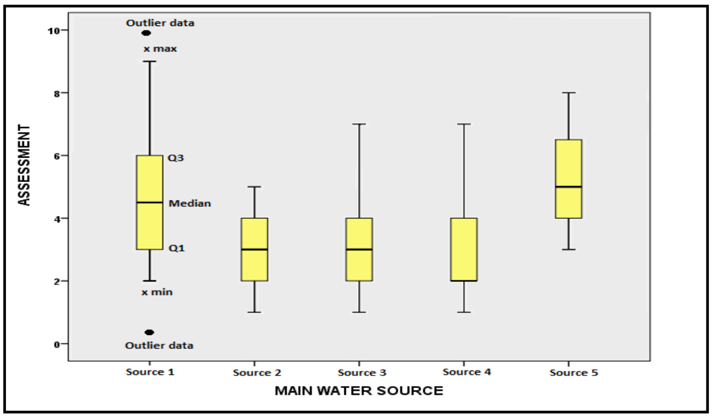


Figure 3.3. The illustration of the boxplots

In this research, we plotted the respondent's opinion about their current domestic water sources. There are three aspects that are assessed. They are the respondent's satisfaction on the quantity, quality, and price of the current domestic water sources. The computation of the analysis is also assisted by the computer statistics software (SPSS version 23).

3.4.6. Statistical Projections and Mathematical Optimization Modelling

Statistical projections and mathematical optimization modelling are highly employed to formulate the scenarios for improvement in chapter 6. The statistical projection is conducted to extrapolate the current trend and to forecast the future situations. They covered the issues related to the population growth, and the production capacity of the public water service provider. The population growth is then used to estimate the future water demand while the production capacity represents the supply side in the domestic water provision. From this analysis, the existing gap between the supply side and the demand side is investigated. Subsequently, possible development scenarios were formulated to reduce the existing gap. Besides, the trend of the revenue belonged to Kota Metro is also projected to investigate the capacity of this city in affording the reasonable targets within the available timespan.

Furthermore, the mathematical optimization modelling was used in searching the optimum proportion of pipeline-based and communal-based water provision when they are combined to accelerate the development of the domestic water sector in Kota Metro. The basic idea of this mathematical modelling is setting an objective function under the existing constraints. To specify, the constraints are limited into two aspects, which are required cost and targeted output. In other words, this model tried to find the composition of the pipeline-based and communal based water provision that resulted the maximum outputs with the minimum cost or to spend the available cost that can generate the maximum output.

3.4.7. Content Analysis

In chapter 7, the collected literatures discussing development strategies from the selected countries are analyzed under the content analysis approach. This analytical tool is widely used in the qualitative research aimed to understand the meaning of verbal materials such as texts, open questioned interviews, focus group discussion etc. This method is generally divided into three types namely conventional, directed, and summative content analysis [32]. The conventional content analysis is usually applied for the data collected from direct observation. Non-verbal aspects such as respondent's expressions, gestures, tones, etc., observed during the interview are included in the conventional content analysis instead of merely assessing the respondent's answers. Meanwhile, the directed content analysis codifies the various responses into acquiescent norms or expert's thought.

Different with the other two types, the summative content analysis identifies the content by quantifying the frequency of the words with the purpose of understanding the contextual use of the words.

In this research, we used the third type of the content analysis. After setting the criteria and selecting the case studies as the references, published materials discussing that are available online were downloaded. Then, the downloaded materials were assessed by the summative content analysis technique with the assistance of the computer software namely NVivo version 12 published by QSR international. In this stage, the most frequently used words were quantified to interpret the importance of the identified factors. Afterwards, the identified key factors are confirmed with the impact of the applied strategies to the country's achievement on the domestic water provision. Eventually, the identified key factors are reflected to the situation in Indonesia as taken as lessons to equip the proposed strategies in the case study area with the necessary elements.

References

[1] I. B. I. Malik, "A study on population growth and the effect on the urban area in Indonesia," The University of Kitakyushu, 2019.

[2] *Undang-undang Nomor 26 Tahun 2007 tentang Penataan Ruang (Law Number 26 Year 2007 about the Spatial Planning)*. Indonesia, 2007.

[3] BPS Kota Metro, "Kota Metro Dalam Angka 2020 (Kota Metro in Figures 2020)," KOta Metro, 2020.

[4] BPS Kota Tebing Tinggi, "Kota Tebing Tinggi dalam Angka 2020 (Kota Tebing Tinggi in Figures 2020," Kota Tebing Tinggi, 2020.

[5] BPS Kota Blitar, "Kota Blitar dalam Angka 2020 (Kota Blitar in Figures 2020)," Kota Blitar, 2020.

[6] BPS Kota Mojokerto, "Kota Mojokerto Dalam Angka 2020 (Kota Mojokerto in Figures 2020)," Kota Mojokerto, 2020.

[7] BPS Kota Bukittinggi, "Kota Bukuittinggi dalam Angka 2020 (Kota Bukittinggi in Figures 2020)," Kota Bukittinggi, 2020.

[8] BPS Kota Magelang, "Kota Magelang dalam Angka 2020 (Kota Magelang in Figures 2020)," Kota Magelang, 2020.

[9] BPS Kota Sibolga, "Kota Sibolga dalam Angka 2020 (Kota Sibolga in Figures 2020)," Kota Sibolga, 2020.

[10] BPS Kota Solok, "Kota Solok dalam Angka 2020 (Kota Solok in Figures 2020)," Kota Solok, 2020.

[11] BPS Kota Padang Panjang, "Kota Padang Panjang dalam Angka 2020 (Kota Padang Panjang in Figures 2020)," Kota Padang Panjang, 2020.

[12] www.surveysystem.com, "Sample size calculator," 2019. [Online]. Available: https://www.surveysystem.com/sscalc.htm. [Accessed: 21-Sep-2019].

[13] D. W. Hosmer and S. Lemeshow, *Applied Logistic Regression*, 2nd ed. Toronto: JOHN WILEY & SONS, INC., 2000.

[14] N. A. A. Aziz, Z. Ali, N. M. Nor, A. Baharum, and M. Omar, "Modeling multinomial logistic regression on characteristics of smokers after the smoke-free campaign in the area of Melaka," in *AIP Conference Proceedings*, 2016, vol. 1750, no. June 2016, pp. 1–18.

[15] C. J. Anderson and L. Rutkowski, "Multinomial Logistic Regression," in *Best Practice in Quantitative Methods*, J. W. Osborne, Ed. California: SAGE Publication Inc., 2008, pp. 390–409.

[16] A. Bayaga, "Multinomial Logistic Regresion: Usage and Application in Risk Analysis," *J. Appl. Quant. Methods*, vol. 5, no. 2, pp. 288–297, 2010.

[17] M. M. Tulong, M. Mananohas, and C. E. Mongi, "Regresi Logistik Multinomial untuk Menentukan Faktor-faktor yang Mempengaruhi Pilihan Perguruan Tinggi pada Siswa SMA dan SMK di Pulau Karakelang Kabupaten Kepulauan Talaud (Multiple Logistic Regression to determine highschool student's choice for univers," *J. Mat. dan Apl. deCartesiaN*, vol. 7, no. 2, pp. 90–94, 2018.

[18] N. Sourial *et al.*, "Correspondence analysis is a useful tool to uncover the relationships among categorical variables," *J. Clin. Epidemiol.*, vol. 63, no. 6, pp. 638–646, 2010.

[19] F. Husson and J. Josse, "Multiple Correspondence Analysis," in *Visualization and Verbalization of Data*, J. Blasius and M. Greenacre, Eds. Florida: CRC Press, 2014, pp. 163–181.

[20] E. J. Beh, "Simple Correspondence Analysis: A Bibliographic Review," *Int. Stat. Rev.*, vol. 72, no. 2, pp. 257–284, 2004.

[21] P. G. M. van der Heijden, J. Teunissen, and C. van Orle, "Multiple Correspondence Analysis as a Tool for Quantification or Classification of Career Data," *J. Educ. Behav. Stat.*, vol. 22, no. 4, pp. 447–477, 1997.

[22] J. Blasius and V. Thiessen, "The use of neutral responses in survey questions: An application of multiple correspondence analysis," *J. Off. Stat.*, vol. 17, no. 3, pp. 351–367, 2001.

[23] R. Lombardo and E. J. Beh, "Simple and Multiple Ordered Correspondence Analysis to Evaluate Customer Satisfaction," in *Third Annual ASEARC Conference*, 2009.

[24] P. Sanova, J. Svobodova, and A. Laputkova, "Using Multiple Correspondence Analysis to Evaluate Selected Aspects of Behaviour of Consumers Purchasing Local Food Products," *ACTA Univ. Agric. Silvic. MENDELIANAE Brun.*, vol. 65, pp. 2083–2093, 2017.

[25] A. Nicolosi, V. R. Lagana, and D. Privitera, "Using the Network and MCA on Tourist Attractions. The Case of Aeolian Islands, Italy," *Sustainability*, vol. 10, pp. 1–17, 2018.

[26] M. R. D'Esposito, D. De Stefano, and G. Ragozini, "On the use of Multiple Correspondence Analysis to visually explore affiliation networks," *Soc. Networks*, vol. 38, pp. 28–40, 2014.

[27] N. Kalayci and M. A. Basaran, "A combined approach using multiple correspondence analysis

and loglinear models for student perception in quality in higher education," in *Procedia Economics and Finance*, 2014, pp. 55–62.

[28] P. S. Costa, N. C. Santos, P. Cunha, J. Cotter, and N. Sousa, "The Use of Multiple Correspondence Analysis to Explore Associations between Categories of Qualitative Variables in Healthy Ageing," *J. Aging Res.*, pp. 1–12, 2013.

[29] R. M. Lana *et al.*, "Socioeconomic and demographic characterization of an endemic malaria region in Brazil by multiple correspondence analysis," *Malar. J.*, vol. 16, pp. 1–16, 2017.

[30] M. Greenacre, "The use of correspondence analysis in the exploration of health survey data," 2002.

[31] N. Gusdini, P. M. Yanuar, K. Murtilaksono, and Kholil, "Water governance model in small city: Review at District Bekasi-Indonesia," *Theor. Empir. Res. Urban Manag.*, vol. 12, no. 1, pp. 38–52, 2017.

[32] H. F. Hsieh and S. E. Shannon, "Three approaches to qualitative content analysis," *Qual. Health Res.*, vol. 15, no. 9, pp. 1277–1288, 2005.

Chapter 4
Preliminary Study on the Community Preferences for Domestic Water Fulfillment in Kota Metro, Lampung Province, Indonesia

4.1. Introduction

Acces to safely managed water source has been a global agenda and the United Nations have also explicitly targeted universal access to water by 2030 as one of the targets of the Sustainable Development Goals (SDGs), which is a continuation of the Millennium Development Goals (MDGs). In particular, Indonesia has ratified the SDG's agenda by issuing a development plan stated in Presidential Decree Nr. 59/2017 about the achievement of the Sustainable Development Goals. Two goals related to water provision are accommodated by this presidential decree: (1) increasing access to drinking water to 100% of the population by 2019, and (2) increasing drinking water production capacity to 118.6 m^3 per second by 2019. Actually, these are reasonable goals considering the report released by WHO and UNICEF in 2015 stating that Indonesia is one of the countries that have met the targets set in the Millennium Development Goals [1] while statistical data show that 72.99% of households in Indonesia already have access to drinking water [2].

Despite this positive trend, some problems appear when the data is broken down into a more specific issue on how people have access to their domestic water source. As a matter of fact, water source utilization in Indonesia is still dominated by individual groundwater exploitation instead of public water service utilization. This is actually alarming situation in the perspective of water resource sustainability considering the negative consequences of excessive groundwater exploitation revealed by many studies [3]–[5]. To be more specific, BPS [2] recorded that only 10.29% of households in Indonesia utilize tap water as their main drinking water source, while 36.28% of households rely on bottled water for drinking and the rest choose to exploit groundwater individually.

Many studies have been conducted to analyze tendencies in domestic water consumption and to find out the reason why people prefer choosing individual water source exploitation instead of utilizing public water service. From a technical point of view, the water service provider's inability to respond to rapidly increasing demand commonly appears as the main reason, while the situation is worsened by the existence of financial and technological constraints [6]. Furthermore, the absence of clear rules to regulate individual water source exploitation also plays an important role [7]. Conceptual solutions have been proposed in several studies. The 3P (places-people-policies) approach and the triangular model of urban water sustainability are examples of conceptual frameworks to deal with water-related issues [8], [9], [10]. Those concepts show the interlinking connection between the three elements, which are physical characteristics (places), human behavior (people), and applied regulation (policies). In the context of the good water governance, they are inseparable and should not be viewed partially. However, this chapter will be more focused on the discussion of domestic water fulfilment from the dimension of the people preference as one of the aspects of these three inseparable elements.

Furthermore, many studies has been done to investigate factors influencing people's preference related to drinking water [11], [12], [13], [14] To summarize, there are two factors, which are internal and external factors, influencing the people's preference on the domestic water utilization. To specify, the internal factors are represented by socioeconomic indicators, i.e. education level, occupation, family size, and total monthly income. Meanwhile, the respondents' accessibility to a piped water network was assessed as an external factor that potentially directs the respondent's opinion on their domestic water fulfillment.

Moreover, this study particularly investigated the domestic water fulfillment issue from the consumers' point of view, which is rarely done, specifically related to small cities such as Kota Metro. The main objective of this study was to reveal the public preferences in fulfilling daily water needs and the motives behind their choices. As is previously mentioned in chapter 1, Kota Metro has the lowest percentage in the case of water service coverage compared to other cities that provide the water service through the same organizational scheme. Hence, it is interesting to investigate the cause of this occurrence and this chapter is the preliminary study to reveal the community preferences of domestic water fulfillment in Kota Metro.

To collect the information, we distributed an online survey to residents of Kota Metro through e-mail and social media. Aside from the issue of statistical representativeness, the online survey is expected to give initial evidence about public preference on domestic water fulfilment in Kota Metro. Several steps were conducted in this investigation. Firstly, data on respondent's socioeconomic attributes such as gender, age, education, occupation, and income were collected. It aims to explore the internal factors that might influence the community preferences. On the other hand, to reveal the external factors, we asked the availability of pipe network to access public water service provided by the government of Kota Metro.

Secondly, we asked the domestic water source that is currently used by the respondents every day. For further elaboration, we also asked the respondents to specify the water source for domestic activities such as drinking, cooking, shower, washing, etc. Subsequently, the respondents' level of satisfaction with their current water source was explored. We asked the respondents to express their satisfaction level by giving the score from one to ten for the quantity, quality, and cost of the current domestic water source. In the end of the questionnaire, we asked respondent opinion to the possibility of shifting their main domestic water source into public water service provided by the government of Kota Metro. In more detail, methods that were applied in this study is discussed in section 4.2.

4.2. Materials and Methods

At the first stage of this study, we collected secondary data officially published by the government of Kota Metro to create a preliminary profile of the city. The data included the administrative area of each village, the population, and the water company's service coverage. The data is collected from annual statistical report that is officially launched by the government of Kota Metro. Besides, other relevant documents are also used to introduce the case study area as well as to grasp the issue of domestic water fulfillment in the context of Kota Metro. Then, we conducted an online survey by spreading online questionnaires randomly using Google Forms. We sent the form to residents of Kota Metro through e-mail and published it to the social media. Indeed, a statistical procedure to determine the number of samples could not be performed in this phase. We expect the snowballing effect appeared in this stage. Thus, the respondents that have voluntarily responded the questionnaire were willing to spread it to their relatives and colleagues. Unlike in direct interviews, the online survey has a limitation in gaining deeper opinion from the respondents. To some extent, respondents are reluctant to respond the questions that need a long explanation. Therefore, we provided questions in the format of multiple choice and short answers. Aside from its limitation, the benefit of online surveys is that they are practically easy to conduct, and respondents are psychologically free to express their opinion. Besides, the online survey can possibly reach more respondents since it is not constrained by the time and geographical barriers [15].

In managing the questionnaire, we divided the questions into four parts. Firstly, we asked the respondents' addresses in order to map their spatial distribution. Since this was a randomly spread online survey, we could not purposively set the respondents' spatial distribution but had to rely on the response to the questionnaire. Secondly, we questioned the respondent's personal data related to their socioeconomic background, such as education level, occupation, family size, and total monthly income of the household. We gathered this information in order to reveal whether socioeconomic background contributes to determining the respondents' domestic water preference. The basic assumption is that socioeconomic background could probably influence people's opinions including in determining their lifestyle as well as preferences. Moreover, family size obviously impacts the amount of water consumed, possibly compelling people to change domestic water sources if the current source is not sufficient. Thirdly, we assessed the accessibility of the public water service to the respondents by asking them whether the public water service was available or not. We did not ask a precise measurement but the respondents' subjective opinions. This essentially aimed to reveal the respondents' thoughts on the existing public water service and their eagerness to use it. Fourthly, we asked the respondents about their choice of water source related to their daily utilization for drinking, cooking, bathing, house cleaning, and so forth. The respondents were also asked about the motives behind their preference. For simplification we provided five categories for choosing as their main reason; they were asked to choose the single strongest reason. The provided reasons were reliable quantity, good quality, affordable price, easy access, and no other choice. Lastly, we asked the respondents to express their satisfaction with the current domestic water source. There are three categories that were questioned. They are quantity, quality, and cost. We provide a one-to-ten interval for the respondents to express their satisfaction. For the category of the quantity and quality, one is to represent very dissatisfied and ten is to represent very satisfied. Meanwhile, in the category of the cost, one is to represent very cheap and ten is to represent very expensive. We end the questionnaire by asking the respondent's opinion of shifting the domestic water source and the reasons whether they like to alter their current domestic water source or not.

After data collection, we analyzed the information gathered using several statistical techniques with the assistance of computer software SPSS (Statistics Package for Social Science), version 23. Descriptive analysis was initially employed to illustrate the existing conditions in Kota Metro and to describe the respondents' profiles. Then, correspondence analysis was utilized to obtain the correlation between the respondents' preferred domestic water source and the motives that triggered their choice. Moreover, the relationship between assessed factors such as socioeconomic background and preferred domestic water source was also analyzed using correspondence analysis. On the other hand, to assess the significance of the existing pipe water network to the choice of the domestic water source, the Pearson correlation method was employed while the respondent's satisfaction levels were visualized by the boxplots. In the end of the analysis, the descriptive statistics was performed to explain the respondent's willingness to shift their current domestic water source into public water service.

4.3. Results and Discussions

4.3.1. Brief Introduction of Kota Metro

Kota Metro is a small city that is a part of Lampung province located in the southern part of Sumatra Island. Due to its small size, Kota Metro is merely a dot in Indonesian map that is actually located not so far from Jakarta, the capital city of Indonesia. In more detail, the orientation of Kota Metro from Jakarta is illustrated in figure 4.1.

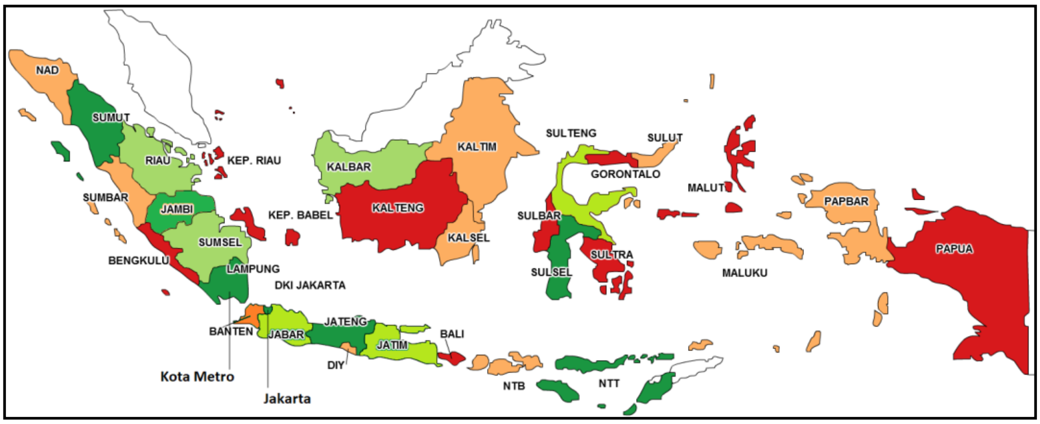
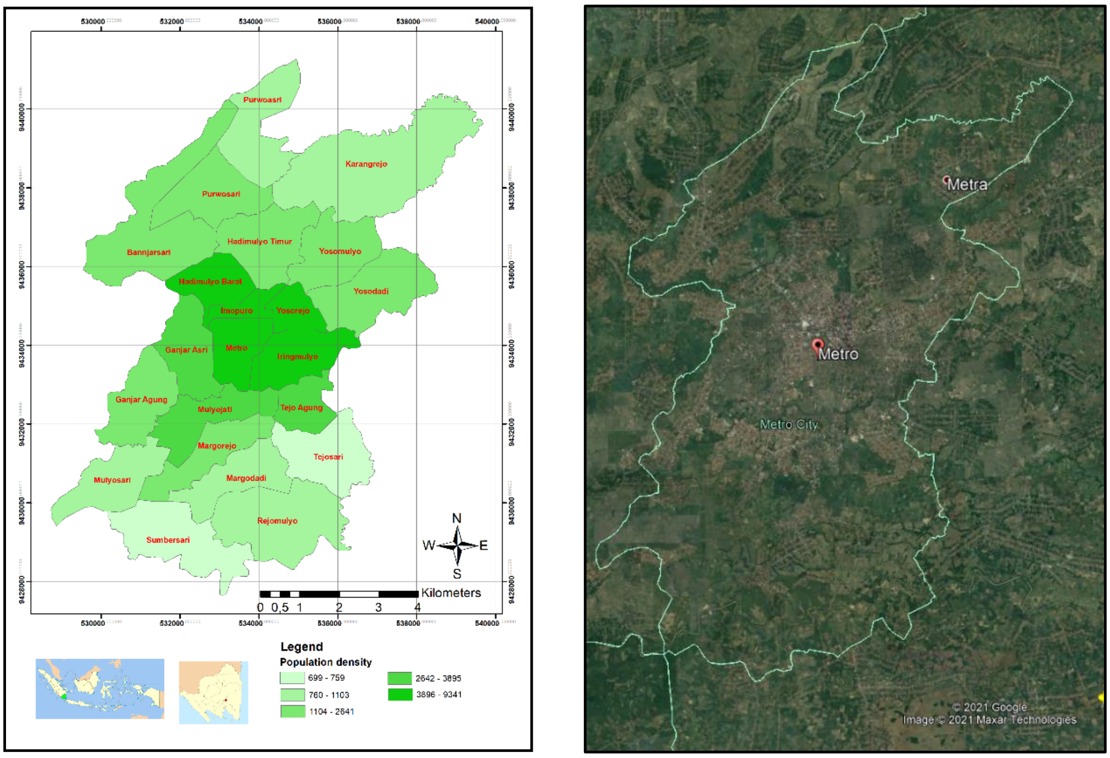


Figure 4.1 The orientation map of Kota Metro (Source: [16])

Regarding its geographical characteristics, the area of Kota Metro is only 68.74 km2, which consists of five sub districts divided into 22 *kelurahan*. The kelurahan is the term in Indonesia to name the smallest administrative unit that is similar to village. This city is located on 50 to 55 meters above mean sea level within relatively flat topography (the slope is around 0% to 3%). Like other areas in Indonesia, Kota Metro also has a high rainfall rate. It is recorded that the annual rainfall rate in this city is 2,375 millimeters with 135 rainy days [17]. Moreover, Kota Metro is crossed by four rivers, which are Way Sekampung, Way Raman, Way Bunut, and Way Batanghari. They are the main water sources for both domestic and agricultural uses. To inform, the agricultural sector, especially rice farming, is one of the dominant economic activities in Kota Metro.

Moreover, Kota Metro is inhabited by 165,193 population (2018) that are distributed throughout 22 kelurahan. The population is concentrated in the central and eastern part of the city. On the other hand, the northern and southern part have low density. The landscape of those areas is dominated by the agricultural lands. In more detail the area fragmentation and the characteristics of each area are illustrated by the following figures.



(a) (b)

Figure 4.2. (a) The area fragmentation of Kota Metro (source: modified by author); (b) The satellite image illustrating the population distribution in Kota Metro (source: [18])

Figure 4.2.a shows the orientation map of Kota Metro and the area fragmentation of this city, which consists of 22 kelurahan. The colors on the map illustrate the population density of the respective kelurahan. The dark green indicates the densely populated areas where the pale green shows

the less density. It can be viewed that the population is concentrated in the central part of the city and the density is getting less as the areas are getting farther from the city center. To validate, the satellite image obtaining from the website (https://www.google.com/earth/) also shows that the green zone appears on the northern and southern part while the central part of the city is dominated by brown color areas indicating settlements or another built environment. In more detail the population distribution in each kelurahan is presented in 4.1

Table 4.1 The population of Kota Metro in 2018 (Source: [19])

Sub district	**Village**	**Area (km2)**	**Population**	**Relative Percentage (%)**	**Density (people/km2)**
Metro Pusat	Metro	2.28	14,405	8.77	6,318
	Imopuro	1.19	6,849	4.17	5,755
	Hadimulyo Barat	1.50	14,012	8.53	9,341
	Hadimulyo Timur	3,37	8,602	5.24	2,553
	Yosomulyo	3.37	8,294	5.05	2,461
Metro Timur	Tejosari	3,76	2,855	1.74	759
	Tejoagung	1.55	5,671	3.45	3,659
	Iringmulyo	1.89	15,387	9.37	8,141
	Yosorejo	1.22	7,610	4.63	6,237
	Yosodadi	3.36	8,155	4.97	2,427
Metro Barat	Mulyojati	2.95	9,601	5.85	3,255
	Mulyosari	3.03	2,915	1.78	962
	Ganjar Agung	2.88	6,798	4.14	2,360
	Ganjar Asri	2.42	9,426	5.74	3,895
Metro Utara	Banjarsari	5.75	10,236	6.23	1,780
	Purwosari	2,55	5,536	3.37	2,170
	Purwoasri	3.62	3,996	2.43	1,103
	Karangrejo	7.72	8,494	5.17	1,100
Metro Selatan	Sumbersari	4.25	2,971	1.81	699
	Rejomulyo	4.75	4,729	2.88	995
	Margodadi	2.87	2,687	1.64	936
	Margorejo	2.46	4,964	3.02	2,018
	Total	**68.74**	**165,193**	**100.00**	

Table 4.1 illustrates that there is a wide disparity in the distribution of the population. The densely populated areas are concentrated in the city center (Metro) and its surrounding areas, such as Hadimulyo Barat. To inform, the densest area (8,141 people/km^2) in Kota Metro is kelurahan Iring Mulyo, which is located in the eastern part while the least density belongs to kelurahan Sumbersari, which is located in the southern part of the city. From the perspective of public water service provision, a large disparity in the population distribution brings a big challenge [20], [21]. The densely populated areas require a larger amount of supply. Indeed, the service provider must increase the production capacity, which implicates on the increasing production and operational cost. Besides, the densely populated areas are usually characterized by the existence of the crowded settlement areas with narrow alleys that make pipeline network and other supporting facilities are difficult to be installed. On the

other hand, in the less densely populated areas, pipeline-based water service is considered economically unbeneficial [22]. This is because the cost to deliver water to the customers cannot be covered by the revenue from the water bill.

In the case of Kota Metro, a similar tendency also appears. The existing pipe water networks and other supporting facilities are concentrated in the areas whose density are high. Meanwhile, in the low densely populated are those facilities are unavailable. To illustrate, we overlaid the existing pipe network and the population density in each village as is illustrated in figure 4.3. The figure shows the existing pipe network in Kota Metro has not covered all areas. The network is mostly concentrated in the central area while it is rarely found in the southern and the northern part. This evidence can also be interpreted that people who are not served by public water service must use other domestic water sources to fulfill their daily needs. In this case, individual groundwater exploitation is becoming a favorable water source due to its easiness to access and the absence of regulations to restrict individual groundwater exploitation.

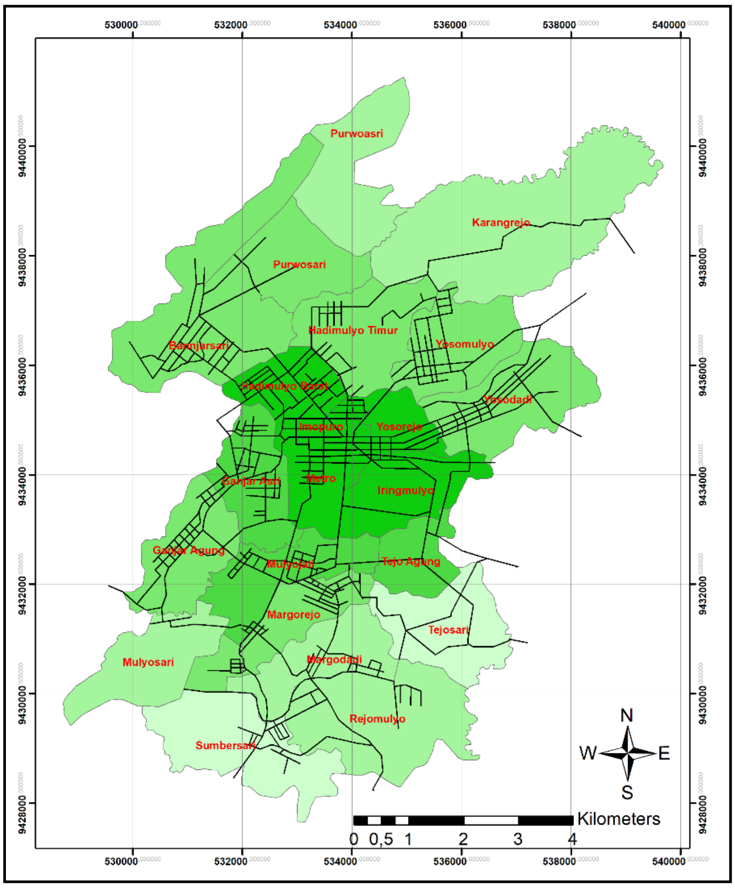


Figure 4.3 the existing pipe water network in Kota Metro (source: modified by the author)

Furthermore, we compiled data from the local government-owned water company to validate the issue of individual groundwater abstraction. We compared the historical data on the number pipe water subscribers and the number of households within the same timeline as is illustrated in figure 4.4. We intentionally verified these two categories since the number of piped water consumers is counted on a household basis rather than the number of individuals. The figure shows a wide disparity between the number of piped water consumers and the number of households. It can be clearly seen that there has been only a small improvement in the number of piped water customers from initial operation of the company from 2003 to 2018. Only 2,134 out of 42,298 households, which equal to 5.05% of households, subscribe to a public water service provided by the government of Kota Metro. Indeed, many possibilities can be subjected to explain this trend. One of the possible explanations is the service provider's inability to respond to the rapid growth of the population. As it can be seen that the population trend is continuously growing while the development of pipeline-based water service cannot balance the rapid growing demand. This could be an acceptable argument since the public water service sector in Kota Metro relies very much on the city government's budget. Thus, the domestic water sector must compete with other sectors. Up to this point, the city government puts the domestic water service as the less prioritized sector compared to other sectors such as education, public health, transportation, etc. On the other hand, the revenue from customers' payments is not sufficient to cover production and operational costs.

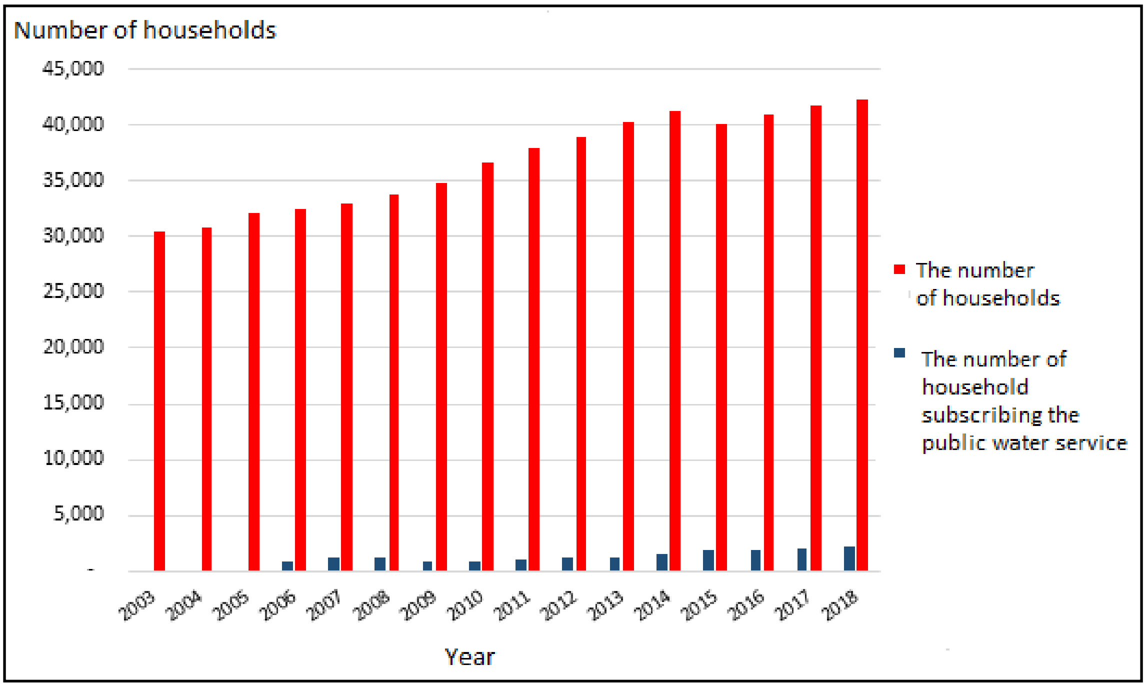


Figure 4.4 Comparison between the number of households and public water service subscribers in Kota Metro (2003-2018)

From the customer's point of view, preference and satisfaction are important factors that influence their decisions. In the case of domestic water service, the service quality plays an important role to determine the customer's willingness to pay [23]. Through this study, Devi et al concluded that the degree of customer's satisfaction level highly influences their willingness to pay that is supposed to be considered in the price formulation for domestic water service. Moreover, the people's decision to choose a certain type of domestic water source can also be intervened by a clear regulation. In the case of Kota Metro (and also Indonesia in general), the absence of clear regulations restricting individual water source exploitation combined with the low performance of the water service provider have triggered people to choose other domestic water source instead of public water service provided by the government. Indeed, this is a dilemmatic situation because the environmental degradation is inevitable if the tendency of individual groundwater abstraction continuously occurs. This research particularly takes customers' views on domestic water provision as a starting point to reveal the main cause of this trend. In more detail, further discussion on this issue is presented in the following section.

4.3.2. Data Collection and Analysis

a. Respondents' Spatial Distribution and Socioeconomic Characteristics

Our online questionnaire resulted in 110 responses from the residents of Kota Metro. In the beginning stage of the online survey, we spread the questionnaire randomly and could not intentionally design the respondents' spatial distribution as is summarized in table 4.2.

Table 4.2 The respondents' spatial distribution resulted from the online survey

Sub district	Village	Respondents	
		Frequency	**Percentage (%)**
Metro Pusat	Metro	14	12.72
	Imopuro	4	3.64
	Hadimulyo Barat	3	2.72
	Hadimulyo Timur	4	3.64
	Yosomulyo	14	12.72
Metro Timur	Tejosari	1	0.91
	Tejoagung	2	1.82
	Iringmulyo	13	11.82
	Yosorejo	2	1.82
	Yosodadi	7	6.36
Metro Barat	Mulyojati	6	5.45
	Mulyosari	2	1.82
	Ganjar Agung	5	4.55
	Ganjar Asri	10	9.10
Metro Utara	Banjarsari	4	3.64
	Purwosari	2	1.82
	Purwoasri	2	1.82
	Karangrejo	5	4.55
Metro Selatan	Sumbersari	1	0.91
	Rejomulyo	1	0.91
	Margodadi	0	0.00
	Margorejo	8	7.26
	Total	**110**	**100.00**

The respondents' spatial distribution shown in table 4.2 does not exactly represent the distribution of the population of each village in table 4.1. Indeed, this is not an ideal situation in the context of statistical representativeness. However, the respondent's willingness to respond an online survey can be seen as a voluntary participation that enable to reveal their free opinion.

Furthermore, we asked the respondents to describe their socioeconomic profile by questioning their gender, age, education, occupation, family size, and monthly income. The data on these issues is summarized in the following figure.

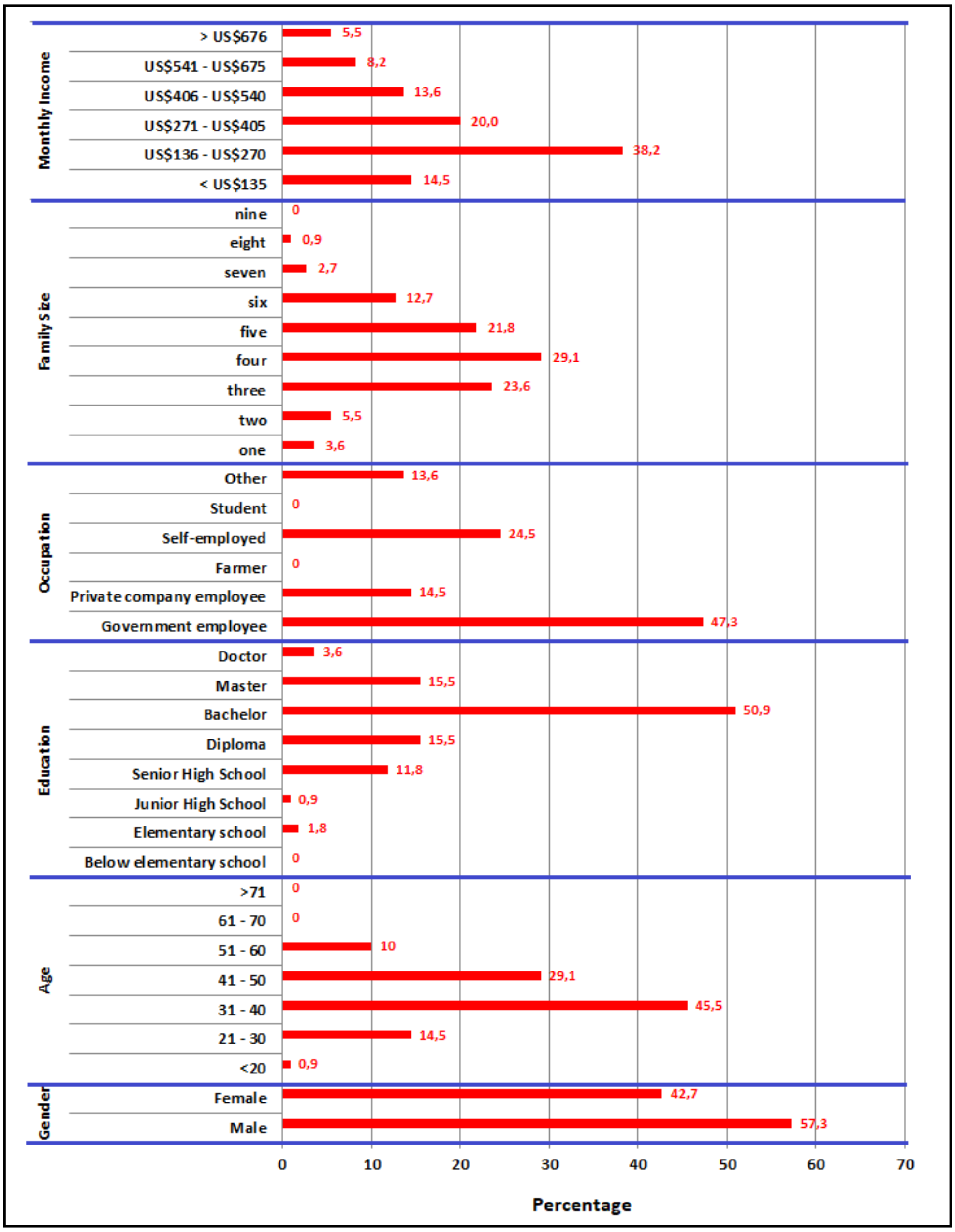


Figure 4.5. The respondents' socioeconomic characteristics from the online survey

Figure 4.5 shows a graphical representation of the respondents' socioeconomic profile resulted from the online survey. The horizontal axis expresses the percentage of each element in the vertical axis. To inform, the vertical axis is the options that are provided in the questionnaire sheets. In this survey, the proportion of male respondents slightly exceeds the female ones, where 63 respondents (57.3%) are male, and 47 respondents (42.7%) are female. They mostly come from the age group of thirties (45.5%) that is followed by the age group of forties (29.1%). The absence of elderly representation (the age group of sixties or seventies) is understandable since they are generally on active users of the internet while the low percentage of the youngsters (twenties or below) might reflect their interest on the domestic water issue although these age groups are active internet users.

In the group of education, our samples are dominated by the respondents who have higher educational backgrounds. They are 50.9% of the whole respondents who hold bachelor's degrees while the respondents who have diploma and master's degree have the same percentage (15.5%). Meanwhile, the respondents who have elementary and junior high school background shared less significant portions. The distribution of the respondent's educational background is understandable since the observation used the online survey so that people come from higher education level might be more aware to replay the questionnaire. Besides, the respondents' educational background is expected to have more knowledge and awareness on the water related issues such as environmental degradation, social justice, and so forth. Moreover, this assumption might also be strengthened by the composition of the respondent's occupation. In this group, 47.3% of respondents, which is the biggest portion, are the government employees. It is expected that they are more literate to the laws and regulations related to water issues. Then, the biggest percentage is followed by the respondents who have self-business to run, which is 24.5%. This group is assumed to have not only independence in their daily actions but also economic-oriented in their motives.

To explore the issues of the households' water consumption and their ability to pay, we asked the respondents about their family size and total monthly income. In the category of the family size, the data set is likely following a normal distribution curve. The composition of the respondents is dominated by middle size households consisting of three, four, and five family members. Meanwhile, the smallest and biggest family size contributes less significantly to the whole sample. On the other hand, the category of the monthly income is dominated by the respondents who come from the middle-to-low-income group. The biggest portion, which is 38.2%, comes from the respondents with the income IDR 2,000,001 to IDR 4,000,000 in a month (approximately equals to USD 136 – USD 270). Then, it is followed by the respondents with the monthly income IDR 4,000,001 to IDR 6,000,000 (USD 271 – USD 405). They contribute twenty percent of the whole sample. The profile of the dataset in the family size and monthly income might imply that the respondents have a moderate amount of the water requirement, but they have a middle-to-low financial capacity.

After gaining the information about the respondents’ personal background, we started our investigation by questioning the respondents’ choice of domestic water source for daily use. In the questionnaire sheets, the responses were clustered into four groups, i.e., piped water, borehole, dug well, and bottled water. These types of water sources met our expectations, where piped water represents the public water service, borehole and dug well reflect individual groundwater exploitation, and bottled water represents water provided by private enterprises. To distinguish, a borehole refers to a deep well (usually more than 50 meters) that is constructed by mechanical drilling and is equipped with electric water pump while a dug well refers to a shallow dug well (about 10 meters) that use small water pump or without water pump. Despite these technical features, both borehole and dug well essentially has similarity in term of individual groundwater abstraction.

(a) (b)

Figure 4.6. (a) A dug well belonged to one of the residents of Kota Metro.

(b) A communal bored well built by the government of Kota Metro

b. Respondents’ Preferences of Domestic Water Sources

After recognizing the respondents’ spatial distribution, we continued the investigation to the issue of the respondents’ daily domestic activities e.g., drinking, cooking, showering, and so forth. We questioned the respondents about what kind of water source they utilize to fulfill the water needs for these routines. Some respondents answered that they use more than one source. For example, the respondent consumed the bottled water for drinking and cooking but he or she relied on the dug well for other activities. That is why we obtained 152 answers about the main water sources for daily uses while the total respondents are only 110 participants. The data is illustrated by figure 4.7.

The pie chart shows the proportion of the domestic water sources that are used by the respondents. The result shows that dug wells are the most preferable domestic water source. There are 64 respondents (42.11% of the total responses) confessed that they use private dug wells as the main domestic water source. The proportion is then followed by the individual boreholes (43 respondents) and bottled water (29 respondents). By contrast, the respondents who are pipe water subscribers share the lowest portion to the total samples. It was recorded that only 16 respondents (10.53% of the total responses).

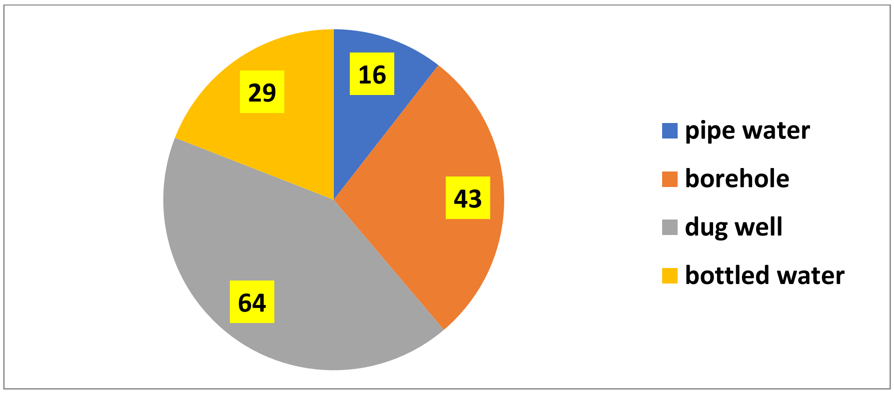


Figure 4.7 the number of the respondents based on their main domestic water sources

Furthermore, we investigated the respondent's reasons of using a certain type of domestic water source. We clustered the respondents' answers into five categories. They are reliable quantity, good quality, affordable price, easy access, and no other choice. In general, the quality of the water is the strongest motive to choose a certain type of domestic water source. In this survey, we found that 47.79% of respondents considered the water quality as the main reason. Then, it is followed by the easiness to access the water source (30.26%). This evidence essentially explain why individual groundwater exploitation is dominant since this water source is considered to have the best quality. Besides, they can easily bore or dug the well on their property without any restriction from the government.

Subsequently, we plotted the information to the cross-tabulation table as illustrated in the table 4.3. The respective cell in this table shows the intersection between two categories (type of domestic water source and the reason of using it). We found that the biggest portion (24 responses) belonged to the respondents who use dug wells and have reason of easy access. The same percentage also comes from the respondents who consume bottled water because of its good quality. On the other hand, we did not find the bottled water users who reply that they consume this kind of domestic water source because of reliable quantity or affordable price. To be more in detail, the data is summarized as follows.

Table 4.3 The cross-tabulation between the respondent's main water sources and the reason of utilization

Domestic water source	Respondent's reasons					Active margin
	Reliable Quantity	Good Quality	Affordable Price	Easy Access	No Other Choice	
Piped Water	1(0.66%)	4(2.63%)	2(1.32%)	9(5.92%)	0(0.00%)	16(10.53%)
Borehole	11(7.24%)	14(9.21%)	1(0.66%)	10(6.58%)	7(4.51%)	43(28.29%)
Dug Well	12(7.89%)	20(13.16%)	7(4.51%)	24(15.79)	1(0.66%)	64(42.11%)
Bottled Water	0(0.00%)	24(15.79%)	0(0.00%)	3(1.97%)	2(1.32%)	29(19.08%)
Active margin	**24(15.79%)**	**62(40.79%)**	**10(6.59%)**	**46(30.26)**	**10(6.59)**	**152(100.00%)**

Table 4.3 can be interpreted in either the horizontal or the vertical direction. The active margin in the last row shows the various reasons stated by the respondents while the active margin in the last column shows the various types of daily water source. The rows can be used to analyze the data based on the type of domestic water source clustering while the columns are useful to see the data based on the reason clustering. For example, most of pipe water subscribers confessed that use this domestic water source because of its easy access, which is the same reason with the dug well users. On the other hand, both borehole and bottled water users said that the good quality is the strongest reason of using these kinds of domestic water sources. The vertical direction particularly expressed that the dug well users dominated in almost all group of reason except the good quality. It implies that the dug well users gave significant influence to shape a general trend in the structure of the data due.

Apart from its simplicity, table 4.3 has a limitation to show statistical expressions explaining the relationship between assessed categories. To overcome this constraint, we did a statistical examination, which is the correspondence analysis, to analyze the relationship between the domestic water utilization and the reason. The summary of the calculation is presented in the following table.

Table 4.4 The summary of the correspondence analysis calculation

Dimension	Singular Value	Inertia	Chi Square	Sig.	Proportion of Inertia		Confidence Singular Value	
					Accounted for	Cumulative	Standard Deviation	Correlation
1	0.447	0.200			0.623	0.623	0.063	0.009
2	0.332	0.110			0.344	0.967	0.080	
3	0.103	0.011			0.033	1.000		
Total		0.321	48.734	0.000[a]	1.000	1.000		

[a] 12 degrees of freedom

Table 4.4 is the summary of the calculation on the assessed categories using a computer software SPSS (Statistics Package for Social Science) version 23. The most important feature of this calculation is the proportion of inertia for the dimension 1 and dimension 2 are 0.623 and 0.344. This means that the calculation is accounted for 96.7% of the total sample. Furthermore, the significance of the data set is estimated at 0.000, which is less than 0.05. This value is considered as statistically significant. Afterwards, the correlation between the respondent's preferable domestic water source and the reason of the utilization is articulated in a scatter plot graph as is illustrated by figure 4.8.

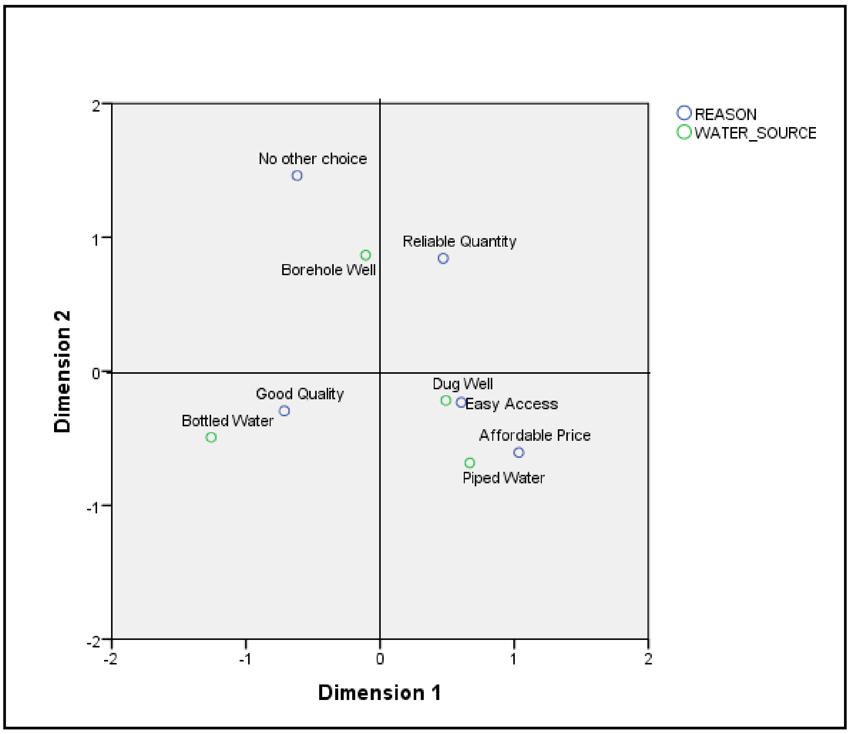


Figure 4.8 The scatter plot of the water source-reason correspondence analysis.

Figure 4.8 shows the relationship between the examined categories. The two categories, which are the respondents' domestic water source preference and their reason of utilization, are represented by green and blue circles. In general, a closer distance between two different color circles indicates a stronger relationship between them. For instance, the preference 'dug well' is closely located to the reason of easy access. It implies that the motivation of dug well users was dominated by easy access compared to other reasons. The same analysis can be employed to the other water source options, i.e. piped water, bottled water, and borehole well. Bottled water was strongly correlated with good quality, piped water was closely correlated with affordable price, and borehole well was correlated with reliable quantity and no other choice. Figure 4.8 also shows that the source borehole and the reason no other choice is located in the same quadrant. Meanwhile, the sources piped water and dug well are in the same quadrant as the reasons affordable price and easy access. Thus, it can be interpreted that these items were closely related.

After examining the relationship between the respondent's main domestic water source and the reason of utilization, we analyzed if the respondent's socioeconomic background has an influence on his or her preferences of domestic water use. Thus, the respondent's preference of domestic water source is assessed in accordance with the data summarized in figure 4.5. The respondents' educational background, occupation, and total income presumably represent the social stratification that commonly appears in the community. It can also reflect the way of decision making in the household, in this case related to the choice of domestic water source. To specify, educational background and occupation are presumably associated with the respondents' knowledge and awareness of important issues such as health and environmental degradation. Nevertheless, this assumption should be tested by assessing whether these elements significantly correspond with an environmentally friendly choice of domestic water source. Furthermore, family size and total monthly income aimed to represent the economic situation of the households. Family size is obviously related to the amount of water consumption while total monthly income is closely related to the household's ability to pay the water bill.

Table 4.5 The cross-tabulation table between the respondents' socioeconomic background and their domestic water source

Socioeconomic profile	Domestic water source			
	Piped water	**Borehole well**	**Dug well**	**Bottled water**
Education				
Elementary school	0	0	2	0
Junior high school	0	0	1	0
Senior high school	2	4	9	3
Diploma	3	6	5	2
Bachelor	8	21	35	19
Master	1	11	10	5
Doctor	2	1	2	0
Total	**16**	**43**	**64**	**29**
Occupation				
Government employee	12	22	27	17
Private company employee	1	6	10	5
Entrepreneur	2	9	15	3
Others	1	6	12	4
Total	**16**	**43**	**64**	**29**
Family size				
1	2	1	3	3
2	1	1	5	1
3	4	11	12	6
4	6	13	15	6
5	2	10	12	4
6	0	5	14	6
7	1	1	3	2
8	0	1	0	1
Total	**16**	**43**	**64**	**29**
Total monthly income				
Less than IDR 2,000,000	1	6	5	2
IDR 2,000,001 to IDR 4,000,000	5	10	22	10
IDR 4,000,001 to IDR 6,000,000	3	11	17	6
IDR 6,000,001 to IDR 8,000,000	2	8	11	4
IDR 8,000,001 to IDR 10,000,000	4	5	6	5
More than IDR 10,000,001	1	3	3	2
Total	**16**	**43**	**64**	**29**

This data summary shows the distribution of the respondents' socioeconomic profiles, which is dominated by the middle-class group. Related to the education level, for instance, half of the total respondents stated that their highest education level was bachelor while the others were distributed among various other levels of education. A similar trend also appeared related to family size and total monthly income. The values related to these indicators were also concentrated in the middle range. Meanwhile, most respondents were government employees.

Furthermore, we conducted a correspondence analysis to show whether the socioeconomic factors (education, occupation, family size and monthly income) correspond to a certain choice of water source. Similar to the analysis of the respondents' preferences and reasons that is previously conducted, the procedure was started by generating a cross-tabulation table that correspond each element with the preferable domestic water use. Subsequently, the table is plotted into the scatter plot graph.

It can also be seen that domestic water source preference is dominated by individual groundwater exploitation, as represented by borehole wells and dug wells. Socioeconomic indicators such as education did not significantly contribute to determining the reason 'more environmentally friendly'. To be specific, the data show that respondents who have a higher education background still dominantly utilize borehole wells and dug wells for their daily water needs. The same tendency appeared when the respondents' occupation was assessed. Most respondents were government employees but few of them utilized the public water service, while they are supposed to be more aware that it is better to use piped water and even campaign for it. Related to family size, it is understandable that households consisting of more people tend not to choose piped water because of the insufficient quantity of water provided by the public water service. On the other hand, the indicator of lower purchasing power causing people's reluctance to use the public water service is not fully correct. The data show that in all income groups, the number of public water service subscribers is always the smallest. It is even always smaller than the number of bottled water consumers, whereas bottled water is far more expensive than piped water.

In more detail, the scatter plot graph corresponding the respondent's educational background and the domestic water source preferences is illustrated figure 4.9. The correspondence between the respondent's educational background and his or her preference for the domestic water use can be interpreted by measuring the closeness between points. Figure 4.9 shows the points are flocked close to the origin implying that all elements give a significant contribution to the whole tendency. By looking at the closeness between the two categorical data, it can be seen that the respondents with a senior high school, bachelor, or master background tended to use dug wells, bottled water, and borehole wells. By contrast, the point representing piped water is located relatively far from any kind of educational background indicating a weak correspondence between pipe water users and the educational background.

This result is not in line with our previous assumption. Our initial assumption was that a higher education would raise the respondents' awareness of contemporary water issues such as social justice and environmental degradation. However, this assumption is not confirmed by the scatter plot considering that the individual groundwater abstraction is still preferable for them rather than public water service.

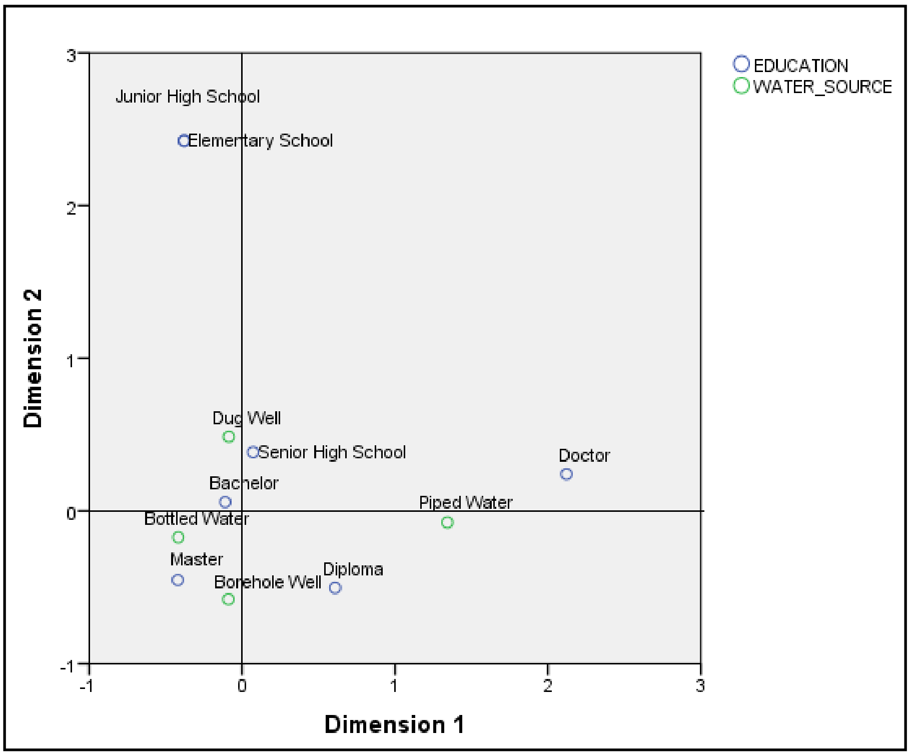


Figure 4.9 the scatter plot of the respondents' educational background and the preferences of the domestic water sources

Furthermore, there is a distinction in the category of the respondent's occupation compared to the category of the respondent's educational background as is illustrated by 9.10. The scatter plot graph shows that the dots are located dispersedly showing a weak correlation between two assessed categories (occupation and water source). Furthermore, the dots have relatively similar distance to the origin. It can be interpreted that a certain type of occupation does not show a tendency to choose one type of domestic water source. Thus, the initial assumption also does not fully match with this result. It is presumable that the government employees are more concern to the contemporary water related issues. However, the respondents who are government employees is located closer to borehole rather than piped water indicating that they prefer borehole to piped water due to a certain reason. Referring to table 4.6, the reliable quantity is the strongest reason for those choose the borehole as their main domestic water source.

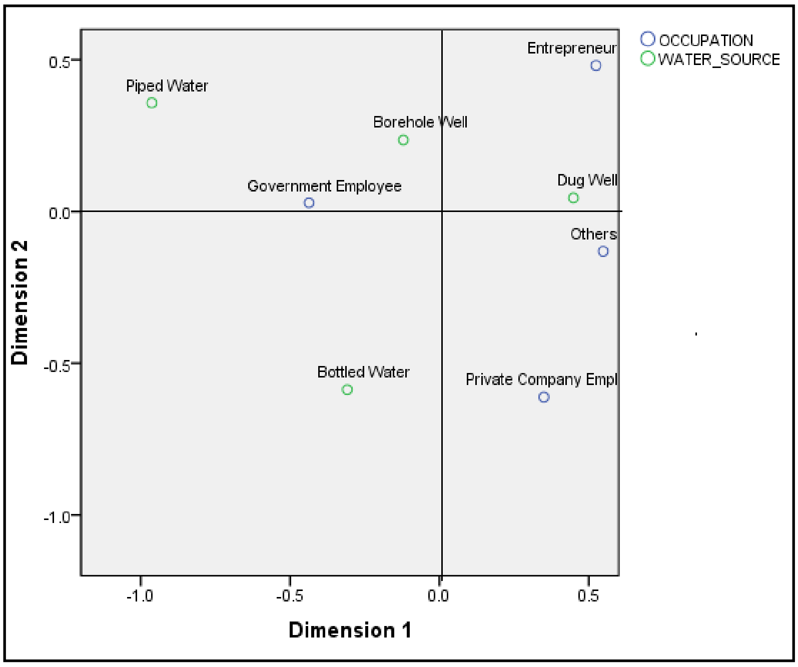


Figure 4.10 the scatter plot of the respondents' occupation and the preferences of the domestic water sources

Moreover, the correspondence analysis on the category of the respondent's family size and the preference for the domestic water utilization is presented in figure 4.11. The figure shows the points representing the respondent's family size are spreading around the origin. It implies that their contribution is relatively equal with the exclusion of the respondents with eight family members.

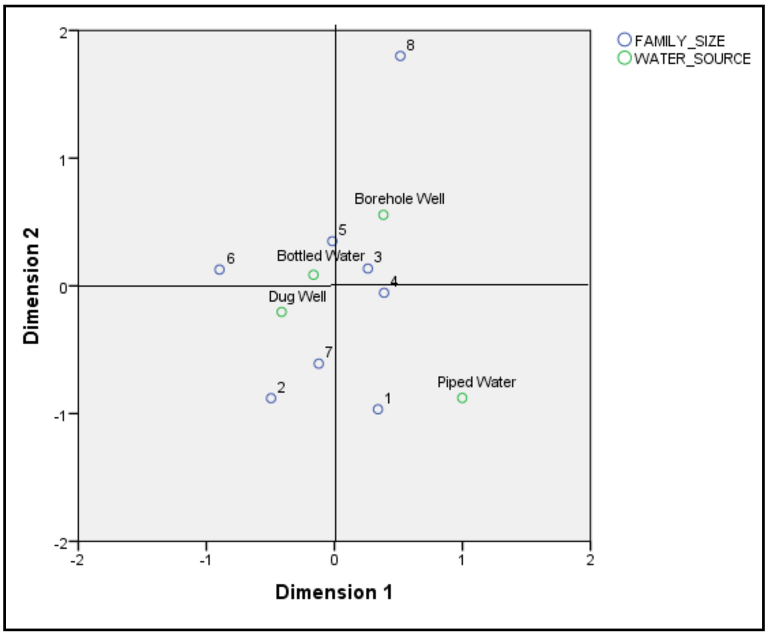


Figure 4.11 the scatter plot of the respondents' family size and the preferences of the domestic water sources

The same tendency also appears in the category of the respondent's main water source. All types of the respondent's domestic water sources except piped water are also located surrounding the origin. Furthermore, the respondents with three, four, and five family member look like have the same distance either to borehole or to bottled water. It can be interpreted that those types of domestic water source are preferable for the respondents more or less at the same level. So, middle size families tend to use borehole to satisfy their needs because of its reliable quantity and bottled water for the sake of its good quality or practicality.

On the other hand, the respondents who have more family members (six and seven) are located nearer to dug well than to bottled water or to borehole. It is understandable since more family members mean more water consumption implicating on more cost to expense. Therefore, they prefer dug wells considering borehole and bottled water are more expensive that the dug well. On the other hand, the respondents with less family members (two) choose dug well because they have less water consumption and the dug well is still able to satisfy their daily needs.

The last respondent's socioeconomic background that we assessed is the monthly income. This item is chosen considering the fact that the level of financial capacity correlates to the purchasing power that might influence people's lifestyle as well as their preferences. The correspondence analysis on this issue is illustrated by figure 4.12.

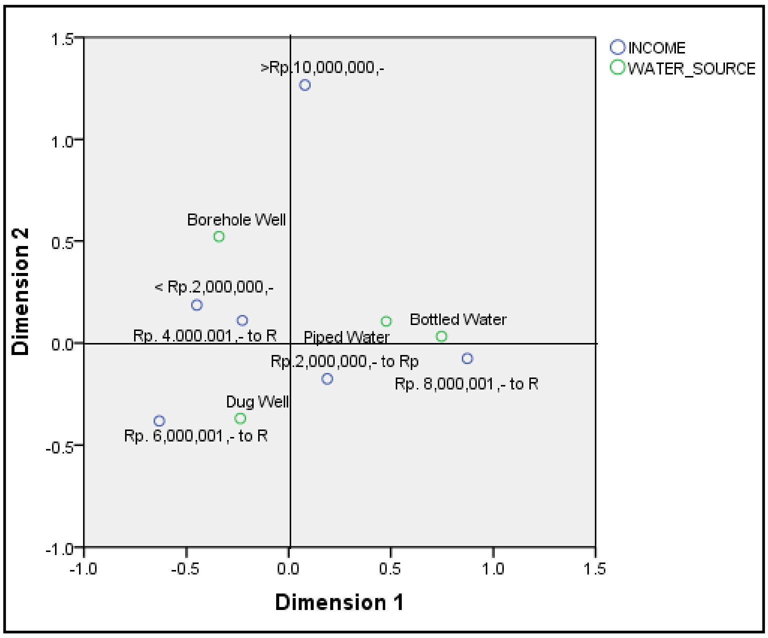


Figure 4.12 the scatter plot of the respondents' monthly income and the preferences of the domestic water sources

The figure shows the more clustered pattern similarly to the categories of education, family size, and monthly income. The dots are located close to the origin. To specify, dug well and piped water are located closer to the origin compared to borehole and bottled water. It can be interpreted that the dug well and piped water are more preferable. This is understandable because these types of domestic water sources are considered cheaper compared to borehole or bottled water. This is supported by the evidence showing the dot representing respondents with the monthly income from IDR 2,000,001 to 4,000, 000 is located most closely to the origin. This is an indicator that this group of income shared the most significant portion to the whole sample. Unsurprisingly, the most economical domestic water sources such as dug well, or pipe water service are the most preferable choice.

4.3.3. Assessing the Pipe Network Accessibility

Besides socio-economic background, another element that was investigated was access to the public piped water network. We distinguished those two factors as internal and external elements that may influence people's preferences. To assess the external trigger, we asked the respondents' opinions about the accessibility of the public piped water network. Four qualitative answers were provided in accordance with the respondents' opinions on piped water network accessibility. The answers were: (1) Yes, at a close distance, (2) Yes, at a far distance, (3) No access, (4) Do not know. The respondents' answers would be subjective since they could not use a quantitative measurement. However, this question was intended to reveal the respondents' opinions and to assess whether their opinion influences their preference.

Furthermore, we examined the respondents' opinions on their public water accessibility and their preference for a domestic water source for daily use. Correspondence analysis was also employed here to analyze the relationship between public water service accessibility and the respondents' preferences. We first mapped the categories into a correspondence table and subsequently plotted the data into a scatter plot. The following table illustrates the correspondence between the two categories.

Table 4.6 The correspondence table of the respondents' access to the pipe network and their domestic water sources

Access to piped water network	**Domestic water source**			
	Piped water	**Borehole well**	**Dug well**	**Bottled water**
Yes, at a close distance	16	15	30	10
Yes, at a far distance	0	9	7	10
No access	0	14	14	6
Do not know	0	5	13	3
TOTAL	**16**	**43**	**64**	**29**

Table 4.6 shows that piped water customers are strongly motivated by the accessibility of the piped water network. The most obvious evidence is that the piped water users come from areas where piped water is available at a close distance, which is shown by the intersection of both categories in the table. However, the existence of this network has not been able to attract more customers. In fact, respondents who stated that the piped water service is available at a close distance (the first row) are also using other water sources instead of the public piped water service. In this category, the number of respondents who consume water except piped water is far higher than the number of piped water consumers. To give a clearer illustration of the relationship between piped water accessibility and main domestic water source, we provide a scatter plot derived from the correspondence analysis in Figure 4.13.

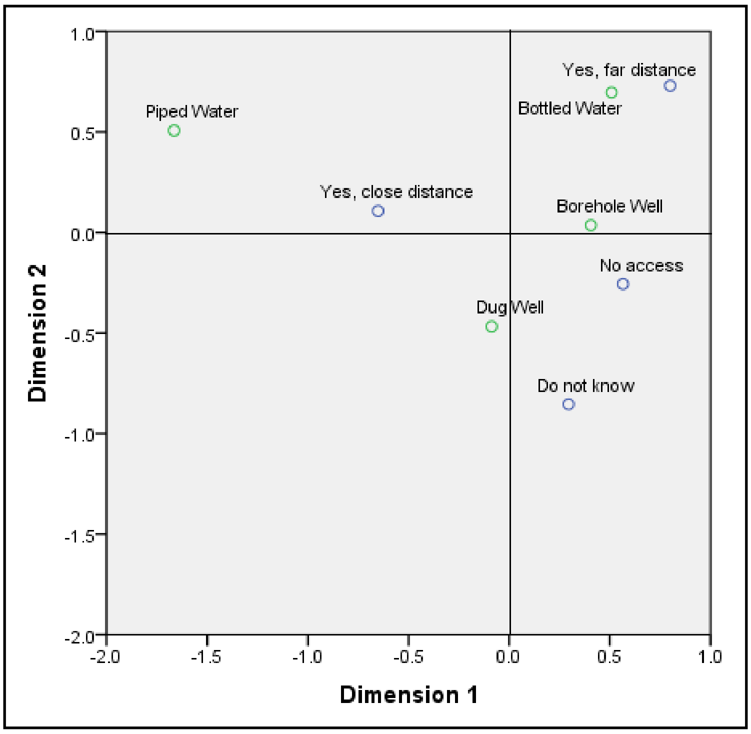


Figure 4.13 the scatter plot of the respondents' access to pipe network and the preferences of the domestic water sources

Presumably, the dot that represents piped water accessibility is located close to piped water as the main water source. However, figure 4.13 shows that these two dots are not located close to each other. Hence, the assumption is not fully correct. The dot representing piped water is far from all options in the category of piped water accessibility. It implies that the pipe network availability does not significantly influence the respondent's preference on the piped water. At this point, the effect of piped water accessibility puts into question whether this kind of infrastructure is optimally functioning and is able to intervene in people's choice of water source. On the other hand, bottled water customers and borehole well users are clustered in the same quadrant as the respondents with piped water accessibility at a far distance. This implies that there is a strong correlation between them. A similar clustering pattern also appears in the case of dug well users, i.e., the respondents who said they had no access to the piped water network and those who were not well informed about piped water availability in the surroundings their house.

To validate this trend, we also performed Person correlation analysis to measure the significance of pipe network availability to the respondent's choice of domestic water source. The calculation of the Pearson correlation analysis is presented in table 4.7.

Table 4.7 The correlation between respondent's access to pipe water network and main water sources based on the Pearson Correlation Analysis

		Access to pipe water network	Main water source
Access to pipe water network	Pearson Correlation	1	0.139
	Significance (2-tailed)		0.088
	N	152	152
Main water source	Pearson Correlation	0.139	1
	Significance (2-tailed)	0.088	
	N	152	152

The basic principle of the Pearson correlation value is expressing within the interval -1 to +1. To interpret, 1 is to express that two variables are perfectly correlated while the negative or positive mark shows the type of correlation. By contrast, if the two variable is entirely not correlated the value of the Pearson correlation is 0. The assessment of the dataset gained from the online survey resulted in the Pearson correlation value 0.139. It implies that the existence of the pipeline network in Kota Metro is positively correlated with the people's preferences of the domestic water source. However, they are merely a weak correlation. On the other hand, the existence of the pipeline network cannot strongly influence people to choose a certain type of domestic water fulfillment, in this case the pipeline-based water service provided by the city government.

4.3.4. Assessing the Respondents' Satisfaction Level

The next step conducted in this study is assessing the respondents' satisfaction level to their current domestic water utilization. Three categories are assessed to measure the respondent's satisfaction level. They are quantity, quality, and price. We provided one-to-ten interval to the respondents to express their opinion about their current water use. For the categories of the quantity and quality, the respondent can give the score 1 if they are very dissatisfied and 10 if they are very satisfied with their water source. Meanwhile, in the category of the price, 1 is the representation of the very cheap price and 10 is the representation of very expensive price. Then, the responses are analyzed through a descriptive analysis illustrating by boxplots with the assistance of SPSS (version 23) software. In more detail, the results are discussed as follows.

a. Assessment on the Category of the Water Quantity

The assessment of the respondent's satisfaction level on the category of water quantity is illustrated by figure 4.14. The trend generally shows the high satisfaction level of all types of domestic water sources. To specify, the highest satisfaction level comes from the bottled water users with the average score of satisfaction level is 8.81. Moreover, the boxplot representing the bottled water users has the narrowest range (from 8 to 10). It implies that the bottled users almost never have problem to get bottled water within the desirable volume. Besides, the narrow range also shows that their opinion on the water quantity is relatively uniformed. Then, the second highest score is occupied by the private borehole users with the average satisfaction level is 8.69 but the score to express the satisfaction level for this type of water source is dispersed from 5 to 10. By contrast, the pipe water users expressed the lowest satisfaction level, which is only 7.60 even though they have a similar range to the private borehole users. Moreover, the position of the box of the pipe water users is the lowest compared to other categories strengthening the conclusion that the pipe water users have the lowest satisfaction level regarding its water quantity. Lastly, the dug well users has the widest range (from 4 to 10) in expressing their satisfaction level indicating a wide variety of satisfaction level.

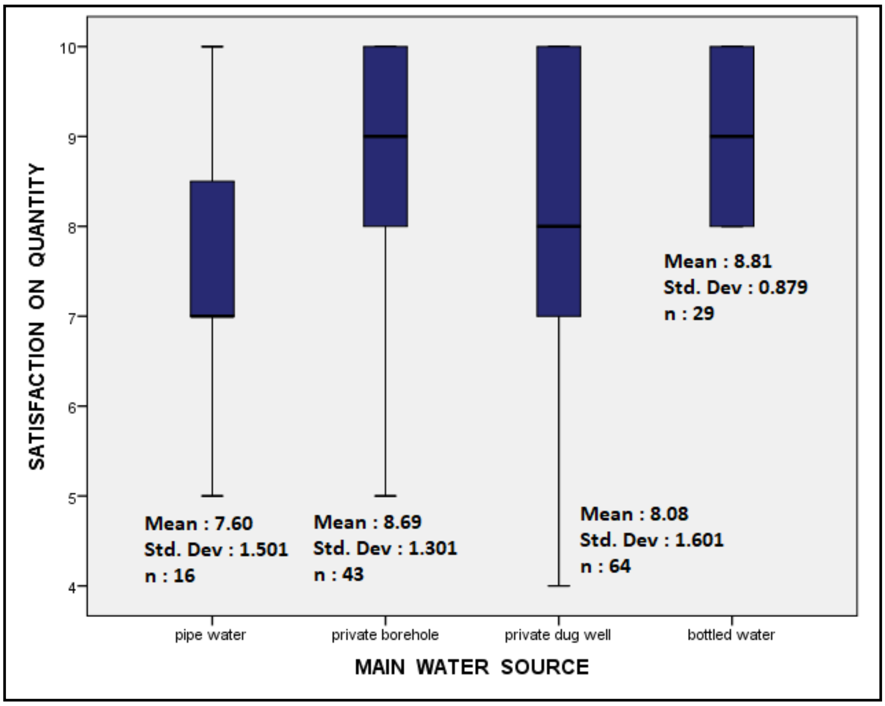


Figure 4.14 The boxplots of the respondent's satisfaction level on the category of the water quantity

b. Assessment on the Category of the Water Quality

The assessment of the respondent's satisfaction level on the category of the water quality is presented in figure 4.15. There are some similar trends in this category compared to the previous one. Similar to the assessment on the category of the water quantity, the highest satisfaction level in the category of the water quality is also occupied by the bottled water users with the average score 8.67. Besides, the respondents who use bottled water also gave their opinion within the narrowest interval (from 7 to 10) compared to the other types of the domestic water sources. By contrast, the pipe water users have the most dispersed opinion in expressing their satisfaction level on the issue of the water quality, which is from 3 to 10. It implies that the existing pipe water service has not been able to fully meet the customer's expectation regarding the water quality. In addition, this public water source also has the lowest average score (7.25) compared to the others although it can still be classified as moderate-to-high satisfaction level.

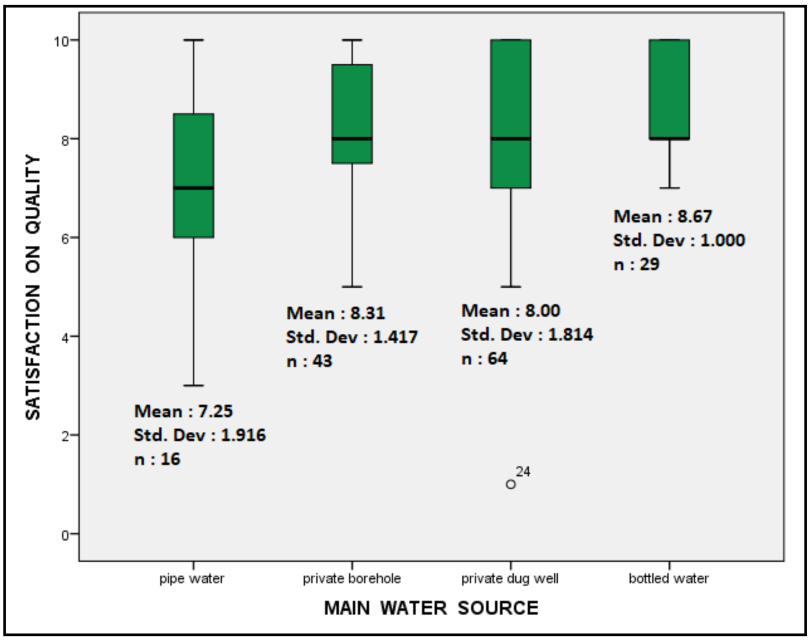


Figure 4.15 The boxplots of the respondent's satisfaction level on the category of the water quality

c. Assessment on the Category of the Water Price

In the category of the water price, the dug well users considered that their domestic water source is the cheapest one despite some outlier data existed. The average score given by the respondents who use this domestic water source is 2.79, which can be categorized as very cheap. By contrast, the bottled water users answered that their domestic water source is the most expensive one. The average score that is given is 5.41 (moderately expensive). Besides, there is no wide variety regarding the score that they gave (the interval is from 4 to 7). In detail, the assessment of the respondent's satisfaction level on the water price is presented in figure 4.16.

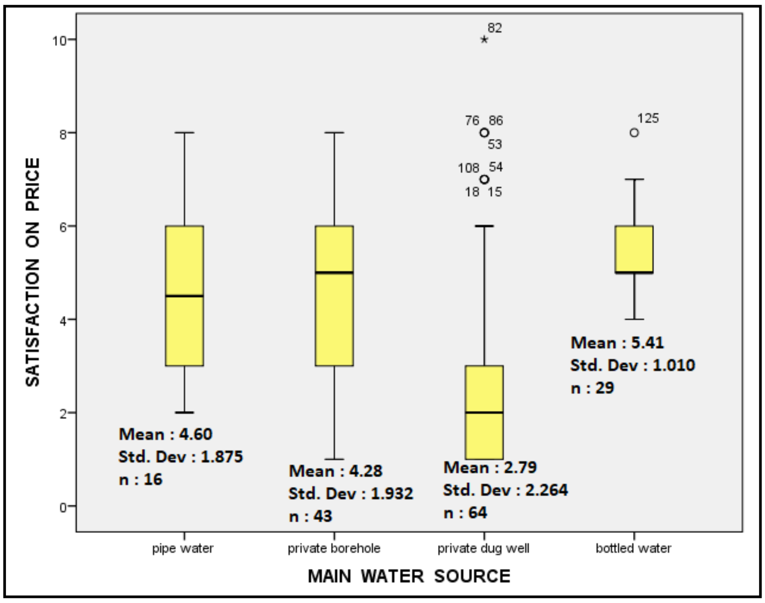


Figure 4.15 the boxplots of the respondent's satisfaction level on the category of the water price

Furthermore, the boxplot shows that the second cheapest domestic water source is pipe water. Unlike the previous two categories, the variation of the respondent's answers is not the widest. In the category of the water price, the widest range of the satisfaction level (from 1 to 8) is expressed by the borehole users.

4.3.5. Considering the Community Preferences to Improve Public Water Provision

The development of public water provision in Kota Metro formerly is dominated by a rational technical approach that is more focused on the supply side. This might be considered scientifically objective in spite of the huge investments and advanced technology required. However, the development of the domestic water sector has not been able to satisfy the increasing demand. Therefore, other approaches are needed to accelerate the development of the domestic water sector. The findings of this study can be used as a starting point to formulate the improvement strategies employing other approaches rather than the supply-side management approach.

The findings of this study particularly show that a certain choice of water source is related to a specific reason. For instance, affordable price is closely correlated to piped water. It can be interpreted that there is sufficient consumer purchasing power to use the public water service, the price of which is currently considered the main cause of the community's reluctance to subscribe to the public water service. This finding can also be used as a consideration to re-evaluate and recalculate the current water price, based on the question whether it is still reasonable to let the production cost be fully covered by customers. Meanwhile, quality and quantity respectively are correlated to bottled water and borehole wells. Up to this point, the water quality and quantity provided by the public water service need to be evaluated since they strongly determine the community's decision not to choose piped water to fulfill their daily water needs. Both the quantity and quality aspects of the public water service should be of great concern since they seem to be essential factors that influence the community's preference and expectations rather than the price. From the perspective of accessibility, dug well users stated that easy access is the most important reason for them, while the respondents tended to use a borehole well because they had no other choice.

Furthermore, socioeconomic background also contributed to the respondents' preference. This factor influences their lifestyle as well as their decisions. For instance, low-income groups would be economically rational if they chose the cheapest way to fulfill their needs, while high-income groups would be expected to demand a higher level of satisfaction when they seek a certain good or service. In this research, we found that the same premises held true in the issue of domestic water fulfillment. This can be considered when improvement strategies are formulated. Service diversification, for instance, could be considered, instead of providing one single type of service. The small number of public water service customers that currently exist may be caused by the fact that the available service is merely suitable for a certain group and does not fit the other groups. Further research is required to confirm or contradict this premise.

Eventually, improvement strategies for the public water service provider will result in piped water network expansion. The findings of this study can be employed as input to evaluate whether the existing piped water network functions optimally and as planned. To specify, the Pearson correlation analysis shows that the correlation between pipe water network availability and the choice of the domestic water uses is weak although they are positively correlated. Henceforth, a network expansion scenario can be formulated in accordance with the community's preferences, where piped water accessibility corresponds to public water service utilization. This prioritization approach is also an alternative to overcome the problem of budget limitations, which is the most common reason for the limited piped water network coverage.

4.4. Conclusions

This study showed that the respondent's water source preference was closely related to certain motives. Piped water was closely correlated with affordable price while dug well was correlated with easy access. Moreover, good quality and reliable quantity were correlated with bottled water and borehole well, respectively. In addition, those who have no other choice tend to choose borehole well. The assessment of the respondents' socioeconomic background shows that their educational background, income, and family size had a significant influence on the choice of water source while the respondent's occupation did not have a significant influence. A similar tendency was also visible when piped water accessibility was assessed.

The establishment of a public water service in Kota Metro has been unable to trigger people to change the most popular choice of domestic water source, i.e., individual groundwater exploitation. Obviously, this is not a favorable trend, and this issue should be carefully managed. The community's preference, as discussed in this research, can be combined with technical aspects such as the spatial distribution of the population, socioeconomic profiles, and existing public water service availability, to formulate improvement strategies for the development of public water provision.

Furthermore, this research tried to elaborate the influencing factors and their correlation with the respondents' motives for choosing a certain domestic water source. The correspondence analysis conducted in this research did not reveal any quantitative mathematical relationship between these categories. Nevertheless, the scatter plots from the analysis can more easily be read and interpreted the relation among assessed categories. Therefore, the findings are useful for local governments or other relevant parties for future public water service improvement. The findings of this research can potentially be considered in planning public water service expansion as well in formulating alternative strategies. Involvement of various interest groups and stakeholders is highly suggested in the case study area rather than applying the traditional approach, which relies strongly on technical aspects and requires huge investments.

The results of this study validated the triangular model of urban water sustainability, especially concerning the issue of associating infrastructure accessibility with achievement of equitable access and cost. The empirical evidence showed that inadequate infrastructure encourages people to seek alternatives to fulfill their daily water needs. Nevertheless, this preliminary study is supposed to be validated by a field survey due to some limitation attached to the online survey. Besides for confirming the initial findings, the field survey also enables to reveal the residents' opinion more deeply on the current situation of domestic water fulfillment as well as their expectation of desirable situation.

References

[1] UNICEF and WHO, "25 Years Progress on Sanitation and Drinking Water : 2015 Update and MDG Assessment," Geneva, 2015.

[2] BPS, "Statistik Kesejahteraan Rakyat 2018 (Welfare Statistics 2018)," Jakarta, 2018.

[3] R. N. Gejl, M. Rygaard, H. J. Henriksen, J. Rasmussen, and P. L. Bjerg, "Understanding the impacts of groundwater abstraction trough long-term trends in water quality," *Water Res.*, vol. 156, no. 2019, pp. 241–251, 2019.

[4] A. Menció and J. Mas-Pla, "Influence of groundwater exploitation on the ecological status of streams in a Mediterranean system (Selva Basin, NE Spain)," *Ecol. Indic.*, vol. 10, no. 2010,

pp. 915–926, 2010.

[5] S. S. Sayre and V. Taraz, “Groundwater depletion in India: Social losses from costly well deepening,” *J. Environ. Econ. Manage.*, vol. 93, no. 2019, pp. 85–100, 2019.

[6] F. Alihar, “Penduduk dan Akses Air Bersih di Kota Semarang (Population and Access to Clean Water in Semarang City),” *J. Kependud. Indones.*, vol. 13, no. 1, pp. 67–76, 2018.

[7] N. Gusdini, M. Y. J. Purwanto, K. Murtilaksono, and Kholil, “Water Governance Model in Small City: Review at District Bekasi- Indonesia,” *Theor. Empir. Res. Urban Manag.*, vol. 12, no. 1, pp. 38–52, 2017.

[8] O. Romano and A. Akhmouch, “Water Governance in Cities: Current Trends and Future Challenges,” *Water*, vol. 11, no. 2019, pp. 1–9, 2019.

[9] A. Akhmouch and F. N. Correia, “The 12 OECD Principles on Water Governance: When Science Meets Policy,” *Util. Policy*, vol. 43, no. 2016, pp. 14–21, 2016.

[10] N. G. Leigh and H. Lee, “Sustainable and Resilient Urban Water System: The Role of Decentralization and Planning,” *Sustainability*, vol. 11, no. 3, pp. 1–17, 2019.

[11] I. R. Abubakar, “Factors Influencing Households Access to Drinking Water in Nigeria,” *Util. Policy*, vol. 59, no. 2019, pp. 40–51, 2019.

[12] W. F. Vasquez and E. A. Adams, “Climbing the Water Ladder in Poor Urban Areas: Preference for Limited and Basic Water Service in Accra, Ghana,” *Sci. Total Environ.*, vol. 673, no. 2019, pp. 605–612, 2019.

[13] L. Li, C. S. Li, and D. Wichelns, “Assessing household willingness to pay for bottled water in rural areas of the Mekong Delta, Vietnam,” *Water Resour. Rural Dev.*, vol. 7, pp. 36–49, 2016, doi: 10.1016/j.wrr.2016.03.001.

[14] L. A. E. J. M. Li, “The drivers of households drinking water choices in Singapore: Evidence from multivariable regression analysis of perceptions and household characteristics,” *Sci. Total Environ.*, vol. 671, pp. 1116–1124, 2019, doi: 10.1016/j.sciotenv.2019.03.351.

[15] J. R. Evans and A. Mathur, “The value of online surveys,” *Internet Res.*, vol. 15, no. 2, pp. 195–219, 2005, doi: 10.1108/10662240510590360.

[16] www.dlpng.com, “Peta Indonesia (The Map of Indonesia),” 2020. https://dlpng.com/png/6413599 (accessed Jul. 19, 2020).

[17] Bank Data Kota Metro, “Jumlah Crah Hujan dan Hari Hujan di Kota Metro Tahun 2014-2016 (Rainfall rate and the numbers of rainy days in Kota Metro 2014 - 2016),” 2016. https://data.metrokota.go.id/2017/12/13/jumlah-curah-hujan-dan-hari-hujan-menurut-bulan-di-kota-metro-tahun-2016/ (accessed May 03, 2021).

[18] Google Earth, “The Map of Kota Metro (Satelite Image),” 2021. https://earth.google.com/web/search/Kota+Métro,+Metro+City,+Lampung,+Indonesia/@-3.44022759,96.77056912,34.27591939a,10376399.80713999d,35y,0h,1.60187818t,0r/data=CigiJgokCQbuzfclVRPAEdcSyIKeXRXAGYP0-sCjdVpAIaMUu2_bMFpA (accessed May 03, 2021).

[19] BPS Kota Metro, “Kota Metro dalam Angka 2019 (Kota Metro in Figures 2019),” Kota Metro,

2019.

[20] E. Li, J. Endter-wada, and S. Li, “Linkages Between Water Challenges and Land Use Planning in Megacities Author,” *Water Resourcse Impact*, vol. 17, no. 1, pp. 9–12, 2015.

[21] J. Mcconville, “Peri-Urban Sanitation and Water Service Provision: Challenges and Opportunities for Developng Countries,” Stockholm, 2014.

[22] J. J. Hukka and T. S. Katko, “Appropriate pricing policy needed worldwide for improving water services infrastructure,” *J. Am. Water Works Assoc.*, vol. 107, no. 1, pp. E37–E46, 2015, doi: 10.5942/jawwa.2015.107.0007.

[23] J. S. Devi, B. Joseph, K. Karunakaran, B. Anurdha, and K. R. Devi, “People’s attitudes towards pricing for water,” *Curr. Sci.*, vol. 97, no. 9, pp. 1296–1302, 2009.

Chapter 5

The Public Preferences for Domestic Water Utilization in Kota Metro, Lampung Province, Indonesia: Validating the Preliminary Findings with the Field Study

5.1. Introduction

Our preliminary study on the public preferences for domestic water utilization has revealed the fact that most respondents prefer abstracting individual groundwater wells due to their reliable quantity and easy accessibility. The motive is then strengthened by poor performance performed by the public water service provider. It can be recognized by the low coverage area of the pipe network as well as the duration of the service. To inform, the public water service in Kota Metro currently can only serve the customers within 12 hours (morning to evening) and it is even worse in the drought season when the available water source is decreasing. Unsurprisingly, some respondents who are pipe water subscribers in our preliminary study also have borehole well to suffice their daily water need. On the other hand, the shallow dug well users also become pipe water subscribers since experienced water shortage in using the dug well while to construct a borehole well is too expensive for them.

Furthermore, several literatures suggested driving factors such as household socioeconomic background [1]; [2], spatial characteristics [3], water price [4] [5] and the seasonal water availability [6] to choose preferable domestic water sources. The factors were also confirmed by our findings in the preliminary study. In this stage, we focus our study in identifying the most preferable domestic water sources utilized by the respondents and the reason for choosing them through a household survey, which is the validation of the previous online survey. Similar to the preliminary study, we also analyzed the respondent's socioeconomic background which corresponded to his or her main water utilization. This aimed to examine to what extent those respondent's embedded attributes contribute to the motive of choosing a certain type of water source. To obtain our goal, we conducted a household survey in November 2019. The survey took 599 respondents chosen randomly from 22 villages (those are called kelurahan) in Kota Metro. The 599 respondents were proportionally distributed to the villages based on each portion of the total population in Kota Metro.

In elaborating socioeconomic background, we questioned respondents about their gender, age, education, and occupation to identify characteristics of the respondents. Afterwards, we asked the respondents about the number of people who live in the house and the total monthly income. The former aimed to calculate the amount of minimum water requirement while the latter is useful to estimate the purchasing power. Then, we asked the respondents about their main domestic water source and the reason of the utilization. To identify the availability of supporting infrastructure, we asked respondents if the water pipe network is available surrounding their residence. Indeed, we did not ask the respondents to answer with the exact measurement. This question is aimed to reveal the respondent's opinion whether the existing facilities is convenient for his or her to be accessed.

Moreover, we extended the study to the issue of the water shortage encountered by the respondents. It is triggered by the finding in our preliminary study showing that many respondents use two kinds of domestic water sources or more. This finding can be interpreted that the current domestic water utilization does not suffice the respondent's needs. Indeed, this trend is an alarming situation indicating that groundwater has degraded. Thus, this confirmed negative effects caused by the excessive groundwater exploitation reported by many studies [7]–[11].

After collecting the data, we performed the Multinomial Logistic Regression to analyze the relationship between the respondent's choice of the main domestic water sources and the reasons. This statistical technique is useful as a predictive measurement tool to correlate the respondent's water use and the reason behind the choice. The two categories were considered as independent and dependent variables assessed. Afterward, we employed the Multiple Correlation Analysis, which is the extension of the Correspondence Analysis done in the previous stage, to examine factors determining the choice. Moreover, we elaborated the respondent's satisfaction on the current utilized domestic water source using descriptive statistics. Similar to the previous stage of the online survey, three elements, which are quantity, quality, and price, were assessed to identify the respondent's satisfaction level. This analysis is subsequently continued with the exploration on the issue of the water shortage experienced by the respondents and their willingness to use public water service. We did a stratified classification to reveal the respondent's willingness and factors that discourage them to use the public water service provided by the government.

The household survey also gained the respondents who use public groundwater well as their domestic water source, which was not found in the previous online survey. Nevertheless, the household survey is still dominated by the respondents who are individual water source users, and the data analysis indicates that the easiness to access this type of water source in the strongest reason. Further, we also found that in Kota Metro the household's monthly income is the most influential factor to determine the choice then is followed by the amount of the water requirement and the availability of the public water service. In the case of the respondent's satisfaction level, the result shows that the public well users express the highest satisfaction level in the categories of the quantity and quality. Despite its small portion out of the total sample, the public well users consider that their main domestic water source is the cheapest one. Besides, the users of this domestic water source confessed that they have not experienced the water shortage during the utilization and the majority of them do not want to shift their current water use.

The significance of the pipe water network availability to the respondent's choice is also analyzed under the Pearson correlation analysis. This aimed to confirm the findings in the preliminary study showing the weak correlation between the two elements although they are positively correlated. Besides, the calculation on the online survey shows the statistical insignificance that might be caused by the small number of samples. That is why we would like to do the same test for the bigger number of sampled obtained from the household survey.

5.2. Materials and Methods

5.2.1. Data Collection

In conducting this study, we compiled both secondary and primary data. In dealing with secondary data particularly, we collected the information from the statistical reports that are launched by the government of Kota Metro. For instance, we collected the data on the population of Kota Metro to determine the expected number of the respondents before we did a field study by conducting a household survey. To understand the current status of the public water service in Kota Metro, we also collected the data on its current achievement such as the existing pipe network and the production capacity. This information is essential to define the benchmark and the possible forecasting for the future development. Besides, we compiled the historical data on the pipe water subscribers to observe the tendency of the pipe water utilization as well as to interpret the current development of the public water sector.

Furthermore, we calculated the number of expected respondents by setting the confidence level, the sample proportion, and the margin of error. The sample size was calculated according to this following equation 3.1 in chapter 3 [12]. To specify, we set the confidence level at 95%, which corresponds to the *z* score of 1.96. The sample proportion (p) was defined at 50% and the margin of error (e) was desired at 4%. The population size that we used as the basis of the calculation is the population data of the Kota Metro launched by the city government. It was recorded that the population of Kota Metro in 2018 was 165,193 people [13]. The calculation resulted in 599 expected respondents. Then, the number of expected respondents was proportionally distributed to all villages in Kota Metro following the relative percentage of the respective village population as is summarized in table 5.1.

After setting the number of expected respondents and their spatial distribution, we conducted a household survey through in-person interviews in November 2019. We visited the respondents' houses and did the interview with a person whom we met in the house. The survey was conducted around four weeks and we were helped by voluntary surveyors. The written questionnaires were prepared and explained to the surveyors before they visited the respondents.

In the interview, we firstly asked respondents about their personal information including gender, age, education, and occupation. Besides, we also questioned the number of people who live in the house and the monthly income. To explore the issue of water consumption, we asked the respondents about their main domestic water use, the reason of the utilization, and the satisfaction level in consuming the current domestic water source. In the issue of the respondent's satisfaction level, three aspects were examined. They were the quantity, the quality, and the cost that they expensed to consume the main domestic water source. We asked the respondents to express their satisfaction level in a one-to-ten scale. In the categories of the quantity and quality, the respondent could give score one to show that they are very dissatisfied and ten to show that they are perfectly satisfied. On the other hand, respondents could give the score one if they think that the cost to consume water is very cheap and ten to express that the cost is very expensive.

Table 5.1 the population figure of each village in Kota Metro in 2018
and the numbers of the expected respondents

Sub district	Village	Area (km^2)	Population (people)	Relative Population Percentage (%)	The numbers of expected respondents
Metro Pusat	Metro	2.28	14,405	8,77	54
	Imopuro	1.19	6,849	4.11	28
	Hadimulyo Barat	1.50	14,012	8.53	44
	HadimulyoTimur	3.37	8,602	5.24	31
	Yosomulyo	3.37	8,294	5.05	30
Metro Timur	Tejosari	3.76	2,855	1.74	11
	Tejoagung	1.55	5,671	3.45	21
	Iringmulyo	1.89	15,387	9.37	55
	Yosorejo	1.22	7,610	4.63	27
	Yosodadi	3.36	8,155	4.97	34
Metro Barat	Mulyojati	2.95	9,601	5.85	32
	Mulyosari	3.03	2,915	1.78	10
	Ganjar Agung	2.88	6,798	4.14	24
	Ganjar Asri	2.42	9,426	5.74	32
Metro Utara	Banjarsari	5.75	10,236	6.23	40
	Purwosari	2.55	5,536	3.37	19
	Purwoasri	3.62	3,996	2.43	12
	Karangrejo	7.72	8,494	5.17	32
Metro Selatan	Sumbersari	4.25	2,971	1.81	13
	Rejomulyo	4.75	4,729	2.88	19
	Margodadi	2.87	2,687	1.64	11
	Margorejo	2.46	4,964	3.02	20
Total		68.74	165,193	100	599

We also questioned if the piped water network is available surrounding the respondent's residence. Furthermore, we asked the respondents whether they ever experienced a water shortage in using their main domestic water source and what did they do to overcome this problem. Lastly, we questioned the respondent if the water shortage could encourage them to shift their domestic water source to the public water service. For those who did not want to shift their water source, we also asked them to tell the reason.

5.2.2. Data Analysis

Firstly, we summarized the data on the respondents' socioeconomic background i.e. gender, age, education, occupation, family size, and monthly income. This stage aimed to grasp the initial understanding regarding the respondent's characteristics. We considered this respondent's information as embedded attributes could potentially influence opinion and perspective on the domestic water issues.

Secondly, we elaborated on the respondent's main water source that is daily used for domestic purposes and the reason for choosing the preferable one. We examined the dataset by conducting a Multinomial Logistic Regression analysis to explore the respondent's preference for the domestic water use. To perform the computation, we employed statistics software (SPSS version 23).

After examining the respondent's preferences and the motive encouraging the choice, we analyzed factors determining the respondent's preferences on the domestic water source using Multiple Correspondence Analysis. We set our assumption regarding factors determining the respondent's choice of the domestic water needs in three aspects. They are the quantity of water requirement, the availability of public water service, and the respondent's purchasing power. Due to data unavailability, we associated the number of water requirements with the respondent's family size since the two aspects are positively correlated. Moreover, the existence of the pipe network surrounding the respondent's residence was considered to represent the availability of public water. As a matter of fact, the pipe water network has not fully covered all regions in Kota Metro. Therefore, it is interesting to assess whether this factor contributes to influence the respondent's decision. Besides, we also explored the issues regarding the respondent's economic characteristic, which was represented by the monthly income. This is important because the financial aspect is an essential factor in the decision-making process including choosing a preferable domestic water source.

Furthermore, we continued our analysis on the issue of the respondent's satisfaction level to their current main domestic water use. We employed the descriptive statistics to the respondent's satisfaction level to their main domestic water source. We plotted the result of the calculation into the box plots. To describe, a box plot illustrates the figure of the descriptive statistics i.e., minimum and maximum value, mean, median, mode, standard deviation, and the outlier data. These parameters are important to describe the data set and analyze the characteristics of the samples.

Finally, we elaborated the issue of the water shortage encountered by the respondents. We did a stratified categorization to cluster the water shortage that was ever experienced based on the respondent's main domestic water source. Then, the data is broken down into more specific issue on the respondent's willingness to shift their current domestic water use to the public water service. We paid more attention to the respondents who do not want to move to the public water service by asking them the reason of the reluctance to collect the respondents' opinions as well as their expectation regarding the public water service provision in Kota Metro.

5.3. Results and Discussions

5.3.1. The Socioeconomic Description of the Respondents

We collected valuable information by interviewing 599 respondents who are randomly chosen from 22 villages in Kota Metro. Then, we analyzed the data set through several statistical calculations using computer software (SPSS version 23). At the beginning stage of the analysis, we elaborated on the respondent's socioeconomic background i.e., gender, age, education, occupation, family size, and monthly income. We clustered the wide range numerical data with high variation such as age and monthly income to simplify the presentation of the data. In the category of the age, for instance, we got the youngest respondents who are eighteen years old while the oldest is seventy two years old. Indeed, it would be impractical to present them in the form of singular data set. The same case also appeared in the category of the monthly income. In this category we got a high variation in the respondents' answers ranging from one million to ten million rupiahs. Therefore, the data is presented in the clustered data set. To specify, the data set on the respondent's socioeconomic background is illustrated in the following graph.

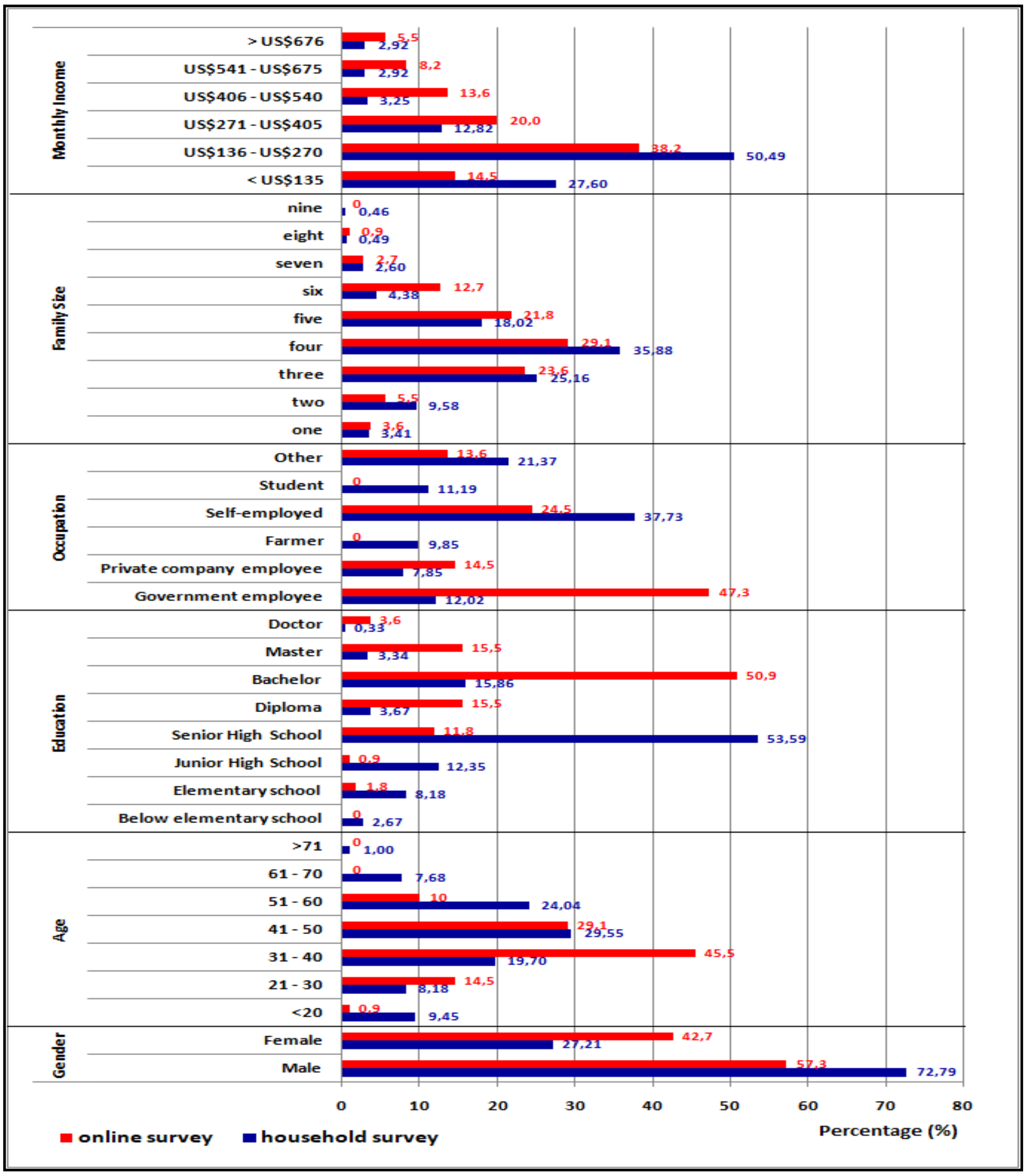


Figure 5.1 The socioeconomic description of the respondents of the household survey (n=599) in comparison with the results of the online survey (n=110)

Figure 5.1 compares the socioeconomic figure resulted from the household survey and the online survey. The household survey shows that our samples are dominantly male, which are 72.79% of the total respondents. The composition of the respondent's gender is different with our online survey that was discussed in the previous chapter. Our preliminary study showed the composition of the male and female respondents shared relatively equal portion. However, this households survey resulted in the proportion of the male respondents is far bigger that the female respondents. This is understandable since we conducted the household survey mostly in the evening after working hours or on the weekend when the head of the household is in the house. Furthermore, the respondents come from various groups of age ranging from teenagers to elderly. The range in the age category in the household survey is wider than our finding in the online survey. In this household survey, the respondent's age varies from 17 to 78 years old while in the online survey the respondent's age is from 19 to 59 years old. It is understandable since this group of generation is more active as the internet users that the older generation. To specify, the respondents of the household survey are dominated by the people from the group of age 30 to 60-year-old. In total, their proportion is almost three-quarters of the total samples. In more detail, the respondents who are forties shared the biggest proportion, which is 29.55 of the total samples. By contrast, the smallest portion, which is only 1% of the sample, is occupied by the elderly.

Moreover, other socioeconomic attributes that we elaborated are the respondent's educational background and occupation. We considered both elements as important aspects to influence people's opinions. A higher level of education, for instance, would give broader knowledge on a certain issue. In the case of the domestic water fulfillment, respondents with higher education presumably have broader concerns in various issues such as social justice and environmental degradation rather than driven by merely their today's necessity. A similar assumption is also applied in elaborating on the respondent's occupation. For instance, the respondents who work for the government are presumably more aware of the regulations about public water service as well as individual groundwater exploitation. To specify, the respondent's educational background is dominated by senior high school, which is 53.59 percent of the total samples. By contrast, there are only 0.33 percent of the total respondents who have a doctoral degree. The second-largest percentage in the category of educational background is the respondents with a bachelor's degree. This group shared 15.86 percent of the total samples. On the other hand, the composition of the respondent's education background is dominated by the people who have higher education background. In this online survey, the respondents who have bachelor's degrees shared the highest portion (50.9%).

In the case of the respondent's occupation, we obtained many nomenclatures expressed by respondents regarding their occupation. To summarize this diversity, we grouped respondent's answers into several types of occupations namely government employee, private company employee, farmer, self-employed, student, and others. To explain, self-employed refers to the type of work where people work for their own business such as small traders, street vendors, and so forth while people who could not be grouped in any categories (such as retirees, housewives, informal workers, etc.) belonged to the category of others. The data shows that self-employed appeared dominantly, which is 37.73 percent, among all types of jobs, and is followed by 'other' category (21.37%) and government employees (12.02%). On the contrary, private company employees shared the least percentage (7.85%). Unlike the household survey, the respondents of the online survey mainly come from the government employees, which is almost a half of the total respondents while students and farmers are the occupations that were not found in the online survey.

Moreover, we explored the information about respondent's family size and monthly income to interpret the amount of their domestic water requirement and purchasing power. When we asked respondents about the family size, the answers were varied ranging from one to nine people living in the house. The respondents who answered 'one' are usually students who rent a room or live in the dormitory. To specify, the respondent's family size was concentrated in three, four, and five family members. These three groups contributed more than three-quarters of the total respondents. In detail, the highest percentage (35.88%) belongs to the respondent with four people living in the house. Afterward, it is followed by households with three and five family members, which were respectively 25.16 percent and 18.02 percent. A similar composition also appears in the online survey data set. In the category of the family size, the online survey data set is also dominated by the respondents with three, four, and five family members. In addition, we did not find the respondent with nine family members in the online survey.

When we asked the respondents about their monthly income, the answers are as also widely varied ranging from IDR 2,000,000 to IDR 10,000,000 (approximately US$135 to US$ 675). To simplify, we grouped the respondent's monthly income into several intervals as is illustrated in figure 5.1. It can be seen that the respondent mostly comes from the middle to low-income groups, which is dominated by the respondents with US$136 to US$270 monthly income (50.49%). Then, it is followed by the respondents who have the least income (27.60%) and the third least income category (12.82%). Unlike the respondent's monthly income in the household survey that is dominated by the lowest and the second lowest income group, the online survey dataset shows that the second and the third lowest income group shared the biggest portion of the whole sample.

5.3.2. Investigating the Respondents' Reasons in Choosing their Domestic Water Sources

After gaining respondent's socioeconomic figures, we elaborated on the respondent's daily domestic water utilization. We got 616 answers from 599 respondents since some of them use more than one type of water source. To compare with our preliminary study, in this household survey we have respondents who use public well, which was not found in our online survey. In general, the composition of the respondents' domestic water source is still dominated by the private dug well users. In more detail the data is summarized in table 5.2

Table 5.2. The respondents' domestic water sources

Respondent's domestic water source	Frequency	
	Number of respondents	Percentage (%)
Pipe water	16	2.60
Public well	10	1.62
Private borehole	151	24.51
Private dug well	431	69.97
Bottled water	8	1.30
TOTAL	616	100.00

Similar with the online survey, the individual groundwater exploitation (private borehole or dug well) still shares the biggest portion in the composition of the respondents. The private borehole and dug well users respectively share 24.51% and 69.97% of the total samples. To compare with the results of the online survey, the percentage of the private borehole users is 28.29% and the percentage of private dug well users is 42.11% of the total samples. By contrast, the use of public facilities such as pipe water service or public well is still rarely found in the survey (either online or household survey).

Furthermore, we elaborated the reasons of the respondent's choice on the domestic water use. In the interview, various statements were expressed by the respondents to show their reasons. Nevertheless, their answers can be grouped into five categories. They are related to reliable quantity, good quality, affordable price, easy access, and no other choice. Despite its fuzziness, the last answers often appeared in the household survey and can be interpreted as the respondent's skepticism to the current situation.

Table 5.3 The cross-tabulation of the respondent's main water sources and the reason of the utilization (n=616)

Main water sources	Reason for water use (percentage)					Active Margin (%)
	Reliable quantity	Good quality	Affordable price	Easy access	No other choice	
Pipe water	0.49	0.32	0.16	1.14	0.49	2.60
Public well	0.00	1.30	0.16	0.00	0.16	1.62
Private borehole	4.54	10.88	0.49	7.31	1.30	24.51
Private dug well	1.14	10.88	11.20	35.23	11.53	69.97
Bottled water	0.00	1.14	0.00	0.00	0.16	1.30
Active Margin (%)	6.17	24.51	12.01	43.69	13.64	100

Table 5.3 is the cross tabulation of the respondent's domestic water sources and the attached reasons in choosing them. As a general explanation, the active margin in the last row indicates a cumulative percentage of a certain reason expressed by each type of domestic water user while the active margin in the last column representing the composition of the respondents' domestic water sources. In this household survey, the most frequent reason expressed by the respondents is easy access (43.69%), which is followed by good quality (24.51%) and no other choice (13.64%). This is different with the result of the online survey, which was dominated by good quality (40.79%). It can be interpreted that there is a distinction in the respondent's motives in choosing the domestic water utilization. The distinction could be related to the different socioeconomic background belonged to the respective sample as is illustrated in figure 5.1. The significant difference in the socioeconomic background (e.g., age group, education, and occupation) might influence the respondent's main reason in choosing the domestic water source). The age group of thirties with bachelor's degree and work as a government employee, which appear dominantly in the online survey, might have more concern about the water quality issues. On the contrary, the respondent with low income, with the senior high school (or lower) educational background, and work as a self-employed worker put accessibility as the strongest reason to choose a certain domestic water use.

For further analysis, each cell in table 5.3 indicates the intersection between a certain type of domestic water source and the reason to choose. For example, the most common reason for choosing private dug well is easy access (35.23%). The second most frequent reason expressed by the private dug well users is no other choice, which is 11.53%. It means that the respondents have no access to public water service and choose other water sources such as borehole and bottled water seem to be economically unaffordable. Unlike the dug well users, the private borehole users tend to choose their water source because of the water quality issues. It was recorded 10.88% of respondents who use private boreholes admitted that they use this water source because of its good quality compared to others. Then, the second strongest reason for the private borehole users is easy to access, which is 7.31% of the total samples. In addition, the cells consisting of zero score indicate that there is no relationship between a certain domestic water use and the attached reason. For instance, no public well users decided to choose this type of domestic water use because of its reliable quantity or easy access. Meanwhile, the bottled water users never put reliable quantity, affordable price, and easy access as the reason of choosing the bottled water.

Then, we elaborated the relationship between the respondent's choice of the domestic water use and the motive encouraging the choice by demonstrating the multinomial logistic regression model to the dataset. The computation of the multinomial logistic analysis is presented in table 5.4.

Table 5.4 The parameter estimation for the respondent's water sources and reasons

Main Water Source [a]		B	Std.Error	Wald	dF	Sig.	Exp(B)	95% Confidence Interval for Exp (B)	
								Lower Bound	Upper Bound
Public well	Intercept	-1.099	1.155	.905	1	.341			
	Reliable quantity	-18.356	9679.634	.000	1	.998	1.067E-8	.000	.[b]
	Good quality	2.485	1.399	3.153	1	.076	12.000	.773	186.362
	Affordable Price	1.099	1.826	.362	1	.547	3.000	.084	107.447
	Easy access	-16.410	2395.068	.000	1	.995	7.471E-8	.000	.[b]
	No other choice	0[c]	.	.	0	.	.	.	.
Private borehole	Intercept	.981	.677	2.099	1	.147			
	Reliable quantity	1.253	.910	1.897	1	.168	3.500	.589	20.813
	Good quality	2.531	.987	6.580	1	.010	12.563	1.817	86.860
	Affordable Price	.118	1.339	.008	1	.930	1.125	.082	15.506
	Easy access	.880	.790	1.242	1	.265	2.411	.513	11.330
	No other choice	0[c]	.	.	0	.	.	.	.
Private dug well	Intercept	3.164	.589	28.816	1	.000			
	Reliable quantity	-2.317	.908	6.517	1	.011	.099	.017	.584
	Good quality	.347	.929	.140	1	.708	1.415	.229	8.737
	Affordable Price	1.070	1.167	.841	1	.359	2.915	.296	28.713
	Easy access	.270	.703	.147	1	.701	1.310	.330	5.200
	No other choice	0[c]	.	.	0	.	.	.	.
Bottled water	Intercept	-1.099	1.155	.905	1	.341			
	Reliable quantity	-18.579	.000	.	1	.	8.538E-9	8.538E-9	8.538E-9
	Good quality	2.351	1.406	2.798	1	.094	10.500	.668	165.114
	Affordable Price	-16.071	5348.582	.000	1	.998	1.049E-7	.000	.[b]
	Easy access	-16.633	2677.768	.000	1	.995	5.977E-8	.000	.[b]
	No other choice	0[c]	.	.	0	.	.	.	.

a. The reference category is pipe water.
b. The floating-point overflow occurred while computing this statistic. Its value is therefore set to system missing.
c. This parameter is set to zero because it is redundant.

This table shows the parameter estimation to relate the respondent's choice on the domestic water use and the motive behind the choice. In this computation, pipe water was treated as the referent group and therefore estimated a model for other types of domestic water sources relative to pipe water. Furthermore, B scores in the third column are the estimated multinomial logistic regression coefficients for the model. The B value indicates the likelihood of the assessed respondents' reason to choose their main water source compares to pipe water. For instance, the respondents who answered reliable quantity (B = -18.356) and easy access (B = -16.410) compared to the respondents with other reasons (with positive B coefficient) are less likely to choose the public well than pipe water. The same interpretation can be applied to other types of water sources. The private borehole, for example, has a positive B coefficient for all reasons. It shows that the respondents uniformly are more likely to choose private borehole than pipe water and the good quality is the strongest reason for the choice because of its biggest B coefficient (2.531). In the case of the private dug well, reliable quantity (B = -2.317) is the only reason that made respondents are less likely to choose this type of domestic water source than pipe water. On the other hand, good quality (B = 2.351) is the only reason for bottled water users to choose bottled water than pipe water.

The fourth column consists of the standard errors of the individual regression coefficients for the two respective models estimated while the fifth column indicates the Wald chi-square test that tests the null hypothesis. Furthermore, the sixth column is the degree of freedom and the seventh column shows the significance with an associated Wald chi-square test. If the significance is defined at 0.05, the null hypothesis would be rejected for private borehole and good quality (sig. = 0.010) and private dug well and reliable quantity (sig. = 0.011), but other rows failed to reject since their significance score is more than 0.05. However, the good quality is the reason for the public well and bottled water users that have significance scores nearly 0.05 (0.076 for public well and 0.094 for bottled water).

Moreover, the Exp (B) is the exponentiation of the B coefficient, which is called the odds ratio. The negative B coefficient would generate an odd ratio < 1 while the positive B coefficient would generate the odd ratio > 1. In the category of public well, for instance, the odds ratio for the good quality is 12.000 which means that the respondents who pose this answer are 12 times more likely to choose public well than pipe water (as the referent group). By contrast, the respondents who have easy access reasons are 7.471×10^{-8} times less likely to choose the public well than pipe water. The highest odds ratio for the easy access reason, in general, belonged to the category of the private borehole (the odds ratio = 2.411) even though the most preferable reason in this domestic water source is good quality (the odd ration = 12.536). The same interpretation can also be applied for private dug well and bottled water users by viewing the odds ratio of the respective row.

One of the constraints in observing the respondents' reasons of their domestic water choice through cross-tabulation (table 5.3) and multinomial logistic regression (table 5.4) is the numerical expressions, which is impractical and somehow difficult to understand. To overcome this constraint, we plotted the relationship into a scatter graph resulted from the Correspondence Analysis (CA). This visual presentation could give clearer explanation about the relationship between the respondent's choice and the motive behind it. In the correspondence analysis, individuals are geometrically indicated by spots scattering one to another and the distance between two spots shows how close the similarity between the two individuals. The scatter plot graph of the correspondent analysis can give a clearer illustration to analyze the relationship between categorical data in the multi-dimensional directions. Moreover, the feature to analyze individual's characterization and contribution to the whole collected sample is CA's strong feature that make it preferable [14]. Besides, CA also enables to quantify respondent's preference leading to a more meaningful interpretation [15]. To illustrate, the scatter plot graph of the correspondence analysis is presented in figure 5.2.

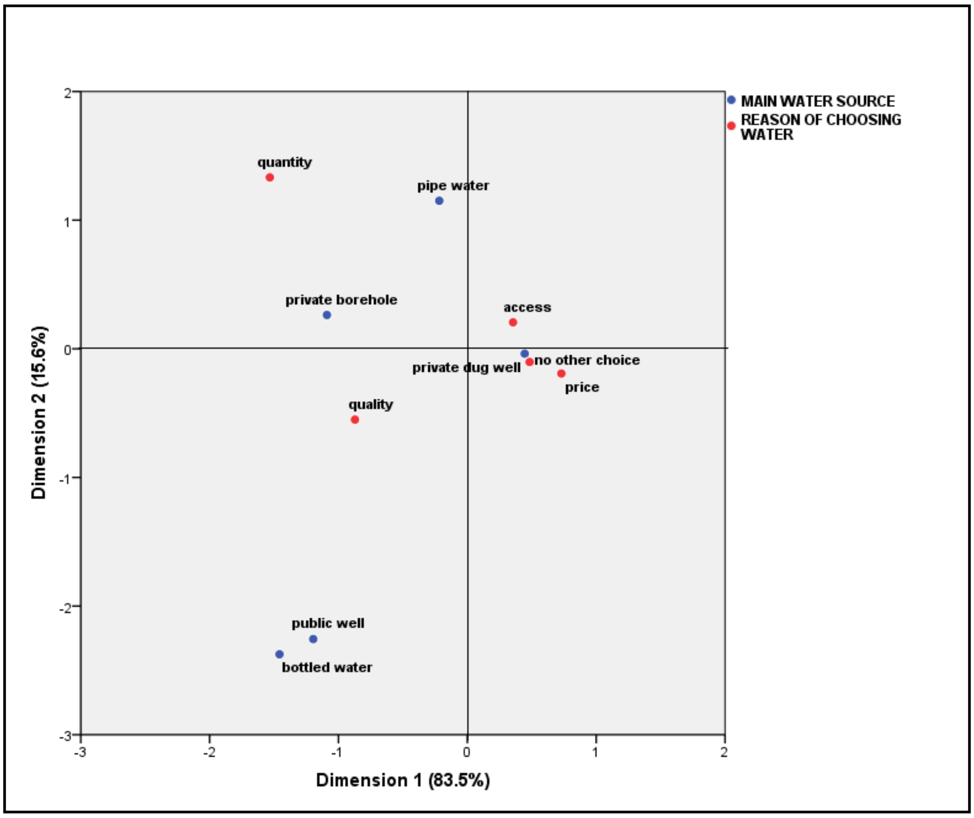


Figure 5.2 The scatter plot graph resulted from the correspondence analysis of the respondent's domestic water choice and the reason

Unlike the ordinary Cartesian coordinate system, the graphical representation of data in CA illustrates the contribution of each assessed element out of all samples rather than showing a functional relationship. To specify, the basic principle of CA is to identify more influential elements by reducing synthetic dimensions [16]. The percentages that are showed on the horizontal and vertical axis are the results of the reduced synthetic dimensions performed by the computer software (SPSS version 23). Moreover, Le Roux and Rouanet [17] stated that individuals who share more similarities are located closely and smaller frequencies of disagreement categories implicate on the farther distance between individuals. Besides, less frequent categories are located farther from the origin and they give a smaller contribution to overall propensity. Hence, graphically, the distance between the two categories depends on their frequencies.

Furthermore, figure 5.2 is correlating the respondent's domestic water sources (represented by the blue dots) and the reason for choosing them (represented by the red dots). The point representing the private dug well, for instance, has close distances with accessibility, affordable price, and no other choice. It implies that these reasons have stronger correlation to the private dug well rather than to other types of domestic water source. On the other hand, the private borehole users likely rely on this domestic water source because of its quantity and quality. The distances from the blue dot representing the borehole users to both reasons are more or less the same. It can be interpreted that these two factors equally influence the respondents to choose private boreholes as their main domestic water source. Meanwhile, quantity and accessibility are two influential factors for the pipe water users considering their closeness.

Another feature of the CA's scatter plot is its ability to explain the significance of a certain element in the dataset. The distance of a certain dot to the origin in the graph shows the frequency of the data founded in the survey. The closer distance indicates the more frequent appearance. Figure 5.2 shows that the dot representing the dug well users have the closest distance. Thus, this is the most frequent data that appear in the household survey. By contrast, the dot representing bottled water, also the public well users, is the farthest dot from the origin showing their less significance to the whole samples.

In comparison with the online survey, figure 5.2 have similarity in the way of the private dug well is closely located to the easy accessibility. However, the online survey show that affordable price is the strongest reason, rather than reliable quantity or easy access. Thus, it can be interpreted that individual groundwater exploitation is triggered by the accessibility issue since it can be freely done on the respondent's property without any strict restriction. Meanwhile, the decision to choose public water service (piped water) is based on pragmatic reasons, which are diverse. Regarding this issue, factors determining the respondent's preference (i.e., internal, and external factors) are interesting to be explored to grasp deeper understanding to view the issue of the domestic water fulfillment in Kota Metro. The discussion of this issue is elaborated in the next section of this chapter.

5.3.3. Factor Influencing the Respondent's Preference

After grasping the understanding on the domestic water choice and the respective reason, the next step that we conducted in this research is investigating factors that influence the preference by analyzing the respondent's characteristics. We set our assumption by referring the recognized reasons to the respondent's socioeconomic dataset from the previous discussion. For example, the quantity and quality aspects are related to the community's demand while price is strongly connected with the community's purchasing power. Therefore, we set the assumption that these issues refer to family size since the amount of water requirement is positively correlated to the number of consumers. Although the assumption seems to be less appropriate for the quality issue, we considered that the public demand for water with good quality is something obvious. Furthermore, we assumed the affordable price is closely related to the household's income and the accessibility is represented by the availability of piped water network surrounding the respondent's residence. The data is presented in table 5.5.

Table 5.5 The cross-tabulation of the respondent's socioeconomic characteristics and their main domestic water sources (n=616)

Socioeconomic characteristics	Respondent's main domestic water source (%)					Total
	Pipe water	Public well	Private borehole	Private dug well	Bottled water	
Family size						
One	0.32	0.16	0.16	2.76	0.00	3.41
Two	0.49	0.00	1.95	7.14	0.00	9.58
Three	0.81	0.16	7.79	16.23	0.16	25.16
Four	0.49	0.81	8.44	25.81	0.32	35.87
Five	0.32	0.49	4.55	12.18	0.49	18.02
Six	0.00	0.00	0.65	3.73	0.00	4.38
Seven	0.16	0.00	0.49	1.79	0.16	2.60
Eight	0.00	0.00	0.16	0.16	0.16	0.49
Nine	0.00	0.00	0.32	0.16	0.00	0.49
TOTAL	2.60	1.62	24.51	69.97	1.30	100
Monthly income						
< US$ 135	1.14	0.32	2.60	23.21	0.32	27.60
US$ 136 to US$ 270	0.81	1.14	10.71	37.66	0.16	50.49
US$ 271 to US$ 405	0.32	0.16	4.87	7.14	0.32	12.82
US$ 406 to US$ 540	0.00	0.00	2.11	0.97	0.16	3.25
US$ 541 to US$ 675	0.32	0.00	1.95	0.65	0.00	2.92
> US$ 676	0.00	0.00	2.27	0.32	0.32	2.92
TOTAL	2.60	1.62	24.51	69.97	1.30	100
Access to the pipe network						
Yes, close distance	2.43	0.00	9.58	22.73	0.81	35.55
Yes, far distance	016	0.00	3.08	8.93	0.16	12.18
No access	0.00	1.46	8.12	27.44	0.32	37.50
Do not know	0.00	0.16	3.73	10.88	0.00	14.77
TOTAL	2.60	1.62	24.51	69.97	1.30	100

Table 5.5 illustrates the cross-tabulation between the respondent's socioeconomic attributes and the preferable water source. Each intersection cell indicates the proportion of the assessed attribute and the respondent's choice of water. It can be seen that the private dug well is the most preferable for all categories. To specify, in the category of the family size the biggest percentage (25.81%) belonged to the family with four family members. Meanwhile, in the category of the monthly income, the private dug well is mostly preferred by the families which have a monthly income from US$ 136 to US$ 270 (37.66% of the total respondents). Besides, the private dug well is also chosen by 27.44% of the total respondents, which do not have access to the pipe network.

The same analysis can be done to observe all intersection cells in table 5.5 to observe the respondent's preference for the domestic water source based on the attached socioeconomic attributes. However, all assessed categories are naturally interlinked with each other in multi-dimensional direction and table 5.5 has a limitation to describe the relationship. To overcome this problem, we employed a Multiple Correspondence Analysis (MCA) to analyze the data. The MCA is the extended version of the Correspondence Analysis (CA), which was done in chapter four. The additional feature of the MCA is its ability to analyze more than two categorical data in a single scatter plot graph, which is unable to be done in the Correspondence Analysis.

Furthermore, the calculation of the dataset resulted in two major dimensions with the variance accounted for 39.2% and 34.4% inertia (as is illustrated in figure 5.3). To describe, the graph shows that almost all categories flock surrounding the origin. It implies that the data has less variance and is concentrated to a certain tendency. On the other hand, points that are located relatively far from the origin have less frequency based on the survey. In this case, respondents with eight family members are rarely founded in the field survey and so are respondents who mainly consume bottled water and who are with income 6 (>US$ 676). To inform, we codified the category of income by numbering with income 1, income 2 and so forth following the ascending order in figure 5.1 to simplify the presentation.

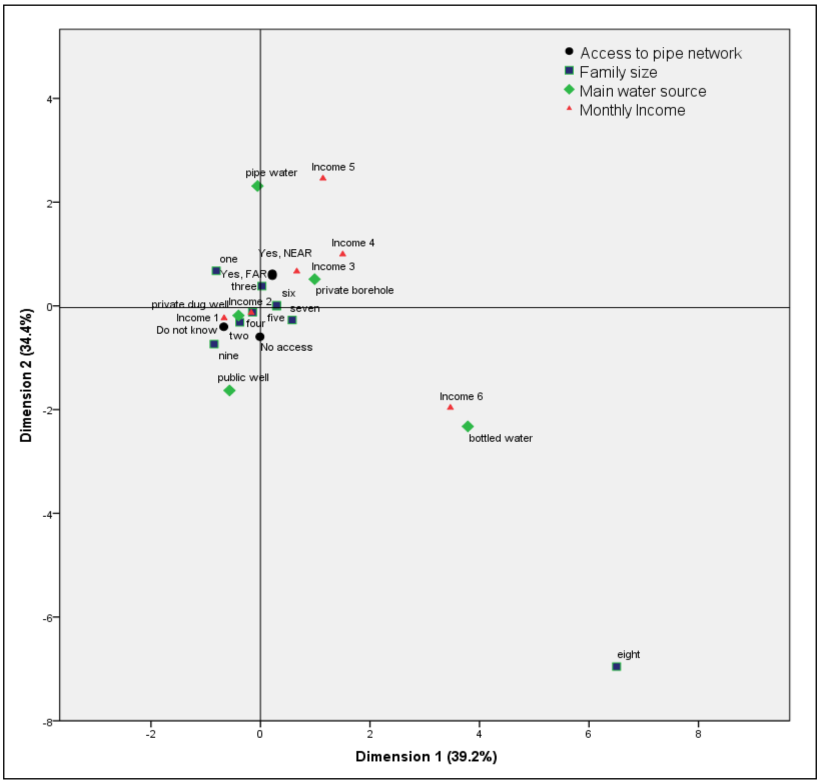


Figure 5.3 the scatter plot graph resulted from the Multiple Correspondence Analysis

Moreover, the coordinates of the points can be used to analyze their significance. For instance, income 2 is closely located to the origin meaning that the respondents from this income group shared the most significant contribution to the whole sample, which is then followed by income 1. In the category of the family size, the data is dominated by the respondents with three, four, and five family members. The three dots corresponding to the data are located closely surrounding the origin. On the other hand, in the category of pipe network availability, the dots approximately have the same distance to the origin. It implies that the data is rather equally distributed among all categories.

Figure 5.3 can also be used to analyze the correspondence between categories where the closer the distance the closer the relationship is. For example, bottled water is located close to income 6 but does not have proximity to other categories. It implies that the bottled users inclusively correspond to this income group. On the other hand, private dug well is closely surrounded by many dots e.g., income 1, income 2, family size 4, and the respondent who do not have access to the pipe network. Furthermore, the private borehole is closely located to income 3, income 4, and the respondents who have access to pipe networks either near or far. By contrast, the distance between the pipe water availability to pipe water users is farther than to the private water source (dug well or borehole). It indicates that the piped water network empirically did not significantly encourage people to choose pipe water service.

Furthermore, we did cross-tabulation to analyze how significant each category influences the choice as is presented in table 5.6.

Table 5.6 Correlations Transformed Variables

Dimension: 1

	Main Water Source	Family Size	Monthly Income	Access to Pipe Water
Main Water Source	1.000	0.157	0.395	0.058
Family Size	0.157	1.000	0.231	-0.002
Monthly Income	0.395	0.231	1.000	0.158
Access to Pipe Water	0.058	-0.002	0.158	1.000
Dimension	1	2	3	4
Eigen value	1.570	1.005	0.845	0.580

This table is essentially a symmetrical matrix consist of four rows and four columns. The software sets the main water source category as a reference (dimension 1) so that other categories are calculated relatively to the referent category. Furthermore, the values in the intersection cells express the correlation between two interlinked categories. That is why the scores in the intersection cells involving the same category (the diagonal) are 1.000 implying that they are perfectly correlated. For further interpretation, the second column can be used to measure the correlations. It can be seen that monthly income has the biggest coefficient (0.395) then is followed by family size (0.157) and access to pipe water (0.058). The scores imply the rank of influential factors in choosing a certain type of domestic water use. In another word, when a respondent's decision is orderly determined by monthly income (purchasing power), family size (water demand either quantity or quality), and access to pipe water (accessibility).

Similar to the previous chapter, the significance of pipe network availability, which is subjected to be an external factor, is also performed for the data obtained from the household survey. The Pearson correlation analysis is also performed to the dataset gained from the household survey. In more detail, the result of the computerized calculation is presented in the following table.

Table 5.7. Correlation between the respondent's access to pipe water network and main water sources based on the Pearson Correlation Analysis

		Access to pipe water network	Main water source
Access to pipe water network	Pearson Correlation	1	0.103
	Significance (2-tailed)		0.011
	N	616	616
Main water source	Pearson Correlation	0.103	1
	Significance (2-tailed)	0.011	
	N	616	616

Assessment on the dataset gained from the household survey resulted in the value of the Pearson Correlation 0.103. Similar to the assessment on the dataset of the online survey, it can be interpreted that the availability of the pipe network does not have a significant correlation to the respondent's choice on the domestic water source. Nevertheless, the household dataset is considered as statistically significant. It can be seen from the value of the significance 0.011, which is less than 0.05. It is understandable due to the number of samples in the household survey is much larger that the number of samples in the online survey.

5.3.4. The Respondents' Satisfaction Level of the Utilized Domestic Water Sources

The next issue that we would like to explore is the respondent's satisfaction level regarding their daily utilized water source. We questioned the respondent to express their satisfaction by giving points within a one-to-ten interval. There are three main issues to be answered. They are quantity, quality, and price. After obtaining the respondent's answers, we analyze the respondent's satisfaction level on those three categories based on the type of domestic water source classification. We employed the descriptive statistics to describe the respondent's satisfaction level and presented the analysis in the form of the box plots. In general, a box plot illustrates the descriptive statistics of the recorded samples. The distance between the lowest and the highest cut-offs respectively indicates the minimum and maximum values in the data range. Furthermore, the box shows the first quartile, the median, and the third quartile while the outlier data is located outside the box plot area. We set the box plot on the confidence level 95 percent. The horizontal axis shows the category of the respondent's main water source, and the vertical axis indicates the respondent's satisfaction level. Besides, the numbers appear outside the box plots diagram shows the respondent's serial number considered as the outlier data based on their answer.

To specify, the box plot illustrating the respondent's satisfaction level on the issue of quantity in presented in figure 5.4. The box plots compare the respondent's satisfaction level among all types of domestic water sources. It can be seen that all types of domestic water users share the same maximum value, which is ten. Moreover, the box plot of the pipe water is the longest showing that respondents who use pipe water are more dispersed when they express their satisfaction with the quality of water. The satisfaction level of the respondent utilized pipe water is ranging from six (moderate satisfaction) to ten (maximum satisfaction) with the average satisfaction level is 7.81, which is the lowest compared to the others. This is slightly lower than the average satisfaction level of bottled water users. Meanwhile, the highest score of the average satisfaction level in the category of the water quantity is 9.1, which is occupied by the public well. Even though we found only ten respondents using this water source, their opinion about the water quality is the most convergent among all types of water sources. It can be seen by the figure of its box plot that is the shortest ranging from 8 to 10.

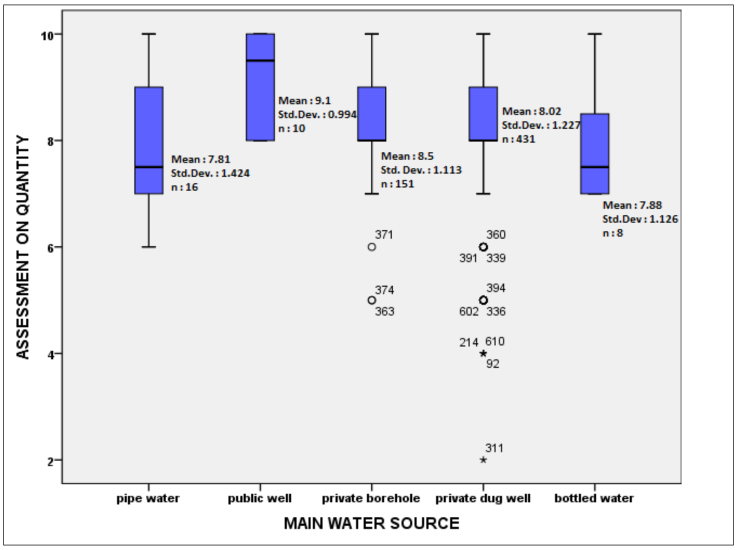


Figure 5.4 The box plots representing the respondent's satisfaction level on the category of the water quantity

Furthermore, figure 5.4 also shows that the private borehole and the private dug well have similar figures in their box plots although the number of respondents using these water sources is significantly different. Nevertheless, the dug well dataset has more outlier data than the private borehole. The extreme outlier in the dug well dataset even reaches two points that expressed the respondent's least satisfaction. It can be interpreted that the private dug well users have more dispersed opinion related the quantity of their utilized water source and the outlier data is even recognized as statistically invalid.

The second category of satisfaction level that we assessed is water quality, which is illustrated by figure 5.5. The most remarkable feature appeared in this figure is that all public well users gave the same answer in expressing their satisfaction regarding the quality of the consumed water. That is why the box plot is only represented by a single line meaning all variables in the descriptive statistics uniformly refer to a single value, which is 8. This is the second-largest value of the respondent's satisfaction level behind the private borehole (8.51) followed by a private dug well and bottled water respectively in the third and fourth rank. By contrast, the pipe water has the worst quality based on the respondent's opinion. The average value of the satisfaction level for this public water service is only 6.88 (moderate) while the lowest point given by the respondent reaches 3 (in the box plot) and 2 (outlier data), which is very poor quality. Besides, the box plot of this category of water source has the longest distance indicating the most dispersed opinion even though the number of pipe water users in this survey is only 16.

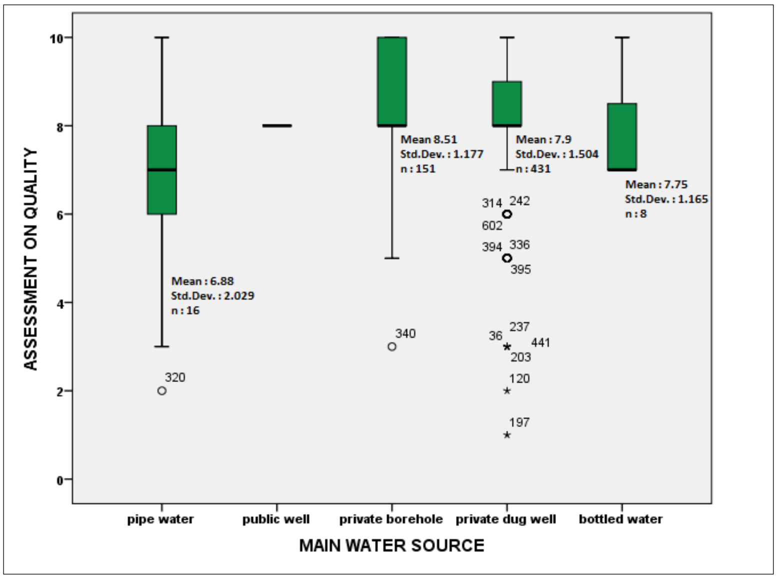


Figure 5.5 The box plots representing the respondent's satisfaction level on the category of the water quality

Similar with the assessment on the issue of the water quantity, the private dug well users also have more dispersed opinion in the issue of the water quality. The outlier data shown in figure 5.5 has strengthened this premise. Moreover, it can also be used as an indication of the current condition of degraded groundwater source in Kota Metro, especially for shallow groundwater wells. To some extent, it does not match with the consumer's desire and could not even suffice the consumer's daily needs.

Eventually, we assessed the respondent's opinions on the price of their daily consumed water as is illustrated by figure 5.6. Similar to the former two categories, the assessment on the water price shows the same trend where the pipe water has the most dispersed opinion, which is ranging from 2 (very cheap) to 9 (very expensive). Besides, the average satisfaction level of the pipe water users is 4.75, which is the second most expensive after the bottled water (5.25). In this category of water price, the cheapest is occupied by the public well then is followed by private dug well and private borehole. Not only has that, but the dataset on the category of public well also showed the most convergent propensity ranging from 1 (very cheap) to 5 (moderate).

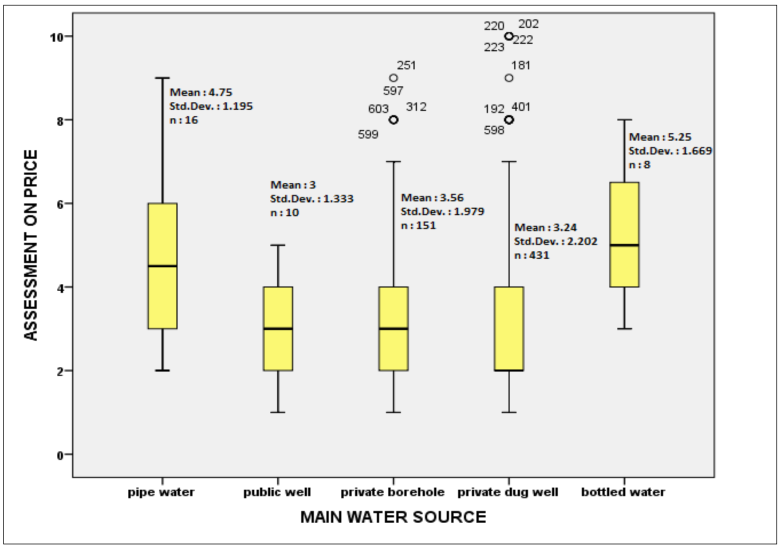


Figure 5.6 The box plots representing the respondent's satisfaction level on the category of the water price

To summarize, the assessment on the three aspects (quantity, quality, and price) shows that public well users' opinion is the most compact. They even have the same rating to express their opinion about the water quality. Meanwhile, the respondents who utilize individual groundwater resources (boreholes and dug wells) have more dispersed opinions in expressing their satisfaction level on the assessed aspects.

5.3.5. The Water Shortage Experience and the Willingness to Move to the Public Water Service

In this section, we elaborated on the respondents' opinions on the water shortage that they encountered and revealed their willingness to shift their main water source due to this occurrence. The importance of this stage is to identify possible actions that can be formulated to anticipate future situations based on people's preferences as well as expectations. Besides, the information is also useful for the public water service provider to improve the current situation. In general, some respondents confessed that they ever experienced the water shortage. However, most of the considered that it was merely a sporadic event which did not directly related to environmental degradation on climate change. In addition, they also considered the water shortage event was still tolerable and they just did interim measures such as asking a favor from their neighbors who have a better situation or purchasing water from vendors. To illustrate, table 5.8 summarizes the water shortage encountered by the respondents classified by their main domestic water source.

Table 5.8 Respondent's experience on the water shortage based on the main water sources

Water Shortage Experience	Main Water Source					Total
	Pipe water	Public well	Private borehole	Private dug well	Bottled water	
Yes	4	0	6	89	0	99
No	12	10	145	342	8	517
Total	16	10	151	431	8	616

Table 5.8 shows that 99 out of 616 (16.07% of total reply) respondents experienced water shortage in using their domestic water source. Most of them come from the respondents who utilized private dug well. It is understandable since dug wells usually have shallow depth (about 7 to 10 meters) and the availability of water depends very much on seasonal rainfall rate. On the other hand, respondents utilizing private boreholes exploit deep groundwater sources (mostly more than 40 meters). Moreover, we also noted that 25% of pipe water subscribers did not get adequate supply. It usually occurred in the drought season when the water service providers had less production capacity that should be distributed to all customers.

Furthermore, we paid more attention to the respondent's actions to overcome the water shortage problem. We grouped various respondents' answers into four classification which are did nothing, asked favor from neighbors, accessed water from public facilities (such as mosques, community centers, public tap, etc.), and installed more water sources (such as deepening the well, constructing borehole well, subscribing pipe water, or purchasing water from vendors. The respondents who did nothing to overcome the problem could tolerate the water shortage and they just adapted with the situation such as reducing water consumption, or simply waited their shallow dug well to be naturally recharged. These actions can be understandable since this group of respondents usually comes from the small size families but has low monthly income. Thus, they did not have much money to have another water source but could still manage their water need. The summary of the respondent's answers is listed in the following table.

Table 5.9 The respondent's measures to overcome the water shortage (n=99)

Measures done by the respondent	Percentage (%)
Doing nothing	8.08
Asking favor from neighbor	60.60
Accessing water from public facilities	19.19
Installing more water sources	12.12

Table 5.9 shows the majority of the respondents were asking a favor from their neighbors or relatives who have better situation to cope with the water shortage problems. Mostly, the shallow dug well users asked a favor from those who have deep borehole. The spirit of togetherness and solidarity in the society, which still appeared especially in rural areas, enabled the community to help each other. Furthermore, we also found that the respondents who have middle to high monthly income prefer installing more facilities (e.g., borehole, pipe water, etc.) in their house to overcome the water shortage problems. The data shows 12.12% of respondent choose to have this measure. On the other hand, 19.19% of respondents who experienced the water shortage chose to take water from public facilities. The respondents who are classified in this category usually live in the urban areas, where people are more individualistic. However, they still have an option to access public facilities. In more severe situation, they asked the local government to provide an emergency support such as through water tank cars.

Furthermore, we questioned respondents whether they want to move to public water service to reveal their willingness to forsake individual groundwater exploitation. As a matter of fact, the respondent who experienced water shortage did not automatically have an intention to shift their current water use into the public water provided by the city government. We then paid more attention to reveal the respondent's reason not to move to public water service. To illustrate, the respondent's responses are presented in figure 5.7.

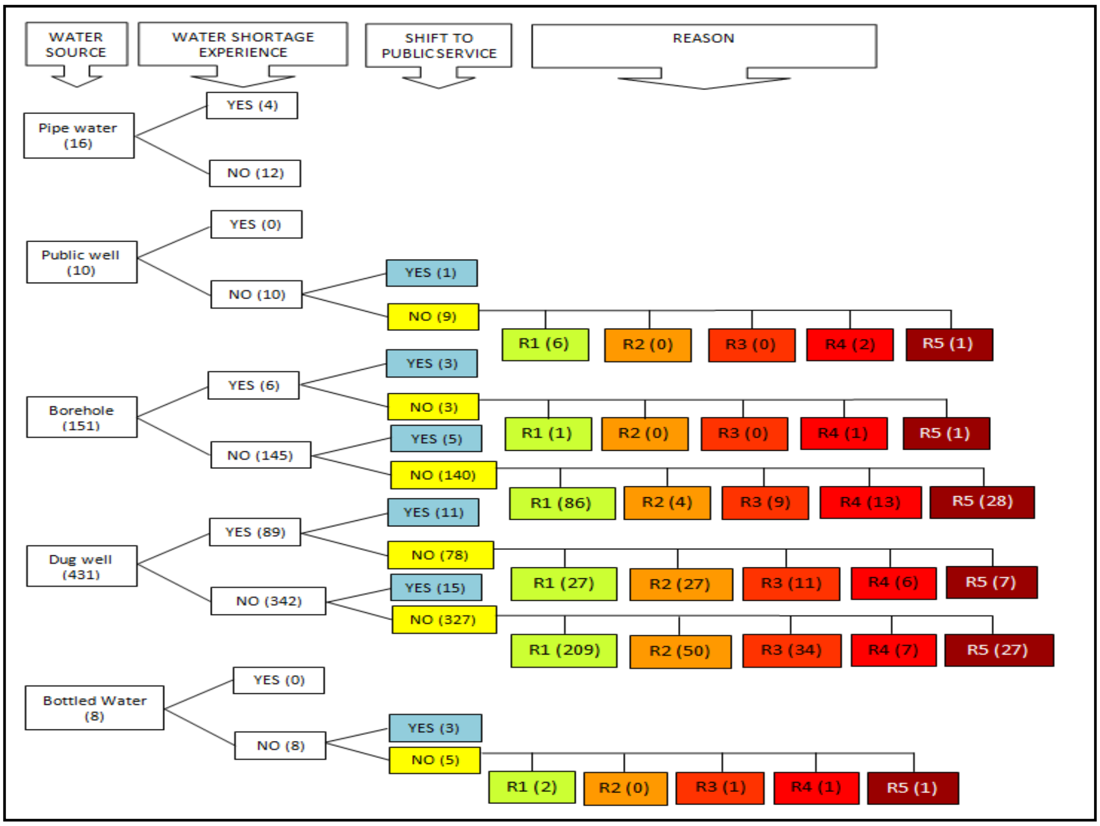


Figure 5.7 The respondent's willingness to shift to public water service

Figure 5.7 illustrates the information about the respondent's experience of water shortage that is extended into a more specific issue on the willingness to shift to public water service and the motive encouraging the decision. Numbers inside parentheses show the numbers of respondents concerning their opinion. We simply distinguished the respondent's willingness to shift to public water service with a "yes" or "no" answer. In this issue, we gave more attention to the respondents who are not willing to shift to public water service since respondents who want to become public water service subscribers gave a similar answer, which is to anticipate water shortage in the future. By contrast, the respondents who said "no" gave various expressions to show their reason. Therefore, we classified the respondent's reason and codified them with R1, R2, R3, R4, and R5 to simplify the presentation of the data. R1 means respondents are satisfied with their current water source. Meanwhile, R2 shows respondents answer related economic reasons such as financial incapability, unaffordable water price, and so forth. Moreover, issues related to the unavailability of the pipe network and other supporting facilities surrounding the respondent's residence is classified into R3. Another reason why respondents hesitate to move to public water service is their doubt about the quality of the public water service. Respondents thought that their current water source is far better than pipe water both its quantity and quality so that shifting to public water service is something unnecessary. We classified these types of reasoning into R4. Then, R5 is for those who did not specify their reason.

Generally, if numbers in blue boxes are summed, only 38 out of 600 respondents (6.33%) who are non-pipe water users like to move to public water service although some of them had ever encountered water shortage. On the contrary, the majority of respondents (93.67%) are not willing to move to public water service for various reasons. We could sum numbers in the boxes with the same color to see the proportion of each reason. Among all categories of the main water source, the satisfaction to the current main water source (R1) is the strongest reason why respondents do not want to move to public water service. It is recorded that 331 respondents (55.17%) have this kind of reason. Moreover, economic reason (R2) is the second strongest reason where 81 respondents (13.50%) explained that financial factors are the main constraint of shifting their water source into public water service. Then, the percentage is followed by R5 (65 respondents/10.83%), R3 (55 respondents/9.17%) and R4 (30 respondents/5.00%). Thus, if respondents who did not express their reason are excluded, the respondent's priority in accessing public water service can be arranged as follows: satisfaction (in both quantity and quality of water), price, supporting infrastructures, and service quality.

Moreover, the findings on this issue can also be used as an input to formulate improvement strategies to develop public water service in Kota Metro. The high percentage of the respondent who has been fully satisfied with the current domestic water utilization, which is individual groundwater exploitation, certainly is difficult to change without strong interventions from the government of Kota Metro. The respondent's reluctance is even strengthened by the absence of pipe network and their skepticism of the public water service performance.

To verify respondent's argument on the issue of unaffordable water price, we revisited respondent's socioeconomic data particularly the respondent's monthly income and family size. We started the analysis by calculating the average of the monthly income and the average of the family size in order to estimate respondent's purchasing power and water consumption. Since the respondent's income data is grouped data with a certain interval, we employed the mid-point formula to determine the average income following this equation.

$$\bar{x} = \frac{\sum f * x_m}{\sum f} \qquad \text{Eq. 5.2.}$$

Where $\bar{x}$ is the mean; f is the frequency of the data; and x_m is the midpoint of each class. The calculation is presented in table 5.10. This table shows the average monthly income from all respondents, which is approximately US$ 216. To relate with the economic issue of the water consumption, we compared the respondent's average monthly income with the expense for water consumption.

Table 5.10 The respondents' average monthly income (n=599)

Monthly Income (in US$)	Frequency (f)	Midpoint of Income (x_m)	$f*x_m$	Average income ($\bar{x}$)
0 – 135	167	67.5	11,273	
136 – 270	305	203	61,915	
271 – 405	77	338	26,026	
406 – 540	18	473	8,514	
541 – 675	16	608	9,728	
676 – 810	16	743	11,888	
TOTAL	599		129,344	216

To begin with, we calculated the average family size to estimate the amount of monthly water consumption based on our dataset in figure 5.2. Our calculation resulted in the average family size is 3.82. Due to data unavailability on the water consumption in Kota Metro, We estimated the water consumption based on the minimum water requirement standardized by the National Standardization Board, which is 100 Liters per person per day [18]. Then, the monthly water consumption is estimated approximately 11,460 Liter (11.46 m^3) for each household.

Furthermore, the respondent's opinion about the high cost of pipe water is not completely true. The boreholes or dug well users considered that their water consumption is free of charge while they thought that pipe water is costly. Because of that, they did not want to shift their current water source although some of them had experienced water shortage. Nevertheless, the respondents never counted the hidden price such as electricity for water pumping. They merely considered cost for construction and equipment installation as the only expense to get the water since the operational cost went to the electricity monthly bill. The borehole users commonly use water pumps that have capacity 30 to 50 Liters per minute and consume electricity 250 to 500 Watts. On the other hand, the shallow dug well users use pumps with smaller capacity (10 to 20 Liters per minute) and lower electricity consumption (100 to 125 Watt).

To summarize, the respondent's hesitation to use public water service is generally driven by internal and external factors. The former is dominated by the satisfaction to use individual borehole or dug well due to its easiness to access and cheap cost. In addition, the respondent's doubt on the public water service quality is also strengthened the reluctance. On the other hand, the current situation of public water service (e.g., the pipe water availability, the water quality and quantity, and the service continuity) is influential factor to influence the respondent's opinion not to choose subscribing public water service.

5.3.6. Considering Empirical Evidence to Formulate Improvement Strategies: Taking Insights from the Circular Economy Concept

The assessment conducted to the data of the online or household survey indicates various aspects influencing the respondent's preferences of the domestic water utilization. From this point of view, a traditional approach, which is more concentrated on the supply-side management, is likely unable to follow the dynamics. Moreover, paradigms in the development planning have also transformed to respond various societal changes. For example, the collaborative planning [19], which employ bottom-up approach, is promoted to replace the top-down approach to accommodate public aspirations in the development process. In this regard, the perspective to view community's role as the object of the development to be the subject. Moreover, the shifting from centralized to decentralized approaches also emerge in line with the introduction of the participatory development concepts. Meijerink and Huitema [20] noted that the introduction of participatory governance through a decentralization system in Indonesia, which was in line with the political regime shifting in 1998, is a window of opportunity to stir a transition in the water governance. The decentralized water system potentially brings advantages to reduce negative environmental impacts as well as to improve water service quality even though legislation, administrative structure, and community involvement are challenges that are supposed to be highly considered [21]. Along with water resource scarcity, participation and the scale of water service should be well managed in formulating approaches in the water governance [22]. Furthermore, the local municipality has significant roles to encourage community involvement in water-related activities [23].

Furthermore, limited resources (e.g., water resources availability, financial constraints, technical obstacles, etc.) severely complicate the domestic water provision. Regarding this issue, the circular economy concept is introduced to deal with the dilemma of limited resources and continuously growing demand [24]. In the circular economy concept, environmental or resource problems can be managed not only by technological advancement but also through efficient allocation [25]. As a matter of fact, many studies reported the merits of circular economic concepts in the field of commercial enterprises [26] [27]. However, studies exploring the role of public sectors in the circular economy focused more on regulating the transition while few of them discuss the issue in the context of the organizational level [28]. Moreover, a study by Scarpellini et al [29] suggested that the economic and social benefits gained from the circular economy activities are more effective when implemented at the regional level. From this point of view, expectantly, the findings of this research can be used as a valuable input to formulate alternatives to overcome the dilemma, which the local government frequently faces, in fulfilling domestic water needs. Not only that, but the discussion might widen the perspective of the circular economy at the micro level starting from the issue of community preferences for domestic water utilization.

Combining our findings and observation on the existing situation of the domestic water fulfillment in Kota Metro, we tried to suggest a sort of improvement proposal following the principles of the circular economy. However, the current trend of research interests on the issue of the circular economy is still dominated by commercial business fields at a national or even global scale [30] [31]. Meanwhile, the discussion at small scale organizations in nonprofit sectors is still limited. Despite this constraint, we tried to bring the basic concepts of the circular economy to explore the domestic water utilization issues on the community scale.

Then, we referred to the improvement stages proposed by the Ellen MacArthur Foundation [32], which are vision, engagement, urban management, economic incentives, and regulation, to stir the transition. Firstly, sufficing reliable domestic water needs for all residents in the Kota Metro along with the reduction of the individual groundwater abstraction is set as the vision of the improvement strategies. In the issue of engagement, community participation in the development planning process could be viewed as an essential starting point to accommodate various interests from stakeholders. Borrowing Lacy's terminology [33], the existing condition of the domestic water utilization in the Kota Metro could be characterized as the emerging stage of maturity in the circular economy implementation. Further, awareness-raising and capacity-building are two things that have not been well managed. Thereby, we suggested an intensive campaign of the use of public water sources to raise public awareness on the negative impacts of individual groundwater exploitation. Meanwhile, public doubt of the public service quality (as is illustrated in figure 5.8) should also be properly responded to support the vision. The level of service quality provided by the piped water service provider should be boosted to gain public trust as well as to encourage public enthusiasm. On the other hand, the community-based water provision can be strengthened by maintaining the existence of those who proposed the communal groundwater facilities and assisting them with the training to manage small scale water provision. The government agency can also involve universities to transfer their knowledge and enhance the capacity of either community or piped water provider to manage their water source [34]. Besides, the existing communal groundwater facilities can be upgraded by installing a pipe network to the surrounding neighborhood (e.g., one groundwater well for twenty to thirty houses) so that the water can be directly delivered without spending any effort to bring the water to the house. Then, the users contribute to pay the operational and maintenance cost of the communal facility. The significant percentage showing that the respondents asked a favor from neighbors or relatives to overcome the water shortage problem (table 5.8) indicates the spirit of togetherness and solidarity among society. This valuable social capital can also be utilized in managing the communal facility. Hence, the existing piped water service can be combined with the community-based domestic water provision through communal groundwater facilities to accelerate the development of the domestic water sector in Kota Metro.

5.4. Conclusions

This research found that the respondent's reasons correspond respectively to the choice of the domestic water source. The easiness in accessing the water source is the most common reason expressed by the respondents who use private dug wells while the water quality is strongly considered by the private borehole users. Furthermore, the inadequate pipe network discourages people to choose public water services. The respondent's reason not to choose the pipe water is also strengthened by the fact that the water service is still in poor performance. Meanwhile, the price of bottled water, which is quite expensive for most respondents, is the strongest reason why it is not preferable. The respondents mostly consume bottled water as a supplementary water source because their main water source is not drinkable or for practical reasons.

Furthermore, this research also found that the household's income gives the most significant contribution in determining the preference of domestic water use in Kota Metro. This factor is then followed by the family size and pipe network availability. These three elements can implicitly be interpreted as the respondents' scale of priority in their decision-making process. Besides, they can also be used as valuable inputs for institutions in Kota Metro who are responsible for the domestic water service provision to develop improvement strategies.

In the issue of the respondent's satisfaction level, we found that the public well users have the most concentrated propensity in expressing their opinion despite its small percentage to the total sample. By contrast, the pipe water users shared the most dispersed opinions in expressing their satisfaction level. It can be interpreted as an alarming situation for the development of public water service in Kota Metro. The various satisfaction level expressed by the pipe water users can potentially encourage them to stop to subscribe the public water service if the service provider fails to maintain the customer's satisfaction. In addition, the respondent's willingness to shift to public water service is not significant even though they ever encountered the water shortage during the individual groundwater utilization. On the other hand, the trend on the public well utilization also enables the local authority to formulate other strategies besides developing public water service through pipe network. Community based water management can be an option to be examined considering the fact that the public well users have the most satisfaction level for all assessed categories (quantity, quality, and price).

In the case of the water shortage, 99 out of 616 responses confessed that they ever experienced the water shortage in utilizing their main domestic water source. To deal with this occurrence, they undertook various strategies such as asking a favor from neighbors or relatives, accessing public facilities, or installing more water sources. Some respondents even did nothing to tackle this problem. Nevertheless, the water shortage experience has not been able to trigger the community to leave the individual groundwater abstraction because of several causes such as economic reasons or pipe network unavailability. This phenomenon raises the question of the level of community awareness about the current dynamics of the environmental event. The government of Kota Metro, as the authorized party, should carefully manage this issue to anticipate worse situations in the future. Along with excessive groundwater abstraction, the land use shifting that apparently occurs in the Kota Metro, which is an implication of urban growth, can potentially exacerbate the situation.

Furthermore, we compiled our findings and the current status of the domestic water utilization in Kota Metro to formulate an improvement proposal inspired by the circular economy concepts. We proposed a mixed-method, which consists of piped water service and community-based domestic water management considering constraints belonged to Kota Metro and potentials that can be utilized. Not only is the improvement strategy formulation, but the discussion is also expected to be able to elaborate on the principles of the circular economy to be implemented in the small-scale administration and nonprofit organization, which has not been widely discussed. Indeed, this theoretical exploration should be followed by further studies on the more detail issues such as cost-benefit analysis, optimum scaling of each element in a mixed water provision system, spatial arrangement, legislation, and so forth to verify the possibilities of applying the concepts of the circular economy in the domestic water sector.

Findings on the ways in which the respondent deals with water shortage experiences and the motives to change current water use are essential to elaborate on possible solutions for improving the current situation. The existing pipe network and communal groundwater wells are also important assets. These elements can be used as inputs to formulate a strategy mixing pipe water and community-based water service. The pipe water can be optimally utilized in the more densely populated area while the community-based water management can be applied in the area with less density. The next agenda is to assess the optimal proportion of the respective mode of the domestic water provision, which will be discussed in the next chapter.

REFERENCES

[1] D. B. Rahut, B. Behera, and A. Ali, “Household access to water and choice of treatment methods: Empirical evidence from Bhutan,” *Water Resour. Rural Dev.*, vol. 5, pp. 1–16, 2015, doi: https://doi.org/10.1016/j.wrr.2014.09.003.

[2] L. Li, E. Araral, and M. Jeuland, “The drivers of household drinking water choices in Singapore: Evidence from multivariable regression analysis of perceptions and household characteristics,” *Sci. Total Environ.*, vol. 671, pp. 1116–1124, 2019, doi: https://doi.org/10.1016/j.scitotenv.2019.03.351.

[3] I. R. Abubakar, “Factors influencing household access to drinking water in Nigeria,” *Util. Policy*, vol. 58, pp. 40–51, 2019, doi: https://doi.org/10.1016/j.jup.2019.03.005.

[4] E. Gross and O. Elshiewy, “Choice and quantity demand for improved and unimproved public water sources in rural areas: Evidence from Benin,” *J. Rural Stud.*, vol. 69, pp. 186–194, 2019, doi: https://doi.org/10.1016/j.jrurstud.2019.02.021.

[5] W. F. Vasquez and E. A. Adams, “Climbing the water ladder in poor urban areas: Preferences for ‘limited’ and ‘basic’ water services in Accra, Ghana,” *Sci. Total Environ.*, vol. 673, pp. 605–612, 2019, doi: https://doi.org/10.1016/j.scitotenv.2019.04.073.

[6] L. Li, C. S. Li, and D. Wichelns, “Assessing household willingness to pay for bottled water in rural areas of the Mekong Delta, Vietnam,” *Water Resour. Rural Dev.*, vol. 7, pp. 36–49, 2016, doi: 10.1016/j.wrr.2016.03.001.

[7] A. Menció and J. Mas-Pla, “Influence of groundwater exploitation on the ecological status of streams in a Mediterranean system (Selva Basin, NE Spain),” *Ecol. Indic.*, vol. 10, no. 2010, pp. 915–926, 2010.

[8] R. N. Gejl, M. Rygaard, H. J. Henriksen, J. Rasmussen, and P. L. Bjerg, “Understanding the impacts of groundwater abstraction trough long-term trends in water quality,” *Water Res.*, vol. 156, no. 2019, pp. 241–251, 2019.

[9] S. S. Sayre and V. Taraz, “Groundwater depletion in India: Social losses from costly well deepening,” *J. Environ. Econ. Manage.*, vol. 93, no. 2019, pp. 85–100, 2019.

[10] S. Ohgaki *et al.*, “Comparative Study of Groundwater Management,” Kitakyushu, 2007.

[11] F. R. Wahyudi and S. S. Moersidik, “The analysis of ground water availability and utility in DKI Jakarta,” *Procedia - Soc. Behav. Sci.*, vol. 227, no. 2016, pp. 799–807, 2016.

[12] “Sample size calculator,” 2019. https://goodcalculators.com/sample-size-calculator/ (accessed Sep. 16, 2019).

[13] BPS Kota Metro, “Kota Metro dalam angka 2019 (Kota Metro in figures 2019),” Kota Metro, 2019.

[14] E. J. Beh, “Simple Correspondence Analysis: A Bibliographic Review,” *Int. Stat. Rev.*, vol. 72, no. 2, pp. 257–284, 2004.

[15] P. G. M. van der Heijden, J. Teunissen, and C. van Orle, “Multiple Correspondence Analysis as a Tool for Quantification or Classification of Career Data,” *J. Educ. Behav. Stat.*, vol. 22, no. 4, pp. 447–477, 1997.

[16] A. I. D'Enza and M. Greenacre, "Multiple Correspondence Analysis for the Quantification and Visualization of Large Categorical Data Sets," in *Advanced Statistical Methods for the Analysis of Large Data-Sets: Studies in Theoretical and Applied Statistics,* A. Di Ciaccio, Ed. Springer, 2012, pp. 453–463.

[17] B. Le Roux and H. Rouanet, *Multiple Correspondence Analysis*. Los Angeles: SAGE Publication Inc., 2010.

[18] BSN, *Penyusunan Neraca Sumber Daya Air (Water Balance Arrangement)*. Indonesia, 2002.

[19] K. Purbani, "Collaborative planning for city development: A perspective from a city planner," *Sci. Rev. - Eng. Environ. Sci.*, vol. 26, no. 1, pp. 136–147, 2017.

[20] S. Meijerink and D. Huitema, "Policy Entrepreneurs and Change Strategies Lessons from Sixteen Case Studies of Water Transition around the Globe," *Ecol. Soc.*, vol. 15, no. 2, pp. 1–19, 2010.

[21] N. G. Leigh and H. Lee, "Sustainable and Resilient Urban Water System: The Role of Decentralization and Planning," *Sustainability*, vol. 11, no. 3, pp. 1–17, 2019.

[22] P. Woodhouse and M. Muller, "Water Governance: An Historical Perspective on Current Debates," *World Dev.*, vol. 92, no. April 2017, pp. 225–241, 2017.

[23] A. A. Jama and K. A. Mourad, "Water Services Sustainability: Institutional Arrangements and Shared Responsibilities," *Sustainability*, vol. 11, no. 2019, pp. 1–15, 2019.

[24] A. Heshmati, "A Review of the Circular Economy and Its Implementation," Bonn, 2015.

[25] C. Fogarassy and D. Finger, "Theoretical and Practical Approaches of Circular Economy for Business Models and Technological Solutions," *Resources*, vol. 9, no. 76, pp. 1–9, 2020.

[26] T. Lahti, J. Wincent, and V. Parida, "A Definition and Theoretical Review of the Circular Economy, Value Creation, and Sustainable Business Models: Where Are We Now and Where Should Research Move in the Future," *Sustainability*, vol. 10, no. 2018, pp. 1–19, 2018.

[27] L. T. Peiro, D. Polverini, F. Ardente, and F. Mathieux, "Advance towards circular economy policies in the EU: The new Ecodesign regulation of enterprise servers," *Resour. Coservation Recycl.*, vol. 154, no. 2020, pp. 1–11, 2020.

[28] N. Klein, T. B. Ramos, and P. Deutz, "Circular Economy Practices and Strategies in Public Sector Organizations: An Integrative Review," *Sustainability*, vol. 12, no. 2020, pp. 1–24, 2020.

[29] S. Scarpellini, P. Portillo-Tarragona, A. Aranda-Uson, and F. Llena-Macarulla, "Definition and measurement of the circular economy's regional impact," *J. Environ. Plan. Manag.*, vol. 62, no. 13, pp. 2211–2237, 2019.

[30] J. Korhonen, A. Honkasalo, and J. Seppala, "Circular Economy: The Concept and its Limitations," *Ecol. Econ.*, vol. 143, no. 2018, pp. 37–46, 2018.

[31] M. Borrello, S. Pascuci, and L. Cembalo, "Three Propositions to Unify Circular Economy Research: A Review," *Sustainability*, vol. 12, no. 2020, pp. 1–22, 2020.

[32] Ellen MacArthur Fondation, "City Governments and Their Roles in Enabling A Circular

Economy Transition: An Overview of Urban Policy Levers," 2019.

[33] P. Lacy, J. Long, and W. Spindler, *The Circular Economy Handbook: Realizing the Circular Advantage*. London: Palgrave MacMillan, 2020.

[34] A. Distanont, O. Khongmalai, and R. Rassameethes, "Collaborative triangle for effective community water resource management in Thailand," *Kasetsart J. Soc. Sci.*, vol. 39, no. 2018, pp. 374–380, 2018.

Chapter 6

Formulating Development Planning Scenarios to Improve Domestic Water Sector in Kota Metro, Lampung Province, Indonesia

6.1. Introduction

Findings discussed in the previous chapters indicated that in Kota Metro pipe water is less preferable compared to groundwater for several reasons. Indeed, this is an alarming situation considering negative impacts caused by the excessive groundwater abstraction. As a matter of fact, many studies revealed this phenomenon. For example, [1] detected the appearance of land subsidence due to rapid groundwater abstraction for industrial and agricultural uses. Moreover, domestic uses also contribute significantly to groundwater depletion resulted from rapid population growth and land-use change [2].Thus, human activities cannot be simply separated from the issue of the water requirement and the land-use change that subsequently contribute to the groundwater depletion [3].

Indeed, the water demand would keep increasing as the population grows and people have more various activities. On the other hand, water availability in the earth is essentially constant [4] and the water that can be safely consumed for potable uses tend to decrease due to pollution and environmental degradation issues. Because water is finite substance and prone to be polluted, its utilization is supposed to be well regulated. Besides, the awareness on the efficient utilization has to be more intensively encouraged to ensure its sustainable availability. [5] underlined that discussing water-related issues is not merely about its physical scarcity but regulating the water use within good governance is far more relevant. Nevertheless, a good governance cannot be easily generated but it requires active participation from various stakeholders as well as normative and institutional framework to execute their roles [6].

Furthermore, every locality has unique water-related problems as well as potentials requiring context-dependent approaches to deal with water issues. Some areas might have major technical problems such as unreliable water resources or topographical constraints while the other considered administrative and institutional issues as the biggest challenges. By the same token, the disparity between investment required for developing a reliable service and potential revenues might come as the biggest burden for some public water service providers. However, competition among different interests is a common dilemma faced by local governments in urban water management besides the resource scarcity [7][8]. Thus, it can be said that there is no single solution that fits for all situation but context-dependent [9]. The solution that suits in one place and time might not be applicable for different localities and/or time setting [10].

Aside from the dilemma to deal with the issue of domestic water provision, every locality has potentials that can be optimized. In the context of Indonesia, the big amount of the rainfall rate that is available throughout a year is one example of the overlooked potentials. The report recorded that minimum average of annual rainfall rate, which is gauged in 34 observation stations, is 1806.97 millimeters and the minimum numbers of days with precipitation is around 145 days a year [11]. Paradoxically, rainwater has not been well managed, and its scarcity (or abundant availability) often generates disaster. Due to poor water management practices, some areas undergo severe water shortage in the dry season and flood in the rain season. Moreover, a shifting in administrative and political regime in Indonesia, which is more decentralized, can also be seen as a window of opportunities in the development of domestic water sectors [12]. The new system enables local governments to innovate creative approaches to provide reliable domestic water although it can also be viewed as a challenging situation especially for local government that have limited resources [13].

In this chapter, the objective is to list potential alternatives that can be taken to improve the recent situation of domestic water fulfillment in Kota Metro by synthesizing a theoretical exploration with the empirical evidence attained from either our online survey and/or household survey. To achieve the objective, we first revisited the results achieved in the previous chapters to understand the current stage of the domestic water fulfillment in Kota Metro. We set the current status of domestic water fulfillment in Kota Metro as a starting point. Then, the universal access to domestic water was set as an ultimate goal and an element to focus on. In this regard, population projection is crucial to estimate future water requirement. Hence, statistical calculation was highly employed to justify the population projection as well as estimated water requirement.

Afterwards, we explored opportunities that are possible to be optimized by identifying potentials belonged to Kota Metro. They include technical elements such as the availability of water sources, existing water-related facilities, and so forth. Besides, non-technical aspects such as socioeconomic as well as sociocultural characteristics of the communities in Kota Metro are also identified. Then, based on the goal setting and opportunity exploration, we analyzed alternatives that are possible to be applied Kota Metro. Thus, the theoretical exploration and our empirical findings would be synthetized. In this regard, we did not have an intention to formulate one best solution to solve the current problem but creating scenarios that accommodate desirable goals under reasonable cost. In general, three scenarios are assessed. They are implementing doing-business-as-usual approach, accelerating pipeline-based water service, and combining pipeline-based and communal-based water provision. To elaborate these three alternatives, trade-off between all embedded constraints in Kota Metro and desirable goals are assessed to gain optimum output. Hence, mathematical optimization modelling is employed to analyze various possibilities as well as to seek an optimum result.

6.2. Materials and Methods

To achieve the objective in this stage, several steps were taken. First, we explored the current situation of public water service provided by the local government owned water company in Kota

Metro. The exploration is on both technical and non-technical issues. The technical issues included the production capacity, the availability of the pipe network in each village and the respective number of subscribers, production and distribution system, quality control, and maintenance. Besides, another information such as rainfall rate is also explored to identify potentials that can possibly be utilized. On the other hand, the institutional issues included the organizational matters of the water providers, budget allocation, and water pricing mechanism. Not only that, the existence of societal organizations in Kota Metro is also included in the discussion considering its potential to deliver community-based water provision. The information was gathered from the secondary data that is officially published by the government of Kota Metro and other relevant institutions.

Second, we elaborated the development programs that have been being done or is planned by the government of Kota Metro related to domestic water provision beyond pipe water service. To inform, the local government actually has several programs related to domestic water provision and water source protection such as developing communal wells, campaigning what is called as bio pore to infiltrate rainwater into the ground, and so forth. These actions can be considered as potentials that can be boosted to improve the current situation. However, questions might arise if the programs were well delivered, and the built infrastructures are sustainably functioned. In this stage, we evaluated the existing ones and posed a proposal for the improvement.

The two aforementioned steps are considered as analyses on the supply-side of the domestic water provision in Kota Metro, the third step taken in this chapter is exploring the demand-side of the domestic water needs. In this stage, water demand was calculated and projected for the future domestic water needs. It started by viewing the population trend occurred in Kota Metro. We collected the data on the population from 2003 to 2019 to observe the propensity of the population growth and project the trend using the equations. Furthermore, the result of the population projection is multiplied by the minimum water requirement suggested by the literatures. We intentionally calculated a sort of interval (from the lowest to the most ambitious) in projecting water demand to provide a wider spectrum in achieving the ultimate goal, which is universal access on the safely managed domestic water sources. Besides analyzing the population trend and the minimum water requirement, the public preference on the chosen domestic water source would also be elaborated. The results gained from both online and household surveys, which were discussed in the previous chapters, would be taken as fruitful inputs.

The next step that is taken in this study is formulating improvement scenarios. In the analysis, statistical projection and the mathematical optimization are performed. The scenarios are constructed under three conditions. Then, the consequences of the respective scenarios are analyzed. The first is implementing doing-business-as-usual approach, which means letting the existing trend on the domestic water utilization keeps going on. The second scenario is accelerating the expansion of pipeline-based water service so that the individual groundwater can be eliminated within a certain timespan. The last scenario is combining the pipeline-based and community-based water provision. It implies that the development of pipeline-based water service is accelerated but for the areas that is not beneficial to develop this system the community-based water provision can be applied. In other word, the groundwater abstraction is still allowed but is regulated under community-based water management system.

6.3. Results and Discussions

6.3.1. Identifying Current Achievement of Domestic Water Sector in Kota Metro

The recent data shows that the number of the pipe water subscribers in Kota Metro is 2,205 households [54]. They are concentrated in the central and eastern part of the city, which are Metro Pusat sub-district (45.85%) and Metro Timur sub-district (41.81%). By contrast, there is no pipe water subscriber in the northern part of Kota Metro (Metro Utara sub-district). Furthermore, the number of pipe water subscriber in Kota Metro slowly grow from the initial establishment of the pipe water service provider in 2006. In the beginning period, the number of the pipe water subscriber was only 801 households [55]. To compare with the number of households in the same period, the respective achievement was only 2.46% in 2006 and 5.05% in 2019. Thus, it insignificantly increases within the last thirteen years. Indeed, there are many possibilities to explain this trend. The low pace of pipe network and other infrastructure development might be the cause of this occurrence. On the other hand, preference of Kota Metro residents can also determine insignificant increase of the pipe water service subscribers.

Furthermore, the development of pipe network and other supporting facilities in Kota Metro is likely unable to balance population growth. As a matter of fact, the pipe network is not entirely available all over villages in Kota Metro currently. Besides, the production capacity is also far behind the estimated demand. Table 6.1 compiles the annual water production capacity in Kota Metro.

Table 6.1 The annual water production capacity in Kota Metro

Year	Production Capacity (m^3/year)
2008	NA
2009	NA
2010	476,586
2011	539,393
2012	633,244
2013	500,713
2014	NA
2015	553,643
2016	895,206
2017	NA
2018	972,135

The table shows that the annual production capacity nowadays is doubled in spite of the fact that there was fluctuating trends is some years. Indeed, the volume has not fully fulfilled the actual needs if the number of actual production capacity is equally distributed to the whole population of Kota Metro. However, the volume is exceeding the minimum water requirement that is suggested by literatures if it is distributed only for the pipe water subscribers. To illustrate, in 2018 the number of the pipe water subscribers are 2,134 households [56]. If this number is multiplied by the average family size in Kota Metro, which is four people per household, the number of people who consume pipe water service would be 8,536 people. Under this assumption, the actual production capacity in 2018 could provide 312 Liters per person per day if factors such as water loss, or leakage is excluded.

In spite of the fact that the actual water production capacity could not serve all residents, the government of Kota Metro keeps trying to provide a reliable water service and to expand the service coverage area. Furthermore, we elaborated the data on the annual production capacity (table 6.1) by projecting the trend. Presumably, the production capacity continuously increases following the current trend. Nevertheless, the assumption does not fully fit to the fact that the production capacity might be stagnant or even decreases due to aging production facilities belonged to the pipe water service provider. This following figure illustrates the trend on the production capacity and its projection.

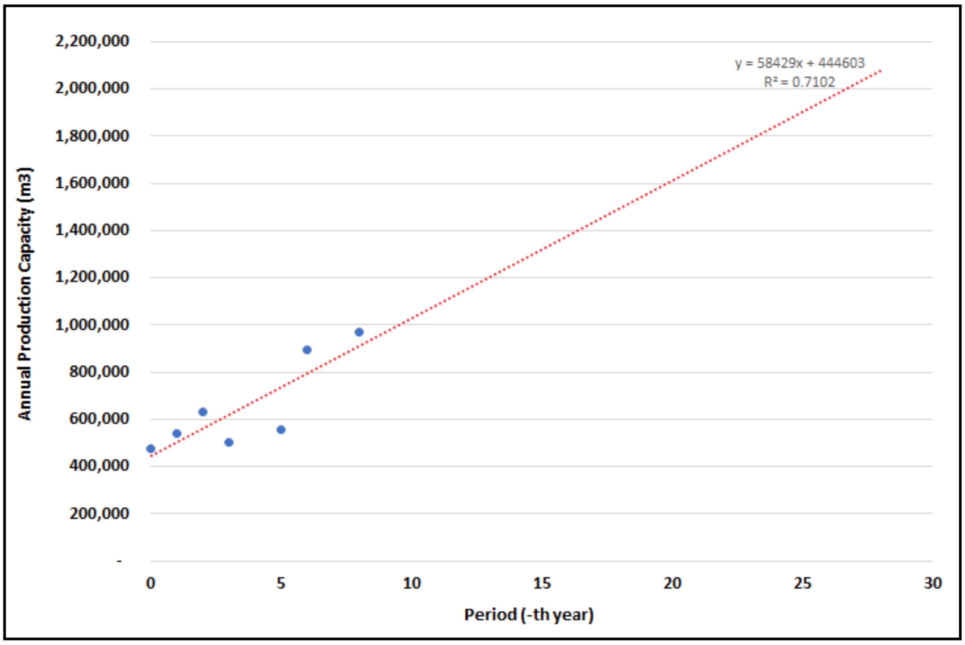


Figure 6.1 The trend of the water production capacity in Kota Metro and its projection

Figure 6.1 was generated by plotting data on table 6.1 into a scatter graph. We set available information about the annual production capacity in 2010 as an initial period of the trend (t_0) and plotted other available information (represented by blue dots). Subsequently, a trendline (a red line) was added to represent a general trend represented by the linear equation $y = 58{,}429x + 444{,}603$ where x is representing the period. The equation resulted in the correlation coefficient 0.7102, which is moderately good even though it is not excellent (more valid data has correlation coefficient closer to 1). Missing data in some year is probably the cause of the result. Beyond data unavailability, this simple statistical approach can be used to project the production capacity at any years by simply replacing x variable with the desired period. Indeed, it assumes that the government of Kota Metro continuously develop the production capacity following this tendency.

To inform, the existing water service provision can be generally divided into three units namely production unit, transmission unit, distribution and customer service unit. Figure 6.2 illustrates the existing condition of pipe water service provided by the government of Kota Metro. The main water source utilized in the production unit is coming from surface water (Way Sekampung river) supported by deep groundwater wells. The production unit, where the Water Treatment Plant (WTP) is installed, is located in the southern part of the city (Kelurahan Rejomulyo). The capacity of the WTP is 100 Liters per second and is supported with four deep groundwater wells with the capacity of around 40 Liters per second.

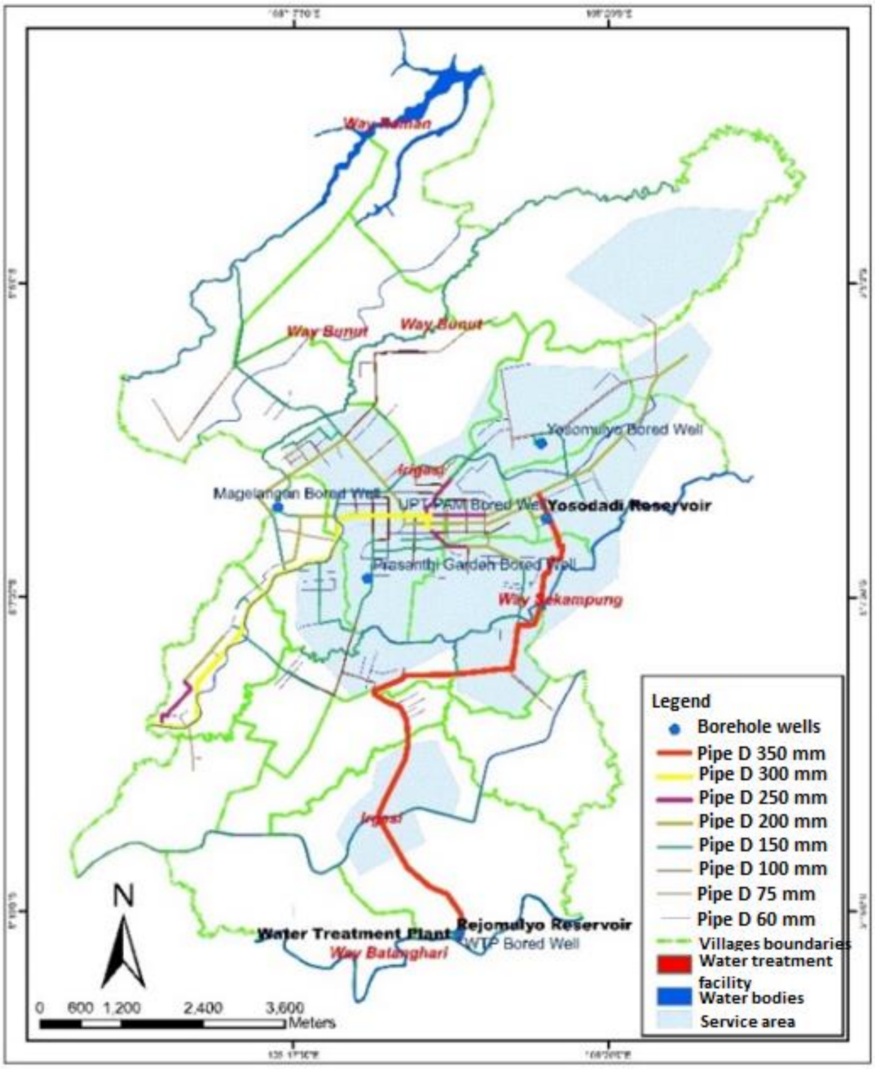


Figure 6.2 The map of the piped water service coverage in Kota Metro

Furthermore, the water source is still supported by three groundwater wells respectively located in Magelangan, Prasanti Garden, and Yosomulyo as are shown in figure 6.2. Nevertheless, these groundwater wells are only utilized for emergency situation when the quantity of surface water and the groundwater wells in the WTP is far below the expected volume to serve the existing customers in the service coverage area indicated by the pale blue areas in the map.

Furthermore, the water that is ready to be distributed for the customers is stored in the reservoir in Kelurahan Yosodadi (in the eastern part of Kota Metro) before it is delivered to the customers. From this reservoir, the water is pumped to the customers' house through pipeline network. Currently, the pipe network and the customers are only concentrated in the central and eastern parts of the city. The existing infrastructure was built a long time ago, when the local provider was established, and has not been significantly revitalized. That is why, the NRW (Non-Revenue Water) rate, which also indicates the water loss, is quite high. To define, the NRW is calculated by subtracting the annual production with the volume of the water paid by the customers. The latest data shows the monthly NRW in 2018 is ranging from 30% to 60% [56]. It implies that current system is not effective and need to be revitalized.

From the perspective of the institutional arrangement, the water service provider in Kota Metro is attached to the city governmental structure. To inform, in Indonesia, there are three organizational types of the public water service conducted by the local government namely PDAM[7], UPT[8], BLUD[9]. They are different mainly in term of organizational arrangement and budget allocation. Besides, they are also different in the responsibility mechanism and personnel arrangement. In the case of Kota Metro, its organizational form belongs to the second type. The current organizational form of the public water service in Kota Metro might be the cause of the low development pace in the domestic water provision. This is because almost all aspects of the public water service in Kota Metro are under the local government authority and are supposed to be discussed with the local parliament. For instance, budget allocation and tariff formulation are fully decided by the Major after having discussed and approved by the local parliament.

To compare, the difference between PDAM, UPT, and BLUD is summarized in table 6.2 [57]. The comparison summarized in this table implies that the second type of the public water service provider, to which Kota Metro belongs, is fully dependent on the city government including in the decision-making process and financial matters. Unsurprisingly, the development of public water service is likely insignificant since the governmental issues cannot be separated from politics and public water sector is often considered politically unpopular. Therefore, this sector is rarely put on the top priority to discuss when the political events such as election for the Major or the member of local

[7] PDAM stands for Perusahaan Daerah Air Minum (Local Government Owned Water Company)
[8] UPT stands for Unit Pelaksana Teknis (Technical Service Unit)
[9] BLUD stands for Badan Layanan Umum Daerah (Public Service Agency)

parliament. Besides, the nature of non-profit organization could also trigger the personnel who are in charge in the public water service sector to be less motivated. Thus, their performance is doing business as usual rather than searching innovation for business expansion.

Table 6.2 The comparison of the public water service organization in Indonesia

Aspect to be compared	PDAM	UPT	BLUD
Business orientation	Profit oriented	Non-profit oriented	Non-profit oriented
Organization	Considered as local government owned company, is not a part of governmental structure.	Attached to the city governmental structure	Attached to the city governmental structure
The role of the local government	The local government is a part of shareholders	The local government fully control the organization	The local government partly control the organization
Budget mechanism	Enable to independently manage financial matter, the revenue can be directly used by the company	The budget is decided city government, the revenue is considered as the local government revenue.	Enable to manage financial matters (revenue and expense) but require approval from the city government
Personnel	not government officials	Government officials	Government officials
Supervisory board	yes	no	possible
Responsibility	Responsible to supervisory board and the shareholders	Responsible to the Major	Responsible to the Major

6.3.2. Identifying Domestic Water Requirement in Kota Metro

Estimating domestic water requirement cannot be separated from the issue of the population growth and Indonesia is widely known to undergo increasing population growth. BPS recorded 255.6 million population in 2015 and is projected increasing with 1.07% population growth [58]. In the case of Kota Metro, a similar trend also appears although a specific projection project has not been officially conducted in this city. Regarding this issue, we compiled the population data from several years to observe the tendency of the population growth in Kota Metro. The data was compiled from the annual statistical reports published by BPS Kota Metro from 2003 to 2019. During this period, the population rise around forty-five thousand the trend shows increasing propensity with a constant population growth rate. In detail, the population growth is illustrated by figure 6.3. Furthermore, combined with the more various socioeconomic activities in Kota Metro, this increasing population trend obviously implicates on the increasing water demand. To estimate the future water demand, we firstly calculated the population projection. Due to data unavailability, we employed the mathematical projection rather than the component projection method even though the last method is considered more realistic reflecting demographic occurrence. However, our main intention is to estimate the amount of domestic water requirement instead of describing the demographic phenomenon.

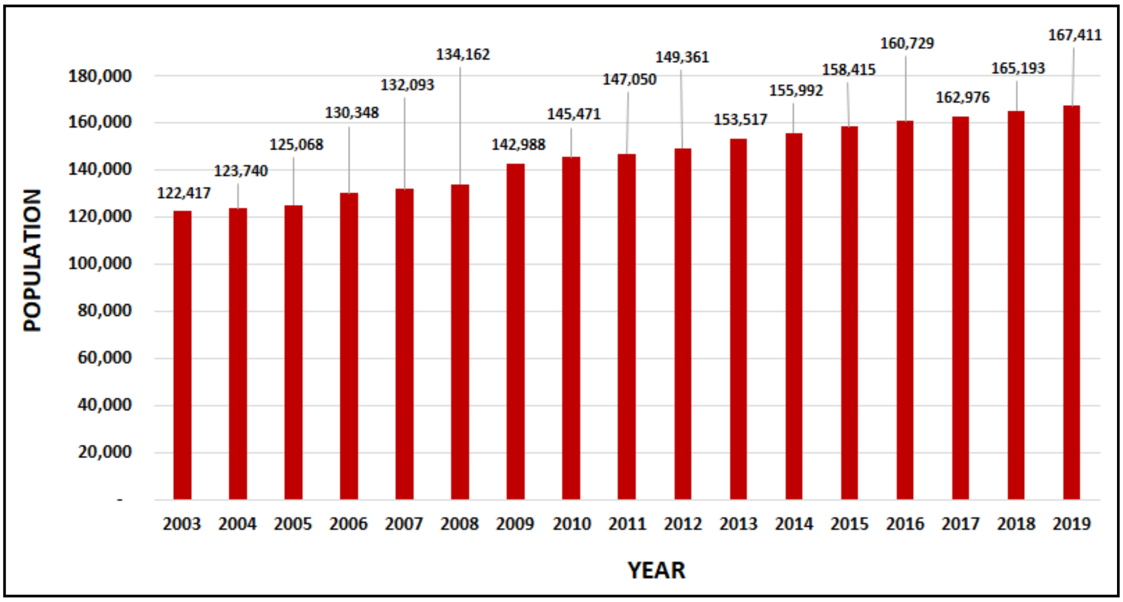


Figure 6.3 The population of Kota Metro from 2003 to 2019

We started the projection by calculating the population growth rate. The population data from 2018 and 2019 are used as the reference to calculate the population growth rate. The calculation shows the population growth rate in Kota Metro 1.013% per year. Then, we used this percentage as the basis of the population projection following the mathematical projection formulas. The population data in 2019 and the estimated population growth are utilized to project the population in 2020. Then, we set the projection timeline on the five-year basis considering the period of the political election in Indonesia. This is because the political event in Indonesia is usually followed by the five-year development plan proposed by the elected regime. In this regard, the population issue is expected to be accommodated by the proposed five-year development plan.

The calculation shows that in the short projection period the difference between the three projection methods is not significant. However, the difference is getting bigger in the long run. The projection shows the exponential projection method always achieves the highest number while the arithmetic projection method always results in the lowest number. To specify, the projection is presented in figure 6.4.

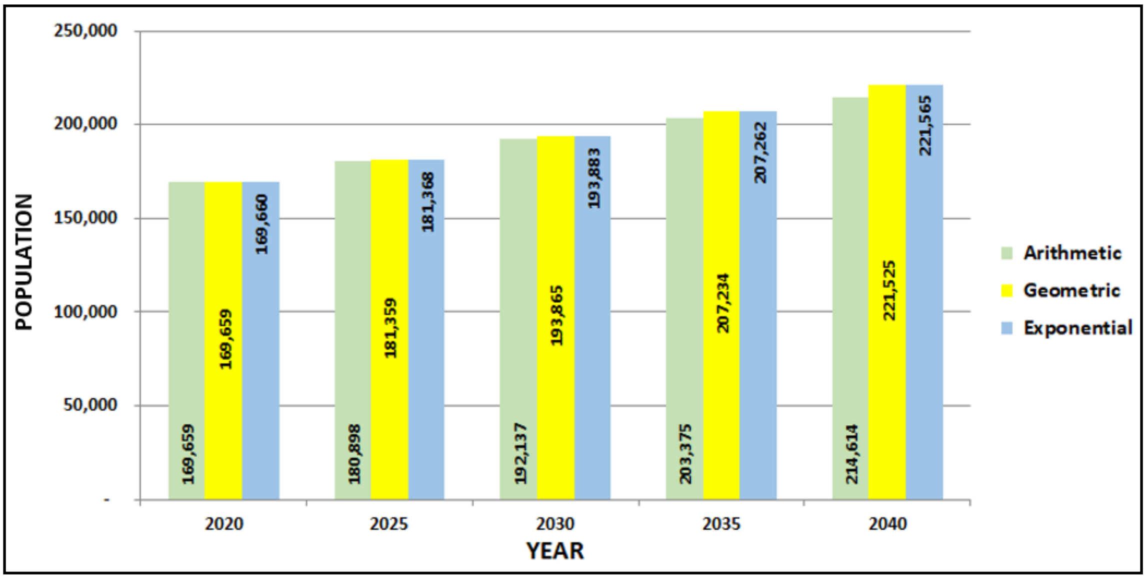


Figure 6.4 The population projection of Kota Metro under various projection methods

After calculating the population projection, the water need is estimated by multiplying the number of population with the minimum water requirement suggested by literatures, which are listed in table 2.1. We set a stratified minimum domestic water requirement from 5 Liters, 20 Liters, 50 Liters, 70 Liters, to 100 Liters per person per day to justify what is the current status of the water provision as well as reasonable targets to achieve. The 5-Liter category (or below) is considered as no access to water while the 20-Liter category is considered as basic access [34]. Moreover, this literature also suggests that 50 Liters per person per day as an intermediate level, which is the same as basic water requirement suggested by [32] while 100 Liter is an optimal level of access to water, which is also the minimum water requirement suggested by Indonesian standard [33]. The 70-Liter category is suggested by WHO to suffice potable need and personal sanitation especially in the emergency situation [37].

Furthermore, we multiplied the suggested amount of the daily water requirement in a year (365 days) with the projected population to estimate the water needs in the future. Three types of the population projection were set as the target of projection. This aimed to provide the estimation under various possible population trend that might happen in Kota Metro. Subsequently, the estimated water need was compared with the actual production capacity. The estimated water requirement is overlaid with the trend on the annual production capacity (figure 6.1) to investigate the gap between the actual supply and the projected demand. To illustrate, the comparison is shown by the following figure.

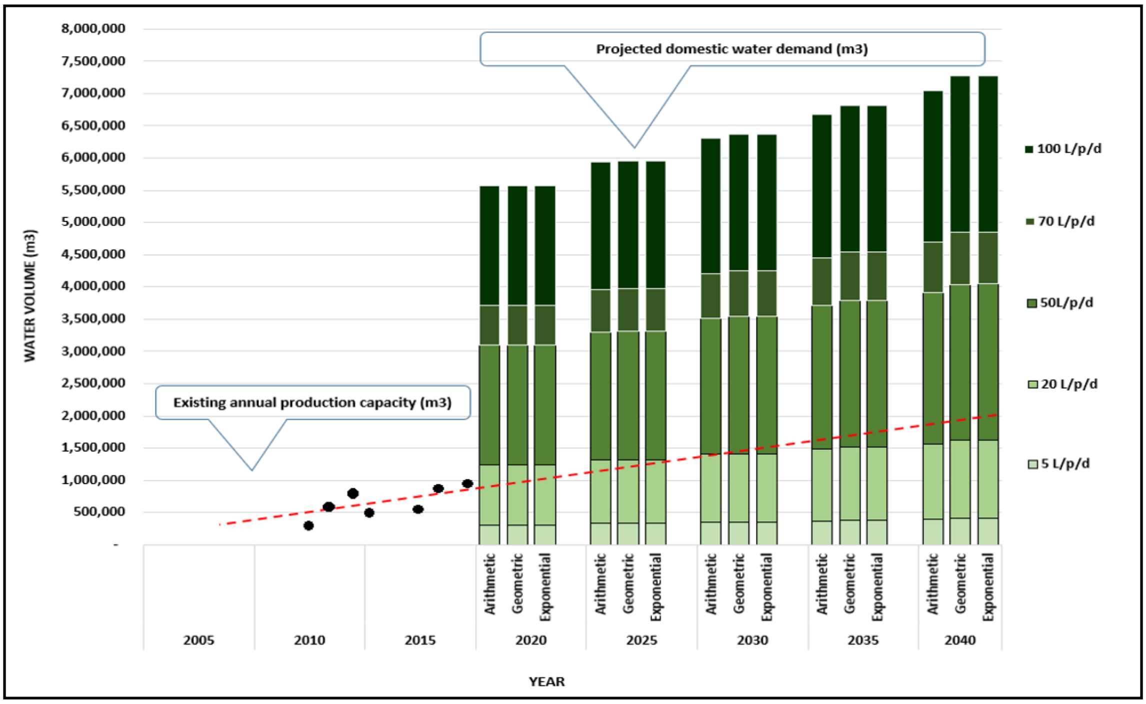


Figure 6.5 comparison between the existing annual water production in Kota Metro and the projected domestic water demand

Figure 6.5 illustrates the current trend of annual production capacity performed by the pipe water service provider in Kota Metro in comparison with projected domestic water requirement under various population projection methods. It can be clearly seen that the projection of the production capacity trend (as is indicated by the red line) is far below estimated water demand. To specify, the existing capacity will only be able to suffice the domestic water need in Kota Metro up to the basic access level (20 Liters per person per day) if the water is equally distributed for all residents even though it can provide 312 Liters per person per day for the registered customers (as is discussed in section 6.4.1). The comparison between actual production capacity and estimated water demand shows a wide gap. Unsurprisingly, people who are not pipe water subscribers, would seek other types of domestic water fulfillment. This estimation has confirmed our findings that were discussed in previous chapters showing that poor performance of the domestic water service provider in Kota Metro highly influences people’s reluctance to choose pipe water as the main source for daily domestic water utilization.

The next section of this chapter would elaborate the issue of improving current situation. The principles of the circular economy, which emphasize the use of resource more efficiently, would be an approach to formulate the alternatives. Hence, literatures in this field were utilized as valuable references. Moreover, the improvement proposal would consist of several strategies and respective implications from various perspectives such as financial, institutional, environmental, and so forth.

6.3.3. Exploring Potentials Belonged to Kota Metro

a. Climatic and Hydrological Characteristics of Kota Metro

The most obvious potential that has not been optimally utilized is rainwater. This is probably because rainwater requires a further process to be readily use and its availability is seasonal dependent. Besides, its distribution is also spatially unequal. Aside from this premise, the rainwater can be viewed as the most promising water resource to be exploited sustainably. Rainwater harvesting, for instance, can be an alternative to deal with water shortage and play an important role in the hydrological discharge-recharge mechanism. The following table illustrates the potential of rainwater in Kota Metro.

Table 6.3 The annual rainfall rate and numbers of rainy days in a year in Kota Metro (2008 – 2019)

Year	Annual Rainfall Rate (mm)	Numbers of Rainy Days in a Year
2008	2,076	108
2009	1,507	113
2010	NA	NA
2011	1,983	79
2012	1,724	96
2013	2,503	124
2014	480	73
2015	1,429	117
2016	2,375	135
2017	2,095	101
2018	NA	NA
2019	1,526	76

Table 6.3 recaps annual rainfall rate that is recorded in the rainfall gauge station. Despite unavailable data in some years, it can be seen that the rainfall rate in Kota Metro is relatively high and the rainwater is available throughout a year. As a simple illustration, 1,000 millimeters (one meter) of rainfall rate results in one cubic meter of water potential if it falls on the one square meter of area. Thus, the area of Kota Metro, which is 68.74 square kilometers, will potentially restore a large amount of rainwater. However, there are many factors causing this simple assumption does not meet the reality. The land use change, for instance, has decreased the availability of pervious areas that can accommodate rainwater infiltration mechanism. As a result, more rainwater becomes run off flowing to river bodies and finally to the sea. On the other hand, less water infiltrates into the ground to be restored as groundwater deposits. Hence, this potential offers more sustainable water resources, but it has not been well managed.

Theoretically, factor such as soil dept and geomorphology, soil hydraulic properties, and climatic properties highly influence the infiltration rate [59]. Besides, it is independent on the condition of the land surface (cracked, crusted, compacted, etc.), land vegetation cover, surface soil characteristics (grain size and gradation), rainfall characteristics (intensity and duration), and so forth. One of prominent models to estimate the rainfall infiltration rate is suggested by Horton [60]. Horton proposed this following equation to estimate infiltration capacity.

$$f_p = f_c + (f_o - f_c)e^{-kt} \quad \text{(eq. 6.1)}$$

Where, f_p=infiltration capacity in mm/hour at any time t

f_o=initial infiltration capacity in mm/hour

f_c=final constant infiltration capacity in mm/hour at saturation. It depends on soil type and vegetation.

t=time in hour (calculated from the beginning of rainfall)

e=Euler's number (2.71828…)

k=an exponential decay constant dependent on soil type and vegetation.

Furthermore, estimated values of Horton parameters are suggested as the following table.

Table 6.4 Estimated values of Horton parameters

Soil/cover complex	f_o (mm/hour)	f_c (mm/hour)	K(Liters/hour)
Standard agricultural (bare)	280	6 – 220	1.6
Standard agricultural (vegetated)	900	20 – 290	0.8
Peat	325	2 – 29	1.8
Fine sandy clay (bare)	210	2 – 25	2.0
Fine sandy clay (vegetated)	670	10 – 30	1.4

Table 6.4 implies the importance of soil properties and vegetation to determine the infiltration capacity. Following the formula in the equation 6.1, vegetated land has much larger initial infiltration capacity that means the rainwater infiltrates much faster into the vegetated land than into the bare land. In addition, the small value of the K also indicates the big infiltration rate since the relationship between this parameter to the infiltration rate is inversely proportional. Moreover, in the Horton model, the infiltration rate is considered to decrease with time. The initial infiltration rate is the rate prevailing at the beginning of the precipitation and is maximum then gradually decrease in time and reach a constant value. Considering this principle, the big potential of the rainwater cannot be optimally conserved if it merely relies on the natural recharge mechanism. Besides land and vegetation conservation, it is supposed to be added with technical measures such as rainwater harvesting tanks, collecting ponds, and so forth. Regarding the rainwater harvesting issue, Indonesian government has encouraged various stakeholders to conduct this kind of measure by issuing the Regulation of the Ministry of Environment number 12 in 2009. Through this regulation, building owners or housing developers are obligated to conduct rainwater harvesting measures that can be done by building collecting ponds, infiltration wells, or bio pore holes [61]. This policy can be viewed as a good political will to perform better environmental conservation attempts as well as to utilize the big potential of rainwater more significantly.

In the case of Kota Metro, population growth and urban development have also caused changes in the land use. A study by [62] found that from 2000 to 2015 Kota Metro 819 hectares of rice field have shifted into residential or commercial uses as is illustrated in figure 6.6. The yellow-colored areas showed in this figure were formerly rice fields that currently function as the residential or commercial areas.

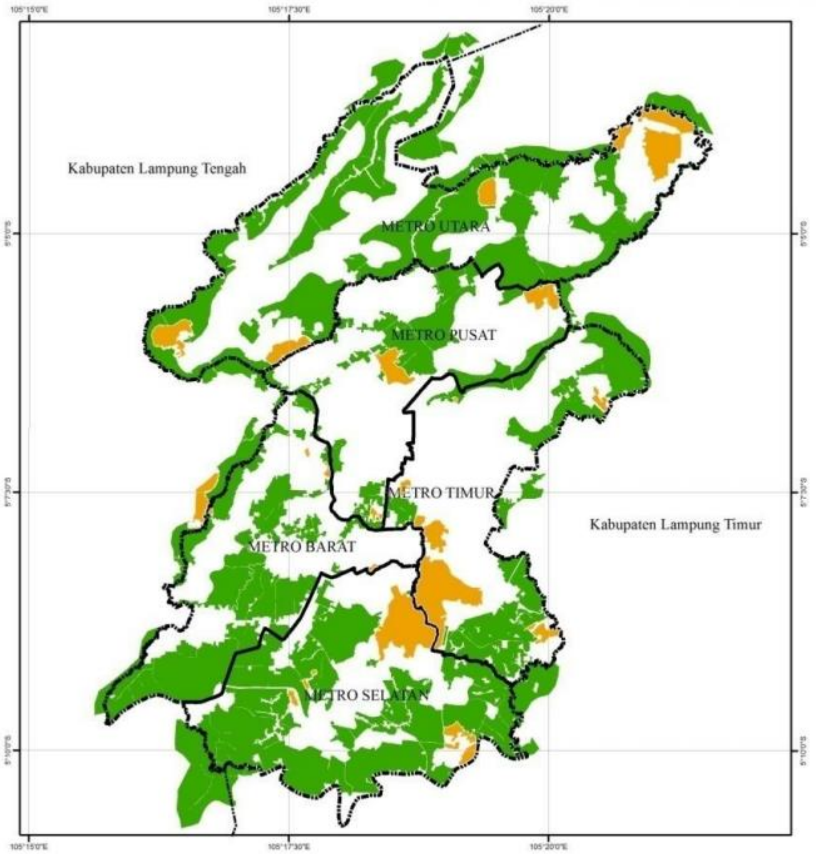


Figure 6.6 The land use-shifting from rice field to residential areas in Kota Metro (source: [62])

Furthermore, the analysis of this research was conducted merely for the rice fields excluding other agricultural activities such as horticultural cultivation or dry land farming. Hence, the changing would be much more significant if these types of agricultural activities are included. In the context of the rainwater infiltration issue, this shifting implies to the decrease of permeable surfaces enabling rainwater infiltration (as is suggested by table 6.4). Consequently, less water can be absorbed into the ground causing the groundwater deposit decrease.

b. Paradigm-shifting in the Development Approach

Besides the hydrological potentials, the shift in the Indonesian political setting also brings a consequence in the development planning regime. Currently, the decentralized approach, which encourages more public engagement in the development planning process, is highly promoted. This change also enables local authorities e.g., the city government to have more initiative and innovation to manage local issues. In Kota Metro, the city government has also applied the principle of community involvement in the development planning process. In this procedure, the city government allocates funding for the development in the village level and public aspirations are accommodated from the smallest level such as neighborhood. At the beginning process of annual development plan, communities have opportunities to articulate their actual problems and pose proposals to the city government.

Moreover, the proposals are compiled by the city administrative body at the village level to be discussed. Afterwards, the discussion at the higher level i.e., sub-district level and city level is subsequently conducted. Despite merits offered by the public participation approach, a critic might be posed regarding this procedure. Inevitably, the submitted proposals should compete each other to be matched with the allocated finding. The proposals coming from community groups who have higher social-economic status and more power in the society frequently dominate over the others. Up to this point, the decision occasionally does not reflect the scale of priority but competition among powerful people in the society. Besides, their proximity to the political power in the city level does matter to determine selected proposals to be approved.

Regarding domestic water sector, most proposed plans are building communal groundwater well to overcome water shortage problems. It is recorded that from 2010 – 2014 the government of Kota Metro has built 82 units of this type of communal groundwater well that are scattered in all villages in Kota Metro as is illustrated by figure 6.7. From the perspective of the development of domestic water sector, this facility is supposed to be very useful to overcome the problems of public water service provision and to encourage people to use more public water source rather than individual groundwater exploitation. However, this assumption is not fully correct since almost all these public groundwater wells are temporarily functioned by the community in the dry season. As a matter of fact, these public facilities cannot encourage people to leave their individual groundwater exploitation but merely a supplementary option that is functioned when the water from their individual groundwater wells cannot be abstracted.

There are some reasons to explain why people only utilize communal water wells and hesitate to use them as the primary water source to fulfill their daily needs. Some of them are even used for merely limited functions such as religious activities in mosques or other community activities. First, the unavailability of supporting facility might be the main cause. To inform, a built communal groundwater well consists of only standalone well and a water tank. It is not equipped with the pipe network to deliver the water to the surrounding houses. Because of that, people have to come to the standpipe to collect the water and bring it to their house. Hence, the reluctance to spend more time and efforts to access the water discourage people to shift their main domestic water utilization into this kind of public water facility.

(a) (b)

Figure 6.7 (a) A communal groundwater well located near the village office of Kelurahan Yosomulyo; (b) A communal groundwater well located in one of the mosques in Kota Metro.

Second, the communal groundwater well is not followed up with the organizational arrangement to manage the facility. Most of them are operated by people who voluntarily take care of the facility without clear job description as well as advantages that they have. Not only that, the issue of operational and maintenance cost is also not clearly organized. Unsurprisingly, only some communal wells, especially those managed by religious groups in communities, are sustainably utilized even though they are only utilized for specific purposes.

Despite their less functionalized, the built groundwater wells are potentials. Combined with the spirit of togetherness that is widely practiced in the society, this communal facility can potentially be optimally functioned e.g., through community-based water management. For example, one communal well can be used to suffice water needs for several houses in a neighborhood. Indeed, it is supposed to be equipped with necessary supporting elements such as organizational arrangement as well as the way to pay operational and maintenance cost.

c. Social Capital Belonged to Kota Metro

Many literatures revealed the importance of the social capital. For instance, a study by [63] elaborate the importance of the social capital in developing community-based to respond natural disaster while [64] revealed the role of the community social capital for food security in an extreme weather. To elaborate, the social capital is defined as "*multidimensional phenomenon encompassing a stock of social norms, values, beliefs, trusts, obligations, relationships, networks, friends, memberships, civic engagement, information flows, and institutions that foster cooperation and collective actions for mutual benefits and contributes to economic and social development*" [65]. This definition gives an insight that social capital, which is an intangible element in the development process, plays an important role in the development process. Mentioned elements in this definition enables to enhance cooperation and collective actions. Ultimately, these are beneficial for economic and social development. Moreover, the social capital, which is in the form of community participation and social trust, have positive correlation with environmentally responsible behavior [66] and collective action plays important role in natural capital conservation and management [67]. In the economic development, the social capital enhancement is articulated in the form of the program involving self-help group to alleviate the poor [68]. This study shows that the program substantially improve livelihood, encourage savings, and create social capital among the poorest group through organizing self-help groups.

Literatures mentioned above show that the social capital hold an important role to accelerate the development process. The social capital can complement the tangible elements in delivering any development programs. In the case of Kota Metro, the social capital is promising to accelerate the development in domestic water sector due to many constraints, such as financial, belonged to this city. The communal groundwater wells, which were proposed by communities and built by city government, can be taken as an example of the collaborative action to overcome problems in domestic water provision issue. The main challenge is to encourage public participation not only in the planning process but also in the operation and maintenance phase of the built facilities. Hence, the facility can last longer and be functioned more optimally. The absence of organizing groups that are responsible to operate and maintain the facilities could be handled by utilizing variety of informal groups e.g., religious groups, women groups, or youth groups, that largely exist in every neighborhood.

Besides informal community groups, formal neighborhood organization can also be utilized to overcome the issue of operating and maintaining communal groundwater facilities. To inform, kelurahan, which is the lowest tier of the city government, is assisted by neighborhood organization called RT (*Rukun Tetangga*). One RT usually consists of 30 to 50 households and totally Kota Metro has 802 RTs [69]. This societal structure is actually potential to organize community-based domestic water provision. This following table compares the number of communal groundwater facilities and the number of RT every kelurahan in Kota Metro.

Table 6.5 The number of RTs and communal groundwater well in Kota Metro

No	Kelurahan	Number of RT	Number of communal groundwater well
1	Metro	57	3
2	Imopuro	32	2
3	Hadimulyo Barat	42	1
4	Hadimulyo Timur	39	4
5	Yosomulyo	44	3
6	Tejosari	24	0
7	Tejoagung	37	4
8	Iringmulyo	42	2
9	Yosorejo	37	0
10	Yosodadi	34	0
11	Mulyojati	27	3
12	Mulyosari	20	2
13	Ganjar Agung	39	2
14	Ganjar Asri	52	1
15	Banjarsari	59	10
16	Purwosari	44	13
17	Purwoasri	30	9
18	Karangrejo	46	13
19	Sumbersari	18	4
20	Rejomulyo	29	3
21	Margodadi	25	2
22	Margorejo	25	1
	TOTAL	802	82

Currently, the role of the RT leader, who is directly voted by the residents in the neighborhood, is to help the society when they need administrative service e.g., resident permit, birth certificate, marriage certificate, etc. It could be beneficial if the role of RT in the societal structure is extended to manage communal facilities such as communal groundwater wells. Besides, other societal organizations such as youth groups, woman groups, religious activities groups, and so forth can also be utilized. Unlike the RTs, which are formally recognized by the local government, the voluntariness of the community participation can be more implemented through these informal organizations. Thus, the problem of organizational arrangement can potentially be solved by using the existing societal organizations.

6.3.4. Scenarios to Improve Domestic Water Fulfillment in Kota Metro

This section discusses possible alternatives that can be proposed to improve the domestic water provision in Kota Metro. The main intention is to provide solutions to reduce the potential of the individual groundwater exploitation. Indeed, it does not aim to generate a single solution that is considered as the best option, but to explore planning scenarios enabling to adapt with the current dynamics of the domestic water issues in Kota Metro as well as to tolerate the constraints belonged to this city. To conduct this approach, there are three scenarios will be elaborated. They are doing business as usual, pipeline-based water service, and combining pipeline-based water service and community-based water service.

Furthermore, the proposed alternatives are assessed against financial and environmental considerations to measure their benefits and drawbacks. Subsequently, the required factors of the respective scenario are also explored to strengthen the cost-benefit analysis. Not only that, public preference, and willingness, which were discussed in the previous chapter, are also recalled examining the applicability of the proposed alternatives. In detail, the discussion is presented below.

a. Performing ‘Doing Business as Usual’ Approach

The easiest and cheapest way to deal with domestic water problems is performing doing business as usual approach. Doing business as usual does not mean doing nothing but letting the existing trend keeps on continuing without any significant interventions. In the case of Kota Metro, current achievement on production capacity and the number of the pipe water subscribers can be a benchmark. Then, domestic water development can only follow the trend. In terms of financial support, the government funding can only be spent in a small portion. However, environmental degradation caused by uncontrolled individual groundwater exploitation is something obvious in the future (or even in the short run). This is because the remaining gap between water supply and demand insist people to seek other sources to suffice their daily water need. In this case, individual groundwater exploitation the most accessible and preferable source.

To begin with, figure 6.8 illustrates the current trend on the annual production capacity, the volume that is currently used, and the volume that is supposed to be provided to suffice the actual demand.

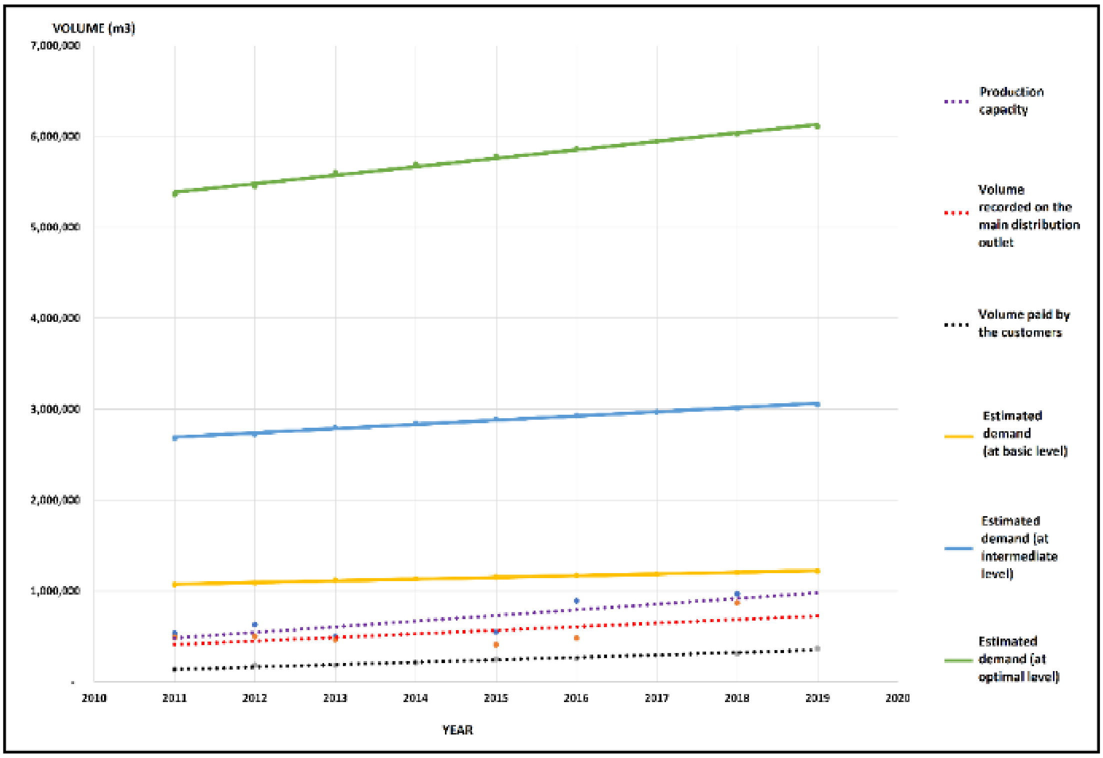


Figure 6.8. The trend of the water production capacity and the estimated demand in Kota Metro

The trendlines shows the comparison between the actual production capacity and the estimated domestic water demand from 2011 to 2019. The purple dash indicates the production capacity that is recorded in the production unit of the water service provider in Kota Metro while the red dash shows the volume that is recorded on the main distribution outlet. The gap between these two dashed lines indicates the water lost from production unit to the distribution unit. Moreover, the volume of the valued water, which is recorded from the customer's water bill, is much smaller than the distributed water. This situation can be viewed as inefficient supply might possibly be caused by water leakage because of aging pipe network or lacking maintenance.

To overview the trend of the domestic water fulfillment in Kota Metro, the water supply can actually suffice the subscriber's needs. However, it is far below the total domestic water demand of the city. The yellow, blue, and green lines illustrate the estimated total demand. The estimation is conducted by multiplying the minimum water requirement (in a year) suggested by literature and the population of Kota Metro. In this case, we refer to Howard and Bartram [34] to define the minimum daily water requirement, which are 20 Liters per person (basic), 50 Liters per person (intermediate), and 100 Liters per person (optimal). Furthermore, the gap between the actual production capacity and the estimated demand shows not only insufficient supply but also the bulky use of other domestic water sources beyond pipeline-based water service.

In the perspective of doing business as usual approach, we started the analysis with the extrapolation of the existing trend as is illustrated in figure 6.9.

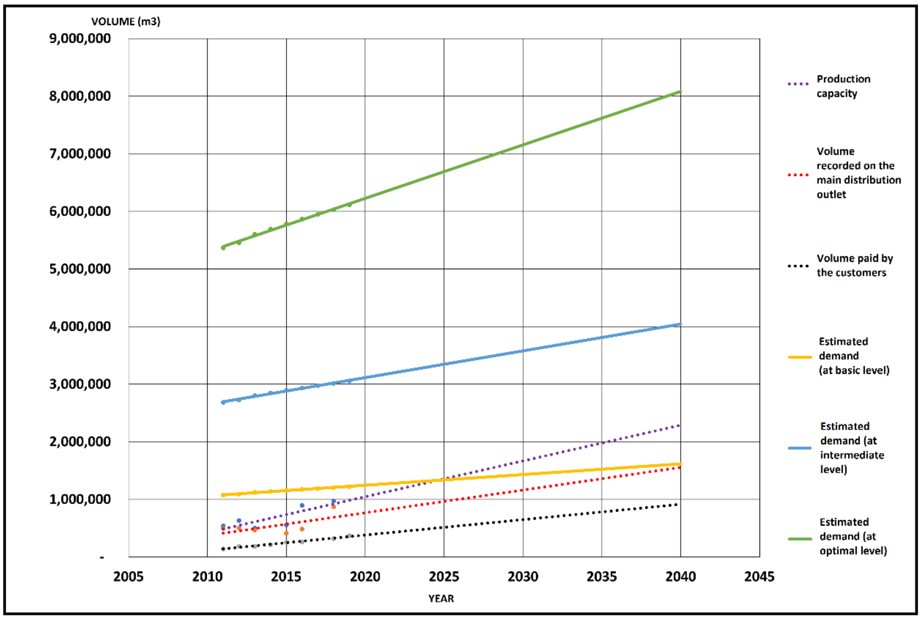


Figure 6.9. The projection of the trend on the water supply and demand in Kota Metro

The projection illustrates no significant intervention in the supply side of the domestic water service. Thus, it is only continuing the existing trend. Furthermore, the intersection between the purple dashed line and the yellow line (around 2025) indicates the production capacity meet the minimum water requirement at basic level. However, the meeting point will take a longer time (around 2040) if the minimum requirement is assessed against the water recorded at the main distribution outlet. Up to this point, the development of the pipeline-based water service can be more focused to increase the efficiency by revitalizing the aging infrastructure to reduce the leakage rather than expanding the coverage area. As a consequence, the gap between the production capacity and the water that is readily distributed to the customers will be significantly decreased. It is in line with the report launched by the World Bank stating that most of development projects finance in pipeline-based water infrastructure in Indonesia is less efficient. Therefore, the World Bank recommend upgrading the existing network than developing the new ones due to more efficient public spending [70].

Moreover, increasing efficiency will reduce the leakage implicating on the increasing performance the service. This is important to build company image and gain more trust from the customers. Besides, better performance is useful to encourage people to subscribe the pipeline-based water service and leave their individual groundwater exploitation. The trend actually shows that the production capacity exceeds the customer’s need, which is indicated by the purple line (or the red line) is on top of the black line. This also strengthen the evidence showing the inefficiency. Once the supply efficiency increase, the city government can more intensively campaign the pipeline-based water service so that the number of customers also increase. As a result, the revenue will potentially increase enabling the city government to finance more projects on the development of the pipeline-based water service. Hence, increasing the efficiency of the existing pipeline networks is more economically beneficial in terms of effective expenditure and potential revenue.

Besides the benefits to conduct doing business as usual approach, this method can be viewed as the most reasonable choice due to various constraints belonging to the government of Kota Metro. Nevertheless, it can also bring negative consequences. Firstly, this approach will put the issue of public water provision in less priority. Consequently, encouraging public awareness on the negative impacts of the individual groundwater abstraction will be getting more difficult since the issue will be considered as unimportant. Secondly, the service performed by the service provider will remain at low level or even be worsened through this approach. Besides, this approach does not provide a good environment to stimulate innovation in the domestic water provision. Thirdly, doing business as usual approach offers only a slow pace of development in the public water. It implies that the trend of the individual groundwater abstraction will continuously go on, or even significantly increase along with the rapid population growth. In the long run, the trend will rapidly deplete the groundwater table and degrade the environment.

b. Accelerating Pipeline-based Water Service

The next scenario to develop domestic water provision proposed for Kota Metro is accelerating pipeline-based water service. A big investment required can be viewed as the main constraint of this approach. One of examples to show required budget for water improvement is reported by Hutton and Bartram in 2008 [71]. In this report, the initial investment cost per capita for pipeline-based water infrastructure in Asia is approximately USD 148 while the annual recurrent cost is around USD 9.6 per capita. On the other hand, borehole requires USD 27 per capita for initial investment and USD 0.2 per capita for annual recurrent cost. Since this cost was estimated in 2005, adjustment to the current price is done by adding the cost with the average annual economic growth in Indonesia. It is estimated that the average annual economic growth from 2005 to 2019 is 5.49% [72]. In more detail, the financial requirement for the domestic water improvement programs and the estimation to the current price are summarized in the table 6.6. Furthermore, the population data of Kota Metro is assessed with the estimated costs listed in this table to demonstrate the analysis of the financial need. Subsequently, the gap between the existing pipe water subscribers and the population of Kota Metro was calculated to estimate the initial cost required to accelerate the pipeline-based water service. To provide a proper comparison, the numbers of pipe water subscribers were converted into the estimated users by multiplying them fourfold. This is because the number of subscribers is registered as a household that on average consists of four members [54].

Table 6.6. The cost per capita of the water improvement programs

Water improvement	Per capita cost in 2005 [71] (USD)		Estimated per capita cost in 2019 (USD)	
	Initial cost	Annual recurrent cost	Initial cost	Annual recurrent cost
Household connection	148	9.6	156.12	10.13
Standpost	103	1.0	108.65	1.05
Borehole	27	0.2	28.48	0.21
Dug well	35	0.2	36.92	0.21
Rainwater	55	0.4	58.02	0.42

Furthermore, to represent the trend with a mathematical equation, the year was converted into a *t* period so that the mathematical equation corresponds the population and the pipe water users as the function of *t* (period). As a result, the estimated population and the pipe water users would be easily calculated by replacing the variable (in the equation it is expressed by *x*) with the desired period. In more detail, the projection is illustrated by the following figure.

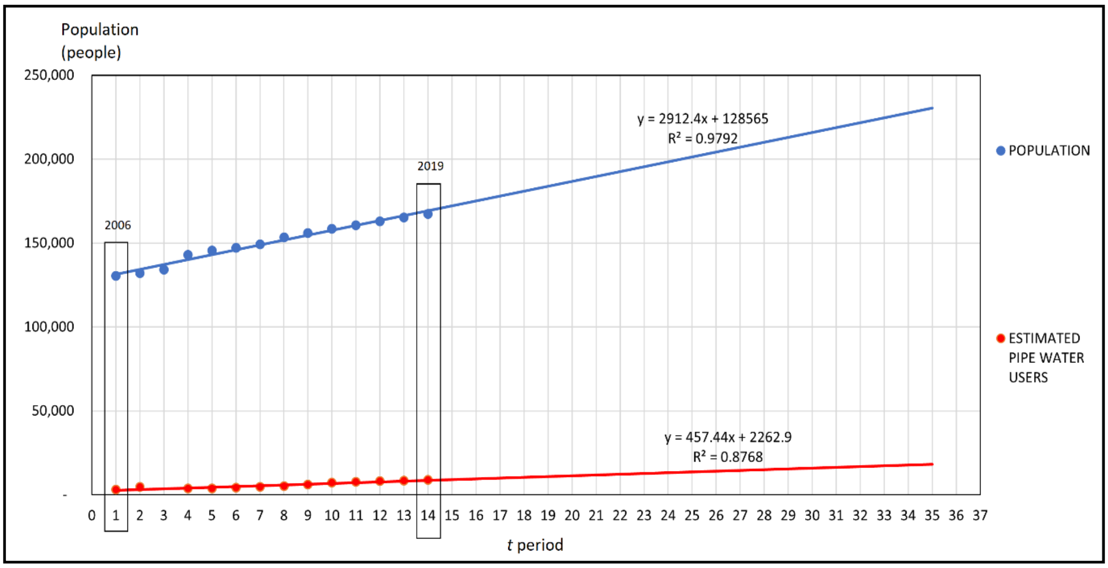


Figure 6.10. The comparison between the projection of the population and pipe water users in Kota Metro

The graph illustrates the projection resulted from the existing data, which is available from 2006 to 2019. The red and blue dotes indicates the existing situation while the lines show the trend. It can be seen that the blue line (population) is steeper that the red one indicating the gap between the population and the pipe water users will be getting bigger. Following cost per capita (table 6.6). this situation implicates on the increasing budget that should be provided for initial cost if the full pipeline-based is chosen as domestic water improvement strategy. To illustrate, if the strategy will be applied in 2021 (t=16) the population will be approximately 175,163 people where 165,582 of them are not the pipe water users. Therefore, the budget that should be provided to developed fully pipeline-based water service will be around 25.85 million dollars. On the other hand, total revenue of Kota Metro in 2020 is estimated at 178,466,801,656 rupiahs (around 12.75 million dollars for the rate USD 1 = IDR 14,000). To inform, the revenue is gained from the tax and retribution from the residents that can be fluctuated in accordance with the economic situation. Thus, financing fully pipeline-based water service in a year will cost more than the financial capacity of Kota Metro, which is unrealistic. Moreover, the budget allocation must be approved by to local parliament. At this stage, different interests among political parties in the parliament will make the problems are getting more complicated.

Another approach to provide a fully pipeline-based water service is accelerating the pipe network expansion within a certain timeline instead of building the infrastructure at once. The desired achievement can be targeted through a certain period. For instance, the target is set for five year, which is in line with the Major election. The scheme can be simulated as the following figure.

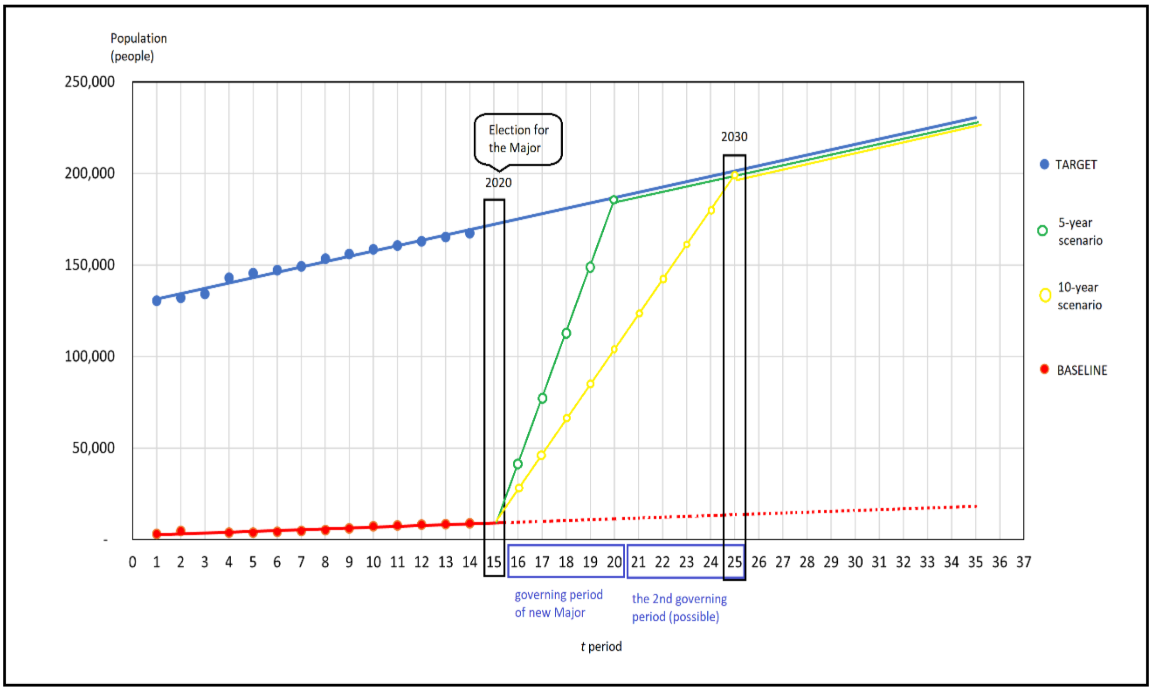


Figure 6.11 Scenarios for improvement strategies through fully pipeline-based water provision

This figure compares two scenarios to accelerate the development of pipeline-based water service. The green line refers to a 5-year development scenario where the ultimate target is divided into five years. This timeline is selected in accordance with the political event (the Major election) in Kota Metro, which was held in 2020. Thus, the plan is accommodated into a 5-year development planning that is traditionally proposed by the elected Major to be implemented during his 5-year governing period. Furthermore, in Indonesian election system, it is possible for the Major to be re-elected for the second time. Hence, a 10-year scenario is also possible to be formulated and remaining target can be continuously achieved in the second governing period. Otherwise, the program can be taken over by the new elected Major.

The basic idea of dividing the target is to overcome financial constraints. The allocated budget is calculated by multiplying the desired target and cost per capita suggested by the literature. To specify, the target is set in accordance with the projected gap between the pipe water users and the total population. The green line shows the scenario for 5-year development plan and the yellow line indicates the 10-year development scenario. On the other hand, the straight red line is the projection of the current achievement while the dashed red line is the situation where the business-as-usual approach will be applied in the development of pipeline-based water service. To simplify, in the 5-year plan the target is 20% of the gap in the respective year while in the 10-year plan the target is 10%. In more detail, the target setting and required budget is summarized in the following table.

Table 6.7. The comparison between 5-year and 10-year development plan of the fully pipeline-based water service

Year	Projected population	5-year development plan				10-year development plan			
		Existing gap	Annual target	Cum. target	Required initial cost (USD)	Existing gap	Annual target	Cum. target	Required initial cost (USD)
2021	175,163	165,581*	33,116	42,698	5,170,116	165,581*	16,558	26,140	2,585,058
2022	178,076	135,378	33,844	76,543	5,283,786	161,518	17,946	44,086	2,801,793
2023	180,988	104,446	34,467	111,010	5,380,994	136,902	17,113	61,199	2,671,637
2024	183,901	72,891	36,445	147,455	5,380,994	122,701	17,529	78,728	2,736,592
2025	186,813	39,358	39,358	186,183	6,144,550	108,085	18,014	96,742	2,812,372
2026	189,725					81,114	18,597	115,339	2,903,309
2027	192,638					64,891	18,597	133,935	2,903,309
2028	195,550					53,578	20,538	154,474	3,206,432
2029	198,463					38,174	21,994	176,468	3,433,774
2030	201,375					21,542	24,907	201,375	3,888,458
	Total		177,231		27,669,313		191,793		29,942,733

*) the existing gap in 2021 is the difference between projected supply and demand (the distance between red line and blue line in figure 6.11). Meanwhile, the existing gap in 2022 until the end of period is the difference between the projected population and the cumulative target.

Table 6.7 compares 5-year and 10-year development scenarios in terms of target to be achieved and required initial cost. The accumulative target is numerical expressions of green and yellow dots illustrated in figure 6.8. The calculation starts with estimating the existing gap between the population and the pipe water users in 2020. Then, the annual target for 2021 is calculated by dividing the gap with the available period (5 years). On the other word, the remaining gap is multiplied by a fifth. Afterward, the existing achievement is added by the projected annual target resulting in the number of the cumulative target. Subsequently, the existing gap in 2022 is subtracted by the cumulative target in 2021 resulting in the remaining gap to be handled in 2022. Furthermore, the calculation for the remaining period is done iteratively but using different multiplying coefficient. For example, the remaining gap in 2022 is multiplied by a quarter while the remaining gap in 2023 is multiplied by a third and so forth. Moreover, to estimate the initial cost required in every year, the annual target is multiplied by the cost per capita suggested in table 6.6, which is USD 156.12. The same mathematical procedure is also applied for 10-year development plan. However, the multiplying coefficients are different. In this timeline, the multiplying coefficient for 2021 is a tenth, for 2022 is a ninth, and so forth while the rest of the calculation stages are similar.

In comparison, annually, the 5-year development plan required bigger allocation that the 10-year development plan. Nevertheless, the total budget to achieve the ultimate goal of the universal access to pipeline-based water service in the 5-year development plan is less costly. It is understandable since in the 10-year development plan the value of the projected population will be getting bigger implying bigger water demand. Moreover, the target of fully pipeline-based water service will also be achieved in shorter period through this scheme implicating on less recurrent cost that should be provided. To illustrate the comparison between required funding and the financial capacity belonged to Kota Metro, the trend on the total revenue of this city is elaborated. The data was compiled from the documents of the annual budget (2010 – 2020) approved by the city government and the local parliament. The original data was stated in Indonesian rupiah that has been converted into the US dollars (USD 1 approximately equals to IDR 14,000 in 2019). The comparison is illustrated in the following figure.

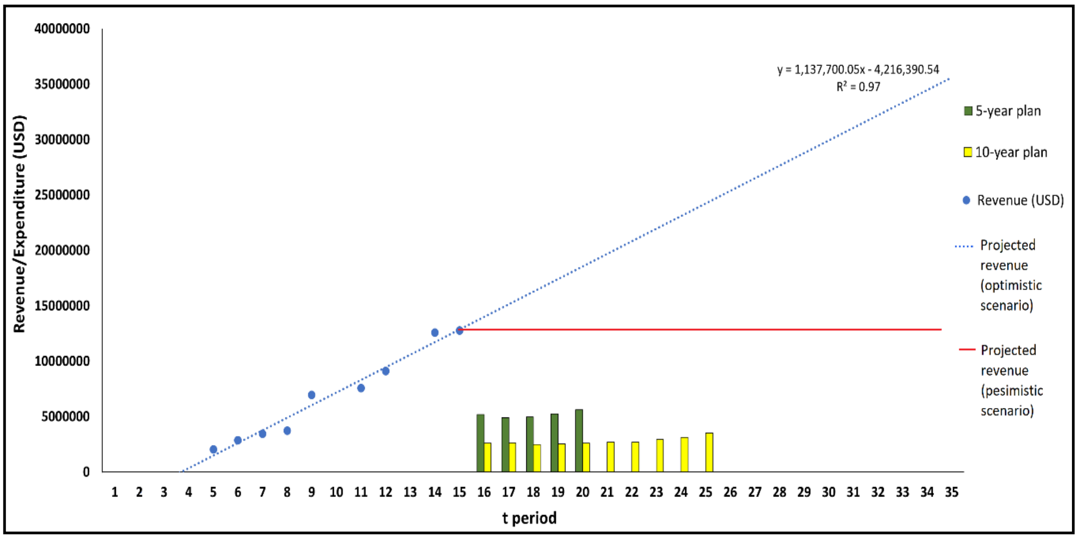


Figure 6.12. The comparison between the annual revenue of Kota Metro and the funding required by the 5-year and 10-year development plan

Figure 6.12 shows the comparison between the annual revenue of Kota Metro and required funding for respectively 5-year and 10-year development plan. The blue dots are the available data on the total revenue launched by the city government while the blue line indicates the trendline of the data for the future forecast. Although the data shows an upward trend, the pessimistic scenario is also provided to anticipate the possibility of the extremely low economic growth. The red line takes the assumption of zero growth compared to the revenue in 2020. To specify, in the optimistic scenario, the expenditure for the 5-year development plan service will cost 36.96% in 2021 while it will take 18.48% of the total revenue for 10-year development plan. The percentage will be getting less along with increasingly projected revenue. On the other hand, in the pessimistic scenario, the spending will take 40.24% of the revenue in the 5-year development plan and the percentage is 20.11% in the 10-year development plan. In this scenario, the percentage will be relatively constant until the end of the projected period.

Aside from the financial aspect, another challenge to apply fully pipeline-based water service is related to the public preferences in Kota Metro in the domestic water utilization. Our household survey discussed in the previous chapter shows that only 6.33% of respondents, who currently do not subscribe pipe water service, are willing to move to water service although they ever had the water shortage experience in using their current domestic water source. Meanwhile, the rest of the respondents expressed their reluctance to use pipe water service when they were asked about this issue. Their reasons are dominated by the satisfaction of using their current domestic water source. Besides, the absence of regulation to obligate the use of public water source and restrict the individual groundwater abstraction is also strengthen the public reluctance. Thus, the scenario of the fully pipeline-based water service should be able to convince people to gain the same level of satisfaction with their current domestic water source. Not only that, a set of policies to encourage (or even to enforce) people to use public water source rather than individual groundwater abstraction is also required. The policies can be articulated in the form of intensive campaign to use public water service, incentive and disincentive policies, subsidy for the low-income households, and so forth.

In short, implementing the fully pipeline-based water service required not only a big investment but also a set of supporting policies. Certainly, it is not an easy task to do although this approach promises the merits of groundwater conservation. In the next section, the discussion about the scenario of combining pipeline-based and community-based domestic water fulfillment will be elaborated.

c. Combining Pipeline-based and Community-based Water Service

Analysis on the financial aspect of the fully pipeline-based shows the drawback of this approach due to its high cost. On the other hand, applying doing business as usual approach implicates on the environmental degradation. To deal with this dilemma, a combination between pipeline-based water service and other types of measures is potential to be conducted. As is previously discussed, Kota Metro has accommodated community's requests on the domestic water provision through the development of the communal drilled wells facilities. Nevertheless, these facilities have not been optimally utilized for domestic water service provision. The built facilities are currently utilized for emergency uses in drought season.

The existing communal drilled wells are not equipped with pipe network so that people have to make extra efforts to access water. This situation can probably explain why the people are reluctant to use the communal facilities for daily use. This is supported by the evidence found in the household survey (as are illustrated in table 5.3 and figure 5.2) showing that the easiness to access the water is strongest reason to use private water sources such as individual dug wells or boreholes. On the other hand, the users of public water sources i.e., pipe water service or communal wells are strongly corelated to the price affordability. Thus, supporting facilities such as small-scale pipe network, which make communal facilities on premises, is important element to be considered to encourage people use public water source. Indeed, it would be more costly and limited budget is the main constraint when many projects had to be financed, and various interests should be accommodated. To some extent, the city government merely allocated limited budget but tried to develop a good image from accommodating the community's proposals. Hence, it needs to reposition the community involvement programs so that they result in bigger impacts rather than are merely used to develop political images.

To estimate the contribution of the existing communal groundwater wells, we elaborated the volume of the water that can potentially be utilized. The existing groundwater wells usually are equipped with small electric pumps with the capacity around 10 to 20 Liters per minute. If a pump is presumably operated for 12 hours a day, the total volume resulted from a communal groundwater well can reach 7,200 to 14,400 Liters a day. Thus, the small capacity pump can actually suffice 144 people within an intermediate level (50 Liter per person per day) under this assumption. It approximately equals to 36 households. Furthermore, this estimation can be added to the baseline data on the production capacity of the pipeline-based water service to set a benchmark to combine these two approaches.

In detail, the calculation is simulated by figure 6.13. The figure illustrates the comparison between the annual domestic water demand and the production capacity. The blue dots represent the annual volume produced by the water service provider in Kota Metro, which is collected from the annual statistics launched by the city government. Meanwhile, the blue line is the projection of the trend in the production capacity. To estimate the water demand, which are represented by the yellow and red dots. The calculation is based on the multiplication of the population of Kota Metro and minimum water requirement suggested by literature [34]. The yellow dots represent the minimum water requirement at intermediate level (50 Liters per person per day) while the red dots indicate the minimum water requirement at optimal level (100 Liter per person per day)

Furthermore, the blue and green bars show the estimated annual production resulted from respectively water service provider and existing communal groundwater wells in Kota Metro. The calculation shows the water treatment facility in Kota Metro is expected to produce approximately a million cubic meter in 2020 while the 82 communal groundwater wells in total can potentially produce 215,496 m^3 per year under the assumption of 12 hours operational time using a pump with the capacity 10 Liter per minute. To compare with the projected demand, the total production capacity can actually suffice 39.57% of the total demand (at intermediate level) or 19.78% of the minimum water requirement (at optimal level). Then, this situation is justified as a benchmark to formulate scenario using a combination between pipeline-based and community-based water fulfillment.

.

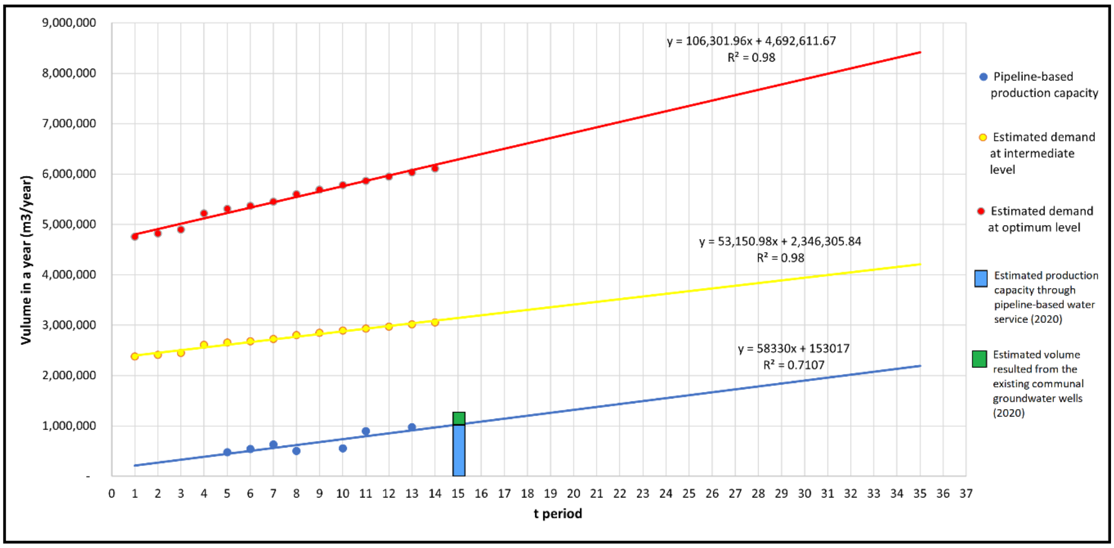


Figure 6.13 Estimated production capacity to set a benchmark for combining pipeline-based and community-based domestic water fulfillment.

The proposed combination approach basically aims to search optimum combination between the pipeline-based and the community-based water fulfillment. The minimum cost and the maximum possible achievement are the parameter to define the optimum situation. To gain the optimum objectives, mathematical inequalities are formulated to construct functions of constraints aiming to draw a feasible region in the linear programming system. The number of people that are expected to be served by pipe water service (x) and communal well (y) is set as variables in the Cartesian coordinate system. Furthermore, we divided the linear programming system under two scenarios. The first scenario is to maximize the possible achievement within limited budget while the second scenario is to minimize the budget to gain maximum target.

Moreover, the current situation of the pipe water utilization is also added in the linear programming system as one of constraint functions. The projection of the existing data on the production capacity (6.10) is interpreted as the baseline that is supposed to be boosted. To specify, the gradient of the blue line in figure 6.13, which is 58,330, indicates the pace of production capacity of the pipeline-based water service projected from the available data. Thus, it can be interpreted that the annual production capacity is 58,330 m^3/year. This value equals to 159,808.219 Liters/day, which is able to suffice 3,196 people at intermediate level. In this inequality, the numbers of people using pipeline-based water service is maintained to be 3,196 at minimum. In the mathematical expression, it can be written as $x \geq 3{,}196$. To propose the use of the communal groundwater wells, data on the availability of pipe network are analyzed. Currently, the pipe network has not been available in the northern part of the city. There are four villages in this area that have no access to pipe network. Meanwhile, in the southern part, the primary network is available but the network for household connections has not been developed. To consider this situation, we proposed the communal groundwater wells are prioritized for the northern part whose population is 17.21% of the total population of Kota Metro [56]. It equals to 20.79% of population that actually has access to pipe network. Therefore, we set this situation to the constraint function in the linear programming system mathematically expressed as $y \leq 0.20x$, which means the number of communal groundwater users must be greater than or equal to 20% of the pipe water users. Then, the percentage is gradually reduced year by year so that the number of the proposed communal groundwater wells will be decreased.

Regarding the objective function, the two conditions (i.e., maximum output and minimum cost) are established. The maximum output is mathematically expressed as $f(x, y) = x + y$ while the minimum cost is represented by $f(x, y) = 156.12x + 28.48y$. The former implies the accumulation of the pipe water users and communal groundwater users. Meanwhile, the coefficient in the latter equation (156.12 and 28.48) is derived from the initial cost per capita required for pipe water and borehole facilities (table 6.6). When the maximum output is set as the objective function, the required initial cost is set as the constraint function and vice versa. The values of the constraints (targeted achievement and required initial cost) are derived from table 6.7. In addition, the linear programming system is applied for both 5-year and 10-year development plan. In more detail, the set of constraint functions under the objective of the maximum output in the 5-year development plan are summarized in the following table.

Table 6.8. The constraint functions under the objective of the maximum output in 5-year development plan

Year	Constraint Functions	Objective Function
2021	$x \geq 3{,}196$; $y \leq 0.20x$; $156.12x + 28.48y \leq 5{,}170{,}116$	$f(x + y) = x + y$
2022	$x \geq 3{,}196$; $y \leq 0.1x$; $156.12x + 28.48y \leq 5{,}283{,}786$	
2023	$x \geq 3{,}196$; $y \leq 0.05x$ $156.12x + 28.48y \leq 5{,}380{,}994$	
2024	$x \geq 3{,}196$; $y \leq 0.025x$ $156.12x + 28.48y \leq 5{,}689{,}866$	
2025	$x \geq 3{,}196$; $y \leq 0.0125x$ $156.12x + 28.48y \leq 6{,}144{,}550$	

Moreover, these mathematical expressions can be converted into a graphical illustration in the Cartesian coordinate system. Therefore, the feasible area that represent the combination of x and y to produce possible values of the objective function. The graphical illustration of the linear programming system is illustrated by figure 6.14.

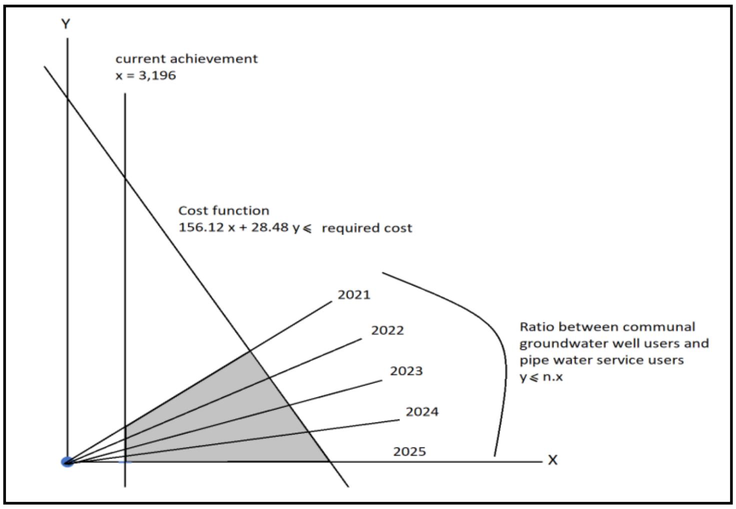


Figure 6.14. The graphical illustration of the linear programming system under the objective of the maximum output

The basic idea of the optimization model in this scenario is to search the coordinate resulting the maximum achievement under defined constraints. The constraint functions shape the grey polygon as is illustrated in figure 6.14. The coordinate must be located in this area. To find out the coordinate, we employed the Simplex Linear Programming Method. The mathematical calculation is assisted by Microsoft Excel to find the desired coordinates. Then, the resulted coordinates are converted to the number of both pipe water users and communal groundwater users. Besides, the required initial cost for the proposed scenario is also estimated.

Table 6.9. The result of the optimization model under the objective of the maximum output for 5-year development plan

Year	Projected population	Existing gap	Results from the optimization model			Cumulative result	Required initial cost (USD)
			Pipe water users (x)	Communal groundwater users (y)	Total achievement (x + y)		
2021	175,163	165,581	31,906	6,633	38,539	48,121*	5,170,016
2022	178,076	129,955	33,238	3,324	36,562	84,683	5,283,786
2023	180,988	96,305	34,155	1,708	35,863	120,546	5,380,994
2024	183,901	63,355	36,280	907	37,187	157,733	5,689,866
2025	186,813	29,080	29,080	0	29,080	186,813	4,539,969
	Total		164,659	12,572	177,231		26,064,631

*) the cumulative result in 2021 is the sum of the estimated pipe water users in 2020 and the total achievement resulted from the optimization models.

In more detail, the result is summarized in table 6.9. The computer-assisted iteration for the linear programming system listed in table 6.8 resulted in the coordinates as are summarized in this table. Then, the iteration is continued by the estimation of the annual achievement, remaining gap for the next period, and the required cost for the respective scenario. In total, this optimization model suggested the expansion of pipeline-based water service up to 164,659 people while 12,572 people can be served by communal groundwater wells. Moreover, the cost of this scenario is USD 26,064,631. To compare with the fully pipeline-based water service (table 6.7), this scenario can reduce USD 1,604,681 of the cost for initial investment.

Furthermore, the same procedure is also conducted for the 10-year development plan. For this scenario, the function representing the current achievement is not different with the 5-year development plan. However, the constants representing the constraint of budget are following the required cost as is listed in the last column of table 6.7. Besides, the ratio between communal groundwater users and pipe water users is gradually decreased from 20% to 0% in the end of period. Subsequently, the mathematical iteration is also similar. The result of the calculation is presented in table 6.10.

Table 6.10. The result of the optimization model under the objective of the maximum output for 10-year development plan

Year	Projected population	Existing gap	Results from the optimization model			Cumulative result	Required initial cost (USD)
			Pipe water users (x)	Communal groundwater users (y)	Total achievement (x + y)		
2021	175,163	165,581	15,975	3,195	19,170	28,752*	2,585,058
2022	178,076	149,323	17,376	3,128	20,504	49,256	2,801,793
2023	180,988	131,732	16,627	2,660	19,288	68,544	2,671,637
2024	183,901	115,357	17,092	2,393	19,485	88,029	2,736,592
2025	186,813	98,784	17,628	2,115	19,744	107,772	2,812,372
2026	189,725	81,953	15,932	1,593	17,525	125,298	2,532,707
2027	192,638	67,340	15,989	1,279	17,269	142,566	2,753,707
2028	195,550	52,984	17,666	1,060	18,726	161,293	2,788,219
2029	198,463	37,170	18,949	758	19,707	180,999	2,979,853
2030	201,375	20,376	20,376	0	20,376	201,375	3,181,101
	Total		173,611	18,182	191,793		27,622,039

*) the cumulative result in 2021 is the sum of the estimated pipe water users in 2020 and the total achievement resulted from the optimization models.

Table 6.10 shows that the total cost required to achieve universal access to water within 10-year development plan is bigger than the similar approach within 5-year development plan. This tendency is also similar with the proposal of the fully pipeline-based water service. Nevertheless, combining pipeline-based water service and communal groundwater wells (either in the 5-year or 10-year development plan) is less costly than the fully pipeline-based water service. Besides, the optimization modelling also shows that the combination approach potentially results in bigger output. It can be seen by comparing the total targeted achievement in table 6.10 and table 6.7. The result shows the combination approach (for 10-year development plan) has bigger output than the fully pipeline-based approach while in the 5-year development plan the result is exactly similar.

Furthermore, the simulation is continued under the objective of minimum cost with $f(x, y) = 165.12x + 28.48y$. In this regard, the targeted achievement is defined as the constraint function. Thus, the annual target should be minimum at the values listed in table 6.7. Meanwhile, the current achievement ($x = 3{,}196$) and the ratio between groundwater users and pipe water users ($y = nx$) are remained the same. To specify, the constraint functions summarized in the following table.

Table 6.11. The constraint functions under the objective of the minimum cost in 5-year development plan

Year	Constraint Functions	Objective Function
2021	$x \geq 3{,}196$; $y \leq 0.20x$; $x + y \geq 33{,}116$	$f(x + y) = 156.12x + 28.48y$
2022	$x \geq 3{,}196$; $y \leq 0.1x$; $x + y \geq 33{,}844$	
2023	$x \geq 3{,}196$; $y \leq 0.05x$ $x + y \geq 34{,}467$	
2024	$x \geq 3{,}196$; $y \leq 0.025x$ $x + y \geq 36{,}445$	
2025	$x \geq 3{,}196$; $y \leq 0.0125x$ $x + y \geq 39{,}358$	

A similar principle is also applied to convert these linear programming systems into a graphical illustration. Nevertheless, the feasible areas to search an optimum result will be obviously different since the constrain function are also different. The defined area is illustrated by figure 6.15. Unlike the previous scenario, the feasible area for the optimization modelling under the objective of the minimum cost does not generate the polygon-shaped area but infinite area on the upper side of the targeted achievement function. It is normal in the linear programming system aimed to find the minimum result since the bigger value of x and y will obviously implicates on the bigger value of the objective function.

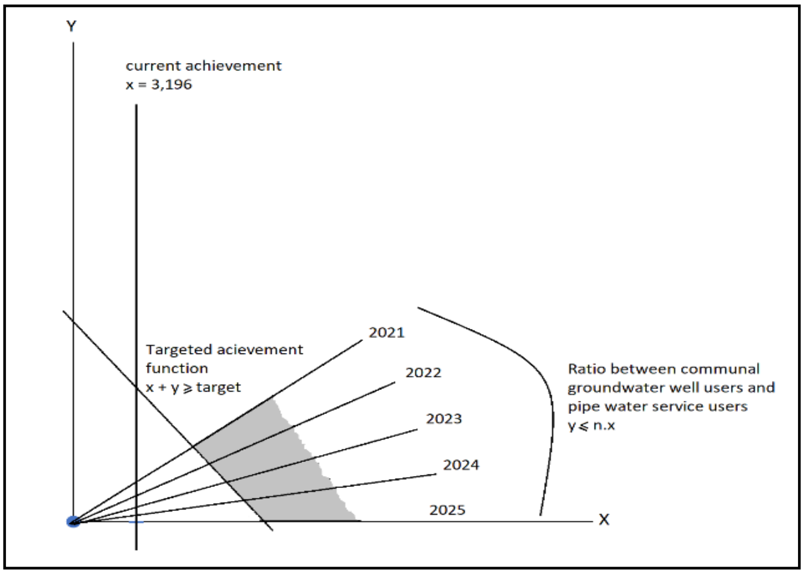


Figure 6.15. The graphical illustration of the linear programming system under the objective of the minimum cost

Afterward, the same mathematical procedure is applied to find a coordinate resulting in the minimum value of the objective function. The result of the calculation is presented in table 6.12.

Table 6.12. The result of the optimization model under the objective of the minimum cost for 5-year development plan

Year	Projected population	Existing gap	Results from the optimization model			Cumulative result	Required initial cost (USD)
			Pipe water users (x)	Communal groundwater users (y)	Total achievement (x + y)		
2021	175,163	165,581	27,597	5,519	33,116	42,698*	4,465,582
2022	178,076	135,378	30,767	3,077	33,844	76,542	4,891,012
2023	180,988	104,446	32,826	1,641	34,467	111,009	5,171,494
2024	183,901	72,892	35,557	889	36,446	147,455	5,576,487
2025	186,813	39,358	38,872	486	39,358	186,813	6,082,551
	Total		165,619	11,617	177,231		26,187,126

*) the cumulative result in 2021 is the sum of the estimated pipe water users in 2020 and the total achievement resulted from the optimization models.

The optimization model under the objective of the minimum cost for 5-year development plan resulted in the combination of 165,619 pipe water users and 11,617 communal groundwater users. As a matter of fact, this combination is actually more costly than the simulation under the objective of maximum output. The total cost required to accomplish this scenario is USD 122,495 more expensive compared to the cost for the same target setting under the objective of the maximum output. By the same total targeted achievement, the cost will be cheaper for the combination of 164,659 pipe water users and 12,572 communal groundwater users. Nevertheless, the optimization model under the objective of the minimum cost is still cheaper that the cost required for the scenario of the fully pipeline-based water service.

Furthermore, the simulation is also conducted for the 10-year development plan to assess whether it shows similar propensity. The result of the simulation is presented in table 6.13.

Table 6.13. The result of the optimization model under the objective of the minimum cost for 10-year development plan

Year	Projected population	Existing gap	Results from the optimization model			Cumulative result	Required initial cost (USD)
			Pipe water users (x)	Communal groundwater users (y)	Total achievement (x + y)		
2021	175,163	165,581	13,798	2,760	16,558	26,140*	2,232,791
2022	178,076	151,936	15,208	2,738	17,946	44,086	2,452,312
2023	180,988	136,902	14,753	2,360	17,113	61,199	2,370,398
2024	183,901	122,702	15,376	2,153	17,529	78,728	2,461,859
2025	186,813	108,085	16,084	1,930	18,014	96,742	2,565,991
2026	189,725	92,983	16,906	1,691	18,597	115,339	2,687,571
2027	192,638	77,299	17,219	1,378	18,597	133,936	2,727,532
2028	195,550	61,614	19,375	1,163	20,538	154,474	3,058,007
2029	198,463	43,989	21,148	846	21,994	176,468	3,325,730
2030	201,375	24,907	24,419	488	24,907	201,375	3,826,145
	Total		174,288	17,505	191,793		27,708,337

*) the cumulative result in 2021 is the sum of the estimated pipe water users in 2020 and the total achievement resulted from the optimization models.

The scenario is still under the same objective function and the constraint functions of the current achievement. The similar setting is also applied for the ratio between pipe water users and communal groundwater users, but it is different in the constants of the targeted achievement functions. Furthermore, the optimization model resulted in the combination of 174,288 pipe water users 17,505 communal groundwater well user to fulfill the objective function. Similar to the 5-year development plan, the simulation for 10-year development plan also shows more expensive cost compared to the result of the maximum output simulation listed in 6.10. However, the combination suggested by the simulation is still less costly compared to the scenario of the fully pipeline-based water service.

6.4. Conclusions

To summarize, this chapter provides three approaches to develop the situation of the domestic water fulfillment in the case study area. They are doing business as usual approach, fully pipeline-based approach, and combination between pipeline-based and communal groundwater well-based approach. Certainly, each approach has its own benefits and drawbacks. The doing business as usual approach is considered as the cheapest one from the economic perspective. However, letting the current trend keeps going on can potentially degrade the environment due to the increasing trend of the individual groundwater abstraction. By contrast, the fully pipeline-based water service requires a big investment although it is considered more environmentally friendly. Between these two extreme sides, the combination approach offers an opportunity to develop the domestic water sector with more reasonable cost but its negative impacts on the environment are still tolerable.

For further elaboration, the current status of the domestic water fulfillment in Kota Metro was investigated to set a benchmark for the scenario formulation. Besides, findings discussed in the previous chapter were also recalled understanding the public preferences in the case study area. Moreover, research and reports regarding the development of domestic water sector in Indonesia are also explored. In general, the studies reported inefficient expenditure in projects related to the expansion of pipe network infrastructures. Therefore, small budget allocation under the doing business as usual approach is better to be spent to revitalize the existing facilities and increase their efficiency rather than to expand the new pipe network.

Subsequently, the fully pipeline-based water service is the ultimate ambition in developing domestic water sector in Kota Metro. The scenario is modified for 5-year and 10-year development plan considering the timeline of the political event in Kota Metro. This is due to a consideration that the development planning cannot be simply separated by the political setting. Moreover, the financial condition of Kota Metro, which is represented by its local revenue, was also investigated to set a reasonable budget allocation. The estimation shows that the fully pipeline-based water service might take around 32.70% to 36.96% of the city revenue annually under the 5-year development plan. On the other hand, the 10-year development plan annually requires 12.17% to 18.52% of the city revenue.

Indeed, these are big proportions considering many sectors must be financed by the government of Kota Metro. Hence, for further research, it is beneficial to explore private sector investment or other financial schemes to overcome the financial constraint.

Furthermore, a mathematical optimization model was developed in this research to demonstrate the possible scenarios to gain maximum results at minimum cost under the combination approach. The assessment was also conducted for the 5-year and 10-year development plan. The result shows that combining pipeline-based water service and communal groundwater well-based domestic water provision requires less initial cost than the fully pipeline-based approach under the same target setting. For the 5-year development plan, the optimum proportion, which results in the minimum cost, is 164,659 pipe water users and 12,576 communal groundwater well users. It will cost USD 26,064,631 to accomplish the scenario. On the other hand, the optimization model for 10-year development plan suggests 173,611 pipe water users and 18,182 communal groundwater well users that totally requires USD 27,622,039 as the optimum value to fulfill the objective function.

Aside from the fact that combining pipeline-based and communal-based water service provision is less costly than the fully pipeline-based water service, this approach faces some challenges such as the organizational arrangement. Currently, the water service provider in Kota Metro is a part of governmental structure. Thus, it is fully dependent in term of personnel and budget arrangement. To some extent, the arrangement is not free from subjectivity and political interest. Therefore, institutional reforms are needed so that the proposed scenario will be well delivered. On the other hand, the current practice of communal groundwater use has not been formalized under formal regulation. Therefore, the city government needs to pay more attention on this aspect if the communal-based water service is chosen as one of strategies in the domestic water fulfillment.

References

[1] E. Chaussard, F. Amelung, H. Abidin, and S.-H. Hong, “Sinking cities in Indonesia: ALOS PALSAR detecs rapid subsidence groundwater and gas extraction,” *Remote Sens. Environ.*, vol. 128, no. 2013, pp. 150–161, 2013.

[2] S. Wangsaatmaja, A. D. Sutadin, and M. A. N. Prasetiati, “A review of groundwater issues in the Bandung Basin, Indonesia: Management and Recommendation,” *Int. Rev. Environ. Strateg.*, vol. 6, no. 2, pp. 425–442, 2006.

[3] S. Lamichhane and N. M. Shakya, “Shallow aquifer groundwater dynamics due to land use/cover change in highly urbanized basin: The case of Kathmandu Valey,” *J. Hydrol. Reg. Stud.*, vol. 30, no. 2020, pp. 1–16, 2020.

[4] D. I. Leap, “Geological Occurrence of Groundwater,” in *Handbook of Groundwater Engineering*, J. Delleur, Ed. Florida: CRC Press, 1993.

[5] A. K. Biswas and C. Tortajada, “Future Water Governance: Problems and Problems and Perspectives,” *Water Resour. Dev.*, vol. 26, no. 2, pp. 129–139, 2010.

[6] A. K. Biswas and C. Tortajada, "Water Supply of Phnom Penh: An Example of Good Governance," *Water Resour. Dev.*, vol. 26, no. 2, pp. 157–172, 2010.

[7] L. Ruelas-Monjardin, C. Laura, J. M. Chavez-Cortez, and D. P. Shaw, "Scarcity and conflict, key problems in water management: A Mexican case study," *Local Environ.*, vol. 14, no. 8, pp. 765–782, 2009.

[8] F. von Benda-Beckmann, "Contestations over a life-giving force: Water rights and conflicts, with special reference to Indonesia," *A World Water*, pp. 259–277, 2013, doi: 10.1163/9789004254015_011.

[9] L. Donaldson, "The Normal Science of Structural Contingency Theory," in *Studying Organization: Theory and Method*, S. R. Clegg and C. Hardy, Eds. London: SAGE Publication Inc., 1999.

[10] P. Bradshaw, "A Contingency Approach to Non-profit Governance," *Nonprofit Manag. Leadersh.*, vol. 20, no. 1, pp. 61–80, 2009.

[11] BPS, "Statistik Lingkungan Hidup Indonesia 2017 (Environmental Statistics of Indonesia 2017)," Jakarta, 2017.

[12] S. Meijerink and D. Huitema, "Policy Entrepreneurs and Change Strategies Lessons from Sixteen Case Studies of Water Transition around the Globe," *Ecol. Soc.*, vol. 15, no. 2, pp. 1–19, 2010.

[13] S. Pal and Z. Wahhaj, "Fiscal decentralisation, local institutions and public good provision: evidence from Indonesia," *J. Comp. Econ.*, vol. 45, no. 2017, pp. 383–409, 2017.

[14] United Nations, "The Sustainable Development Goals Report 2018," New York, 2018.

[15] WHO Western Pasific Region, "Sanitation, drinking-water and health: Achievements and challenges ahead," Manila, 2017.

[16] WHO and UNICEF, "The new JMP ladder for drinking water," 2017. https://washdata.org/monitoring/drinking-water (accessed Nov. 11, 2020).

[17] Asian Development Bank, "Nepal: Community-Based Water Supply and Sanitation Project," Mandaluyong, Philippines, 2012.

[18] The Ministry of Public Works, "Program Hibah Air Minum Kementerian PUPR Berikan Akses Bagi 4,5 Juta MBR (The Ministry of Public Work Grant Program Enables 4.5 Million of Low Income People to Have Access to Drinking Water)," 2017. https://www.pu.go.id/berita/view/18/program-hibah-air-minum-kementerian-pupr-berikan-akses-air-bagi-4-5-juta-jiwa-mbr (accessed Aug. 20, 2020).

[19] OECD, "Financing water: Investing in sustainable growth," 2018.

[20] E. Ostrom, "Polycentric systems for coping with collective action and global environmental change," *Glob. Environ. Chang.*, vol. 20, no. 2010, pp. 550–557, 2010.

[21] A. Agrawal, D. G. Brown, G. Rao, R. Riolo, D. T. Robinson, and M. Bommarito II, "Interactions between organizations and networks in common-pool resource governance," *Environ. Sci. Policy*, vol. 25, no. 2013, pp. 138–146, 2013.

[22] S. J. Van de Meene, R. R. Brown, and M. A. Farrelly, "Towards understanding governance for sustainable urban water management," *Glob. Environ. Chang.*, vol. 21, no. 3, pp. 1117–1127, 2011, doi: 10.1016/j.gloenvcha.2011.04.003.

[23] C. Samekto and E. S. Winata, "Potensi Sumber daya Air di Indonesia (Indonesian Water Resource Potentials)," in *Aplikasi Teknologi Air Bersih untuk Kabupaten/Kota di Indonesia*, 2010, pp. 1–20.

[24] BPS, "Statistik Lingkungan Hidup Indonesia 2019: Hutan dan Perubahan Iklim (Environment Statistics of Indonesia 2019: Forests and Climate Change," Jakarta, 2019.

[25] C. Rickwood and G. M. Carr, "Global Drinking Water Quality Index Development and Sesitivity Analysis Report," Ontario, 2007.

[26] Perpres 185, *Peraturan Presiden Republik Indonesia Nomor 185 tahun 2014 Tentang Percepatan Penyediaan Air Minum dan Sanitasi (Indonesia Presidential Regulation Number 185 Year 2014 about Accelerating Drinking Water Provision and Sanitation)*. Indonesia, 2014.

[27] T. Böhmelt, T. Bernauer, H. Buhaug, N. P. Gleditsch, T. Tribaldos, and G. Wischnath, "Demand, supply, and restraint: Determinants of domestic water conflict and cooperation," *Glob. Environ. Chang.*, vol. 29, pp. 337–348, 2014, doi: 10.1016/j.gloenvcha.2013.11.018.

[28] M. S. Ahmadi, J. Sušnik, W. Veerbeek, and C. Zevenbergen, "Towards a global day zero? Assessment of current and future water supply and demand in 12 rapidly developing megacities," *Sustain. Cities Soc.*, vol. 61, no. June, 2020, doi: 10.1016/j.scs.2020.102295.

[29] E. M. Akpabio, "Water and People: Perception and Management Practice in Akwa Ibom State, Nigeria," *Soc. Nat. Resour.*, vol. 24, pp. 584–596, 2011.

[30] V. K. Mehta, R. Goswami, E. Kemp-Benedict, S. Muddu, and D. Malghan, "Social Ecology of Domestic Water Use in Bangalore," *Econ. Polit. Wkly.*, vol. 48, no. 15, pp. 40–50, 2013.

[31] L. W. House and J. D. House, "Shifting the timing of customer water consumption," *J. Am. Water Work. Assoc.*, vol. 104, no. 2, pp. E82–E92, 2010.

[32] P. H. Gleick, "Basic Water Requirements for Human Activities: Meeting Basic Needs," *Water Int.*, vol. 21, no. 1996, pp. 81–92, 1996.

[33] BSN, *SNI 19-6728.1-2002 Penyusunan Neraca Sumber Daya Air (Water Balance Arrangement)*. Indonesia, 2002.

[34] G. Howard and J. Bartram, "Domestic Water Quantity, Servive Level and Health," Geneva, 2003.

[35] Kemendagri, *Peraturan Menteri Dalam Negeri Nomor 23 Tahun 2006 tentang Pedoman Teknis dan Tata Cara Pengaturan Tarif Air Minum pada Perusahaan Daerah Air Minum*. Indonesia, 2006.

[36] www.pu.go.id, "Pemakaian Air Rumah Tangga Perkotaan 144 Liter per Hari (Domestic water consumption in urban areas is 144 Liters per person per day)," 2007. https://pu.go.id/berita/view/4175/pemaiaian-air-rumah-tangga (accessed Dec. 13, 2019).

[37] B. Reed and B. Reed, "How much water is needed in emergencies: Technical notes on drinking water, sanitation and hygiene in emergencies," Geneva, 2013.

[38] O. Singh and S. Turkiya, "A survey of household domestic water consumption patterns in rural semi-arid village, India," *GeoJournal*, vol. 78, no. 5, pp. 777–790, 2013.

[39] B. A. Benedict, "Benefits of Scenario Planning Applied to Energy Development," *Energy Procedia*, vol. 107, no. September 2016, pp. 304–308, 2017, doi: 10.1016/j.egypro.2016.12.157.

[40] BPS, "Pedoman Penghitungan Proyeksi Penduduk dan Angkatan Kerja (Guidence for Calculating Population and Workforce Projection)," Jakarta, 2010.

[41] M. M. P. Rana and A. Piracha, “Supplying water to the urban poor: Government’s roles and challenges of participatory water governance,” *Cities*, vol. 106, no. August, p. 102881, 2020, doi: 10.1016/j.cities.2020.102881.

[42] Ellen Macarthur Foundation, *Delivering the Circular Economy: A toolkit for Policymakers*. Cowes, UK: Ellen Macarthur Foundation, 2015.

[43] A. Heshmati, “A Review of the Circular Economy and Its Implementation,” Bonn, 2015.

[44] C. Fogarassy and D. Finger, “Theoretical and Practical Approaches of Circular Economy for Business Models and Technological Solutions,” *Resources*, vol. 9, no. 76, pp. 1–9, 2020.

[45] N. Klein, T. B. Ramos, and P. Deutz, “Circular Economy Practices and Strategies in Public Sector Organizations: An Integrative Review,” *Sustainability*, vol. 12, no. 2020, pp. 1–24, 2020.

[46] S. Scarpellini, P. Portillo-Tarragona, A. Aranda-Uson, and F. Llena-Macarulla, “Definition and measurement of the circular economy’s regional impact,” *J. Environ. Plan. Manag.*, vol. 62, no. 13, pp. 2211–2237, 2019.

[47] P. Lacy, J. Long, and W. Spindler, *The Circular Economy Handbook: Realizing the Circular Advantage*. London: Palgrave MacMillan, 2020.

[48] T. Lahti, J. Wincent, and V. Parida, “A Definition and Theoretical Review of the Circular Economy, Value Creation, and Sustainable Business Models: Where Are We Now and Where Should Research Move in the Future,” *Sustainability*, vol. 10, no. 2018, pp. 1–19, 2018.

[49] L. T. Peiro, D. Polverini, F. Ardente, and F. Mathieux, “Advance towards circular economy policies in the EU: The new Ecodesign regulation of enterprise servers,” *Resour. Coservation Recycl.*, vol. 154, no. 2020, pp. 1–11, 2020.

[50] N. S. Kakwani and P. P. Kalbar, “Review of Circular Economy in urban water sector: Challenges and opportunities in India,” *J. Environ. Manage.*, vol. 271, no. July, p. 111010, 2020, doi: 10.1016/j.jenvman.2020.111010.

[51] R. Merli, M. Preziosi, and A. Acampora, “How do scholars approach the circular economy? A systematic literature review,” *J. Clean. Prod.*, vol. 178, pp. 703–722, 2018, doi: 10.1016/j.jclepro.2017.12.112.

[52] P. Morseletto, “Targets for a circular economy,” *Resour. Conserv. Recycl.*, vol. 153, no. November 2019, p. 104553, 2020, doi: 10.1016/j.resconrec.2019.104553.

[53] C. Tortajada and A. K. Biswas, “Achieving universal access to clean water and sanitation in an era of water scarcity: strengthening contributions from academia,” *Curr. Opin. Environ. Sustain.*, vol. 34, pp. 21–25, 2018, doi: 10.1016/j.cosust.2018.08.001.

[54] BPS Kota Metro, “Kota Metro dalam Angka 2020 (Kota Metro in Figures 2020),” Kota Metro, 2020.

[55] BPS Kota Metro, “Kota Metro dalam angka 2006 (Kota Metro in figures 2006),” Kota Metro, 2006.

[56] BPS Kota Metro, “Kota Metro dalam Angka 2019 (Kota Metro in Figures 2019),” Kota Metro, 2019.

[57] Bappeda Kota Metro, “Penyusunan Rencana Induk Pengelolaan Air Bersih Kota Metro (Preparing Master Plan for Domestic Water Management in Kota Metro),” Kota Metro, 2014.

[58] BPS, “Proyeksi Penduduk Indonesia 2015-2045 (Indonesian Population Projection 2015-2045),” Jakarta, 2018.

[59] R. Morbidelli, C. Corradini, C. Saltalippi, A. Flammini, J. Dari, and R. S. Govindaraju, “Rainfall infiltration modeling: A review,” *Water (Switzerland)*, vol. 10, no. 12, 2018, doi: 10.3390/w10121873.

[60] B. Annisa, “Penerapan Model Horton Untuk Kuantifikasi Laju Infiltrasi (The application of Horton model to quantify infiltration rate,” *J. Saintis*, vol. 18, no. 1, pp. 95–102, 2018.

[61] Permen LH 12, *Peraturan Menteri Negara Lingkungan Hidup Nomor 12 Tahun 2019 tentang Pemanfaatan Air Hujan (The Regulation of the Ministry of Environment Number 12 Year 2009 about Rainwater Harvesting)*. Indonesia, 2009.

[62] A. Adipka, I. G. Sugiyanta, and I. L. Nugraheni, “Analisis perubahan penggunaan lahan persawahan di Kota Metro antara tahun 2000-2015 (Analysis on the land use change of the rice field areas in Kota Metro in 2000-2015),” *J. Penelit. Geogr.*, vol. 6, no. 2, pp. 1–11, 2018.

[63] L. M. Bott, B. Pritchard, and B. Braun, “Translocal social capital as a resource for community-based responses to coastal flooding – Evidence from urban and rural areas on Java, Indonesia,” *Geoforum*, vol. 117, no. August, pp. 1–12, 2020, doi: 10.1016/j.geoforum.2020.08.012.

[64] A. Chriest and M. Niles, “The role of community social capital for food security following an extreme weather event,” *J. Rural Stud.*, vol. 64, no. February, pp. 80–90, 2018, doi: 10.1016/j.jrurstud.2018.09.019.

[65] H. Bhandari and K. Yasunobu, “What is social capital? A comprehensive of the concept,” *Asian Jourbal Soc. Sci.*, vol. 37, no. 3, pp. 480–510, 2009.

[66] S. Atshan, R. P. Bixler, V. Rai, and D. W. Springer, “Pathways to urban sustainability through individual behaviors: The role of social capital,” *Environ. Sci. Policy*, vol. 112, no. December 2019, pp. 330–339, 2020, doi: 10.1016/j.envsci.2020.07.005.

[67] A. Auer *et al.*, “The role of social capital and collective actions in natural capital conservation and management,” *Environ. Sci. Policy*, vol. 107, no. February, pp. 168–178, 2020, doi: 10.1016/j.envsci.2020.02.024.

[68] R. Ban, M. J. Gilligan, and M. Rieger, “Self-help groups, savings and social capital: Evidence from a field experiment in Cambodia,” *J. Econ. Behav. Organ.*, vol. 180, pp. 174–200, 2020, doi: 10.1016/j.jebo.2020.09.029.

[69] BPS Kota Metro, “The number of Neighborhood Group in Kota Metro,” 2016. https://metrokota.bps.go.id/statictable/2016/08/30/99/banyaknya-kelurahan-rukun-warga-rukun-tetangga-menurut-kecamatan-di-kota-metro-2015.html (accessed Jan. 05, 2021).

[70] World Bank, “Indonesia Public Expenditure Review: Spending for Better Results,” Jakarta, 2020.

[71] G. Hutton and J. Bartram, “Regional and Global Costs of Attaining the Water Supply and Sanitation Target (Target 10) of the Millennium Development Goals,” Geneva, 2008. [Online]. Available: https://www.ircwash.org/sites/default/files/Hutton-2008-Regional.pdf.

[72] worldbank, “GDP growth (annual%) - Indonesia,” 2019. https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2019&locations=ID&start=2005 (accessed Mar. 15, 2021).

Chapter 7

Determinant Factors Succeeding Domestic Water Provision: Lesson Learned from Various Implemented Strategies

7.1. Introduction

This chapter elaborates various strategies that have been successfully implemented throughout the world. The main objective of this stage is to gain lessons from them in implementing improvement strategies. Considering domestic water issue is a global problem but inseparable with the local context, it is important to grasp wider understanding through the exploration of empirical experiences from many cases. Up to this point, lesson-drawing approach can be employed not only to gain a set of knowledge but also to evaluate the current practice or to assess the applicability of the proposed alternatives. Hence, selecting the cases that fit to the context of our case study is an important aspect to be considered. Mossberger and Wolman [1], for instance, emphasize that the process of knowledge transfer attained from the lesson-drawing process can be helpful to assess the similarity of problems and goals as well as to identify the difference in setting. Nevertheless, the lesson-drawing process cannot be done randomly but is carefully managed so that the results are not merely copying from the source but synthesizing elements from the source with the context of the destination [2].

Moreover, learning various examples from either their successfulness or failure can be very beneficial. In the perspective of policy transfer, the approach has transformed from the descriptive, which focuses on formal institution of government, to the comparative, which more focuses on interaction between community and the state [3]. Besides, the current issue on the lesson-learning in the development study focuses more on the process instead of ideological debate. Dolowitz and Marsh [4] categorize the degree of the lesson-learning process into four levels, which are copying, emulation, mixture, and inspiration. The copying means the referred example is copied and pasted to solve a certain problem while the emulation implies the competition between new approaches and the existing measures and there is a possibility the new one will replace the old one. On the other hand, the old and new approaches are synthetized in the mixture level of lesson-drawing. Meanwhile, on the level of inspiration, the key elements of the referred examples are identified to equip the designated case with empirical evidence.

Regarding its approaches, Evans [4] distinguishes policy transfer in the way it is studied into five approaches. The first is the process-centred approaches. These approaches emphasise on the process of policy transfer to explain whether it is voluntary or coercive. The second is called as the practice-based approaches that are closely related to organizational learning, evidence-based policy making and comparative public policy. The third is named as the ideational approaches, which focus on the social learning approach, the epistemic community approach, and discursive approaches. The fourth is comparative approaches. These approaches require widely qualitative description in explaining factors enabling policy transfer occurs. The last one is called as multi-level approaches. In these approaches, outcomes of policy transfer through macro, meso, and micro levels are deliberately considered.

Furthermore, borrowing a metaphor from medical science, transplantation is suggested for an unhealthy patient that can take advantages from a healthy transplant from a donor [5]. However, a successful policy in a certain place and time cannot be simply implemented in another place and time. It is necessary to check its transferability that very much depends on the context of the country where the policy come from as well as to the country it will be applied. In this regard, van Dijk [6] noticed four characteristics that make policy transfer is failed to be well implemented. The first pitfall is related to terminology that is sometimes misinterpreted viewed by different localities. The second is jumping directly to a conclusion while problem's core and instrument's target have not matched yet. The next pitfall is in tailoring the procedure. It must be concerned that an instrument is not one-size-fits-all. The implementation should consider local contexts. Finally, the assumption that views something new means better than the old ones frequently also leads to pitfall.

Referring to the previous research on the lesson-drawing and policy transfer, this chapter specifically conducts a lesson-drawing process that aims to understand determinant factors improving the domestic water sector. The lessons learned might come from various improvement strategies from all over the world. They could be in the scope of national policies or the small-scale measures. They might also be in the form of policy formulation or technical interventions. However, the case study selection would be carefully done to prevent the irrelevant lesson-drawing process. Regarding this issue, we set two criteria to select the case study areas. They are socio-economic and climatic aspects. The former is represented by the Gross Domestic Product (GDP) of the country, especially at Purchasing Power Parity (PPP). The value of PPP indicates the ability of the citizens to pay the living cost, which is important in the strategy formulation. The latter is represented by the climate zone classification. This is also essential in formulating improvement strategies since the availability of water sources is indispensable to domestic water provision.

Moreover, the reviewed case studies are assigned to come from the countries that have the same climate with Indonesia. However, a small variation is still allowed since some countries can have more than one type of climate. After this selection procedure, the next step is to explore development strategies on domestic water provision implemented in the selected countries. Information from journal papers, reports, news, and other published materials are useful sources to explore the domestic water issues in the selected countries. In the elaboration, key factors determining the successfulness of the development strategies are investigated and summarized. In this stage, content analysis is employed to identify the determinant factors.

After identifying the key factors, the next step is to analyze whether the implemented strategies in the selected cases are also possible to be applied in the context of Indonesia. Regarding this issue, the current status and implemented development strategies on domestic water sector in Indonesia is also briefly overviewed. Besides, proposed scenarios that were discussed in the previous chapter are also recalled and analyzed. Referring to the level of the lesson-learning process [3], it can be categorized in the type of the inspiration or mixture approach. Thus, the determinant factors, which are gained from the systematic literature review, are used as the inspiration or the complement.

7.2. Materials and Methods

7.2.1. The Criteria to Select the Referred Case Studies

A screening process is conducted to select the countries that would be designated as the reference. First, data on GDP launched by international organizations such as IMF [7] and the World Bank [8] is investigated to overview the country's GDP. Then, Indonesian GDP is set as a benchmark to select the study cases. To specify, the World Bank listed Indonesian GDP on the 107th rank with the GDP (PPP) per capita USD 13,057 in 2018. This value is defined as the reference. Subsequently, a country that is expected to be a case study should have roughly USD 4,000 higher or lower GDP than Indonesia. Thus, the interval of the GDP is set from USD 17,000 to USD 9,000 (90th until 130th rank). In more detail, the values of the GDP of countries throughout the world can be illustrated by the following map.

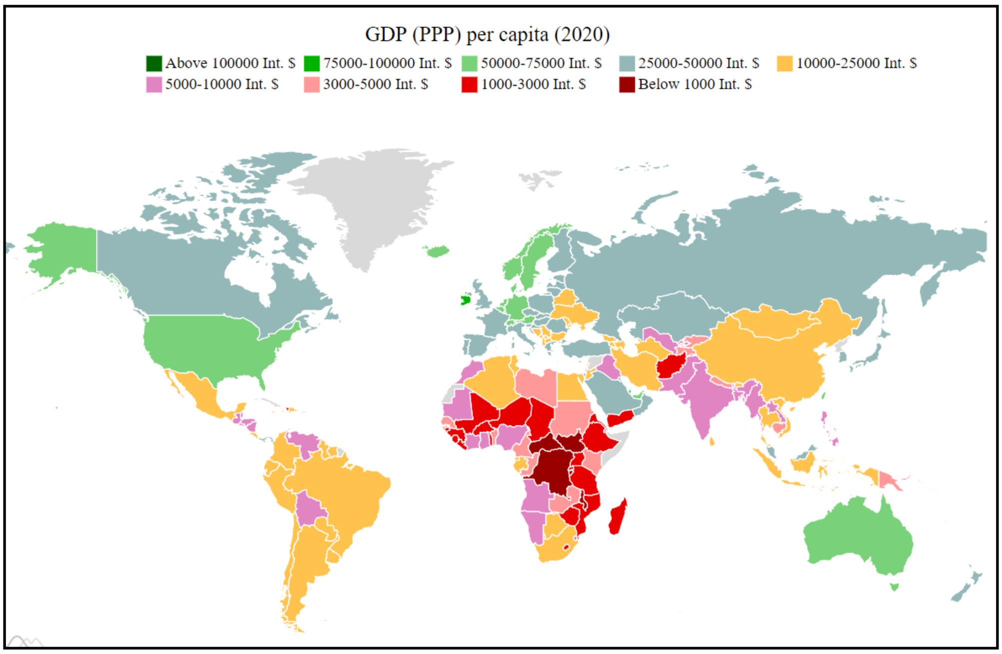


Figure 7.1 The map of GDP per capita (PPP) by country in 2020 (source:[7])

Figure 7.1 illustrates the comparison of the country's GDP all over the world. The same color in this interactive map, which is provided by [7], shows the countries whose GDPs are clustered in the same interval. Thus, the case selection can also be done by simply choosing countries illustrated by the same color with Indonesia. In this first selection stage, 40 countries are chosen. However, the selected countries have significant difference with Indonesia in the case of the climate classification. Hence, the second stage of the selection is conducted to search countries that have the same climate classification with Indonesia.

Furthermore, to justify the climate zone of the selected countries, we followed the Köppen-Geiger classification, which categorizes and codifies the world climate zones into five categories namely tropical (A), arid (B), temperate (C), cold (D), and polar (E) [9]. As Indonesia is categorized as a tropical country (A), the selected countries in this stage should meet the same category of the climate zone. Nevertheless, a small variation in the countries' climate classification is still allowed since a certain country has more than one types of climate. In more detail, the climate zone classification is illustrated in the following figure.

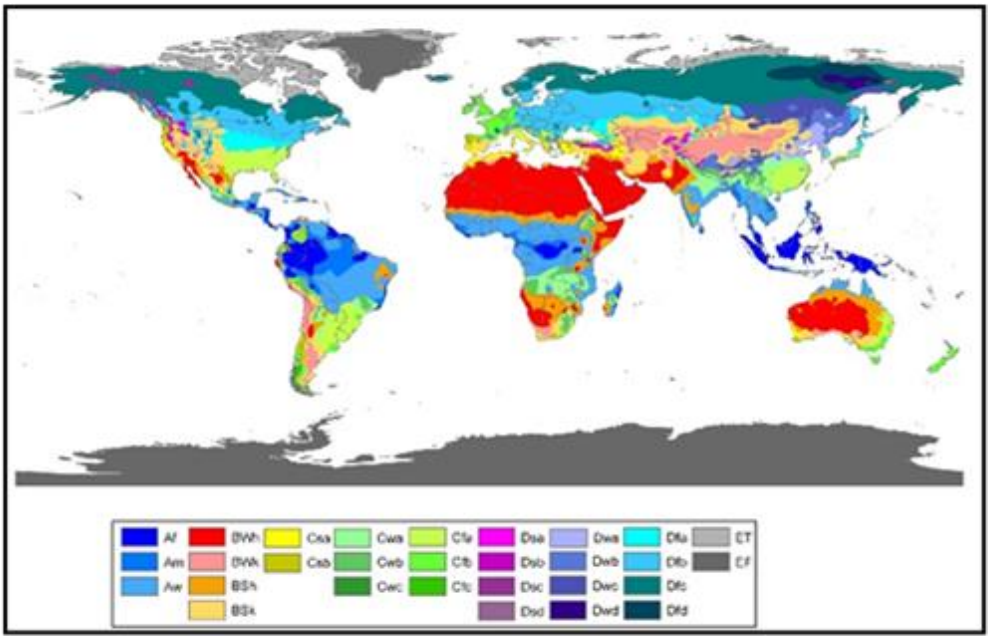


Figure 7.2. The map of the Köppen-Geiger climate classification (source: [10])

Third, information gained from the first and the second step of the selection is combined to justify the referred countries. The intersection between those two information (figure 7.1 and 7.2) resulted in 8 countries that match to the defined criteria. They are Brazil, Maldives, Colombia, South Africa, Sri Lanka, Ecuador, the Philippines, and India. Table 7.1 listed the selected countries and summarized their characteristics of the GDP and climate classification. Furthermore, the stage is continued by searching the relevant literatures and other published materials discussing the issue of domestic water provision in the selected countries. The literatures might cover the topic of the current achievement of domestic water fulfillment, improvement strategies that are implemented, and key factor determining the successfulness of the implemented strategies. The procedure to find relevant literatures is specifically discussed in the next section.

Table 7.1. List of countries selected to be referred case studies

Country	GDP in 2020 (USD) [7]	GDP rank based on World Bank	Climate based on Köppen-Geiger Classification [11]
Brazil	16,068	91	Dominantly A, some areas are B or C
Maldives	15,312	95	A
Colombia	14,999	97	Dominantly A, some areas are B, C, or E
South Africa	13,730	102	A, B, C, and a small percentage of E
Sri Lanka	13,450	104	Dominantly A, a small percentage of C
Ecuador	11,714	111	Varied in A, B, C, E
Philippines	8,935	123	Dominantly A, a small percentage of C
India	7,762	130	A, B, C

7.2.2. The Procedure to Review the Literatures Related to the Development Strategies in the Selected Countries

In this systematic literature review, some stages were conducted as is illustrated in this following figure.

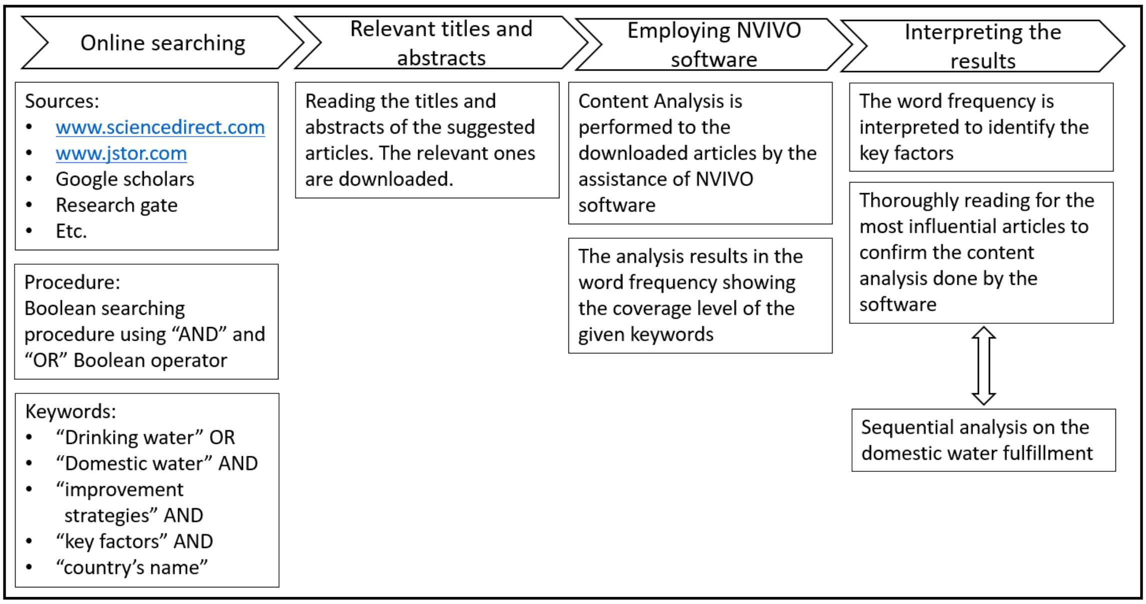


Figure 7.3. The stages conducted for a systematic literature review

The first stage to find relevant literatures is conducted by online searching. The journal paper databases such as https://www.sciencedirect.com/ and https://www.jstor.org/ are the sources to search the required references. Besides, other platforms such as https://scholar.google.com/ and https://www.researchgate.net/ are also useful to expand the searching results. The sources might also come from the official website of the institutions that have an authority to manage domestic water sector. Furthermore, the Boolean search procedure using "AND" and "OR" Boolean operators are applied to limit and specify the searching process into the desired topics. The keywords are “drinking water” OR “domestic water” AND “improvement strategies” AND “key factors” AND “(country’s name)”. Afterward, we selected the most relevant literatures suggested by the searching engine to be downloaded by reading the tittle of the suggested articles.

Moreover, the selection process is continued by reading the abstracts of the downloaded articles to briefly understand the content. Once the abstract is relevant with the desired topics, the article will be selected as the reference. Otherwise, the irrelevant articles will be omitted. For further analysis, the selected articles are examined by the computer software NVivo version 12. This word processing software gives an assistance to classify the articles into a similar topic and to define connections among assessed articles. Not only that, but the software also provides the facility to briefly review the article by showing the coverage percentage of the given keywords.

After assessing the articles using NVivo version 12, further elaboration is conducted. The relevant articles, which is identified by the software by large percentage of issue coverage, are thoroughly read for further elaboration. In this stage, we read the articles directly rather than using the computer software to obtain more deeply understanding to the context of the implemented strategy. Thus, the software is merely used to classify the bulky materials and select the most relevant ones while understanding the context and identifying key factors in the development of the domestic water sector is still needed to be done manually. To validate the identified key factors, a sequential analysis on the applied strategies and their consequences to the achievement on the domestic water fulfillment was also conducted. Hence, the progress on the development of the domestic water sector was confirmed with the implemented strategies. After gaining the results, the next step is to reflect the findings with the context of Indonesia as well as the proposed strategies discussed in the previous chapter.

7.2.3. Reflecting Identified Key Factors to the Context of Indonesia and the Proposed Improvement Strategies

Identified key factors resulted from the previous stage are used as reference to assess the development of domestic water sector in Indonesia. The current implemented strategies in Indonesia as well as the development planning are explored to set the benchmark. The same procedure is conducted to collect information about the issues of the current strategies and the future plan. Hence, published materials such as journal articles, government regulation, development planning documents, news, etc. are useful sources of information. A similar classification procedure is also conducted by the assistance of computer software, which is continued by thorough reading on the suggested literatures. Then, the results in this stage will be confirmed with the findings previously attained.

Moreover, the proposed scenarios for Kota Metro, which were resulted in chapter 6, are recalled. Then, the congruity of these proposals will be assessed to the national policy on domestic water sector. Indeed, they are supposed to be in line with the national guidance. Moreover, insights gained from the global practices, which were discussed in the key factor identification will be useful to equip the proposal with elements that have not been inserted in the strategy formulation process. In short, lessons gained from global practices and national guidance will complete the proposed alternatives for the case study area.

7.3. Results and Discussions

7.3.1. Listing Various Implemented Strategies and Identifying Their Key Factors

In this section, some development projects in selected countries listed in table 7.1 are elaborated to draw lessons related to key factors determining the successfulness of the programs. To begin with, we overviewed the country's achievement on domestic water provision, which is presented in table 7.2. The situation in Indonesia is also listed to see be compared with the referred countries. The achievement on the access to water in 1990 and 2017 is compared to briefly overview the development on domestic water sector of the respective country. Moreover, the country's demographic figures i.e., the number of populations, density, and distribution are also included in the data summary. The population data implies on the volume of water required to fulfill daily needs. Meanwhile, the population density might influence on the approach to be applied whether it should be pipeline-based or non-pipeline-based domestic water provision. The same assumption might also be applied to the data on the population spatial distribution. Then, the data is arranged according to the country's population (in descending order) to illustrate the scale of domestic water supply that should be provided.

Table 7.2. Overview on demographic figures and access to water of the selected countries

Country	Demographic figure (2017) [12]				National achievement on access to the improved water source (%)					
					1990 [13]			2017[14]		
	Population (people)	Density (people per km^2)	Distribution: Urban (%)	Distribution: Rural (%)	Piped	Non-piped	Total	Piped	Non-piped	Total
India	1,352,617,328	455	34	66	16	55	71	44	50	94
Indonesia	267,663,435	148	55	45	9	60	69	18	72	90
Brazil	209,469,333	25	87	13	78	10	88	97	1	98
Philippines	106,651,922	358	47	53	25	59	84	40	55	95
South Africa	57,779,622	48	66	34	56	27	83	90	6	96
Colombia	49,648,685	45	81	19	77	11	88	89	8	97
Sri Lanka	21,600,000	346	18	82	12	56	68	38	54	92
Ecuador	17,084,357	69	64	36	59	15	74	88	6	94
Maldives	515,696	1,719	40	60	13	80	93	48	51	99

Overall, all listed countries in table 7.2 have reached larger than or equal to 90% access to the improved water source. However, the type of domestic water sources is interesting to be elaborated. Latin American countries such as Brazil, Colombia, and Ecuador can significantly provide domestic water through pipeline-based service. It is understandable since these countries are geographically characterized as non-archipelagic countries. Therefore, they likely have fewer technical constraints to expand pipeline networks compared to challenges belonged to archipelagic countries. Moreover, their population dominantly reside in urban areas where the water source is usually scarce and difficult to be individually exploited. Besides, a big number of customers living in the relatively small area also enables the pipe water service provider to gain more economic benefits despite a big challenge to provide more water. On the other hand, archipelagic countries such as Indonesia, the Philippines, and the Maldives have a big reliance on the non-piped based domestic water source. A similar case also appears in India.

Moreover, budget allocation for domestic water sector is also interesting to be explored. The comparison on this issue can be seen in table 7.3. This table shows that the country that allocated the biggest budget to develop domestic water infrastructure in India. This strategy resulted in the significant increase (from 71% to 94%) of population access to improved water source as is presented in table 7.2. However, if the number of budget allocation is divided by the country's population, Maldives places the first rank in the list. Unsurprisingly, the percentage of population who have access to improved water source (table 7.2) in Maldives is the highest among all listed countries. It is the followed by Brazil and Colombia even though the number of budget allocation per capita is slightly different with India even though the increment Brazil and Colombia from 1990 to 2017 is only about 10%.

Table 7.3. The comparison of the budget allocated to develop domestic water infrastructures

Country	Population (people)	The budget allocated for water supply in (million USD) [12]	Budget allocation per capita (USD)
India	1,352,617,328	97	71.71
Indonesia	267,663,435	9	33.62
Brazil	209,469,333	16	76.38
Philippines	106,651,922	27	253.16
South Africa	57,779,622	0.2	3.46
Colombia	49,648,685	3	60.42
Sri Lanka	21,600,000	31	1,435.19
Ecuador	17,084,357	25	1,463.32
Maldives	515,696	9	17,452.14

Furthermore, the brief comparisons presented in table 7.2 and 7.3 is a good starting point to explore the issue of how those countries gain their current achievement. Furthermore, further elaboration is conducted following the stages discussed in the methodology section, which are collecting information from published materials and exploring their contents. In more detail, the overview of domestic water development in the selected countries is respectively discussed as follows.

a. ***India***

By applying Boolean operator to the searching process, thousands of articles are suggested by the searching engine. We selected 29 journal papers that are considered as the most relevant articles. Subsequently, the NVivo software is used to assess the selected papers to find the key factors that are discussed. The assessment starts from identifying the most frequent word used in the articles to analyze the content. Besides, the most frequent words can also indicate the significance of the issue covered by the discussion. In detail, the NVivo analysis on the word frequency can be illustrated by a word cloud or percentage that is presented in figure 7.3.

To inform, figure 7.3 illustrates the word frequency analyzed by the NVivo software. The bar chart indicates the numbers of words counted by the software from 29 assessed articles. Meanwhile, the word cloud graphically shows the most frequent words in the selected articles. The font size of the respective word indicates the frequency. For further analysis, we excluded water and India from the list since these words are not specifically connected to the development strategies. As a result, the three most frequent words appeared in the articles urban, supply, public. These might represent the importance of the issue. For instance, public water supply in urban area might the most crucial issue to be discussed in the articles. Its development (or management) can implicate on the state of the groundwater. Moreover, the issue of public water provision cannot be simply divorced from the issue of sanitation. Up to this point, policy accommodating participation from various actors such as government, communities, households, women, etc. is important to increase the level of water service provision.

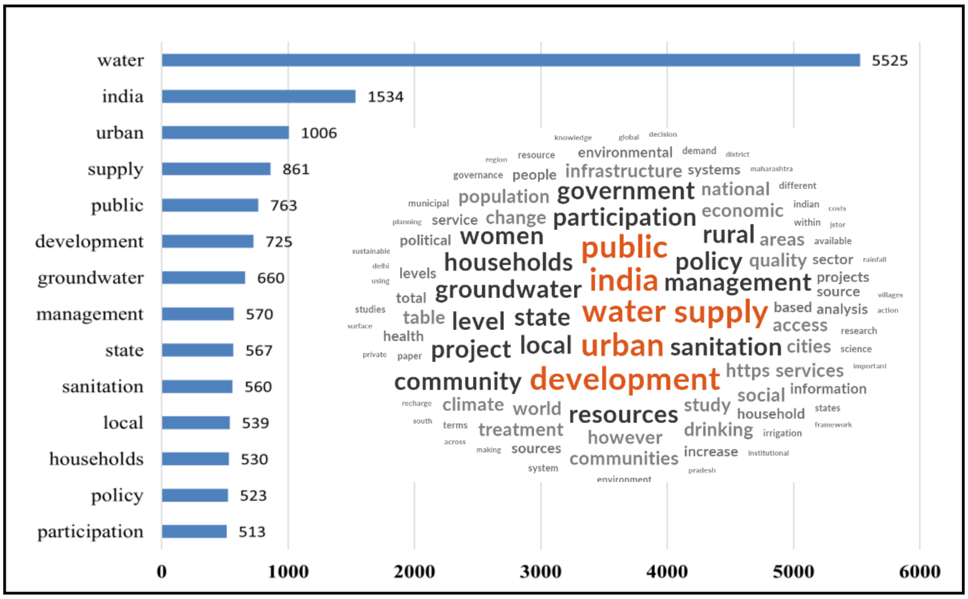


Figure 7.4. Word frequency analysis for articles discussing about the development of the domestic water sector in India.

Subsequently, the stage of the content analysis is continued by searching specific words under the phrases of key factors in improvement (or development) strategies. The NVivo software is still employed in this stage. The result suggests that [15] and [16] have the highest percentage to cover the designated phrase. The first literature widely explores the current stage of development in India. Then, the policies, decision-making process and institutional frameworks are also discussed. Besides, political dimension and institutional framework of Indian domestic water sector is also discussed by [17] and [18]. The most notable issue discussed in [15] is a political commitment of the government to provide urban infrastructure development such as water supply, wastewater, drainage, solid waste service, etc. and the huge investment required to build those facilities. On the other hand, the second literature criticizes the approach taken to conduct the development process, which is considered unsustainable due to the decrease on the use of renewable water sources.

Moreover, another key factor in Indian domestic water development as is illustrated in table 7.3 is a big budget allocation for this sector, which is echoed by the study of Tortajada [15]. This is understandable since India has to deal with a big population that implicating on the huge water demand. In more detail, Tortajada also noted that prioritizing water-related infrastructure development in the national development plan is an essential factor to increase water service provision. Moreover, increasing efficiency in delivering domestic water service is an important aspect [19].

While the aforementioned articles focus on the issue of domestic water provision in urban areas, [20]–[22] widely elaborate the issue of domestic water provision in rural areas. To overcome geographical constraints, the Indian government promotes decentralized governance in domestic water service provision [18] and community involvement in rural areas [21]. These papers highlighted the role of local community participation to face the potential of water insecurity due to climate change, topographical constraints, socio-economic condition, and demand-driven scarcity [20]. Furthermore, [21] found that community involvement in the water development projects positively correlates to the outcome of the projects in Indian rural areas. The analysis in this study shows that the relationship between household involvement and project outcomes (in terms of decision-making process and transparency) is statistically significant. Moreover, collaboration between government and community is also recommended to perform water supply projects [23].

To confirm the results of the systematic literature review, we conducted a sequential analysis on the policies or strategies that have been done in India as is illustrated in figure 7.5. In general, the analysis is conducted by confirming the strategy implemented and the achievement on the domestic water sector at the same timeline. Thus, the strategies were associated with the significance of the improvement. To specify, the development of domestic water sector (and sanitation) in India significantly improved since 2000’s. At this period, the achievement of the Indian domestic water sector is around 84%, which consisted of 44% of pipeline-based water service and 40% of non-pipeline-based water service. Furthermore, the percentage of population served by pipeline-based water service is remaining constant while the non-pipeline-based water service users regularly increased year by year.

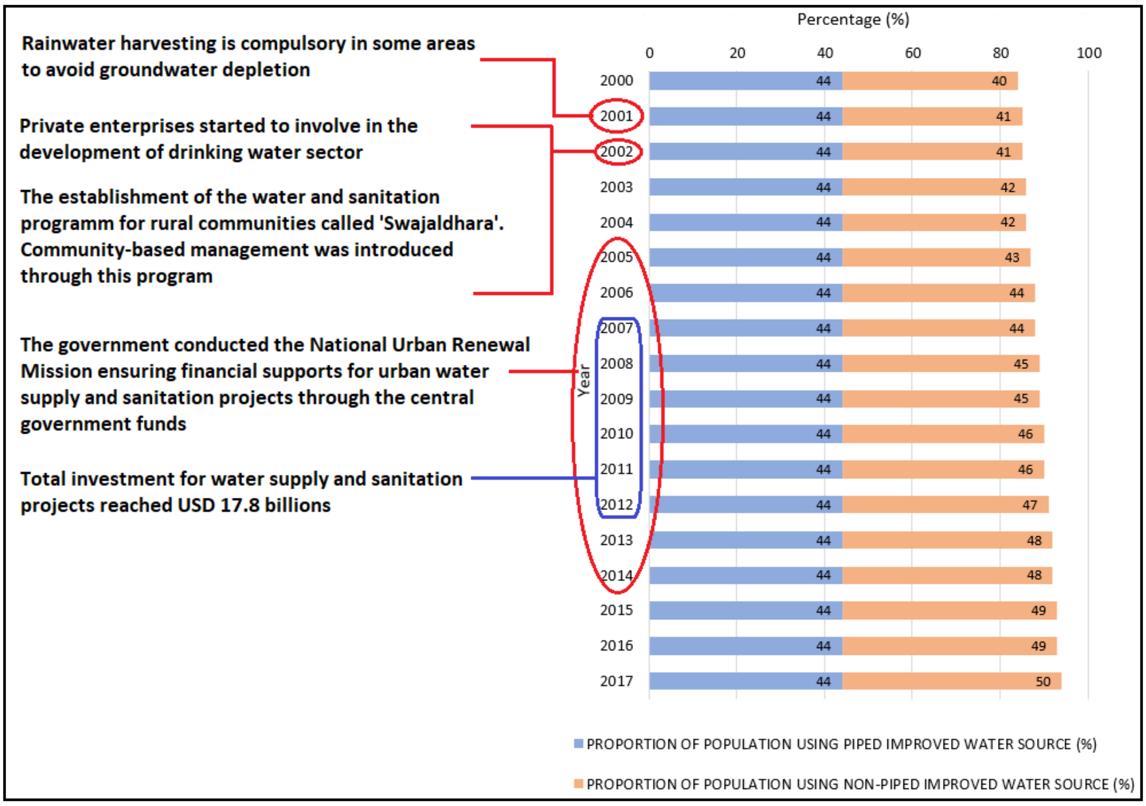


Figure 7.5. The sequential analysis on the strategies conducted in India

In 2001 the government campaigned rainwater harvesting in some areas to avoid groundwater depletion. Moreover, the involvement of the private enterprises in domestic water sector started at 2002. The private companies involved in the development of water-related projects as well as drinking water provision especially in urban areas. Meanwhile, in rural areas, community-based water provision was highly promoted through a program called 'Swajaldhara'. It is understandable due to optimizing the economy of scale. Thus, to accelerate the development in unserved areas, the community-based water provision is preferable instead of the pipeline-based water service. Unsurprisingly, the percentage of population using the pipeline-based water service is stagnant while the percentage of the non-piped water users increased during the recorded period.

Moreover, the role of the government in the development of the domestic water sector is essential. The government conducted a long-term program called the National Urban Renewal Mission from 2005 to 2014. Through this program, the national government ensured financial support to accelerate the development of the water supply and sanitation especially in urban areas. The government has spent a big investment in this sector. It was recorded that the total investment in water supply and sanitation projects reached USD 17.8 billion.

b. ***Brazil***

We chose twenty-two out of thousands suggested articles related to the development of the domestic water sector in Brazil. The same procedure is also applied to identify the key factors of the development strategies in Brazil. The result of the word frequency analysis is presented in figure 7.6. One of the key factors succeeding domestic water provision in Brazil is the integration between water safety plans and land use policy [24] [25]. Not only that, but the strategy is also strengthened by the integration with other sectors as is shown by the word frequency analysis done by the NVivo software. Moreover, figure 7.6 shows that the development of the water supply in Brazil is interlinking various sectors such as energy and environmental. To specify, the link between water, waste, energy and food in Brazil is widely discussed by Couto et al [26]. In their review, the most critical problem of the water management in Brazil is the multi-purposes of the water sources (i.e., hydroelectric, agricultural irrigation, domestic uses, etc.). Therefore, integrating these sectors as well as spatial entities is a crucial issue in Brazilian water management. Another interlinking issue is discussed by Ioris [27], which elaborates the water resource management from the perspective of the sociological economics.

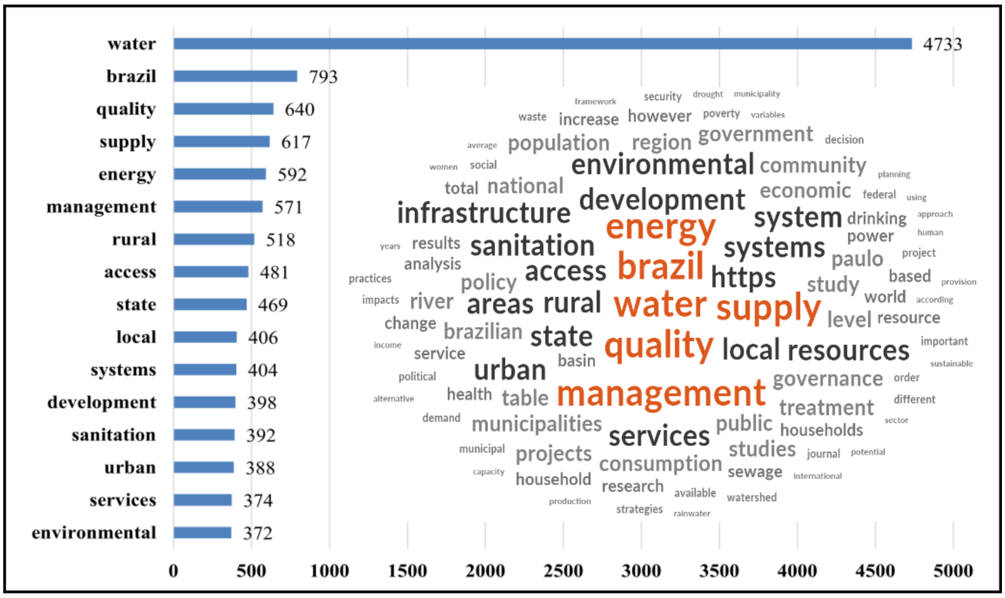


Figure 7.6. Word frequency analysis for articles discussing about the development of the domestic water sector in Brazil.

Furthermore, the development on the domestic water sector in Brazil cannot be separated from the issue on the institutional reforms. The main laws to regulate water and sanitation service are the Water Law and the Sanitation Law, which set out the management systems, policies, and fees, for water resources and water and sanitation services [28]. Besides, proactive legal instruments are also suggested to support the integration between water and solid waste management in the municipality level [29]. Regarding water service provider, domestic water provision was dominated by region owned water and sanitation companies [30] but currently private enterprises are more intensively invited to participate in water service provision. To specify, Kayser et al [31] recorded that in Brazil 3,856 municipalities are served by private-public joint companies, 1,510 municipalities are served by local authorities, and 499 municipalities are served by private companies. To provide domestic water service for rural areas, Machado et al [32] assessed the critical factors to succeed the development strategies. The six elements are identified as in this study. They are innovation at national level, accordance to water quality standards, local entities specialized in planning of local service providers, water tariff that aligned to user's affordability, support systems for post-construction phase, and the existence of local service providers who are responsible to operate, manage and maintain local systems.

Furthermore, the same procedure was conducted to analyze the sequence of the development of domestic water sector in Brazil as is illustrated in figure 7.7.

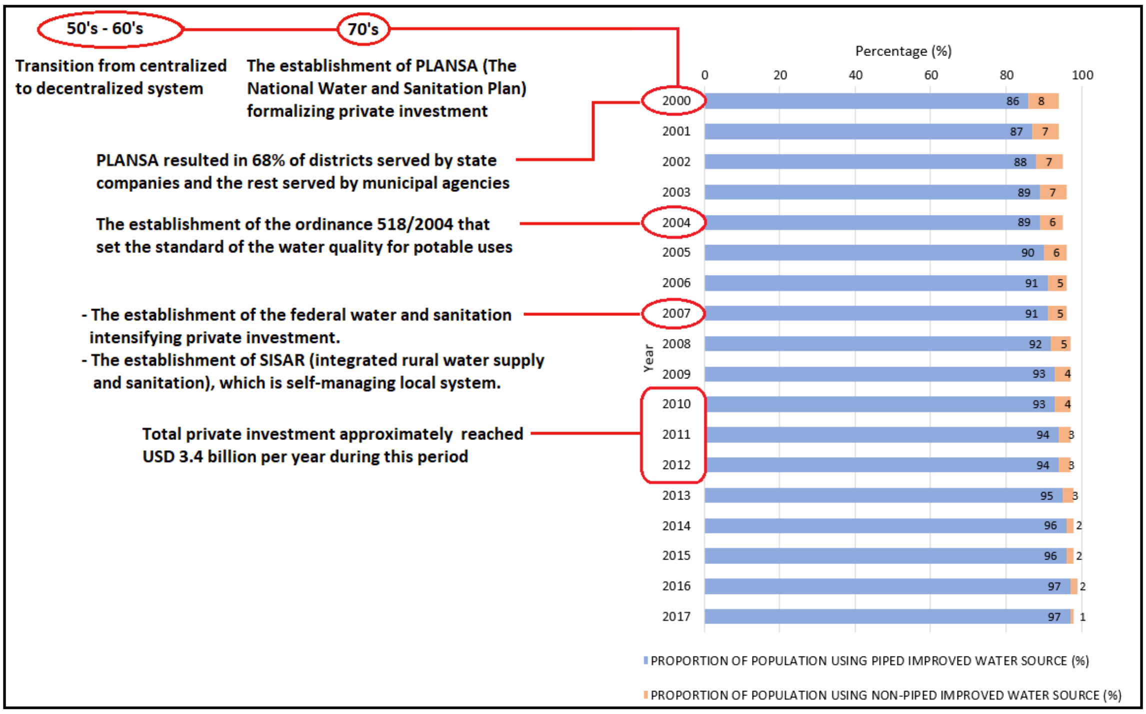


Figure 7.7. The sequential analysis on the strategies conducted in Brazil

This figure shows that the development of domestic water sector is dominated by the pipeline-based water service because of the high percentage of population residing in urban areas, which is illustrated in table 7.2. Furthermore, stages conducted in Brazil shows the significant roles of private enterprises in the development of domestic water sector as a result of the introduction of the decentralized system. The encouragement of the private companies was explicitly stated in the formal legislations such as the establishment of PLANSA (The National Water and Sanitation Plan) and the federal water and sanitation law. This legal framework resulted in USD 3.4 billion of the annual private investment in the development of the domestic water sector from 2010 to 2012.

c. ***The Philippines***

The word frequency analysis for the development of domestic water sector in the Philippines shows that sanitation, development, and supply place the three highest rank after water and the Philippines. Furthermore, household (along with households) also share a significant portion. It can be interpreted that the issue of water supply and sanitation at the household level is crucial to the discussion of the development issue in the Philippines. In detail, the result of the word frequency analysis is presented in the following figure.

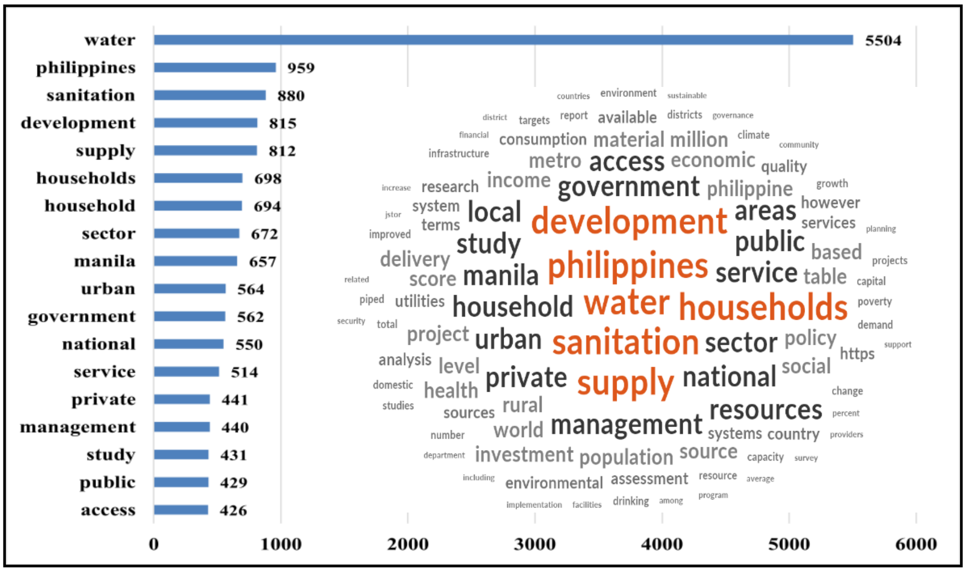


Figure 7.8. Word frequency analysis for articles discussing about the development of the domestic water sector in the Philippines.

In the case of policy issues, governmental regulation at the national level dominantly appears as is illustrated by the word cloud in figure 7.8. To specify, the Philippines has conducted series of reforms to overcome fragmented and overlapped institutions and regulations that had appeared for a long time [33]. Conflicts between national policies and local agreements, along with conflicts of multi-purpose uses, are the main challenges should be handled. In this regards, decentralized system has been promoted but is still under the coordination of the national development plan [34] [35]. In 2009-2010 the Philippine Water Supply Sector Roadmap was prepared to enable multi-stakeholder participation. Another type of multi-actors' engagement in the Philippine's water sector development is the partnership with international organizations such as the World bank and Asian Development Bank to finance projects related to the improvement of domestic water provision [36].

To attract private sector involvement, incentive programs are provided for private investment in all water resource development initiatives. For example, urban water supply service in Manila metropolitan area is served by Metropolitan Waterworks and Sewerage System, which is government-owned company, and its two private concessionaires. Meanwhile, local government units are responsible for providing the service outside Metro Manila [35]. Moreover, the discussion of public-private cooperation in the domestic water provision in the Philippines also takes a significant portion. The Philippine Water Revolving Fund (PWRF), for instance, was introduced to leverage public with private resources especially in remote rural areas [37]. Nevertheless, water tariff is the most challenging since production and operational cost cannot be covered by the current water tariff [34].

Furthermore, community-based water supply management is also applied in some areas. In his study, Ganiron Jr. [38] found that the performance of the communal-based water service in the fringe area of Metro Manila is satisfying. The evaluation covers the issue of the service performance in terms of quality of water delivered, cost effectiveness, and operational-related factors. On the other hand, a study from Mason [39] reveals that pipeline-based water service has the most consistent association with water security. The research that was conducted in Baguio City (the Northern Philippines) found that water quality, accessibility, and affordability are essential factor determining the satisfaction level of the pipe water subscribers.

To confirm the identified key factors obtained in this literature review, the sequential analysis on the implemented strategies in the Philippines' domestic water sector was also done, which is illustrated in the following figure.

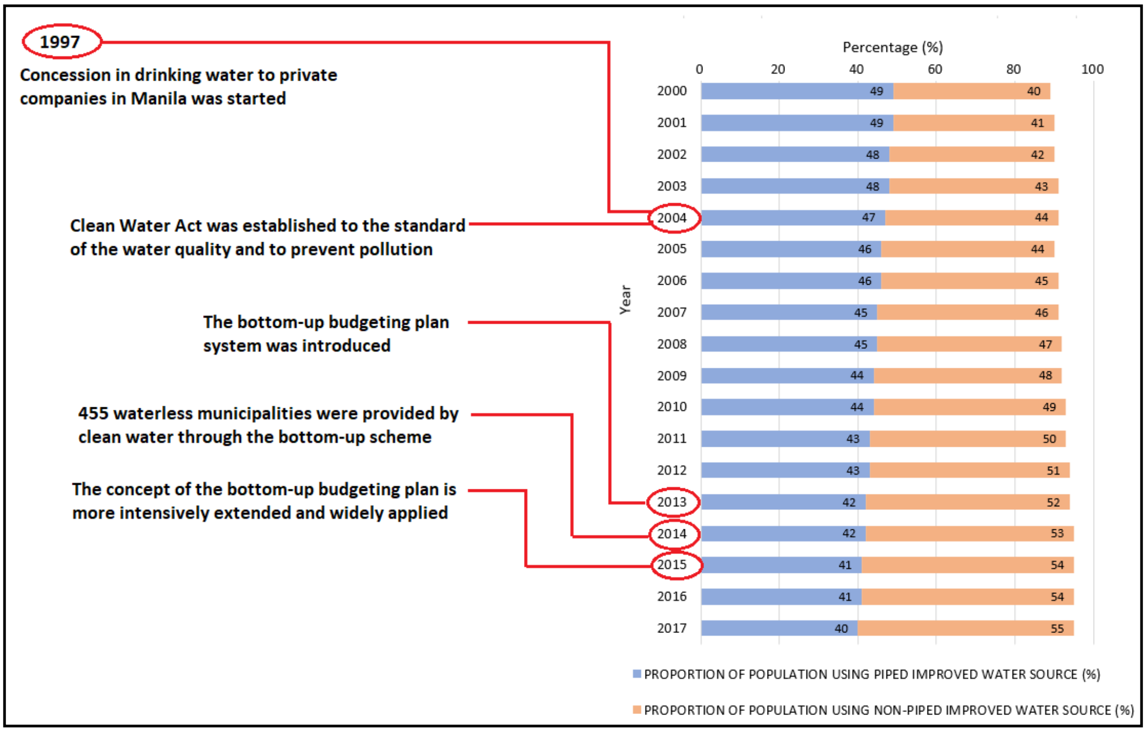


Figure 7.9. The sequential analysis on the strategies conducted in the Philippines

The most notable feature in the development of the domestic water sector in the Philippines illustrated in figure 7.9 is the decreasing trend on the percentage of the pipeline-based water service users along with the increasing trend of the non-pipeline-based water service users. As a matter of fact, the privatization in the drinking water service, which was conducted through the concession, does not significantly affect to the expansion of the pipeline-based water service. It is understandable since the geographical situation of the Philippines, which is archipelagic, might increase the technical constraints as well as decrease the economic benefits. Therefore, the-non-pipeline-based water service is more reasonable to be applied. To implement this system, the bottom-up budgeting plan was introduced in 2013 involving local authorities and communities. They were encouraged to actively participate to propose necessary actions to overcome their domestic water-related problems. This initiative successfully provided 455 waterless municipalities with improved water sources managed by the local communities. Therefore, the concept is subjected to be more intensively extended and widely applied.

d. South Africa

Table 7.2 shows a rapidly increasing trend of piped water users in South Africa from 56% (1990) to 90% (2017) even though its budget per capita allocated for this sector is the smallest compared to the countries listed in table 7.3. In his research, Muller [40] emphasized that a strong political commitment and sufficient funding are the key success factors. Besides, this study also suggested that practical policies, good planning, and continuous monitoring could accelerate the progress. Furthermore, the introduction of the new National Water Act in 1998 and the policy of free basic water in 2001 were marked as a take-off phase that provided the constitutional basis to accelerate the development of the domestic water sector [41][42]. To ensure water quality management, multi-actors incorporation, which clearly defines each actor’s roles and responsibilities, is also highly promoted [43].

For further elaboration, the word frequency analysis by the NVivo software, which is illustrated in figure 7.10, shows that the development of water supply in South Africa put services (and service) on top of priority in the discussion. Along with other words, it forms the phrase service quality and service cost. These two crucial issues are widely discussed in the literature suggested in the online searching such as[44] [45]. Inadequate service, in terms of water quantity and quality, is even triggered serious protests in some areas [46]. Moreover, the historical background of South Africa, which was governed by the apartheid, encourage to bring equality issue in the policy formulation including in the domestic water sector [47].

Regarding the financial issue, the government of South Africa provide a subsidy for low-income people and the water consumption below the basic level (25 Liters/day) is free of charge [47]. Meanwhile, Nleya [48] criticizes the subsidy that might create unfair service since bigger family size, which is usually the have, gain more benefits than households with smaller family size. Besides, Akinyemi et al [45] also found that the South Africans actually have a willingness to pay their water bill but the current system enable to lose the revenue from the water service because of some reasons including lack of water meter and the water bill that is not regularly received by the customers. Besides, the use of free water source and permission from municipality not to pay also discourage the costumer’s willingness to pay.

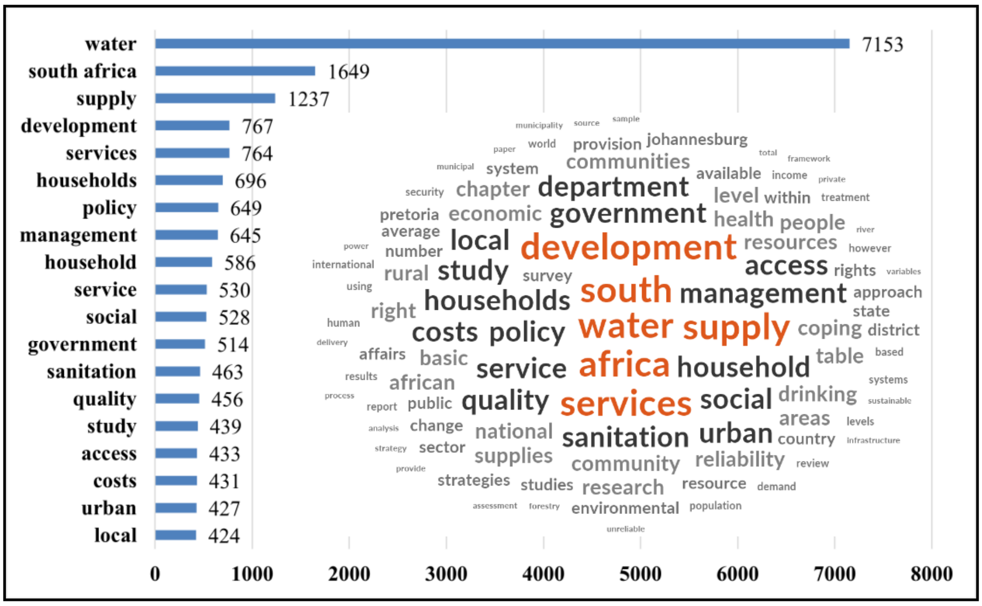


Figure 7.10. Word frequency analysis for articles discussing about the development of the domestic water sector in South Africa.

The free basic water in South Africa is also conducted in the form of communal taps [49]. Three steps are suggested to implement this strategy. First, the government estimates the minimum water requirement for the community that is served by the communal taps. Second, the real consumption is counted in through the water meter. Once the consumption exceeds the designated minimum consumption, the community should pay the cost for the additional consumption. Third, incentives are given for the community that consume less than the minimum water requirement. Furthermore, rainwater harvesting is introduced to improve water supply in rural South Africa. However, the thorough evaluation on the aspects of health-related risk, financial scheme to operate and maintain the facility, and legislations are recommended to be conducted despite promising potentials offered by the rainwater harvesting system [50]. Moreover, this system might also face big challenges due to climatic characteristics of some areas that do not receive a big rainfall rate [47].

Furthermore, the sequential analysis on the implemented strategies is also conducted to confirm the influential factors in the development of the South African domestic water sector found in the literatures. To specify, figure 7.11 illustrates the improvement strategies conducted in South Africa associated with the achievement on the domestic water provision.

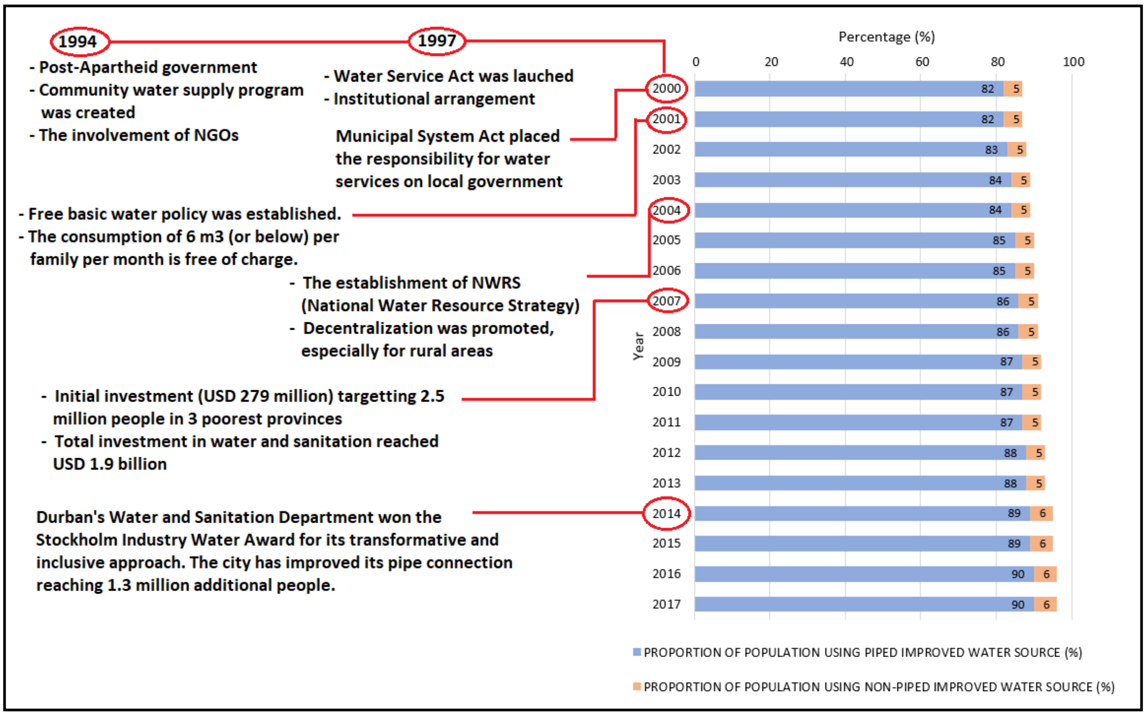


Figure 7.11. The sequential analysis on the strategies conducted in South Africa

The implementation of the Apartheid in South Africa caused a vivid segregation between the poor and the rich municipalities. The rural areas were usually much poorer than the urban areas. Therefore, in 1994, many NGOs started to actively involve giving supports to accelerate the development of the rural water service provision in South Africa. Furthermore, Water Service Act was launched in 1997. Through this regulation, institutional arrangement was set so that inefficient and overlapped institutions were reduced. Then, this legislation was equipped with the Municipal System Act in 2000 that clearly organized the role of local governments to provide water services. Furthermore, free basic water policy was introduced in 2001. Through this policy, the household monthly water consumption up to 6 m^3 was free of charge. It was a sort of subsidy for low-income communities as well as to raise the awareness of the efficient water consumption. In 2004, the National Water Resource Strategy (NWRS) was established, and the decentralization system was promoted for rural areas.

In the case of financial aspect, the government of South Africa has allocated a significant budget in water supply and sanitation sector to accelerate the development on the poor municipalities. In 2007, it was recorded that the government spent USD 279 million initial investment to develop water infrastructure targeting 2.5 million people in three poorest municipalities. At the same year, the total investment in water and sanitation projects reached USD 1.9 billion. Moreover, the water service provider in South Africa has performed a remarkable performance. To specify, Durban's Water and

Sanitation Department won the Stockholm Industry Award for its transformative and inclusive approach resulting in 1.3 million additional people have access to piped water.

e. ***Colombia***

Colombia has conducted series of reforms in the water and sanitation sector since the ’90s. The decentralization system is highly promoted so that municipality governments are autonomous. The corporatization of public service, which are usually managed by municipality government, is conducted to deliver the decentralization system. Besides, private sectors are also encouraged to involve in the public service sectors including domestic water [51]. However, the central government still has a responsibility as the main source of funds to finance the water and sewerage sector [52]. The findings are also supported by the word frequency analysis assisted by the NVivo software as is illustrated in figure 7.12. The word frequency analysis shows that public service system is the most frequent phrase appearing in the discussion of the Colombian water supply issues, which is then followed by the phrase service management quality. Moreover, the word cloud in figure 7.12 also shows the appearance of the word “municipalities”, which is much larger than the appearance of the word “national” or “country”. It can be interpreted that the issue of water service provision in the municipality level is Colombia is more popular to be discussed than in the national level.

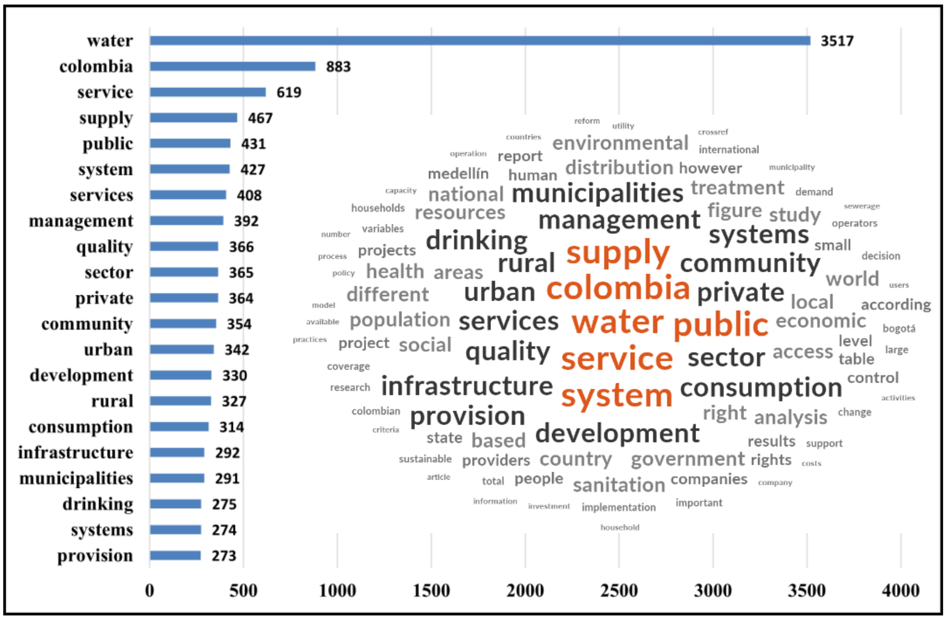


Figure 7.12. Word frequency analysis for articles discussing about the development of the domestic water sector in Colombia.

The second regulatory change in Colombian water sector is the implementation of the cross-subsidy policy to redistribute the resources more equally across populations. By this policy, the low-income communities are charged a lower price other consumers [53]. Nevertheless, this study suggested that the subsidized users receive worse service than the non-subsidized users. Moreover, the inequality issue also appears in the context of urban-rural distinction. The people who live in the urban areas are well served by water service company while the people who live in the rural areas have to struggling through self-managed community water supply system [54]. The word cloud also the appearance of the word “rural” and “urban”, which appear as frequent as the word “private sector “and “community” services. It illustrates that those issues take a significant concern in the discussion of the development of domestic water sector in Colombia.

Furthermore, the regulatory reform that was articulated by the launching of the Law 1508 in 2012 enables non-governmental agents to participate in water provision. The target is to improve the coverage and the quality of rural water infrastructure system [55]. However, the private enterprises are likely reluctant to involve since providing water supply for the rural communities is considered economically unbeneficial and technically difficult. Hence, the community-based water supply system is also promoted to provide water service in rural areas. In this case, communities are given an authority to manage their water supply system including intake, grit chamber, transmission, and household pipe connections [56]. However, this study found that small rural water supplies take as study cases are vulnerable, for which the capacity of communities to manage the system needs to be enhanced. Aside from this supply-side approach, demand-side approach is also conducted to overcome the problems of the limited water sources and the low level of the purchasing power. For instance, pilot projects [57] are established to educate people about wisely use of water especially in the low-income settlement areas.

Furthermore, the sequential analysis regarding the development of the Colombian domestic water sector as is illustrated by figure 7.13.

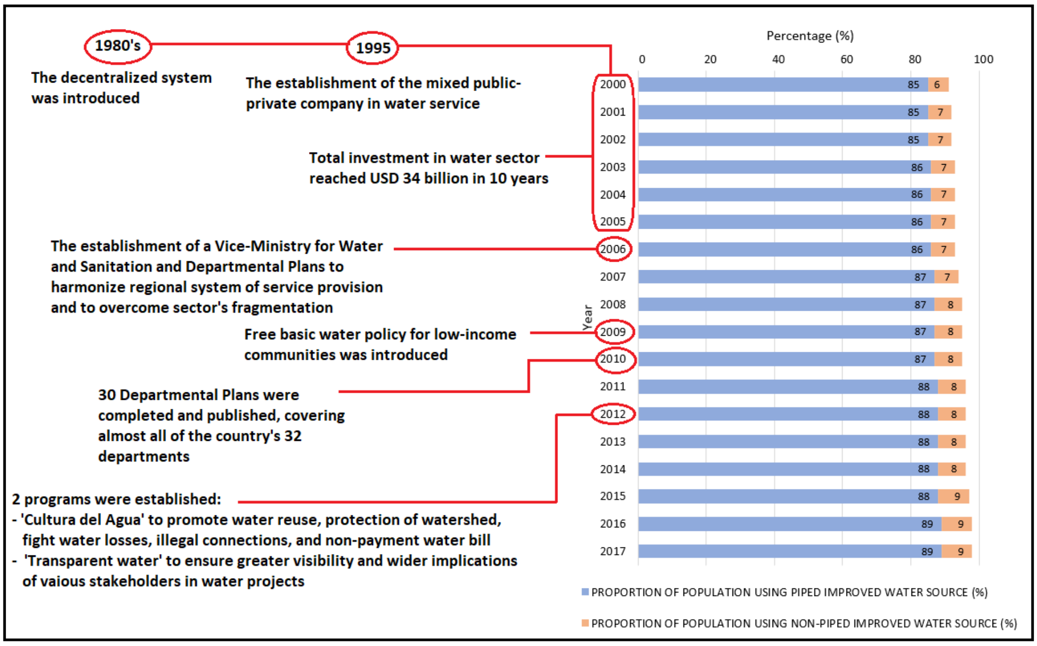


Figure 7.13. The sequential analysis on the strategies conducted in Colombia

Figure 7.13 shows the pipeline-based water provision far exceed the non-pipeline-based water provision resulted from the decentralization system and private sectors participation. In 2004, 125 private companies and 48 mixed public-private companies were involved in water service provision. In addition, more than 12,000 communal organization also participated to provide services in rural areas. Moreover, the private companies' involvement also resulted in USD 34 billion from 1995 to 2005. To coordinate various regional service provision system and to overcome sectors' fragmentation, the government launched the Water and Sanitation Departmental Plans. The plans were completed in 2010 resulted in 30 departmental plans that covered almost all of the country's 32 departments. In 2012, two programs namely 'Cultura del Agua' and 'Transparent Water' were launched to increase the service performance as well as to ensure the visibility of the water-related projects.

f. ***Sri Lanka***

The word frequency analysis conducted for articles discussing the development of domestic water sector in Sri Lanka (figure 7.14) shows that the word "policy" dominantly appears after the word "management" and "development". It can be interpreted the policy dimension is essential in the development of domestic water sector as well as in the management of the service as is also discussed by [58]. This study highlights the importance of water management panel involving several institutions from various levels. Nevertheless, a study by [59] describes that many governing laws as well as coordinating bodies, which genuinely aim to manage water resource, perform less collaboratively leading to minimize productivity of the system and to raise unnecessary conflicts among higher authorities. Similarly, Samad [60] emphasizes that reforms in the Sri Lanka's water sector ware successful in 80's but they are currently to be maintained due to changes in the political setting and organizational gaps.

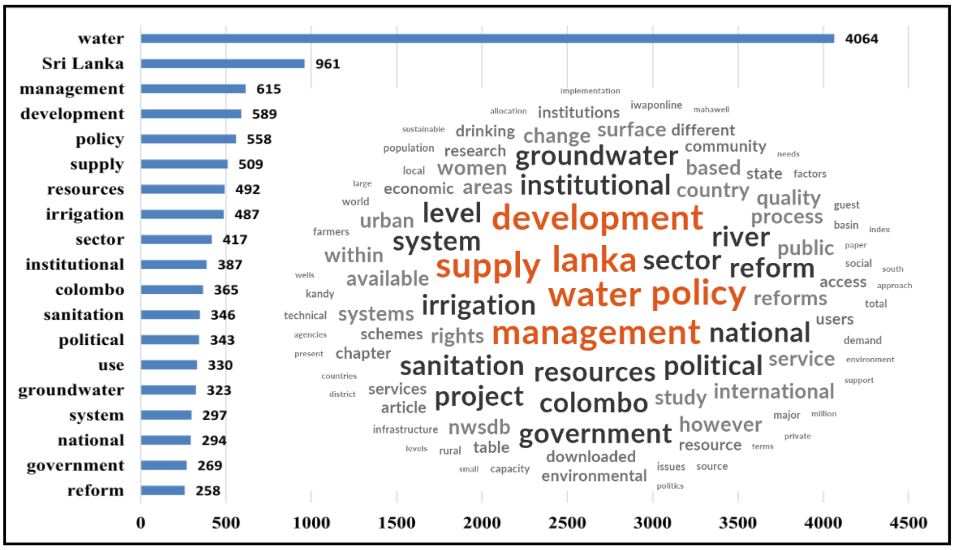


Figure 7.14. Word frequency analysis for articles discussing about the development of The domestic water sector in Sri Lanka.

Another important aspect in the development of Sri Lanka's domestic water sector is the involvement of global donor institutions to financially support the development programs [61]. This situation implicates on the institutional reforms that must be taken by Sri Lanka as the requirement of the agreement to deliver service more efficiently [62]. In this study, Bandaragoda explains that service provision and political issues in Sri Lanka are not separable, where the political practitioners tend to offer cheap (or even free of charge) service to increase their electability. As a result, this conflicting interest might discourage the favorable target to achieve universal access to water and to deliver a reliable water service.

Furthermore, the role of the community participation is also an important factor appearing in the discussion of the Sri Lanka's domestic water sector [63]. The Water Supply and Sanitation Improvement Project (WaSSIP), for instance, was established in 1998 to provide a new water supply system and to rehabilitate the existing one. It was financially supported by the World Bank and collaborated with Community-Based Organizations (CBOs). The local CBOs are trained to operate and maintain the water supply systems to ensure the sustainability of the built facilities and each household agrees to pay tariff covering operational and maintenance costs [64]. Moreover, woman empowerment is also promoted in the water projects [65] considering the central role of the women in the household. This study reveals that women's approach to handling planning in the participatory was simple but highly effective.

Moreover, the sequential analysis on the development of the Sri Lankan domestic water sector is illustrated in figure 7.15.

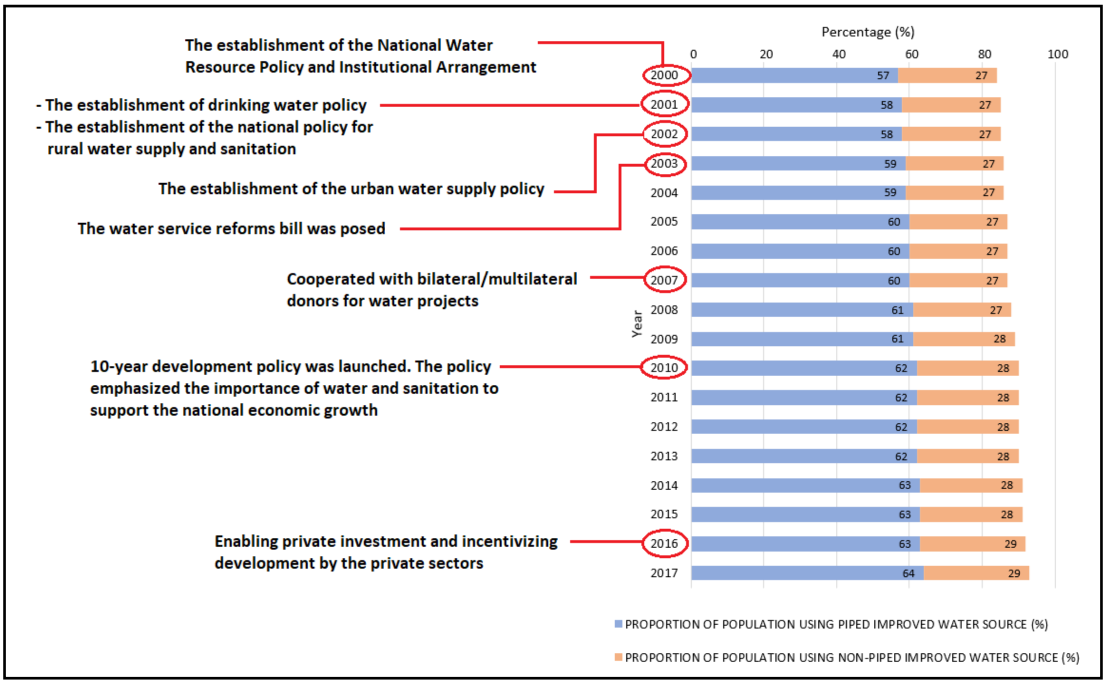


Figure 7.15. The sequential analysis on the strategies conducted in Sri Lanka

The figure indicates that Sri Lanka develop both pipeline-based and non-pipeline-based water service without considering that one type is more prioritized than another. The improvement of these both types look similar. Moreover, the government takes an essential role in the development process while private sectors have not given a significant contribution. Figure 7.15 shows that most of strategies conducted in Sri Lanka was concentrated on the institutional arrangement and regulatory reform, which belonged to the government domain. Meanwhile, the establishment of the private involvement just started at 2016 through a national policy that enabled private investment on water service. Besides, incentives were also given to the private companies that actively participate on the development projects.

Another essential factor in the development of the Sri Lankan domestic water sector is the financial support given by bilateral or multilateral donors. The international institutions also cooperated with the Community-Based Organizations (CBOs). In 2011, National Community Water Trust (NCWT) was formed to increase the sustainability of existing community water supply and sanitation services as well as to increase their capacity. Besides, the NCWT also played an essential role to maintain the relationship with the community.

g. ***Ecuador***

One of interesting findings resulted from the word frequency analysis shows, which is illustrated by figure 7.16, the issue of rural water management grabs a significant attention in Ecuador.

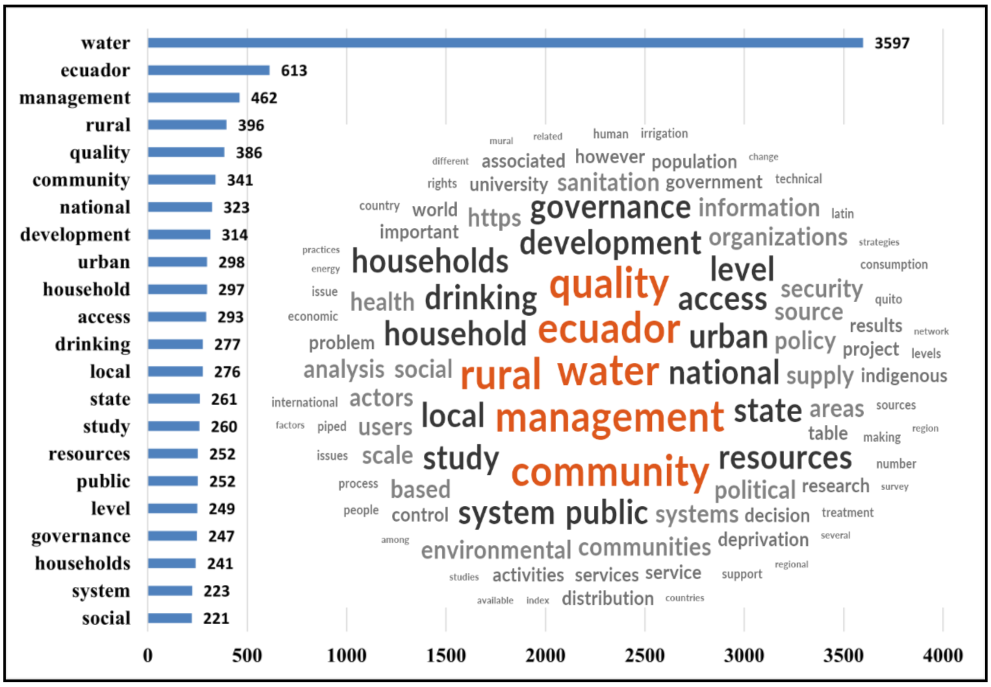


Figure 7.16. Word frequency analysis for articles discussing about the development of the domestic water sector in Ecuador.

For example, a study by Fernandez and Cisneros [66] shows that rural areas were previously less served by water and sanitation service. Hence, the constitution was reformed to accelerate the basic service provision for rural areas. Moreover, the word frequency analysis shows the word "quality" and "community" after the word "rural". It implies that community-based management in rural water provision is essential issue to discuss. The government of Ecuador established improvement programs that are executed by local authorities aiming to improve drinking water and sanitation infrastructure for remote or rural areas that were economically less attractive for private enterprises [66]. Empirically, Hinojosa et al [67] found that rural communities are satisfied with the drinking water service provided by local organizations.

Furthermore, Ecuador reforms the domestic water sector by altering its policy orientation into neoliberal conceptions that strengthen the role of the private sector in water management [68]. As a result, the drinking water and sanitation system was franchised to private companies in some regions especially in urban areas. The two case studies presented by Carrillo et al [69] show that the privatization in the drinking water sector has significantly increased the service coverage. As time goes by, however, the service quality tends to decrease due to low water tariff set by the government in the beginning period of the concession. It seems that the private companies involved are struggling to maintain the high service quality under their limited revenue.

Furthermore, the sequential analysis on the strategies conducted in Ecuador is illustrated by figure 7.17.

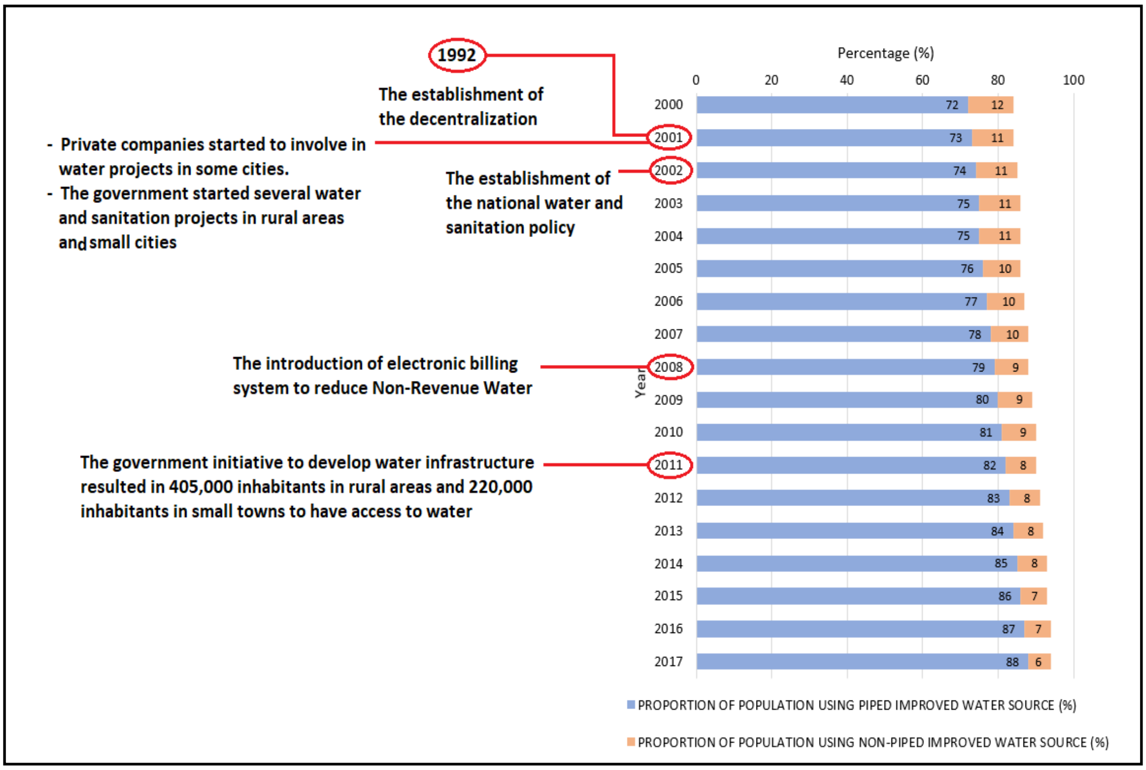


Figure 7.17. The sequential analysis on the strategies conducted in Ecuador

Ecuador started to decentralize its domestic water sector in 1992 by issuing a decentralization law. In urban areas, municipalities were directly responsible for delivering the service. Meanwhile, in the rural areas, community groups called Potable Water Boards provided the service. Besides, private companies also started to involve in the drinking water projects in some cities. In 2002, the National Water and Sanitation Policy was issued but it was criticized due to unclear position on sensitive issues such as investment subsidies by national and sub-national government and who should receive them.

Furthermore, Non-Revenue Water is a big challenge in Ecuador. It made the domestic water sector economically unattractive. The service providers had to face potential financial loss because of the operation and maintenance cost. Unsurprisingly, the government took a significant portion in the domestic water service provision. The data shows that government initiative to develop water infrastructures resulted in 405,000 inhabitants in rural areas and 200,000 inhabitants in small town to have access to the improved water sources.

h. ***Maldives***

Domestic water provision is a big challenge in Maldives due to its geographical characteristics and population growing. Being an archipelagic country, the availability of the fresh water is scarce in Maldives. Then, it is getting more challenging because continuously increasing trend on the population growth, which implicates on the increasing demand. Nevertheless, high reliance on the tourism sector is one of the aspects that strongly motivate the Maldives to ensure safe and reliable drinking water service. Regarding this issue, the government of Maldives established The National Water and Sewerage Policy that uses a holistic and sustainable approach to the management of water resources, and the development and provision of water supply and sewerage system, while concurrently encouraging maximum participation of the stakeholders [70]. As a result, this country could reach an excellent performance in domestic water service provision [71].

Moreover, Maldives relies on three types of the water sources, which are groundwater, desalinated water, and rainwater, to fulfill the daily needs due to its lack of surface water sources. The desalinated water facilities are installed to overcome the water shortage problems in densely populated areas as well as to tackle the problems of the groundwater quality degradation [72]. Regarding the issue of the groundwater quality, Jaleel et al [73] found that the condition of groundwater in Maldives face a serious problem from having elevated salinity.

Furthermore, the importance of the groundwater issue is also confirmed by the result of the word frequency analysis performed by the NVivo software as is illustrated in figure 7.18. The figure shows that the word “groundwater” dominantly appears along with the word “energy” in the discussion of the domestic water issue in Maldives. This is understandable since groundwater as well as desalinated water is the systems that are energy consuming. Moreover, the word frequency analysis also shows that the word "rainwater" is frequently mentioned. In Maldives, the rainwater harvesting is promoted to provide domestic water service in rural areas. The government of Maldives has installed 11,502 rainwater harvesting systems for 26,000 residents in 45 islands and the facilities will be scaled up to be able to provide safe water to 32,000 people [74]. Through this system, rainwater is collected and stored in various types of tanks, which are belonged to either community or private households.

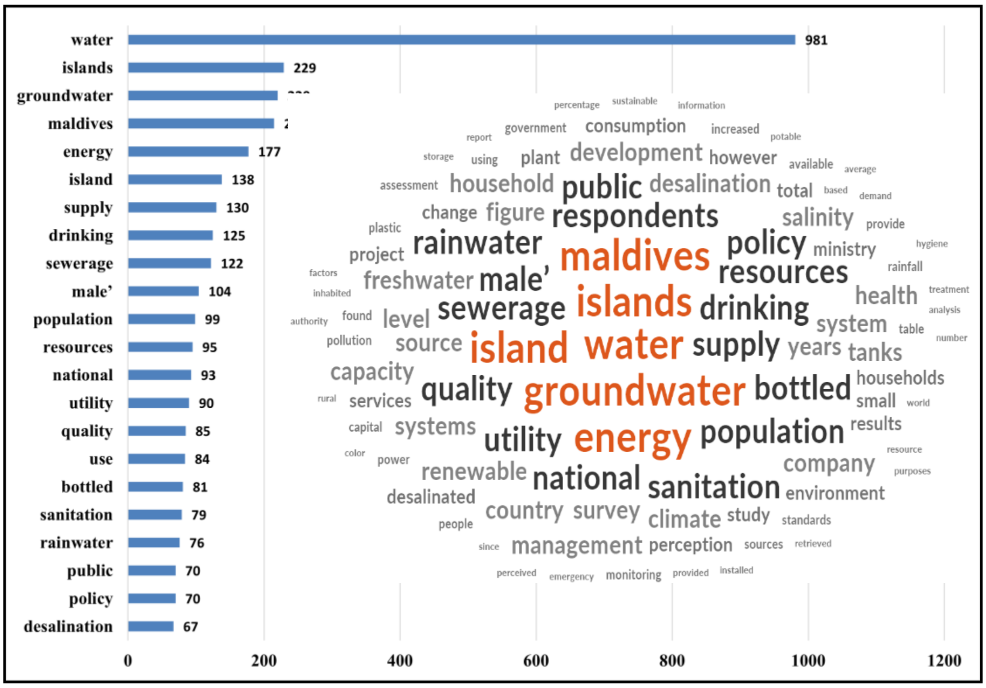


Figure 7.18. Word frequency analysis for articles discussing about the development of the domestic water sector in Maldives.

To finance the development of the water-related infrastructures, private sector investment is encouraged [70]. Moreover, international donor organizations are also invited to collaborate in the water improvement projects [75]. Some strategies are applied to increase the resilience facing the climate change in the domestic water sector. They are integrating rainwater harvesting and desalination technology, improving groundwater quality through artificial recharge technology, increasing community participation in the development process, and up scaling climate-resilient freshwater management.

Similar to previous referred case studies, the sequential analysis on the strategies taken in Maldives is also conducted as is illustrated in Figure 7.19. Generally, Maldives combines various technical measures in drinking water provision such as desalination, rainwater harvesting, and pipeline-based water service. The first desalination plant was built in 1988 with the capacity of 200 m3 per day and it is continuously done with the current capacity reaches 5,800 m3 per day. The National Disaster Management Center had spent USD 2.4 million to provide desalinated water to over

90 islands in Maldives after a big tsunami hit Maldives in 2004. In the case of rainwater harvesting, the government launched a program to provide each household with a 2,500 Liters rainwater storage in 2004. Beside these domestic water sources, the government of Maldives also ever imported bottled water from neighboring countries due to fire on the main water treatment plant that happened in 2014.

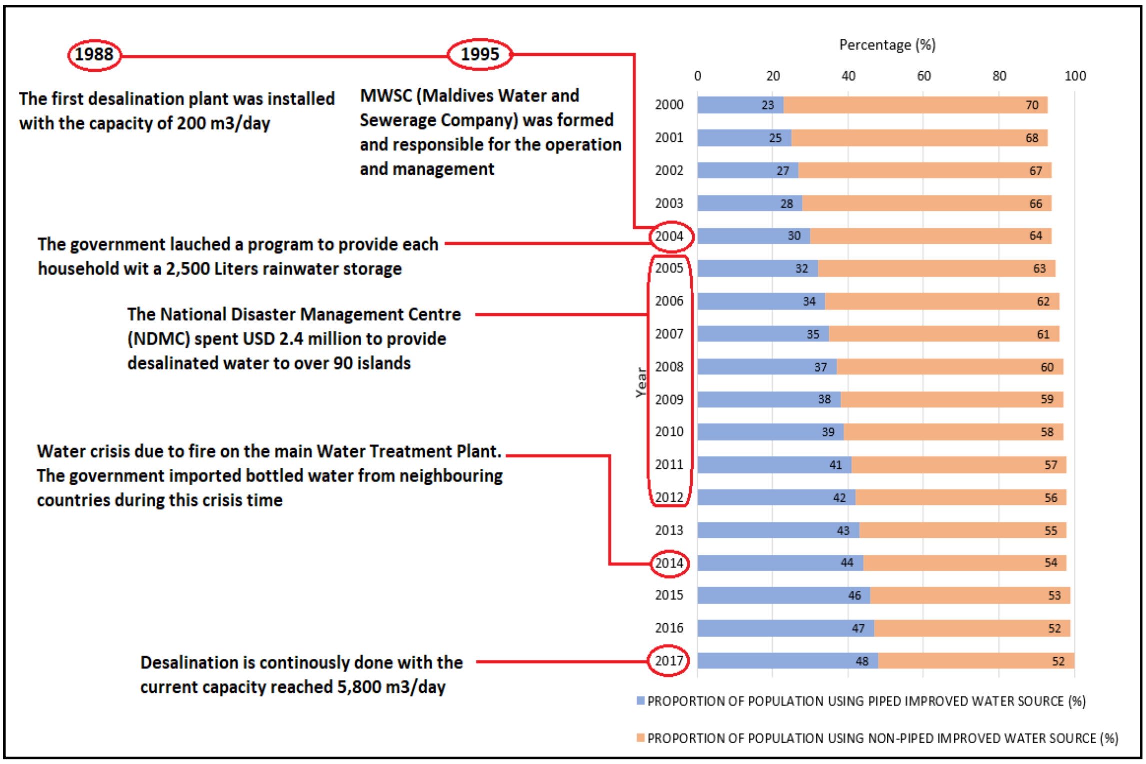


Figure 7.19. The sequential analysis on the strategies conducted in Maldives

7.3.2. Reflecting Identified Key Factors to the Context of Indonesia

Some insights can be taken from various improvement strategies conducted in selected cases discussed above. First, the improvement strategies commonly start with the establishment of the national reform on the domestic water sector, especially in the case of the institutional arrangement and legal framework. Then, this agenda is formally constituted in the national policy or development plan. Not only does this stage articulate the political commitment, but the establishment of national policy also encapsulate derived projects with a formally legal framework. Second, the institutional reform in the selected countries is conducted by altering the paradigm from the centralized to the decentralized system. The rationale behind this strategy is to scale down the problems in the water service provision. Also, the decentralized system enables the decision makers to identify as well as to solve the problems under the perspective of the local contexts. Third, multi-stakeholder participation is an important element to accelerate the development of domestic water sector. In the case of financing the development projects, the private sector investment is important to overcome the limited funding belonged to the government budget. Moreover, community-based water provision is also often undertaken to cope with geographical and economic constraints. This approach is usually applied in the remote or rural areas where the private enterprises are not interested to invest due to less economic benefits. The key aspect determining the successfulness of this approach is upgrading community capacity to manage the built facilities. Besides, formulating the water tariff, which is affordable for community as well as sufficient to cover operational and maintenance cost, is a crucial point to be concerned. Up to this point, collaboration between community and other parties e.g., government institutions or Non-Profit Organizations is also important to be developed. The collaboration can be articulated in the form of training or subsidy. Lastly, the water service is provided by various means e.g., pipeline-based, communal groundwater, rainwater harvesting system, and desalination. The pipeline-based water service might be the best option for densely populated urban area while other measures are suitable for rural areas. Thus, it should be context-dependent rather than proposed a single solution that is considered as the best alternative.

Furthermore, the next part in this chapter will reflect the identified key factors discussed above to the context of Indonesia. The current situation of the domestic water in Indonesia is explored to understand the context. To begin with, the World Bank noted a significant improvement in the Indonesian domestic water sector. In 2018, it is recorded that 73% of households have access to decent water sources while in 1994 the percentage is only 34% [76]. However, this report also suggested that Indonesia's current achievement is the lowest compared to other countries in Southeast Asia such as the Philippines, Vietnam, Malaysia, and Thailand, which achieve more than 90% in the case of access to water. A big population unevenly distributed in thousands of islands might be the cause of this occurrence and the biggest challenge to deal with.

In the case of the regulatory reforms, regulations have been launched to organize domestic water provision system such as the Governmental Regulation Number 122/2015 [77], which is subsequently broken down into more technical guidance. Afterward, to accelerate the development of the domestic water sector, the Indonesian government has also set universal access (100%) as one of the priorities in the National Mid-Term Development Plan [78]. These two aforementioned legal documents can be viewed as the commitment of the Indonesian government to fulfill the citizens' domestic water needs. However, at the implementation level, these normative regulations face big challenges and to some extents are failed to be implemented. The World Bank noted that less coordination among governmental entities from various levels and sectors is the biggest constraint to achieve significant output in the development of the drinking water sector [76]. Therefore, increasing the efficiency of the current drinking water provision system is strongly suggested instead of expanding infrastructure development due to the big investment required. Besides, evidence shows a weak correlation between the amount of government expenditure and output achieved.

In the case of development programs and budget allocation, the government of Indonesia has also given big attention. To finance, the drinking water-related projects, several schemes are introduced. The projects can be funded by the national or local budget. Moreover, private sectors are also invited to participate in the water supply development projects [79], [80], although this approach has be criticized due to its low impact to low-income community. Besides the water service provided by government institutions or private companies, community-based domestic water provision is also promoted through the national program called PAMSIMAS to accelerate the development in rural areas [81]. Through this program, communities especially those who live in rural or remote areas are technically assisted and financially supported to have community-based communal drinking water and sanitation facilities. In short, the political will and financial support given by the government of Indonesia, combined with the abundant water resources, should be catalysts to accelerate the development of domestic water sector. Nevertheless, the ultimate goal of the universal access to water has not been achieve yet.

To reflect key factors gained from the systematic literature review to the context of Indonesia, we conducted the comparative analysis as is illustrated in table 7.4. The table summarizes the key factors identified from the systematic literature review then to be reflected to the current situation in Indonesia. Firstly, in the case of regulation or policy, Indonesian government has issued series of regulations in domestic water sector. To accelerate the development of the drinking water and sanitation provision, the Presidential Decree number 185 in 2014 [82] was launched. Through this regulation, the national government is mandated to establish the roadmap of the development acceleration in domestic water and sanitation sector. Meanwhile, the city government is obligated to establish the master plan for drinking water provision system as a derived product the national roadmap of development. The master plan can be consisted of the plan to build a new system or to revitalize the existing one. Furthermore, this regulation is followed by the technical guidance by launching the Governmental Regulation number 122 in 2015 about drinking water provision system [83].

Secondly, the political shifting in Indonesia in 1998 has transformed the paradigm in the development planning from the centralized to the decentralized system. This is actually in line with the key factors identified from the lesson-drawing process. The regulation also explicitly defines the role distribution of national and local government. Then, the shifting implicates to the development planning process. Besides, through the new system, public aspiration is better accommodated compared to the previous system. Thus, the decentralization in Indonesia also strengthens the community participation approach in the domestic water provision in Indonesia. The community is encouraged to engage in the domestic water provision, especially in the development planning process. Subsequently, the government accommodate the community proposal and build the proposed facilities. Nevertheless, the community has not been well assisted in the post-construction phase.

Therefore, many of the built facilities cannot be sustained since the community lacks ability to operate and maintain them.

Table 7.4. The comparative analysis to reflect the key factors to the context of Indonesia

Sectors to develop domestic water service	Findings in the literature review	The existing condition in Indonesia
Institutional and regulatory reforms	- Establishing regulations or policies to ensure universal access to water.	- The establishment the presidential regulation number 185/2014, the government regulation number 122/2015, and the National Mid-Term Development Plan to accelerate the development of drinking water and sanitation sector
	- Shifting from centralized to decentralized system.	- Indonesia underwent the political shifting in 1998 resulted in the introduction of decentralized system
	- Reforming governing institution to be more efficient	- Overlapping and inefficient institutions is still a big problem to be handled
Multi stakeholder's participation	- Collaborating various parties e.g., private sectors, NGO, community, etc.	- In some big cities (e.g., Jakarta and Batam) private company are involved in the domestic water service provision. - Community-based water provision programs have been initiated and are still conducted
Technical measures	- Integrating pipeline-based water service with other types of water provision such as communal well, rainwater system, desalination, etc.	- There has not been a formal legislation to regulate the integration between pipeline-based water service and other type of domestic water provision.

Moreover, the regulatory reform also enables various parties such as private enterprises to involve in the development of the domestic water sector. The cooperation can be done by giving concession to the private company to serve a certain area or establishing partnership to deliver the service. Regarding this issue, the private companies are usually attracted to the areas that offer bigger economic benefits and less technical constraints. On the other hand, the areas such as remote rural areas or islands are usually beyond the company's preference so that the community involvement is needed. Up to this point, integration between various types of domestic water provision should be gained but these various measures are still treated as standalone alternative that has not been integrated.

7.3.3. Taking Insights for the Proposed Alternatives in Kota Metro

Proposed alternatives to accelerate the development of the domestic water sector in Kota Metro discussed in chapter six provide suggested composition of pipeline-based and communal-based water service. To reflect this issue with the systematic literature review in this chapter, the multi-measures provision system is also one of the identified key factors to suffice the community's water needs under financial and technical constraints. Moreover, the analysis to formulate the alternatives was conducted on the basis of the financial aspect and targeted achievement. Meanwhile, other aspects such as supporting regulations and institutional arrangement have not been widely elaborated. Besides, the issue on how the proposed alternatives is delivered is also important aspect to be explored. Thus, these topics can be more deeply studied to continue this research and findings in this chapter can be utilized as a starting point.

Regarding the issue of the supporting regulation, it has established at the national level. In the case of Kota Metro, the prioritization on the development of the domestic water sector is stated in its spatial planning [84]. The planning targets 90% of service coverage in the drinking water sector. The service can be provided by pipeline-based or non-pipeline-based water service. The non-pipeline-based water provision is prioritized for the northern and the southern part of the city, where the pipe network has not been established. Moreover, the water leakage from the pipeline-based water provision is also targeted below 20%. This scenario is in line with the proposed alternatives and some literatures suggested the similar issues. Nevertheless, this city regulation has not been followed up by more detail plan.

Moreover, in the case of organizational arrangement, reviewed literatures suggest efficient institution to manage the domestic water provision. Currently, the organization who is responsible in the domestic water provision in Kota Metro is directly attached to the city governmental structure. Even though this organizational scheme is considered as a simple structure, this type of organization has a drawback due to its inefficient bureaucracy especially in the decision-making process and budget allocation. In this type of organization arrangement, the decision-making process can take longer time because the process should involve the local parliament. Frequently, the discussion is tough due to different political interests among involving parties. Furthermore, budget allocation is also a complex issue to deal with due to competing interests with other sectors. Also, this type of organizational scheme is unable to invite private investment due to financial responsibility issue. In Indonesian administration system, the private sector cannot finance the government institution and vice versa. It can be done if the water service provider is excluded from the city governmental structure, so the partnership is formulated under the business-to-business framework. Besides, the cooperation between the government institution and the private sectors can be done by giving a concession to the private company to provide water service for a designated area. Thus, organizational rearrangement should be conducted to establish efficient service, especially through pipeline-based water service.

In the case of community participation, the initiative has been taken although the delivery has not been perfect yet. The community is encouraged to actively participate in the development planning process while the city government support the construction cost. Nevertheless, the post-construction phase is still overlooked. In this phase, the community's capacity is not enhanced by supporting program enabling to increase their ability to operate and maintain the facility. Besides, the organizational arrangement to manage the built facilities is still vague. Therefore, the built facilities are often not functioning optimally. The successful community participation approaches are usually equipped with supporting programs such as capacity building, training programs, subsidy, etc. Hence, the collaboration between governmental organizations and community is supposed to be continued in post-construction phase.

7.4. Conclusions

This chapter explores various implemented strategies to develop the domestic water sector from various places. The case selection is conducted on the basis of economic and climatic criteria, which is designated to be appropriate with Indonesia. The GDP is used as a criterion to represent the economic situation while the climate classification is used to identify the geographical characteristic of the selected countries. This selection procedure resulted in eight countries to be learned. They are India, Brazil, the Philippines, South Africa, Colombia, Sri Lanka, Ecuador, and Maldives. Then, determinant factors to succeed the implemented strategies in the selected countries are elaborated by exploring published materials discussing the development of the domestic water sector in the selected countries.

In general, the success of the implemented strategies is determined by three aspects. They are institutional and regulatory reforms, multi-stakeholder participation, and combining various technical measures to provide domestic water supply. Most cases show inefficient institutions governing domestic water sector implicates on inefficient service. Therefore, institutional reforms that formulate efficient organizations within a clear job description is required in the initial phase of the domestic water provision under the good water governance. Subsequently, the institutional reforms should be complemented by legal framework ensuring the ultimate goal of the universal access to water can be gained through reasonable cost and desirable timeline. Moreover, the domestic water sector should be managed within a proper scale (i.e., economic of scale, geographical of scale, etc.). To deal with this issue, some selected cases altered the centralized system into decentralized system to deliver a better service. In the case of Indonesia, regulatory reforms have been conducted by issuing series of legislations to regulate the domestic water provision. Besides, the political change also implicates on the paradigm-shifting in the development planning process from centralized to decentralized approach. Essentially, it has been in line with key factors to succeed improvement strategies in developing reliable domestic water provision. Nevertheless, technical constraints (e.g., geographical characteristics, population distribution, limited budget etc.) are major obstacles to gain optimum outputs besides the appearance of inefficient organizations in Indonesian domestic water sector.

Moreover, the multi-stakeholder's participation is another identified determinant factor in the development of the domestic water sectors from the selected countries. Various parties such as private sectors, communities, NGOs, donor organizations, etc. play important roles to accelerate the development of domestic water sector as well as to overcome diverse problems in the development process. In Indonesian context, the multi-stakeholder participation approach is initiated and is also promising to be enhanced. Subsequently, this approach enables policy makers or planner to combine various measures i.e., pipeline-based, and non-pipelined-based water service to overcome existing technical problems. Similarly, proposed alternatives to accelerate the development of the domestic water provision in Kota Metro is also formulated under the framework to combine pipeline-based and communal-based water provision. Nevertheless, the suggested alternatives merely consider the aspects of the minimum initial cost and maximum reachable outputs. Meanwhile, other elements such as organizational arrangement and financial scheme to actualize the proposal have not been widely elaborated and can be set as topics for further research.

References

[1] K. Mossberger and H. Wolman, "Policy Transfer as a Form of Prospective Policy Evaluation: Challenges and Recommendations," *Public Adm. Rev.*, vol. 63, no. 4, pp. 428–440, 2003, doi: 10.1111/1540-6210.00306.

[2] O. James and M. Lodge, "The Limitations of 'Policy Transfer' and 'Lesson Drawing' for Public Policy Research," *Polit. Stud. Rev.*, vol. 1, no. 2, pp. 179–193, 2003, doi: 10.1111/1478-9299.t01-1-00003.

[3] D. Dolowitz and D. Marsh, "Who Learns What from Whom: A Review of the Policy Transfer Literature," *Polit. Stud.*, vol. 44, no. 2, pp. 343–357, 1996, doi: 10.1111/j.1467-9248.1996.tb00334.x.

[4] D. P. Dolowitz and D. Marsh, "Learning from Abroad: The Role of Policy Transfer in Contemporary Policy-Making," *Gov. An Int. J. Policy Adm.*, vol. 13, no. 1, pp. 5–24, 2000, doi: 10.1111/capa.12295.

[5] H. Pessali, "Public policy design in developing societies: Beyond transplantation," *J. Dev. Soc.*, vol. 27, no. 1, pp. 11–28, 2011, doi: 10.1177/0169796X1002700102.

[6] T. van Dijk, "Transplanting instruments that work: Four practical lessons on eliminating assumptions," *Plan. Theory Pract.*, vol. 7, no. 4, pp. 421–442, 2006, doi: https://doi.org/10.1080/14649350600984758.

[7] www.statisticstimes.com, “List of Countries by GDP (PPP) per capita,” 2020. http://statisticstimes.com/economy/countries-by-gdp-capita-ppp.php (accessed Jan. 12, 2021).

[8] The World Bank, “GDP per capita, PPP (current international $),” 2019. https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?end=2019&start=2019&type=shaded&view=map (accessed Jan. 12, 2021).

[9] H. E. Beck, N. E. Zimmermann, T. R. McVicar, N. Vergopolan, A. Berg, and E. F. Wood, “Present and future köppen-geiger climate classification maps at 1-km resolution,” *Sci. Data*, vol. 5, pp. 1–12, 2018, doi: 10.1038/sdata.2018.214.

[10] M. . Peel, B. I. Finlayson, and McMahon, “Updated world map of the Koppen-Geiger climate classification,” *Hydrol. Earth Syst. Sci.*, vol. 11, pp. 1633–1644, 2007, doi: 10.1002/ppp.421.

[11] Climate-data.org, “Climate Data for Cities Worldwide.” https://en.climate-data.org/ (accessed Jan. 14, 2012).

[12] UN WATER, “SDG 6 Data by country,” 2018. https://sdg6data.org/snapshots?country=#demo-wrapper (accessed Jan. 20, 2021).

[13] WHO; UNICEF, “Progress on Sanitation and Drinking Water: 2015 Update and MDG Assessment,” 2015. doi: 10.1007/s13398-014-0173-7.2.

[14] UN WATER, “Proportion of population using improved drinking water source 2017 (%),” 2020. https://sdg6data.org/tables (accessed Jan. 20, 2021).

[15] C. Tortajada, “Policy dimensions of development and financing of water infrastructure: The cases of China and India,” *Environ. Sci. Policy*, vol. 64, pp. 177–187, 2016, doi: 10.1016/j.envsci.2016.07.001.

[16] A. Roy and K. Pramanick, “Analysing progress of sustainable development goal 6 in India: Past, present, and future,” *J. Environ. Manage.*, vol. 232, no. June 2018, pp. 1049–1065, 2019, doi: 10.1016/j.jenvman.2018.11.060.

[17] B. Punjabi and C. A. Johnson, “The politics of rural–urban water conflict in India: Untapping the power of institutional reform,” *World Dev.*, vol. 120, pp. 182–192, 2019, doi: 10.1016/j.worlddev.2018.03.021.

[18] P. Sharma, “Opportunities and struggles of decentralized governance reform for urban municipalities in India,” *World Dev. Perspect.*, vol. 17, no. January, p. 100174, 2020, doi: 10.1016/j.wdp.2020.100174.

[19] A. Roy and K. Pramanick, “Analysing progress of sustainable development goal 6 in India: Past, present, and future,” *J. Environ. Manage.*, vol. 232, no. November 2018, pp. 1049–1065, 2019, doi: 10.1016/j.jenvman.2018.11.060.

[20] S. M. Sen and A. Kansal, “Achieving water security in rural Indian Himalayas: A participatory account of challenges and potential solutions,” *J. Environ. Manage.*, vol. 245, no. December 2018, pp. 398–408, 2019, doi: 10.1016/j.jenvman.2019.05.132.

[21] L. S. Prokopy, “The relationship between participation and project outcomes: Evidence from rural water supply projects in India,” *World Dev.*, vol. 33, no. 11, pp. 1801–1819, 2005, doi: 10.1016/j.worlddev.2005.07.002.

[22] P. Priyadarshini and P. C. Abhilash, “Promoting tribal communities and indigenous knowledge as potential solutions for the sustainable development of India,” *Environ. Dev.*, vol. 32, no. September, p. 100459, 2019, doi: 10.1016/j.envdev.2019.100459.

[23] R. Das, B. Laishram, and M. Jawed, “Public participation in urban water supply projects – The case of South-West Guwahati, India,” *Water Res.*, vol. 165, p. 114989, 2019, doi: 10.1016/j.watres.2019.114989.

[24] F. Fabbro Neto and M. B. Gómez-Martín, “Water safety plan integrated to the land use and occupation measures: Proposals for Caraguatatuba-SP, Brazil,” *Land use policy*, vol. 97, no. May, p. 104732, 2020, doi: 10.1016/j.landusepol.2020.104732.

[25] K. de Mello *et al.*, “Multiscale land use impacts on water quality: Assessment, planning, and future perspectives in Brazil,” *J. Environ. Manage.*, vol. 270, no. March, p. 110879, 2020, doi: 10.1016/j.jenvman.2020.110879.

[26] L. Caiado Couto, L. C. Campos, W. da Fonseca-Zang, J. Zang, and R. Bleischwitz, “Water, waste, energy and food nexus in Brazil: Identifying a resource interlinkage research agenda through a systematic review,” *Renew. Sustain. Energy Rev.*, vol. 138, no. October 2019, p. 110554, 2021, doi: 10.1016/j.rser.2020.110554.

[27] A. A. R. Ioris, “Socioecological economics of water development in the Brazilian Amazon: Elements for a critical reflection,” *Ecol. Econ.*, vol. 173, no. February, 2020, doi: 10.1016/j.ecolecon.2020.106654.

[28] V. L. Empinotti, J. Budds, and M. Aversa, “Governance and water security: The role of the water institutional framework in the 2013–15 water crisis in São Paulo, Brazil,” *Geoforum*, vol. 98, no. December 2017, pp. 46–54, 2019, doi: 10.1016/j.geoforum.2018.09.022.

[29] M. Fehr, A. F. N. Pereira, and A. K. A. Barbosa, “Supporting waste and water management with proactive legal instruments,” *Resour. Conserv. Recycl.*, vol. 54, no. 1, pp. 21–27, 2009, doi: 10.1016/j.resconrec.2009.06.005.

[30] J. A. Barde, “What Determines Access to Piped Water in Rural Areas? Evidence from Small-Scale Supply Systems in Rural Brazil,” *World Dev.*, vol. 95, pp. 88–110, 2017, doi: 10.1016/j.worlddev.2017.02.012.

[31] G. L. Kayser, U. Amjad, F. Dalcanale, J. Bartram, and M. E. Bentley, “Drinking water quality governance : A comparative case study of Brazil, Ecuador, and Malawi,” *Environ. Sci. Policy*, vol. 48, pp. 186–195, 2015, doi: 10.1016/j.envsci.2014.12.019.

[32] A. V. M. Machado, J. A. N. dos Santos, N. da S. Quindeler, and L. M. C. Alves, “Critical factors for the success of rural water supply services in Brazil,” *Water (Switzerland)*, vol. 11, no. 10, pp. 1–14, 2019, doi: 10.3390/w11102180.

[33] A. C. Rola, J. M. Pulhin, G. Q. Tabios, J. C. Lizada, and M. H. F. Dayo, “Challenges of water governance in the Philippines,” *Philipp. J. Sci.*, vol. 144, no. 2, pp. 197–208, 2015.

[34] D. Israel, “Local Service Delivery of Potable Water in the Philippines: National Review and Case Analysis,” 2009.

[35] Asian Development Bank, *Water Supply and Sector Assesment, Strategy, and Road Map*. 2012.

[36] M. Bonifacio and M. L. Chong, “Philippine experience in introducing and scaling up water

safety plans," *Waterlines*, vol. 30, no. 3, pp. 203–211, 2011, doi: 10.3362/1756-3488.2011.023.

[37] A. D. Porciuncula, "Creative financing solution for water supply and sanitation in the Philippines," *Ocean Coast. Manag.*, vol. 52, no. 7, pp. 374–377, 2009, doi: 10.1016/j.ocecoaman.2009.04.003.

[38] T. U. Ganiron Jr, "Performance of Community Water Supply Management towards Designing Water Safety Plan," *World News Nat. Sci.*, vol. 10, no. 6234, pp. 10–25, 2017.

[39] L. R. Mason, "Examining relationships between household resources and water security in an urban Philippine community," *J. Soc. Social Work Res.*, vol. 5, no. 4, pp. 489–512, 2014, doi: 10.1086/678923.

[40] H. Muller, "The South African Experience on Legal, Institutional and Operational Aspects of the Rights to Water and Sanitation," *Aquat. Procedia*, vol. 2, pp. 35–41, 2014, doi: 10.1016/j.aqpro.2014.07.006.

[41] M. Nastar and V. Ramasar, "Transition in south african water governance: Insights from a perspective on power," *Environ. Innov. Soc. Transitions*, vol. 4, pp. 7–24, 2012, doi: 10.1016/j.eist.2012.05.001.

[42] B. Maphela and F. Cloete, "Johannesburg's implementation of the National Water Act, 1998 in Soweto, South Africa," *Dev. South. Afr.*, vol. 37, no. 4, pp. 535–552, 2020, doi: 10.1080/0376835X.2019.1647834.

[43] K. Hodgson and L. Manus, "A drinking water quality framework for South Africa," *Water SA*, vol. 32, pp. 673–678, 2006, doi: 10.4314/wsa.v32i5.47853.

[44] M. Goldblatt, "Making the cup run over - The challenge of urban water supply for South Africa's Reconstruction and Development Programme," *GeoJournal*, vol. 39, no. 1, pp. 21–26, 1996, doi: 10.1007/BF00174924.

[45] B. E. Akinyemi, A. Mushunje, and A. E. Fashogbon, "Factors explaining household payment for potable water in South Africa," *Cogent Soc. Sci.*, vol. 4, no. 1, pp. 1–16, 2018, doi: 10.1080/23311886.2018.1464379.

[46] J. N. Edokpayi, A. M. Enitan-Folami, A. O. Adeeyo, O. S. Durowoju, A. O. Jegede, and J. O. Odiyo, *Recent trends and national policies for water provision and wastewater treatment in South Africa*. Elsevier Inc., 2020.

[47] P. Mukheibir and D. Sparks, "Water resource management and climate change in South Africa: Visions, driving factors and sustainable development indicators," Cape Town, 2003.

[48] N. Nleya, "Development policy and water services in South Africa: An urban poverty perspective," *Dev. South. Afr.*, vol. 25, no. 3, pp. 269–281, 2008, doi: 10.1080/03768350802212048.

[49] K. W. Scheihing, J. Tanner, M. Weaver, and M. Schöniger, "A strategy to enhance management of free basic water via communal taps in South Africa," *Util. Policy*, vol. 64, 2020, doi: 10.1016/j.jup.2020.101043.

[50] J. marc Mwenge Kahinda, A. E. Taigbenu, and J. R. Boroto, "Domestic rainwater harvesting to improve water supply in rural South Africa," *Phys. Chem. Earth*, vol. 32, no. 2007, pp. 1050–1057, 2007, doi: 10.1016/j.pce.2007.07.007.

[51] Water and Sanitation Program, "Private Sector Provision of Water and Sanitation Services in Rural Areas and Small Towns : The Role of the Public Sector Country Report : Colombia," 2016.

[52] C. Granados and F. Sánchez, "Water Reforms, Decentralization and Child Mortality in Colombia, 1990-2005," *World Dev.*, vol. 53, pp. 68–79, 2014, doi: 10.1016/j.worlddev.2013.01.007.

[53] F. Li, W. Wang, and L. H. G. Ramírez, "The determinants of two-dimensional service quality in the drinking water sector - Evidence from Colombia," *Water Policy*, vol. 18, no. 4, pp. 983–997, 2016, doi: 10.2166/wp.2016.123.

[54] D. Roca-Servat and M. Botero-Mesa, "Water Rights and Everyday Ch ' ixi Practices in the," *Water*, vol. 11, no. 10, pp. 1–20, 2019.

[55] J. D. G. Ruiz, C. A. Arboleda, and S. Botero, "A Proposal for Green Financing as a Mechanism to Increase Private Participation in Sustainable Water Infrastructure Systems: The Colombian Case," *Procedia Eng.*, vol. 145, pp. 180–187, 2016, doi: 10.1016/j.proeng.2016.04.058.

[56] I. Domínguez Rivera, E. R. Oviedo-Ocaña, and I. Restrepo-Tarquino, "Service provision in Rural Water Supplies: Analysis of Four Community-Based Sustem in Colombia," *Cuad. Desarro. Rural*, vol. 13, no. 77, pp. 117–140, 2016, doi: 10.11144/Javeriana.cdr13-77.sprw.

[57] R. A. Alarcón, J. P. Rodríguez, and H. W. Kua, "Voluntary management of residential water demand in low and middle-low income homes: A pilot study of Soacha (Colombia)," *Water (Switzerland)*, vol. 11, no. 2, pp. 1–16, 2019, doi: 10.3390/w11020216.

[58] S. S. K. Chandrasekara *et al.*, "A review on water governance in Sri Lanka: the lessons learnt for future water policy formulation," *Water Policy*, pp. 1–19, 2021, doi: 10.2166/wp.2021.152.

[59] M. D. P. Aluthge, "Pursuing a better national water policy endowed with substantial rights on water: Case study of Sri Lanka," in *11th International Research Conference 2018*, 2018, pp. 55–60.

[60] M. Samad, "Water institutional reforms in Sri Lanka," *Water Policy*, vol. 7, no. 1, pp. 125–140, 2005, doi: 10.2166/wp.2005.0004.

[61] M. Fan, "Sri Lanka's water supply and sanitation sector: Achievements and a way forward," Mandaluyong, Philippines, 2015. [Online]. Available: www.adb.org.

[62] D. J. Bandaragoda, "Limits to donor-driven water sector reforms: Insight and evidence from Pakistan and Sri Lanka," *Water Policy*, vol. 8, no. 1, pp. 51–67, 2006, doi: 10.2166/wp.2005.026.

[63] S. S. Sivakumar and D. Daluwatte, "Community Based Organizations of Water Users and Factors Contributing for Functionality and Sustainability in Sri Lanka," *Glob. Scintific J.*, vol. 6, no. 11, pp. 352–357, 2018.

[64] www.worldbank.org, "Partnership for Progress: Working with Communities in Sri Lanka to Provide Water and Sanitation," 2020. https://www.worldbank.org/en/news/feature/2020/07/13/partnerships-for-progress-working-with-communities-in-sri-lanka-to-provide-water-and-sanitation (accessed Jan. 25, 2021).

[65] S. Aladuwaka and J. Momsen, "Sustainable development, water resources management and

women's empowerment: The Wanaraniya water project in Sri Lanka," *Gend. Dev.*, vol. 18, no. 1, pp. 43–58, 2010, doi: 10.1080/13552071003600026.

[66] N. Fernández and R. Buitrón Cisneros, "The right to water and sanitation in Ecuador: Progress, limitations, and challenges," *Environ. Justice*, vol. 5, no. 2, pp. 77–81, 2012, doi: 10.1089/env.2011.0021.

[67] L. Hinojosa, W. G. Villegas, and P. A. Muñoz, "Exploring water security and water demand determinants in rural areas. The case of canton Cotacachi in Ecuador," *Water Resour. Rural Dev.*, vol. 10, no. October 2016, pp. 22–32, 2017, doi: 10.1016/j.wrr.2018.09.001.

[68] R. Boelens, J. Hoogesteger, and M. Baud, "Water reform governmentality in Ecuador: Neoliberalism, centralization, and the restraining of polycentric authority and community rule-making," *Geoforum*, vol. 64, pp. 281–291, 2015, doi: 10.1016/j.geoforum.2013.07.005.

[69] P. E. Carrillo, O. Bellettini, and E. Coombs, "Stay Public or Go Private?: a Comparative Analysis of Water Services between Quito and Guayaquil," Washington, 2007. doi: 10.2139/ssrn.1815904.

[70] Ministry of Environment and Energy, "National Water and Sewerage Policy," Male', 2017.

[71] UN Water, "Maldives: Sanitation, drinking water, and hygiene status overview," Geneva, 2015.

[72] M. Ibrahim, M. Bari, and L. Miles, "Water resources management in Maldives with an emphasis on desalination," *Maldives Water Sanit.*, pp. 1–16, 2002, [Online]. Available: http://pacificwater.org/userfiles/file/Case Study B THEME 1 Maldives on Desalination.pdf.

[73] M. I. Jaleel, S. A. Ibrahim, A. Hussain, M. Mustafa, and A. Pathirana, "A screening approach for assessing groundwater quality for consumption in small Islands: Case study of 45 Inhabited Islands in the Maldives," *Water (Switzerland)*, vol. 12, no. 8, 2020, doi: 10.3390/w12082209.

[74] The United Nations Development Program, "Supporting of Vulnerable Communities in Maldives to Manage Climate Change-Induced Water Shortages," 2015. https://www.adaptation-undp.org/projects/supporting-vulnerable-communities-maldives-manage-climate-change-induced-water-shortages (accessed Apr. 19, 2021).

[75] Adaptation Fund Project, "Increasing Climate Resilience trough an Integrated Water Resource Programme in HA Ihavandhoo, Adh. Mahibadhoo and GDh. Gadhdhoo Island," *Project/Proggramme Proposal*, 2009. https://www.globalsupportprogramme.org/sites/default/files/downloads/approved_proposal_maldives.pdf (accessed Apr. 19, 2021).

[76] World Bank, "Indonesia Public Expenditure Review: Spending for Better Results," Jakarta, 2020.

[77] *Peraturan Pemerintah Republik Indonesia Nomor 122 Tahun 2015 tentang Sistem PenyediaanAir Minum (the Governmental Regulation Number 122 Year 2015 about Drinking Water Provision System)*. Indonesia, 2015.

[78] *Peraturan Presiden Republik Indonesia Nomor 18 Tahun 2020 Tentang Rencana Pembangunan Jangka Menengah Nasional 2020-2024 (Pesidential Regulation Number 18 Year 2020 about The national Mid-Term Development Plan 2020-2024)*. Indonesia, 2020.

[79] K. Bakker, "Trickle Down? Private sector participation and the pro-poor water supply debate

in Jakarta, Indonesia," *Geoforum*, vol. 38, no. 5, pp. 855–868, 2007, doi: 10.1016/j.geoforum.2005.11.011.

[80] A. Wibowo and S. Mohamed, "Risk criticality and allocation in privatised water supply projects in Indonesia," *Int. J. Proj. Manag.*, vol. 28, no. 5, pp. 504–513, 2010, doi: 10.1016/j.ijproman.2009.08.003.

[81] Kemenkeu, "PAMSIMAS Bantu Masyarakat Sediakan Air Bersih dan Sanitasi (PAMSIMAS helps communities providing drinking water and sanitation)," 2019. https://www.kemenkeu.go.id/publikasi/berita/pamsimas-bantu-masyarakat-sediakan-air-bersih-dan-sanitasi/ (accessed Jan. 12, 2021).

[82] Perpres 185/2014, *Peraturan Presiden Republik Indonesia Nomor 185 tahun 2014 Tentang Percepatan Penyediaan Air Minum dan Sanitasi (Indonesia Presidential Regulation Number 185 Year 2014 about Accelerating Drinking Water Provision and Sanitation)*. Indonesia, 2014.

[83] PP. No 122/2015, *Peraturan Pemerintah Nomor 122 Tahun 2015 tentang Sistem Penyediaan Air Minum (The Governmental Regulation Number 122 Year 2015 about Drinking Water Provision System)*. Indonesia, 2015.

[84] The Government of Kota Metro, *Peraturan Daerah Kota Metro Nomor 01 Tahun 2012 tentang Rencana Tata Ruang Wilayah Kota Metro 2011 - 2031 (City Regulation Number 01 Year 2012 about Kota Metro Spatial Planning 2011 - 2031)*. Indonesia, 2012.

Chapter 8
Conclusions and Recommendations

8.1. Conclusions

There are some notable remarks can be highlighted from this study. Firstly, our study on the current situation of the domestic water fulfillment in Kota Metro show that the individual groundwater abstraction. On the other hand, the local government attempts to provide public water service through the pipeline-based water service even though its development seems unable to equilibrate the increasing demand. Besides, impeding factors to accelerate the development of the public water service in Kota Metro are also identified in this study. From the service provider side, a big investment required to develop a reliable pipeline-based water service is the most challenging obstacle to be handled by a small city like Kota Metro and the burden is becoming heavier due to the organizational issue. The current organizational structure of the water service provider in Kota Metro, which is directly attached to the city governmental structure, is inefficient considering long bureaucracy and conflicting political interests at the local level. Also, this type of the organizational arrangement implicates on the way to view the domestic water service as a purely nonprofit oriented business so that the service provider is unable to set the water price that can cover all operational costs and profit margin. On the other side, from the community perspective, the absence of the regulation obliging the city residents to use only public water service make them have a choice to utilize another water source. Consequently, it influences their preferences in selecting preferable water source to fulfill their daily needs besides the fact that they are doubting the quality of the existing public water service.

Moreover, our investigation on the factors influencing the community preferences of the domestic water sources found that the decision to select a certain water source is attached to a certain reason. In general, five types of reasons are identified in Kota Metro. They are related to the issues of the water quantity, quality, affordability, accessibility, and alternative unavailability. Besides, the preferences are linked with the respondent's socioeconomic background and the existence of pipe network infrastructures. In more detail, the findings on these issues are discussed in the subsections below (subsection 8.1.4 and 8.1.5).

After grasping the current situation of the domestic water fulfillment in Kota Metro (from both service provider and user's perspectives), we formulated the strategies for improvement. Three scenarios are assessed based on the empirical evidence of the current situation and the desirable goal setting. The scenarios are implementing doing business as usual approach, fully pipeline-based water service, and combining pipeline-based and communal-based water provision. The results of the assessment on these development scenarios are discussed in subsection 8.1.6.

Furthermore, this research conducted lesson-drawing process by exploring implemented strategies from various places through a systematic literature review. This stage results in the identified factors determining the success of the implemented strategies. The first factor is related the improvement measures at the macro level such as institutional and regulatory reforms. Indeed, this belongs to the government demand and involves variables such as political will and financial capacity. The second factors that are frequently discussed in the reviewed literatures is the engagement of various parties such as communities, NGOs, private enterprises, donor organizations, etc. Furthermore, combining various measure is also a key factor to deal with technical obstacles. In short, the solution is supposed to be adjusted to the local context.

Eventually, the notable remarks found in the respective chapter are presented in the following subsections.

8.1.1. Conclusion of Chapter 1

This chapter starts with the elaboration on the current issue of domestic water fulfilment at global level. The exploration on the published literatures and data in this stage resulted in the empirical evidence that the existence of the water resources does not guarantee a country can fully suffices its citizens' needs. This is a trigger to grasp a deeper understanding regarding problems to develop a reliable domestic water provision. Furthermore, this global phenomenon is zoomed in at the national level. Indonesia is one of examples to represent countries that have abundant water resources, but those resources are not concurrently in line with the achievement in the access to safely managed water sources. Although the percentage of household having access to decent water source is quite high, the individual groundwater abstraction that dominates the composition of domestic water fulfilment is worrying from the perspective environmental degradation.

Moreover, the issue of the domestic water provision in Indonesia is zoomed in at the local level. Low level of public water service coverage and the high percentage of individual groundwater use is something in common that occurs in all cities. The problem is getting more severe in the small cities due to various constraints attached to them. Then, Kota Metro is selected to be the case study area of this research because this city has the lowest percentage in the coverage of the public water service provision compared to other small cities in Indonesia. Furthermore, the research questions are formulated to direct this study to the objectives. There are for aspects that are covered by the research questions. They are related to the current status of domestic water fulfillment in Kota Metro, factors influencing the people's preferences in utilizing preferable domestic water sources, possible alternatives that can be proposed for the improvement, and examples from implemented strategies from other places.

8.1.2. Conclusion of Chapter 2

This chapter elaborates literatures to encapsulate the research with relevant theoretical framework. In general, most literatures underline imbalance situation between increasing demand and limited water resources appears in almost all countries all over the world. Moreover, the situation is exacerbated by the government inability to provide a reliable water service. Then, many literatures state that people's preferences of the domestic water utilization are influenced by various factors that usually appear with the service quality given by the public water service provider. In general, the preferences are triggered by two factors, which are internal and external factors. The internal factors are related to the individuals' attached characteristics such as socioeconomic background, habits, values, beliefs, etc. On the other hand, the external factors include the existence of facilities to suffice individuals' needs as well as the rules to regulate the domestic water utilization. Subsequently, the survey is designed to validate the statements on the people's preferences through empirical evidence from the case study area.

Moreover, this chapter also explores the paradigm-shifting in the domestic water provision. The most notable finding in this part is the domestic water management has transformed from supply-side to demand-side management approach. Along with this transformation, public service delivery system also changes from centralized to decentralized system. Although the centralized system is considered to be effective, but many literatures argue that it is less efficient and unable to respond various dynamics and complexity that recently appear in the society. Hence, decentralized approaches are introduced to scale the complexity down as well as to respond the dynamics in the societies that different one to another.

Our theatrical exploration also get an insight from beyond water-related disciplines. In this regard, the circular economy concepts are inspiring this research due to the principles of responding increasing demand within limited resources. Afterward, the elaborated concepts are reflected to the context of Kota Metro and are utilized as the theoretical basis to develop the relevant methods for achieving the research objectives. In short, this chapter results in the theoretical basis to design the research methodology and to select relevant analytical tools.

8.1.3. Conclusion of Chapter 3

Methods conducted in this research are discussed in this chapter. They are mainly divided into three sections. The first section discusses the criteria to select the case study area. The size of the city (based on the official categorization in Indonesia) and the service coverage in the public water service are set as the criteria. Kota Metro in Lampung Province is chosen as the case study area because this city meets the criteria, which are small size and small percentage of the public water service coverage. Furthermore, the second section explain the stages in the data collection. There are two types of procedures to collect the data in this study, which is online and household survey. The online survey is the preliminary study aiming to grasp initial figure of domestic water utilization in the case study area. Meanwhile, the household survey is conducted to validate findings obtained from the preliminary study. Lastly, the third section explain the analytical tools and procedures performed to analyze the collected data. To analyze the respondent's preferences of domestic water utilization, the Correspondence Analysis is performed with the assistance of statistics software (SPSS version 23). Afterward, this chapter also discusses the statistical projection techniques and mathematical optimization modelling that are conducted to simulate proposed alternatives.

8.1.4. Conclusion of Chapter 4

The results of the preliminary study through the online survey are discussed in this chapter. There are several findings can be highlighted. First, this study indicates that the respondent's water source preference correlates to certain motives. Piped water was closely correlated with affordable price while dug well was correlated with easy access. Moreover, good quality and reliable quantity were correlated with bottled water and borehole well, respectively. Second, the assessment of the respondents' socioeconomic background shows that their educational background, income, and family size had a significant influence on the choice of water source while the respondent's occupation did not have a significant influence. Third, the establishment of a public water service in Kota Metro has been unable to trigger people to change the most popular choice of domestic water source, i.e., individual groundwater exploitation. The assessment to correlates the impact of the existing pipe network to the respondent's choice of domestic water sources results in a weak correlation even though they are positively correlated. To specify, the Pearson Correlation Analysis, which was demonstrated to the dataset, show the low value (0.139). Besides, the assessment on the user's satisfaction level also shows that the pipe water users have the widest range of satisfaction compared to the other types of domestic water source users.

8.1.5. Conclusion of Chapter 5

Findings gained in chapter 4 are compared and validated by the results of the household survey that is discussed in chapter 5. In this stage, we found that the easiness in accessing the water source is the most common reason expressed by the respondents who use private dug wells while the water quality is strongly considered by the private borehole users. Meanwhile, the expensive price of bottled water is the strongest reason why it is not preferable, but the respondents mostly consume bottled water as a supplementary water source because their main water source is not drinkable or for other practical reasons.

Furthermore, this research also found that the household's income gives the most significant contribution in determining the preference of domestic water use in Kota Metro. This factor is then followed by the family size and pipe network availability. These three elements can implicitly be interpreted as the respondents' scale of priority in their decision-making process. Similar to the results of the online survey, this study also found that the availability of the pipe network positively correlates to the respondent's choice of the domestic water source, but the correlation is weak (the Pearson

Correlation value is 0.103). Besides, the pipe water users shared the most dispersed opinions in expressing their satisfaction level.

In this chapter, we extend the discussion to the issue of water shortage encountered by the respondents in using their domestic water sources. We found that 99 out of 616 responses confessed that they ever experienced the water shortage in utilizing their main domestic water source. To deal with this occurrence, they undertook various strategies such as asking a favor from neighbors or relatives, accessing public facilities, or installing more water sources. Some respondents even did nothing to tackle this problem. Nevertheless, the water shortage experience has not been able to trigger the community to leave the individual groundwater abstraction because of several causes such as economic reasons or pipe network unavailability.

The next stage is compiling our findings and the current status of the domestic water utilization in Kota Metro to formulate an improvement proposal inspired by the circular economy concepts. We proposed a mixed-method, which consists of piped water service and community-based domestic water management considering constraints belonged to Kota Metro and potentials that can be utilized. The pipe water can be optimally utilized in the more densely populated area while the community-based water management can be applied in the area with less density. In more detail, scenario formulation to improve the current situation is discussed in the next chapter.

8.1.6. Conclusion of Chapter 6

This chapter provides three approaches to develop the situation of the domestic water fulfillment in Kota Metro. They are doing business as usual approach, fully pipeline-based approach, and combination between pipeline-based and communal groundwater well-based approach. In general, applying doing business as usual approach is the least costly compared to the others. However, it is suggested to spend the budget to revitalize the existing facilities and increase their efficiency rather than to expand the new pipe network. Subsequently, the fully pipeline-based water service is the ultimate ambition in developing domestic water sector in Kota Metro. The scenario is modified for 5-year and 10-year development plan considering the timeline of the political event in Kota Metro. The estimation shows that the fully pipeline-based water service might take around 32.70% to 36.96% of the city revenue annually under the 5-year development plan. On the other hand, the 10-year development plan annually requires 12.17% to 18.52% of the city revenue. Indeed, these are big proportions considering many sectors must be financed by the government of Kota Metro.

Furthermore, a mathematical optimization model is also explored in this chapter to demonstrate the possible scenarios to gain maximum results at minimum cost under the combination approach. The assessment was also conducted for the 5-year and 10-year development plan. The result shows that combining pipeline-based water service and communal groundwater well-based domestic water provision requires less initial cost than the fully pipeline-based approach under the same target setting.

For the 5-year development plan, the optimum proportion, which results in the minimum cost, is 164,659 pipe water users and 12,576 communal groundwater well users. It will cost USD 26,064,631 to accomplish the scenario. On the other hand, the optimization model for 10-year development plan suggests 173,611 pipe water users and 18,182 communal groundwater well users that totally requires USD 27,622,039 as the optimum value to fulfill the objective function. Thus, combining pipeline-based water service and communal-based water service can be taken as an alternative to provide a reliable domestic water provision with cheaper cost but tolerable groundwater exploitation.

8.1.7. Conclusion of Chapter 7

Various implemented strategies to develop the domestic water sector from various places are explored in this chapter. The cases selection is based economic and climatic criteria, which is designated to be appropriate with Indonesia. The GDP is used as a criterion to represent the economic situation while the climate classification is used to identify the geographical characteristic of the selected countries. This selection procedure resulted in eight countries to be learned. They are India, Brazil, the Philippines, South Africa, Colombia, Sri Lanka, Ecuador, and Maldives. Then, determinant factors to succeed the implemented strategies in the selected countries are elaborated by exploring published materials discussing the development of the domestic water sector in the selected countries.

To specify, the selected published materials are elaborated using content analysis with the assistance of computer software (NVivo version 12). This systematic literature review resulted in three aspects determining the success of the implemented strategies in the selected countries. They are institutional and regulatory reforms, multi-stakeholder participation, and combining various technical measures to provide domestic water supply. The institutional and regulatory reforms are mostly conducted by establishing more efficient organizations to deliver public water service as well as clear regulations as the legal basis. Moreover, the multi-stakeholder's participation is articulated by involving various parties such as private sectors, communities, NGOs, donor organizations, etc. in the integrated water management. Lastly, combining various measures is commonly conducted to overcome technical constraint and the problems of the economy of scale in the domestic water provision.

8.2. Recommendation for the Future Studies

This research has thoroughly conducted several stages to understand the issue of the domestic water provision in Indonesian small city namely Kota Metro in Lampung Province and to formulate alternatives to improve the current situation. Nevertheless, there are some recommendations to follow up this research findings with subsequent studies.

1. The aspects assessed to reveal the public preferences in this research are limited to the attributes attached to the respondents such as their socioeconomic background or personal experiences.

However, it has not covered the farther external elements such as regulations or policies to develop domestic water sectors. Hence, studies discussing these issues can be conducted to widen the spectrum of the public preference in the domestic water utilization.

2. This study needs to be followed with the research discussing more technical issues such as simulating the spatial distribution of pipeline-based and communal based water provision so that they are not overlapped. Besides, the impacts (e.g., social, or environmental impacts) of combining those two measures of the domestic water provision can also be assessed through the research under the topic of the spatial distribution.
3. The development scenarios formulated in this research is limited under the objectives of the minimum cost and the maximum achievement. Indeed, this is a valuable input in the stage of the development planning. It will be far more fruitful to expand the scope up to the stage of the implementation. Topics related to the organizational arrangement to manage mixed modes in the domestic water provision, for instance, can be taken as the next research. Not only that, the financial dimensions such as covering operational and maintenance cost for communal-based water provision is also interesting topic to be explored.