Water meter for household customers with low water consumption in Perumda Surakarta

Diharto, RM B S K Putra
Civil Engineering Department, Faculty of Engineering, Universitas Negeri Semarang, Kampus UNNES Sekaran Gunungpati Semarang, Indonesia
diharto@mail.unnes.ac.id

Abstract. Perumda Surakarta is a company that serves the water needs of the people in Surakarta. In 2018, Perumda Surakarta had 58871 customers. Household customers with very low or unrecorded water usage were 7000. Very low water consumption is water usage of less than 3 m$^3$/month. Very low or unrecorded use of water has an impact on company revenues that decline. One of the causes of very low or unrecorded water use is abnormal water meter conditions. The aim is to determine whether water consumption is very low or not recorded. This research was carried out on the water meter condition for household customers in Perumda Surakarta. This research used a survey method with mWater application and data analysis using the SPSS application. The results showed that 5268 (75.26%) inhabited houses, while 1732 (24.74%) were not inhabited. 4766 (89.34%) inhabited houses have water meters, while those without water meters are 502 (9.53%). The inhabited houses that have normal water meters are 2504 (52.54%), while those with not normal water meters are 2262 (47.46%). The survey data also states that the inhabited houses with the water meter have a pipe leak before the water meter is 117 (2.45%) and that use a water source other than Perumda Surakarta is 3109 (65.23%).

1. Introduction
Perumda Surakarta is a company that serves water needs for people in Surakarta. In 2018, Perumda Surakarta had 58871 customers [1]. There are 7000 household customers whose water usage is very low or not recorded. Very low water consumption is water consumption of less than 3 m$^3$/month. Very low or undocumented water use has an impact on company revenues that decline. One of the causes of very low or unrecorded water usage is abnormal water meter conditions. Abnormal water meter conditions can be caused by dead, leaking, opaque, buried, illegible cubication numbers, construction bypasses. To determine whether water consumption is very low or not recorded, research or survey was conducted on a water meter condition for household customers at Perumda Surakarta.

The objectives of this study are as follows:
• Collecting accurate data on water meter conditions for household customers in Perumda Surakarta, where water consumption is very low or not recorded.
• Perumda Surakarta uses this data for a water meter replacement program to reduce NRW levels. This research uses the mWater application.
2. Theoretical Approach
Water loss can be defined as a number that shows the difference between the volume of supplied water and the volume of water consumed. So in simple terms, water loss is the amount of water lost and does not become income [2].

The most important loss of water and should be kept to a minimum is the loss of water wasted. Water that cannot be accounted for means the difference between water production and water use, including water loss due to physical water loss and non-physical water loss. The rate of water loss is a number in percentage, indicating the amount of water produced but cannot be collected or used as income for the company [2].

The causes of non-physical water loss are unauthorized water consumption, inaccurate customer water meters, and data handling errors. The loss of non-physical water to the water meter can be caused by an error in reading the water meter, the accuracy of the water meter number, the tampering water meter, the broken water meter, and no water meter, and illegal connections.

Water meter is a measuring instrument for the volume of water in a piping network to serve both individual and group users by paying attention to technical and non-technical aspects so that the community can easily obtain water in a certain amount, the quality according to drinking water requirements for health. Non-technical aspects are needed in water meter operation and maintenance, which can be read by officers or the community themselves, so it is easy to know with certainty the use of water [3].

2.1. Water Meter Technical Requirements [4]
The main requirements of a water meter are as follows:
● The water meter must be made of a material with good strength and is durable and has a long service life.
● The material of the water meter should not be affected by water temperature.
● All parts of the water meter that come into contact with running water must be made of non-toxic materials.
● The water meter Q₃ < 15 M³/hour material for water meters (body, head/ring, clutch, coupling ring) is made of brass. Therefore, it must contain Cu > 63%, Zn < 33%, Pb < 3%, or if made of plastic material, must be equipped with anti-ultraviolet material, combined with a metal plate therein.
● The water meter must be constructed of a material that resists corrosion both internally and externally or is protected by suitable counting/coating with a resistant material.
● The water meter's measuring device must be protected by a transparent window made of glass and equipped with a cover or guard.
● The water meter must be equipped with magnetic repellents and placed in a waterproof enclosure or completely waterproof enclosure.
● The water meter is designed to be assembled between the inner side and the water meter house for repair purposes.
● The water meter must meet the resistance requirements of Q₃, Q₄ and simulation service.
● The water meter manufactured cannot be affected by the magnetic strength up to 2500 Gauss at the Q₁ flow without exceeding the maximum limit's measurement error limit. Other technical requirements are as follows:
● The water meter made must be sealed as a technical safety.
● The water meter must be clearly and visibly marked with the verification mark without taking the meter apart.
● The water meter needs to be protected with certain protective equipment as a guarantee.
● The volume indicator on the water meter shall be functional and easy to read, precise and not in doubt about the volume indication. The pointing device shall have a visual instrument for manual and automatic testing and calibration.
A good water meter is as follows:

- Where the water meter is visible and accessible
- The water meter has a protector so that it is protected from sunlight and rain, which can make the water meter glass more and more opaque.
- The water meter has a registration number from the Perumda.
- The water meter is sealed.
- The water meter is in good condition.
- The water meter can be read properly (the glass is not opaque)
- The flow meter (cubication) in the water meter functions / normally runs according to water volume.

Liu et al. [5] showed strong support for water utilities to continue providing water consumption information to households via quarterly paper bills. Most customers would welcome specific informational enhancements made possible through smart metering. Davies et al. [6] confirmed the effectiveness of Smart Metering within the community, regarding the long-term behavioral change without additional interventions following the removal of the technology. It could be assumed if follow-up initiatives, including education and incentive programs, had been introduced the water savings would have been higher. Study of Ornaghi and Tonin [7] found a decrease in consumption of 22% following meter installation, a considerably higher value than assumed as a policy target. The result implied that, overall, the benefits of metering outweigh its costs.

2.2. Using mWater [8]

The mWater platform can be used in different data-driven workflows by end-users. Users typically focus on Surveying, Monitoring, Evaluation, & Learning, and Management.

- **Surveying** - Data collection using Surveys on a one-off basis.
- **Monitoring, Evaluation, and Learning** - Data collection using Sites and Surveys on a repeated basis that informs programming and adapts the monitoring process.
- **Management** - Assignment of in-field actions and reporting to identify, update, resolve, and approve issues in the field.

![Process Surveying](image1)

![Monitoring, Evaluation, and Learning](image2)
Figure 3. Management

Plan- The planning phase involves establishing the data-driven process's objectives, creating surveys, and preparing mobile devices.
Train- The training phase provides the data managers, collectors, and consumers with the capacity to use mWater Portal and Surveyor.
Deploy- The deployment phase is where roles and permissions are established, defining who can Collect, View, Modify, and Approve survey responses. Once deployed, the survey automatically appears on the Surveyor app for the data collectors.
Collect- The data collectors use Surveyor to fill in survey responses and create Sites.
Update- Data collectors revisit the same Site to perform longitudinal monitoring.
Respond- Data collectors receive notifications on their device informing them of a Survey Assignment or an Issue to respond to in the field. They perform the necessary action and respond to the assignment/issue.
Clean- The cleaning phase involves survey and site approvals and the visualization of systematic data errors for correction.
Report- Reporting is done through visualizations, including interactive maps, charts, calendars, summaries, and tables. These functions are then shared in various formats, including live Maps/Dashboards/Consoles, PDF reports, and Excel/CSV.

3. Methodology
This research was conducted on November 18 - December 17, 2019, using mWater, involving 55 enumerators and four field coordinators. The subjects studied were 7000 water meter customers of Perumda Surakarta.

The research was organized into four daily work steps involving the enumerator and the field coordinator. The four steps of daily work are:

a. First Step: A brief meeting between the enumerators and the field coordinators. In the field coordinator meeting carried out the following activities:
   - Check the survey (facilities and infrastructure for enumerators) before going to the field/collecting data.
   - A brief refresher on survey understanding with the mWater application, especially on the first day.
   - Develop a strategy for the sequence of the locations surveyed with enumerators based on the village clusters.

b. Second Step: The enumerator collects and inputs data using the mWater application from respondents to respondents.

c. Third Step: The field coordinator monitors each enumerator data input result and downloads data from the mWater application. Then save it to Xls / CSV format, then check every data input from...
the enumerator. Downloading and checking data are carried out every day. If there are problems or difficulties for the enumerators in the field, the field coordinator can solve them. Enumerator communication in the field with the field coordinator can be done through social media. Including solutions when there is a data input error.

d. Fourth step: meeting of work results. After the day’s data collection, an afternoon or evening meeting is held (according to the agreement between the field coordinator and enumerator) to do the following:

- The field coordinator facilitates the enumerators to share their experiences.
- Enumerators share experiences (difficulties and problems encountered, data input process, or other matters).
- The field coordinator provides solutions if there are problems encountered in the field.
- The field coordinator will inform the results of the achievements of each enumerator. If a data input error is considered the field coordinator to be very large, the enumerator must repeat the data input on the next day.
- Remind the enumerator to charge the smartphone at night so that in the morning, there will be no problems in data input (or the enumerator brings the power bank while in the field).

The data analysis method used in the 7000 water meter household customers' survey activity in Perumda Surakarta is a qualitative-descriptive method. This method is used to analyze non-numeric data or data that cannot be translated into numbers. Meanwhile, the descriptive analysis provides an overview of the understanding and explanation of the water meter condition for household customers in the survey area using frequency tables, graphs, and cross-tabulations. A statistical data processing program is used, the SPSS application, to assist the analysis process.

4. Result and Analysis
For 30 days of research in the field, the following results were obtained:

| Occupancy Status | There is a Water Meter | Water Meter Condition | Pipe leak before the water meter | Having a water source other than Perumda Surakarta |
|------------------|------------------------|-----------------------|----------------------------------|-------------------------------------------------|
| inhabited        | 5268                   | normal 2504 (52.54%)  | 117 (2.54%)                      | 3109 (65.23%)                                   |
|                  | 4766                   | abnormal 2262 (47.46%)|                                 |                                                 |
| uninhabited      | 1732                   |                       |                                 |                                                 |
|                  | (9.53%)                |                       |                                 |                                                 |

The table above shows 5268 (75.26%) inhabited houses, while 1732 (24.74%) were not inhabited. The inhabited houses have water meters as much as 4766 (89.34%), while those without water meters are 502 (9.53%). The inhabited houses have normal water meters as much as 2504 (52.54%), while the abnormal water meters are 2262 (47.46%). The survey data also states that the houses where water meters are inhabited have a pipe leak before the water meter is 117 (2.45%) and using water sources other than Perumda as much as 3109 (65.23%). The source of water that is used mostly uses well water. Respondents use well water due to erratic water continuity, poor water quality, and too high water prices. Those issues are inputs for Perumda Surakarta in improving services, especially water...
continuity and quality. From these data, it can be analyzed that the low consumption of water for household customers can be caused by the existence of a water source other than Perumda Surakarta [9].

Field research found that 2262 water meters were abnormal. For more details, these findings can be seen in the following table.

| Water Meter Condition                  | Total | Percentage |
|----------------------------------------|-------|------------|
| Damaged                                | 346   | 15.30%     |
| Buried                                 | 479   | 21.18%     |
| frosted water meter glass              | 1397  | 61.76%     |
| The direction of turning the needle    |       | 0.18%      |
| upside down                            |       |            |
| Leaking                                | 36    | 1.59%      |

The table above explains that the house where the water meter is not normal is caused by, among others:
1. 346 or (15.30%) water meters were damaged because the needle was missing, the number did not rotate, and the seal was broken.
2. 479 (21.18%) water meters were buried by building materials, household items, soil and building floors.
3. 1397 (61.76%) water meter's glasses were frosted, resulting in illegible cubication of water usage.
4. The direction of 4 (0.18%) water meters’ needles are reversed because it was reversed during the water meter installation.
5. The 36 (1.59%) water meters were leaked due to the inside of the water meter was broken so that the water covered the cubication figure and slowed the flow of the cubication figure.

The survey results are equipped with field photos of normal and abnormal water meter conditions, photos of the front view of the respondent's house, and the coordinates of the water meter location.

5. Conclusions
Of the 7000 water meters from Perumda Surakarta, household customers who do not have water meters were 502, 2261 abnormal water conditions, 117 pipe leaks before the water meter, and 3109 customers water sources other than Perumda Surakarta. Perumda Surakarta has made efforts, including inspecting the presence of water meters for household customers without water meters, replacing water meters that are not normal, repairing pipe leaks before the water meter, and improving water quality and community services. By making these efforts, it is expected that Perumda Surakarta can reduce the level of water leakage.

References
[1] Perumda Surakarta 2019 Company Profile of Perumda Surakarta in 2019
[2] Kementerian Pekerjaan Umum dan Perumahan Rakyat Direktorat Pengembangan SPAM Modul Air Tak Berekening 2018
[3] Pusat Penelitian dan Pengembangan Permukiman Balitbang Kementerian Pekerjaan Umum dan Perumahan Rakyat 2014 Modul Sosialisasi dan Diseminasi Standar Pedoman dan Manual Spesifikasi Meter Air
[4] SNI 2547: 2008 Spesifikasi Meter Air
[5] Liu A, Giurco d, Mukheibir P, Watkins G 2013 Smart metering and billing: Information to guide household water consumption Water (Australia) 40 73-77
[6] Davies K, Doolan C, van den Honert R, and Shi R 2014 Water-saving impacts of Smart Meter
technology: An empirical 5 year, whole-of-community study in Sydney, Australia Water Resources Research 50 7348-7358

[7] Ornaghi C and Tonin M 2019 The effects of the universal metering programme on water consumption, welfare and equity Oxford Economic Papers 1-24

[8] https://portal.mwater.co/

[9] Farley M 2008 The Manager’s Non-Revenue Water Handbook: A Guide to Understanding Water Losses Ranhill Utilities Berhad and United States Agency for International Development (USAID)

Acknowledgement

The authors would like to thank USAID IUWASH PLUS and SECO (Swiss State Secretariat for Economic Affairs) to support this research.