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Investigating Community Preferences in Fulfilling Domestic Water Needs to Improve Public Water Service Provision

A Case Study in Kota Metro, Lampung Province, Indonesia

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Abstract. *Public water service provision is a big challenge for local authorities in Indonesia. Not only does this sector currently require large investments, it also has multi-dimensional impacts on society, the economy, and the environment because of poor service performance. Kota Metro in Lampung province, Indonesia generally faces a similar problem in managing its public water sector. The latest data show that only about five percent of households utilize piped water for their domestic water usage, while others rely on individual water source exploitation. Low service coverage area and poor service performance are frequently blamed as causes of this unfavorable situation. However, few studies have discussed this issue from the perspective of the consumers in Kota Metro. This study specifically looked at the issue of the community's preferences related to their domestic water source and their motivation. We did an online survey among the residents of Kota Metro to get their opinion on this issue. First, we elaborated the respondents' spatial distribution and socioeconomic backgrounds by asking their address and income. This aimed to assess the respondents' accessibility to the existing piped water network and their financial ability to pay the water bill. Furthermore, we asked the respondents about water sources that they use daily and the reasons for using them. Correspondence analysis was used to assess the relationship between their choices and specific factors determining their decision. It is expected that the results of this study can broaden the perspective on drinking water issues by incorporating the consumer's point of view. Moreover, the result can also be used by the local authority of Kota Metro to improve its public water service.*

Keywords. *Community preference, correspondence analysis, domestic water use, Kota Metro.*

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Abstrak. *Penyediaan layanan air bersih menjadi tantangan besar yang harus ditangani oleh pemerintah daerah di Indonesia. Sektor ini tidak hanya membutuhkan investasi besar tetapi juga memiliki dampak multi-dimensional pada masyarakat, ekonomi, dan lingkungan yang disebabkan oleh kinerja layanan yang buruk. Kota Metro di Provinsi Lampung umumnya menghadapi masalah serupa dalam mengelola sektor air bersihnya. Data terakhir menunjukkan bahwa hanya sekitar lima persen rumah tangga yang menggunakan air pipa untuk penggunaan air domestik mereka, sementara yang lain bergantung pada eksploitasi sumber air individu. Wilayah cakupan layanan yang rendah dan kinerja layanan yang buruk sering disalahkan*

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sebagai penyebab kemajuan yang tidak menyenangkan ini. Makalah ini secara khusus membahas masalah preferensi masyarakat untuk sumber air domestik dan motif yang melekat padanya. Kami melakukan survei online kepada penduduk Kota Metro untuk memahami pendapat mereka tentang masalah ini. Awalnya, kami menguraikan distribusi spasial responden dan latar belakang sosial ekonomi dengan menanyakan alamat dan pendapatan mereka. Ini bertujuan untuk menilai aksesibilitas responden ke jaringan air pipa yang ada dan kemampuan keuangan mereka untuk membayar tagihan air. Selain itu, kami bertanya kepada responden tentang sumber air yang mereka gunakan sehari-hari dan alasan untuk menggunakannya. Analisis Korespondensi digunakan untuk menilai hubungan antara pilihan mereka dan faktor spesifik yang menentukan keputusan mereka. Singkatnya, hasil yang diharapkan dapat memperluas perspektif masalah air dari sudut pandang pelanggan. Tidak hanya itu, tetapi hasilnya juga dapat digunakan oleh Pemerintah Derah Kota Metro untuk meningkatkan layanan air bersihnya.

Kata kunci. *Preferensi masyarakat, analisis korespondensi, penggunaan air rumah tangga, Kota Metro.*

Introduction

Domestic water fulfillment is becoming a crucial issue globally. The United Nations have even explicitly targeted universal access to water by 2030 as one of the targets of their Sustainable Development Goals (SDGs), which is a continuation of the Millennium Development Goals (MDGs). To achieve these global goals, 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 popuation by 2019, and (2) increasing drinking water production capacity to 118.6 m^3/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 (WHO and UNICEF, 2015), while statistical data show that 72.99% of households in Indonesia already have access to drinking water (BPS, 2018).

Despite this positive trend, some problems appear when the data are broken down to see how people have access to their domestic water source. Water source utilization is still dominated by individual groundwater exploitation instead of public water service. This is actually alarming in view of water resource sustainability, considering the negative consequences of excessive groundwater exploitation (Gejl et al. 2019; Menció and Maspla 2010; Sayre and Taraz 2019). To be more specific, BPS (2018) recorded that only 10.29% of households 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 (Alihar, 2018). Furthermore, the absence of clear rules to regulate individual water source exploitation also plays an important role (Gusdini et al. 2017). 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

(Akhmouch and Correia, 2016; Leigh and Lee, 2019). This research, however, explored empirical facts in order to validate these conceptual models.

Furthermore, 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. We selected a small city as the case study considering the fact that most small cities in Indonesia face problems in improving their public water service due to financial and technological constraints, while developing a reliable water service requires large investments as well as advanced technological solutions. Thus, the main objective of this study was to reveal the consumers' preferences in fulfilling daily water needs and the motives behind their choices.

To gather the data, we distributed an online survey randomly to residents of Kota Metro and recorded all responses. Several steps were conducted in our study. First, socioeconomic indicators from the respondents were collected, i.e. education level, occupation, and income. Secondly, we collected information about the respondents' preferred water source for domestic use and their motivation. Subsequently, we also asked about the respondents' level of satisfaction with their current water source and whether there was a possibility that they would change it in the future. Furthermore, we analyzed the correlation between the repondents' preferences and their motivation using correspondence analysis. It is expected that the results of this study can be used by public drinking water providers in formulating improvement strategies.

Literature Review

Approaches in Domestic Water Provision

Reliable water supply is absolutely indispensible for every aspect of human life, ranging from an individual's health to national economic growth. Following this premise, 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, focused on increasing the efficiency of water supply in the production, transportation, and distribution stages (Dalhuisen et al., 2002). 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 (Tortajada 2016). Moreover, supply-side management is also dependent on climate, which is now becoming increasingly unpredictable (Romano and Akhmouch 2019).

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 (Lavee et al. 2013). This intervention can be done through various instruments, such as education campaigns, block tariffs, water reuse, and so forth (WMO, 2001). On top of that, clear guidance and firm regulations are required to ensure the methods are well applied.

Supply-side and demand-side management should not be seen as mutually exclusive. Both approaches can be integrated when their respective portions are properly designated. However,

Katz (2016) has shown that there is a negative correlation between supply- and demand-side management when they are concurrently applied.

The community's preference can be also viewed from shifting water consumption trends. In Indonesia, specifically, there has been a significant change in water consumption, which can be seen in the following graph.

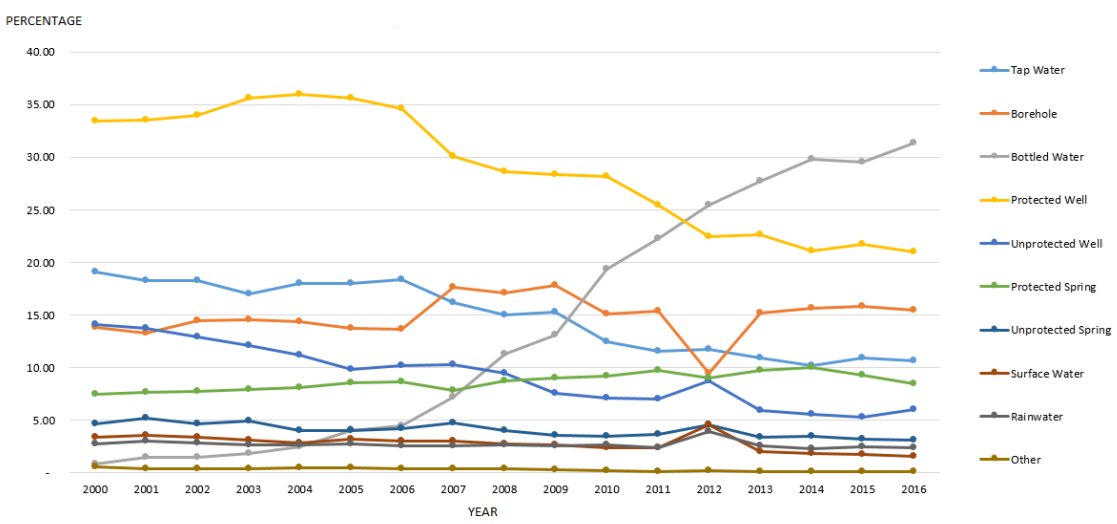

Figure 1. Percentage of households in Indonesia and their water sources (2000-2016). Source: compiled from BPS data

Figure 1 shows that a major change in the way people fulfill their daily water needs has occurred. During the recorded period, the percentage of tap water consumers tended to go down while the percentage of bottled water consumers kept going up. These two types of water service actually represent two different water providers, namely public water service and private enterprise. It is interesting to look closer at the factors causing this phenomenon. From the supply-side point of view, the public water service provider's inability to satisfy water demand can be pointed out as the main cause. On the other hand, a change in consumer preference can be a reason to explain this trend from the perspective of the demand-side management approach.

Moreover, the current approach of domestic water provision is inspired by the principles of sustainability considering various interests and stakeholders. Akhmouch and Correia (2019), for instance, emphasize the importance of various stakeholders' involvement through the 3P (places-peoples-policies) approach in water resource management. 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.

A method that is in line with the 3P concept has been proposed by Leigh and Lee (2019). 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.

Inspired by the 3P concept and the triangular model of urban water sustainability, this research tried to validate the suggested theoretical framework based on empirical facts. We considered that empirical evidence is an instrument that can be used to examine whether a certain concept is feasible. Besides, the two aforementioned models can be confirmed or criticized based on the findings of this research.

Factors Determining Community Preference

People develop their preference for a certain product or service because of various factors, which can come from internal or external triggers. Much research has been done to investigate the factors that influence people's preference related to drinking water. For instance, Abubakar (2016) 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 study was conducted in Nigeria. By using the chi-square and logistic regression methods, it was 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 (2019). 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 queueing. Although having similarity in the absence of piped water networks, household preferences in the Mekong Delta, Vietnam were strongly determined by season (Li, et al. 2016). This is plausible because they rely very much on rainwater to fulfill their water needs.

Furthermore, Li et al. (2019) 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.

In short, internal and external factors are two triggers that determine people's drinking water preference. In this study, 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.

Research Methodology

Several steps were taken to conduct this study. In the first stage, we collected secondary data officially provided 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 number, and the water

company's service coverage. We then conducted an online survey by randomly spreading online questionnaires using Google Forms. We sent the form to residents of Kota Metro through e-mail and social media and expected them to reply. We also considered the use of online media to gather the community's free opinion. Unlike in direct interviews, the respondents are then limited in their response by the provided questions and we could not expand on the questions to dig deeper into the respondents' opinions. However, the benefit of online surveys is that they are practically easy to conduct and respondents are psychologically free to express their opinion.

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 usually influences a person in determining his or her 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. Lastly, we asked the respondent's 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*.

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. Correspondence analysis was utilized to obtain the connection between the respondents' preferered 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. The same procedure was also used to analyze the relationship between the respondents' preferences and access to piped water.

Discussion

Brief Introduction of Kota Metro

Kota Metro is a small city in Lampung province located in the southern part of Sumatra island. The area of the city is only 68.74 km2, it consists of five subdistricts that are divided into 22 villages. Kota Metro is inhabited by 165,193 inhabitants concentrated mostly in the Metro Pusat and Metro Timur subdistricts. To provide more detail, the population number of each village, compiled from BPS (2018), is given in the following table.

Table 1. Population number of each village in Kota Metro (2018).

Subdistrict	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 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. The population density in these areas is more than 8,000 people per square kilometers while the least densely populated area is only inhabited by 759 people per square kilometers. Both situations form a big challenge for public water provision; the densely populated areas require a larger amount of supply while providing water service in the less densely populated areas is economically unbeneficial. This dilemma, combined with the absence of regulations to restrict individual groundwater exploitation, has led to the slow development of the domestic water sector. We compiled data from the local government-owned water company since 2003 and compared them with the number of households in the same period. The data are shown in Figure 2.

Figure 2 shows that there is a wide disparity between the number of piped water consumers and the number of households. We intentionally verified these two categories since the number of piped water consumers is counted on a household basis instead of the number of individuals. 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 in 2003 to recent years. Only 2,134 out of 42,298 households, which is equal to 5.05% of households, subscribe to a public water service provided by the local government-owned company. Many questions can be asked to find an explanation for this trend. One of the possible answers is the service provider's inability to respond to the rapid growth of the population. This could be an acceptable argument since the public water service sector in Kota Metro relies very much on the city government's budget. Meanwhile, the revenue from customers' payments is not sufficient to cover production and operational costs.

From the customer's point of view, preference and satisfaction are important factors that influence their decisions. This is reinforced by the absence of clear regulations restricting individual water source exploitation. This research particularly looked into customers' views on domestic water provision by identifying their preferences for daily water use.

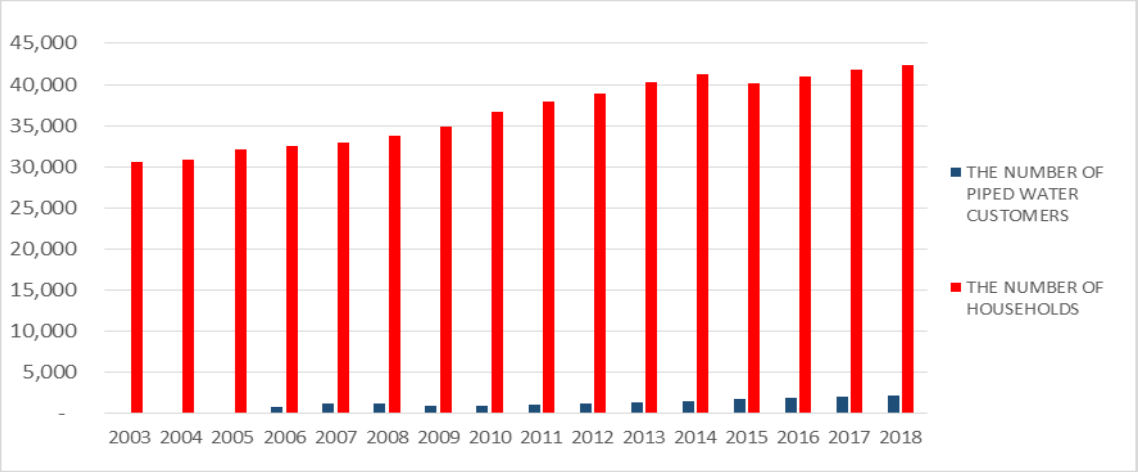

Figure 2. Comparison between the number of piped water customers and the number of households in Kota Metro (2003-2018).

Data Collection and Analysis

Our online questionnaire received 110 responses from residents of Kota Metro. Their discussion is divided into four parts, i.e. the respondents' spatial distribution, their preferences related to domestic water sources, their socioeconomic background, and their access to public piped water networks.

a. Respondents' Spatial Distribution

In the beginning stage of the online survey, we spread the questionnaire randomly and did not intentionally design the respondents' spatial distribution. We expected that the respondents might come from any region of Kota Metro. However, the collected data do not proportionally represent the population from each village. Table 2 summarizes the respondents' spatial distribution based on their response to the questionnaire.

The respondents' spatial distribution shown in Table 2 does not correctly represent the distribution of the population of each village in Table 1. Despite this, the online survey made it technically easier to reveal the respondents' opinions. Furthermore, the issue of the respondents' free opinion in this research is important to investigate the respondents' preferences.

We started our investigation by questioning the respondents' choice of domestic water source for daily use. The responses were clustered into four groups, i.e. Piped Water, Borehole Well, Dug Well, and Bottled Water. These types of water source met our expectations, where Piped Water represents the public water service, Borehole Well and Dug Well reflect individual groundwater exploitation, and Bottled Water represents water provided by private enterprises. The discussion of this issue is presented in the following part.

Table 2. Respondents' spatial distribution.

Subdistrict	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**

b. Respondents' Preferences for Domestic Water Use

We questioned the respondents about what kind of water source they use to fulfill their daily domestic water needs. Some respondents answered that they use more than one source. Therefore, we specify the respondents' water sources based on domestic activities, such as drinking, cooking, washing, house cleaning, and so forth. The following table shows the respondents' main water source categorized by their daily activities.

Table 3. Respondents' main water source categorized by daily activities.

Daily Activities	Domestic Water Source				Total Respondents
	Piped Water	Borehole Well	Dug Well	Bottled Water	
Drinking	3	27	45	35	110
Cooking	10	33	63	4	110
Shower	17	34	59	0	110
Washing	17	34	59	0	110
Toilet	17	35	57	0	110
Car washing	20	35	55	0	110
House cleaning	20	35	55	0	110
Gardening	20	35	55	0	110
Average	**15.50**	**33.75**	**55.88**	**4.88**	

These data show that a certain water source correlates with a specific use. This preference is caused by several factors. To elaborate this issue, we asked the respondents to express their strongest reason to choose a certain water source. The respondents were expected to choose the most influential factor in determining their preference. We provided answers representing the issues of water quantity, quality, price, accessibility, and choice limitation.

Table 4. Correspondence table of respondents' domestic water source and respective reasons.

Domestic Water Source	Respondent's reason					Active Margin
	Reliable Quantity	Good quality	Affordable Price	Easy Access	No Other Choice	
Piped Water	1	4	2	9	0	16
Borehole Well	11	14	1	10	7	43
Dug Well	12	20	7	24	1	64
Bottled Water	0	24	0	3	2	29
Active margin	**24**	**62**	**10**	**46**	**10**	**152**

Table 4 can be interpreted in both the horizontal and 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. Moreover, the respective cells show the intersection between the two categories and the correspondence between them. For example, twenty-four respondents replied that they prefer bottled water because of its good quality. By contrast, the smallest amount of respondents related the issue of quality to piped water. Related to the issue of quantity, most respondents used a borehole well or dug well. Meanwhile, neither piped water nor bottled water contributed significantly to the respondents' preference related to this issue.

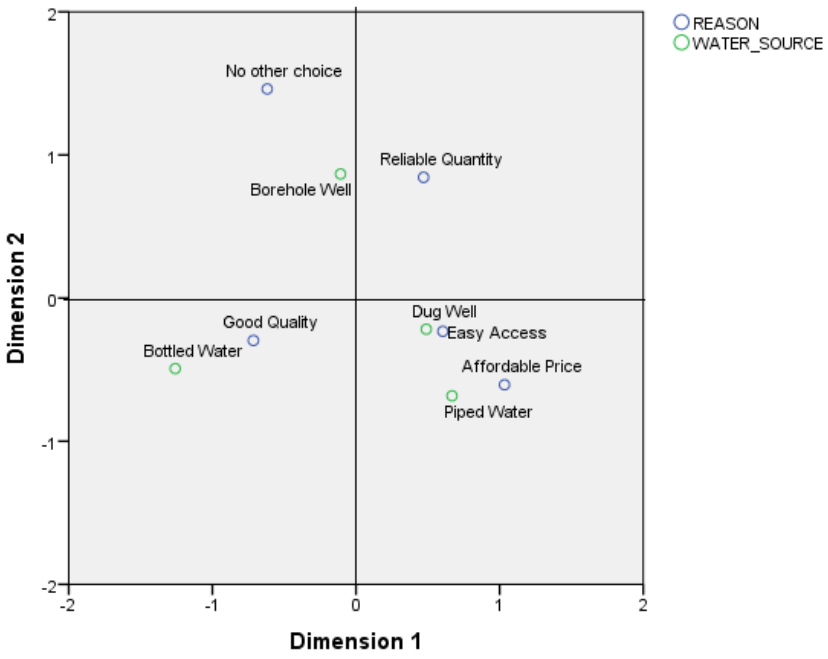

Figure 3. Scatter plot of the water source-reason correspondence analysis.

Furthermore, the strongest reason for the respective types of water source can be analyzed in the horizontal direction. Piped water, for instance, is used mostly because of its easy access. The same reason was stated by dug well users. This is understandable since people would only use piped water if a piped water network is available. On the other hand, the absence of clear regulations to restrict individual exploitation is probably one of the reasons that trigger people to use a dug well. The correlation between the respondents' preferences and their motivations is presented in Figure 3.

Figure 3 can be used to analyze the relationship between the examined categories. The two categories, which are the respondents' domestic water source preference and their motivation, are represented by green and blue circles in Figure 3. In general, a closer distance between two different color circles means a stronger relationship between them. For instance, the preference 'dug well' being located close to the reason 'easy access' means 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 3 also shows that the source borehole well and the reason no other choice are 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 assumed that these were closely related. This finding confirms the triangular model of urban water sustainability, which states that adequate infrastructure enables the provision of equitable access and cost.

c. Socioeconomic Background

After obtaining the factors that triggered the respondents' preferences, we continued by assessing whether the respondents' socioeconomic background significantly contributed to their preference. To obtain the socioeconomic profile of the respondents, we questioned them about their education level, current occupation, family size, and total monthly income. The respondents' educational background, occupation, and total income probably represent the social stratification that is common 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. 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 5 summarizes the information given by respondents through the questionnaire.

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. Figure 4 illustrate the distribution of the respondents' socioeconomic profiles.

Table 5. Respondents' socioeconomic profiles.

Socioeconomic profile	Frequency	Percentage (%)
Education		
Elementary school	2	1.8
Junior high school	1	0.9
Senior high school	13	11.8
Diploma	17	15.5
Bachelor	56	50.9
Master	17	15.5
Doctor	4	3.6
Total	**110**	**100.0**
Occupation		
Government employee	52	47.3
Private company employee	16	14.5
Entrepreneur	27	24.5
Others	15	13.6
Total	**110**	**100.0**
Family size		
1	4	3.6
2	6	5.5
3	26	23.6
4	32	29.1
5	24	21.8
6	14	12.7
7	3	2.7
8	1	0.9
Total	**110**	**100.0**
Total income in the household		
Less than Rp. 2,000,000,-	16	14.5
Rp. 2,000,001,- to Rp. 4,000,000,-	42	38.2
Rp. 4,000,001,- to Rp. 6,000,000,-	22	20.0
Rp. 6,000,001,- to Rp. 8,000,000,-	15	13.6
Rp. 8,000,001,- to Rp. 10,000,000,-	9	8.2
More than Rp. 10,000,001,-	6	5.5
Total	**110**	**100.0**

Figure 4 shows a graphical representation of the respondents' socioeconomic profile listed in Table 5. The number below the horizontal axis does not express certain values but represents items in the respective categories listed in Table 5. Meanwhile, the vertical axis consists of the frequency of the replies obtained from the respondents. All categories, except occupation, follow an ordinal sequence. The histogram of the three categories clearly shows that the distribution of the respondents' profiles is concentrated in the middle range while both the lowest and the highest range had the smallest percentage. In other words, the distribution of the respondents follows a normal distribution profile.

Furthermore, we conducted a correspondence analysis to show whether these socioeconomic indicators correspond to a certain choice of water source. Similar to the analysis of the respondents' preferences and motivation, the procedure was started by generating a correspondence table (see Tabel 6), followed by plotting a scatter plot graph (see Figure 5).

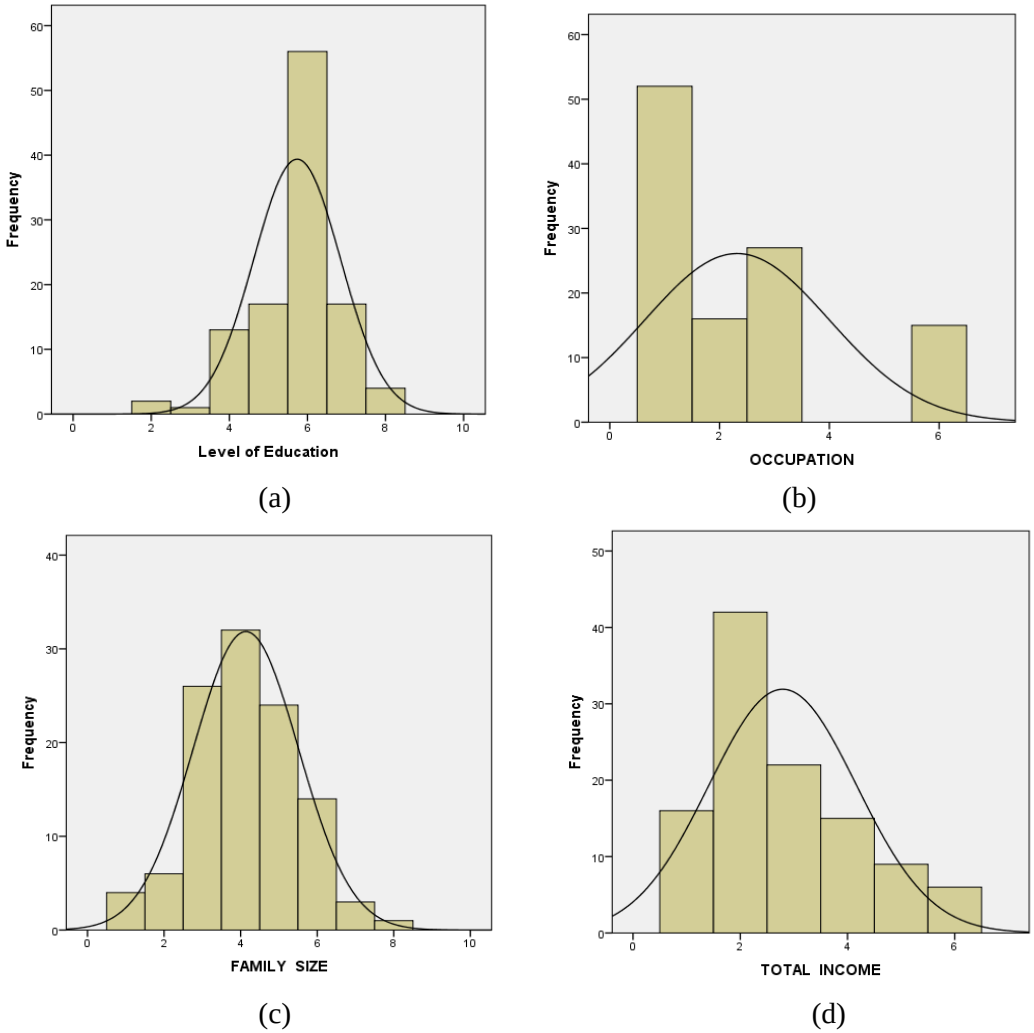

Figure 4. Histogram of respondents' socio-economic profiles.

It can be clearly 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. To illustrate this, the correspondence between the categories is presented in Figure 5.

Table 6. Correspondence table of 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 Rp. 2,000,000,-	1	6	5	2
Rp. 2,000,001,- to Rp. 4,000,000,-	5	10	22	10
Rp. 4,000,001,- to Rp. 6,000,000,-	3	11	17	6
Rp. 6,000,001,- to Rp. 8,000,000,-	2	8	11	4
Rp.8,000,001,- to Rp. 10,000,000,-	4	5	6	5
More than Rp. 10,000,001,-	1	3	3	2
Total	**16**	**43**	**64**	**29**

The correspondence between the categories can be interpreted by measuring the closeness between points. Figure 5(a) shows that the points flock together close to the origin, where the respondents with a senior high school, bachelor, or master background tended to use dug wells, bottled water, and borehole wells. By contrast, piped water had weak correspondence with any kind of 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. The same assumption was applied to the respondents' occupation. However, this assumption is not confirmed by the scatter plot.

Furthermore, a similar pattern also appeared in the category of family size, as illustrated in Figure 5(c). Figure 5(d) shows a similar tendency, but slightly different in terms of the respondents' domestic water source preference. In this category, piped water and dug well are closely correlated to respondents who have a middle income while bottled water is correlated to higher-income groups. A striking distinction occurs in the category of occupation, as can be seen in Figure 5(b). In this category, the dots are widely distributed, which means that there is no significant correlation between occupation and domestic water fulfillment preference.

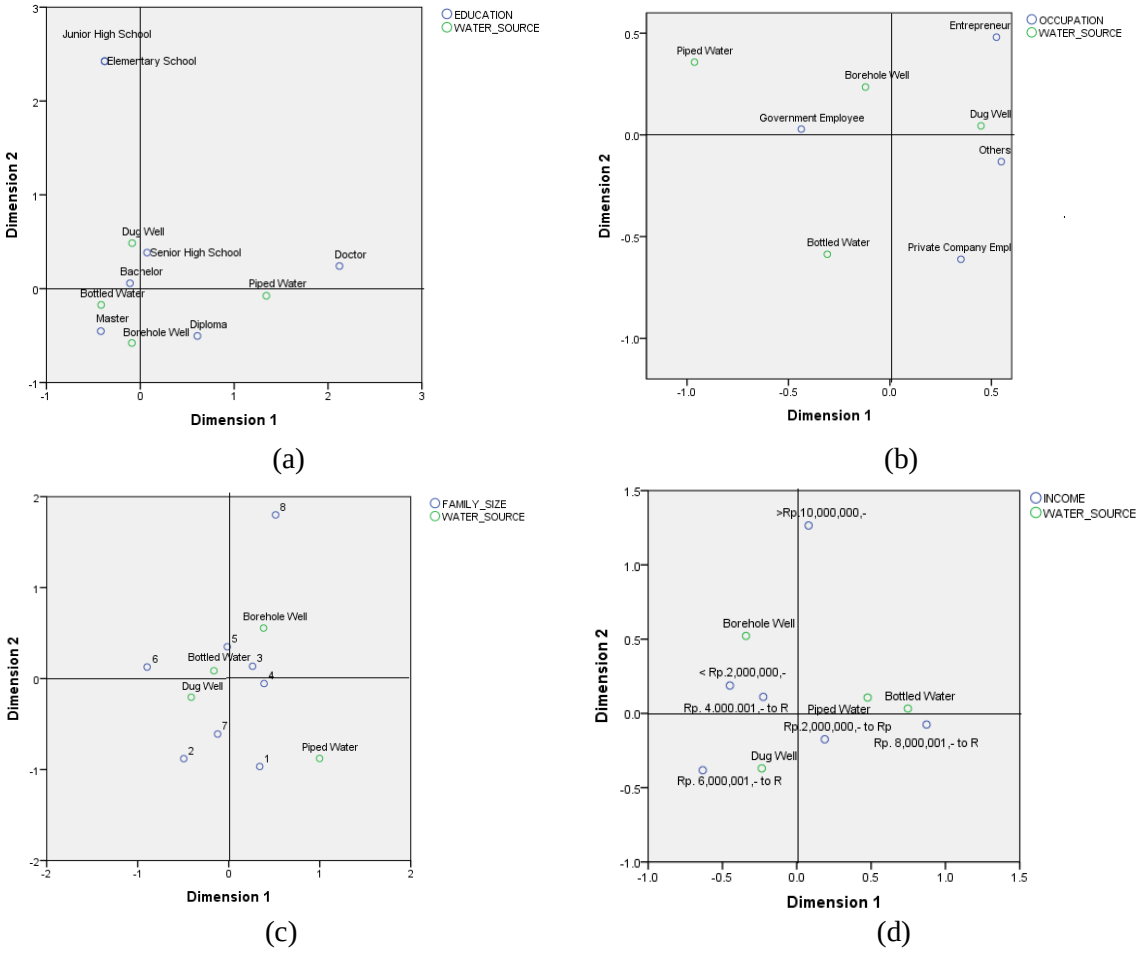

Figure 5. Scatter plot of the correspondence analysis of socioeconomic background versus water source preference.

d. Public Piped water 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 7. Correspondence table of the respondents' access to the public piped water network and their domestic water source.

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 7 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. 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 6.

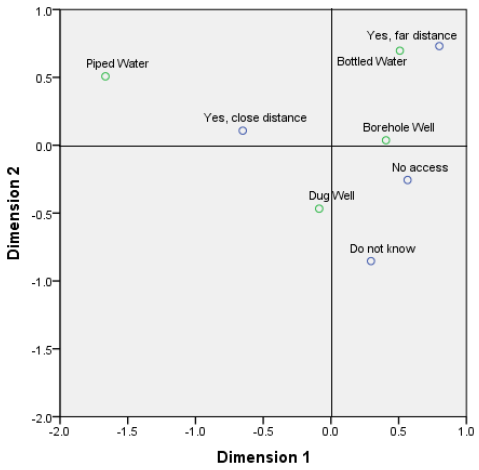

Figure 6. Scatter plot graph of the correspondence analysis of piped water accessibility versus water source preference.

The dot that represents piped water accessibility is supposed to be located close to piped water as the main water source. However, Figure 6 shows that these two dots are not located close to each other. This assumption is not fully correct. The preference 'piped water' is far removed from all options in the category of piped water accessibility. Statistically, this can be interpreted to mean that the preference 'piped water' was the least common reply. 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.

Considering the Community's Preference to Improve Public Water Provision

The development of public water provision in Kota Metro formerly is dominated by a rational, technical approach. This is obviously considered scientifically objective in spite of the huge investments and advanced technology required. The development of the domestic water sector has not been able to satisfy the increasing demand. Other modes of domestic water fulfillment are continuously used by the community in accordance with their respective motivations.

The findings of this study particularly show that a certain choice of water source is related to a specific reason. Thus, these findings can be used to improve the public water service. 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 taken into account 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. 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.

Conclusion

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. 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 availibility, 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 easily be read and interpreted without any specific expertise. Therefore, the findings are useful for local governments and usable for future public water service improvement.

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. This negatively impacts water supply efficiency and threatens water resource conservation.

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.

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