Do the existing pipe network and community satisfaction influence the preferences of domestic water fulfillment? Evidence from Kota Metro, Lampung Province, Indonesia

Sugiyono¹, Bart J. Dewancker²

¹Doctor Student, Graduate School of Environmental Engineering, The University of Kitakyushu, Kitakyushu, Japan.
²Professor, Department of Architecture, the University of Kitakyushu, Kitakyushu, Japan.

E-mail: akmalsugiyono@gmail.com

Abstract. The domestic water fulfillment becomes a crucial issue to be discussed considering limited water resources, continuously increasing demand, and multidimensional impacts of uncontrolled groundwater exploitation. Aside from efforts taken to accelerate the improvement of the domestic water sector, the traditional assumption claiming that pipe water network provision would lead people to shift their preference into public water service is seemingly questionable in Indonesia due to the absence of clear regulation restricting individual groundwater exploitation. This research aims to elaborate on whether the availability of piped water networks significantly influences people’s choice of their main domestic water source. We took Kota Metro, Lampung Province, Indonesia as a case study area considering the challenge of this city to improve its domestic water sector. We initially conducted a household survey to grasp a preliminary figure of people's preference patterns as well as their reason in choosing a certain domestic water source in the case study area. Subsequently, we analyzed the relation between the availability of pipe network in the respondent’s residence and the issue of public preference on the daily water fulfillment then correlated them with the satisfaction level on the utilized water source.

1. Introduction
Kota Metro faces a big challenge in providing basic needs such as public water service. To inform, the number of pipe water subscribes in this city in 2018 was 2,134, which is equivalent to 5.05% of the total households in the same period (BPS Kota Metro 2019). Indeed, this is not a pleasant fact from the perspective of public service development. The water service provider has to be struggling since the total expected revenue coming from the customers’ bill is far less than the cost expensed for production, distribution, and maintenance. Although the public water sector is economically unbeneﬁcial, the service is supposed to be continuously performed as it is mandated by the law (UU No 17 2019) and the inhabitants’ need should be fulﬁlled. Regarding domestic water fulﬁllment, it
was reported that 79.48% of the inhabitants of the Kota Metro have already had access to consumable water (BPS Kota Metro 2018). Considering this percentage and the data of the public water subscribers, it can be interpreted that the majority of the inhabitants exploited other water sources, which is mostly individual groundwater exploitation, instead of public water service.

Even though it is widely understood that exploiting groundwater individually brings negative impacts for both human and environment (Jia et al. 2019);(Bodrud-Doza et al. 2020), the inhabitants of Kota Metro seem to have no other choice to fulfill their daily needs of water except exploiting groundwater in their property. The poor performance of the public water service is often pointed as the main cause of this phenomenon. However, increasing company performance and a big investment is a dilemmatic problem that must be handled in water supply provision (Tortajada 2016). Besides, the sustainability issues are also strongly attached when water management issues are discussed in a broader context (Bell 2018).

Furthermore, the availability of the water-related infrastructure is not the only factor triggering people to access public water, but many elements involved (Armah et al. 2018);(Aleixo et al. 2019). Factors such as socioeconomic background, cultural tradition, and regulation contribute significantly to shape people’s opinions as well as preferences (Abubakar 2019);(Li, Araral, and Jeuland 2019). This research discussed whether this common phenomenon also appears in the case study area. To specify, this study aims to explore the community’s preference in Kota Metro for the domestic water source based on the availability of public water service. To achieve the objective, we conducted a household survey to validate prior secondary data exploration. We interviewed 599 respondents coming from 22 villages in Kota Metro through a field survey to collect information about the respondent’s current domestic water utilization and the reason for using it and confirmed the availability of the pipe network surrounding the respondent’s residence. Then, we asked the respondents about their level of satisfaction to the current domestic water source utilization to validate the reason of choosing a certain type of domestic water sources.

2. Method
First, we collected secondary data on the current achievement of the public water service provision in Kota Metro. The data is gathered from the government annual reports and other documents related to the public water provision. This stage aims to map the supply side of the public water service in this city. Regarding this issue, we compiled the historical data on the production capacity of the public water service. Afterward, we elaborated on the demand side of the domestic water utilization by collecting population data and analyzing the water demand to explore the current gap between supply and demand of the public water service in Kota Metro.

Moreover, we elaborated on community preferences of domestic water utilization through a field survey. To determine the sample size of the survey, we initially did a statistical calculation (www.surveysystem.com 2019) under these desired circumstances: confidence level at 95%, the margin of error at 4%, and the population proportion at 50%. Then, the formula was employed for the population of Kota Metro in 2018, which was 165,193 people (BPS Kota Metro 2019). The calculation resulted in 599 expected respondents that are later distributed proportionally based on the population proportion of the village respectively.

In dealing with the public water service issue, we asked respondents about the availability of the pipe network surrounding their residences. To recapitulate the respondent’s answers, we provided four options i.e. ‘yes, in the near distance’, ‘yes, in the far distance’, ‘not available’, and ‘do not know’. Indeed, this is not an exact measurement but merely the respondent’s opinion. Furthermore, we questioned respondents’ opinions about their satisfaction level on the quantity, quality, and price of the utilized water source. For the quantity and quality issues, we asked the respondent to express their opinion using a one-to-ten valuation scale (one is to express the respondent’s lowest satisfaction while ten is to show the highest satisfaction level). The same method is also applied in revealing the respondent’s opinion about the water price but with a different expression. To show the respondent’s opinion about water price, one is very cheap and ten is very expensive.
On the data analysis, we started the stage by comparing the existing public water provision and the projective water demand calculation to find the current gap between them. This could also be said as a starting point to explore the tendency of people’s reluctance to use public water service in Kota Metro. Afterward, we validated the trend with the empirical evidence attained from the field survey data. At this step, we explored the correlation between respondent’s decision on the domestic water source utilization and the availability of pipe network in surrounding respondent’s residence using the Pearson correlation method. At the end of the stage, we elaborated respondent’s satisfaction level under the categories of quantity, quality, and price of the currently consumed water using descriptive statistics to confirm the respondent’s motive in choosing the domestic water source.

3. Results

3.1. The Current Situation of the Public Water Service in Kota Metro
Kota Metro has established the public water service since 2006. In this period, the number of subscribers was only 801 households (2.46% of the total households) (BPS Kota Metro 2007). Furthermore, the annual statistical report of Kota Metro stated that in 2018 the number of the pipe water subscriber is 2,134 households out of 42,298 households (5.05%) (BPS Kota Metro 2019). Besides the small numbers of pipe water subscribers, the distribution of them and the availability of pipe networks have not also been satisfying.

Moreover, we analyzed the supply and demand side of the public water service in Kota Metro by comparing the historical data on the production capacity and the estimated water requirement. To estimate the amount of the water requirement, we referred to the standard issued by the National Standardization Board (BSN 2002), which is 100 Liters per person per day. We multiplied the population number with the minimum water requirement to estimate the water demand. Then, we compared the existing production capacity to the estimated water demands to calculate the percentage of fulfillment ratio as is illustrated in table 1.

| Year | Production capacity (m³/year) | Population | Estimated water demand (m³/year) | The percentage of production capacity to the estimated water demand (%) |
|------|-----------------------------|------------|---------------------------------|----------------------------------------------------------|
| 2008 | N/A                         | 134,162    | 4,896,913                       | N/A                                                      |
| 2009 | N/A                         | 142,988    | 5,219,062                       | N/A                                                      |
| 2010 | 476,586                     | 145,471    | 5,309,692                       | 8.98                                                     |
| 2011 | 539,393                     | 147,050    | 5,357,325                       | 10.05                                                    |
| 2012 | 633,244                     | 149,361    | 5,451,677                       | 11.62                                                    |
| 2013 | 500,713                     | 153,517    | 5,603,371                       | 8.94                                                     |
| 2014 | N/A                         | 155,992    | 5,693,708                       | N/A                                                      |
| 2015 | 553,643                     | 158,415    | 5,782,148                       | 9.58                                                     |
| 2016 | 895,206                     | 160,729    | 5,866,609                       | 15.26                                                   |
| 2017 | N/A                         | 162,976    | 5,948,624                       | N/A                                                      |
| 2018 | 972,135                     | 165,193    | 6,029,545                       | 16.12                                                    |

Apart from the data unavailability in some years, table 1 shows that the water production capacity in Kota Metro is fluctuating from 2008 to 2018 while the population number keeps increasing that implicates the water demand during this period. Furthermore, the maximum percentage that could be achieved by a public water provider is only 16.12% of the total estimated demand. Unsurprisingly, the residents of Kota Metro search other kinds of water resources i.e. groundwater and bottled water to fulfill their daily needs.
3.2. Assessing Public Preferences of Domestic Water Source

Our survey shows that domestic water utilization is mainly divided into five categories namely pipe water, public wells, private borehole, private dug well, and bottled water. We obtained 616 replies regarding domestic water utilization from 599 respondents because some respondents admitted that they use more than one kind of water source. The information related to the respondent’s domestic water source, access to the pipe network, and reasons is presented in Table 2.

Table 2. The summary of the household survey data

| Category                  | Respondent’s main domestic water source | Total |
|---------------------------|----------------------------------------|-------|
|                           | Pipe water    | Public well | Private borehole | Private dug well | Bottled water |       |
| Access to the pipe network| Yes, close distance | 15          | 0              | 59              | 140           | 5      | 219   |
|                           | Yes, far distance      | 1          | 0              | 19              | 55            | 1      | 75    |
|                           | No access              | 0          | 9              | 50              | 169           | 2      | 231   |
|                           | Do not know            | 0          | 1              | 23              | 67            | 0      | 91    |
| TOTAL                     |                         | 16         | 10             | 151             | 431           | 8      | 616   |
| Reason                    | Reliable quantity      | 3          | 0              | 28              | 7             | 0      | 38    |
|                           | Good quality           | 2          | 8              | 67              | 67            | 7      | 151   |
|                           | Affordable price       | 1          | 1              | 3               | 69            | 0      | 74    |
|                           | Easy access            | 7          | 0              | 45              | 217           | 0      | 269   |
|                           | No other choice        | 3          | 1              | 8               | 71            | 1      | 84    |
| TOTAL                     |                         | 16         | 10             | 151             | 431           | 8      | 616   |

Table 2 shows that the proportion of the respondent’s domestic water fulfillment is dominated by the utilization of private water sources such as dug wells and boreholes which are respectively 431 respondents (69.96%) and 151 respondents (24.51%). By contrast, the utilization of public water sources such as piped water and public well is far less significant. In elaborating the pipe water availability, 231 respondents answered that they have no access to piped water network surrounding their neighborhood. Unsurprisingly, the number of private dug well users is far more than the others (169 respondents). However, we also found that the existence of the piped water network could not encourage people to use public water service. Table 2 shows that 219 respondents answered that the pipe network is available surrounding their neighborhood but most of them still rely on the private dug well and borehole.

To reveal the respondent’s reasoning in choosing a domestic water source, we classified the answers into five categories, which are reliable quality, good quality, affordable price, easy access, and no other choice. To describe, reasons related to easiness in accessing the water source appears most frequently. 269 respondents have this motive to meet their daily needs and most of them exploiting individual water sources. It is understandable since exploiting groundwater individually has not been regulated. From this point of view, the respondents would consider that exploiting groundwater in their property does not violate the law. Further, the quality of the water consumed daily also takes a significant portion. The data shows that 151 respondents reveal their motive related to this issue, which is the second-largest consideration of the total answers.

For the further stage, we analyzed the correlation between the existence of the pipe network and the respondent’s choice on the daily water utilization using Pearson correlation with the assistance of computer software (SPSS version 23). The Pearson correlation is expressed by the interval from (-1) to (+1). The negative and positive sign shows the type of correlation and the score indicate how close the
correlation is (1 means perfectly correlated and 0 means not correlate). Furthermore, the sample size is categorized as statistically significant if the value of the significance is less than 0.05. To specify, the calculation of the household survey data shows that the Pearson correlation coefficient between pipe network availability and respondent’s choice of domestic water source is 0.103 and the significance of the sample is 0.011. It implies that the sample size is statistically significant (less than 0.05) and the two assessed factors have positive correlation but is not so strong (positive value but closer to 0 rather than to +1).

3.3. The domestic water preference and the satisfaction level.
After attaining the correlation between the pipe network availability and the respondent’s choice of domestic water utilization, we analyzed the level of respondent’s satisfaction level of the current utilized water source. We provided a one-to-ten interval for the respondents to express their satisfaction level on the three issues, which are quantity, quality, and price. For both quantity and quality issues, respondents gave one point to show their lowest level of satisfaction and ten-point if they are fully satisfied. Meanwhile, in the issues of the water price, the respondents gave one point if they felt the price to access the water is very cheap and ten points to show the opposite opinion. After gathering the respondent’s opinion on the issues, we summarized the data as is illustrated in the following table.

| Table 3. The respondent’s satisfaction level categorized by the domestic water source |
|-------------------------------------------------|--------|--------|--------|--------|--------|
| Category | Pipe water n=16 | Public well n=10 | Private borehole n=151 | Private dug well n=431 | Bottled water n=8 |
|---------|----------------|------------------|-----------------------|-----------------------|------------------|
| Quantity | Minimum | 6 | 8 | 7 | 7 | 7 |
| | Maximum | 10 | 10 | 10 | 10 | 10 |
| | Average | 7.81 | 9.10 | 8.50 | 8.02 | 7.88 |
| | Standard Deviation | 1.424 | 0.994 | 1.113 | 1.227 | 1.126 |
| Quality | Minimum | 3 | 8 | 5 | 7 | 7 |
| | Maximum | 10 | 8 | 10 | 10 | 10 |
| | Average | 6.88 | 8 | 8.51 | 7.90 | 7.75 |
| | Standard Deviation | 2.029 | n/a | 1.177 | 1.504 | 1.165 |
| Price | Minimum | 2 | 1 | 1 | 1 | 3 |
| | Maximum | 9 | 5 | 7 | 7 | 8 |
| | Average | 4.75 | 3.00 | 3.56 | 3.24 | 5.25 |
| | Standard Deviation | 1.195 | 1.333 | 1.979 | 2.202 | 1.669 |

Table 3 shows that pipe water has the widest range (the difference between the minimum and maximum value) among all types of domestic water sources in all assessed categories. It shows the pipe water users have the most diverse opinion even though their sample size is only sixteen respondents. By contrast, the public well users’ opinion has the most centralized tendencies. The standard deviation for the quality category could not even be calculated due to its perfect uniformity. Moreover, the respondents who use individual water sources have a higher level of satisfaction in the category of quantity and quality compared to pipe water users. Besides, the individual water source users also considered that their utilized water sources are cheaper than pipe water. These respondents’ opinions strengthen the reason not to choose public water service.
To wrap up, the inhabitants of Kota Metro have practiced individual groundwater exploitation for so long and been satisfied with the existing situation. The establishment of public water service has not been able to encourage them to move to this kind of domestic water use. This study shows that the low production capacity and limited pipe network could probably be one of the factors contributing to the current tendency besides the satisfaction of the existing water utilization. Indeed, many elements i.e. financial and technical issues, policies, regulations, and so forth can be explored for further research to explain the phenomenon more comprehensively. On top of that, this study can also be taken as an input to formulate improvement strategies for the public water sector in Kota Metro.

4. Conclusion
Some important findings can be highlighted in this study. First, the disparity between the existing production capacity and the estimated water demand in Kota Metro is quite high implicating insufficient water supply. Combined with the absence of strict regulations, this factor contributes to the respondent’s reluctance to neglect the current practice of individual groundwater exploitation and stimulate the tendency not to use public water service in this city. Second, this study shows that the pipe network availability in Kota Metro positively correlates with the respondent’s choice of domestic water utilization even though the Pearson correlation coefficient indicates a weak correlation. It also implies that the existing pipe network has not been able to encourage people in Kota Metro to use public water service as its main domestic water source. Third, the comparison among all respondents’ satisfaction levels indicates that the pipe water users have the widest range of satisfaction for all assessed categories. This dispersed tendency can be interpreted that the current service provided by the local government of Kota Metro has not fully matched with customer’s expectations. This premise can also be one of the reasons why people in this city tend to use other domestic water sources instead of pipe water.

References
Abubakar, Ismaila Rimi. 2019. “Factors Influencing Household Access to Drinking Water in Nigeria.” *Utilities Policy* 58: 40–51. https://doi.org/https://doi.org/10.1016/j.jup.2019.03.005.

Aleixo, Bernardo, João Luiz Pena, Lêo Heller, and Sonaly Rezende. 2019. “Infrastructure Is a Necessary but Insufficient Condition to Eliminate Inequalities in Access to Water: Research of a Rural Community Intervention in Northeast Brazil.” *Science of the Total Environment*. https://doi.org/10.1016/j.scitotenv.2018.10.202.

Armah, Frederick Ato, Bernard Eckumah, David Oscar Yawson, Justice O. Odoi, Abdul Rahaman Afiriri, and Florence Esi Nyieku. 2018. “Access to Improved Water and Sanitation in Sub-Saharan Africa in a Quarter Century.” *Heliyon* 4 (11). https://doi.org/10.1016/j.heliyon.2018.e00931.

Bell, Sarah. 2018. “Framing Urban Water Sustainability: Analysing Infrastructure Controversies in London.” In *Water Societies and Technologies from the Past and Present*, edited by Yijie Zhuang and Mark Altweel, 200–220. UCL Press.

Bodrud-Doza, Md, S.M. Didar-ul Islam, Tanjena Rume, Shamshad B. Quraishi, M. Safiur Rahman, and Mohammad Amir Hossain Bhuiyan. 2020. “Groundwater Quality and Human Health Risk Assessment for Safe and Sustainable Water Supply of Dhaka City Dwellers in Bangladesh.” *Groundwater for Sustainable Development* 10: 1–12. https://doi.org/https://doi.org/10.1016/j.gsd.2020.100374.

BPS Kota Metro. 2007. “Kota Metro Dalam Angka 2007 (Kota Metro in Figures 2007).” Kota Metro. ———. 2018. “Statistik Kesejahteraan Rakyat Kota Metro 2018 (Kota Metro Welfare Statistics 2018).” Kota Metro.

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

Jia, Xiyue, David O’Connor, Deyi Hou, Yuanling Jin, Guanghe Li, Chunmiao Zheng, Yong Sik Ok,
Daniel C.W. Tsang, and Jian Lua. 2019. “Groundwater Depletion and Contamination: Spatial Distribution of Groundwater Resources Sustainability in China.” *Science of the Total Environment* 672: 551–62. https://doi.org/10.1016/j.scitotenv.2019.03.457.

Li, Li, Eduardo Araral, and Marc Jeuland. 2019. “The Drivers of Household Drinking Water Choices in Singapore: Evidence from Multivariable Regression Analysis of Perceptions and Household Characteristics.” *Science of The Total Environment* 671: 1116–24. https://doi.org/10.1016/j.scitotenv.2019.03.351.

Tortajada, Cecilia. 2016. “Policy Dimensions of Development and Financing of Water Infrastructure: The Cases of China and India.” *Environmental Science and Policy* 64: 177–87. https://doi.org/10.1016/j.envsci.2016.07.001.

UU No 17. 2019. *Undang-Undang Nomor 17 Tahun 2019 Tentang Sumber Daya Air (Law Number 17 Year 2019 about Water Resources)*. Indonesia.

www.surveysystem.com. 2019. “Sample Size Calculator.” 2019. https://www.surveysystem.com/sscalc.htm.