Bank Air Kami: Terban waterscape information system

B Syahputra¹, A Sujarwo² and I Maharika³
¹Department of Informatics, Universitas Islam Indonesia
²Board of Information System, Universitas Islam Indonesia
³Department of Architecture, Universitas Islam Indonesia

2ari.sujarwo@uii.ac.id

Abstract. As an informal urban-rural mixture area in the middle of Yogyakarta, Terban holds a special living facility: water. Dividing the downtown with a popular river sourcing from Mt. Merapi volcano, Terban waterscape has nine springs watering the society in a traditional way. This paper offers a new approach for the Terban waterscape to show water quality data for researcher and society through information system, and to increase the benefits of natural resources among people. The approach was conducted by designing and deploying a set of sensors to collect data which were then managed by information system for further processing by researchers and locals.

1. Introduction and overview
Terban stands as desakota (a mixture of urban and rural living in an area [1]) in Gondokusuman, a sub-district of Yogyakarta, Indonesia. There are nine springs as the part of its waterscape beside the famous Kali Code, a river that divides this cultural city. People around the springs have a long story regarding the usage of the springs. They have used it for their basic needs in traditional way: bathing, toileting, and laundering. Some researchers around the world have come and provided a number of solutions to increase the benefit of the springs, as published in [1], [2], [3], and [4].

The publication describes the job and the research that have been conducted for the installed water purification system for Terban Waterscape. This system is called Bank Air Kami, or Our Water Bank. Since then, people around the spring have been daily consuming the purified water. To ensure the water quality, the locals have periodically sent the water sample to the local health facility to be assessed. The results are then recorded and informed to the consumers manually.

Life has changed. Last decade marks the technology existence as the successor in almost of human daily life. Inevitably, technology has also intervened the way people in consuming the water produced by Bank Air Kami. This paper proposes a system to improve the water quality reporting system, and to digitally increase the awareness of water consumers in the framework of smart city development in Yogyakarta.

The important element of smart city development is smart technology such as smart sensor and wireless platform as stated by Frost and Sullivan as mentioned in [5]. By using technology, water quality such as in pH, turbidity, and temperature are sensed in real time by sensors. At the same time, it is reported and saved to the system.

Sensors placed in the spring in such a way depends on the functionality and controlled by Arduino. The data then are saved into a premise database system and synchronized to the central database in a remote datacenter. Based on this database, data are then used and visualized by the proposed information
system. Water quality data. Beside to show the real-time water quality data, this system also facilitates researchers to download data in bulk for further need.

2. Terban Waterscape
Terban Bawah (Kampung Gondolayu) emerges as an informal residential area with a long story of neighborhood as this location at the beginning was a cemetery area. This area topology (Figure 1) shows the variety in the height of landscape, and slope surrounding the valley.

![Figure 1. Riverside living](image)

2.1. Terban Bawah as Informal City
Kampung, a Javanese terminology explains a living area in an informal residential location. With a basic lifestyle, people in Kampung are often living below the living standard [6]. The low monthly income, uncertain casual job, and many other factors have made people to struggle to fulfill their needs for food, health facility, and housing. In some areas, people still show a traditional living, as they still keep their close relationship with neighbors, high density housing, and limited access to clean water, sanitary, and rubbish management.

Above factors, and the lack of residential space have posed people to live insufficiently. People in Terban Bawah choose to live in an informal residential area rather than in proper residential area (Figure 2). Based on the regulation of Indonesia Government: PP No. 38/2011 it defines that in the area of river, 10-20 meters around the river needs to be kept clear of housing. The slope and the valley owned by government are not permitted for housing. This area is defined as illegal for housing. However, people does not have any options to live better, and face a high risk of disaster (Figure 3). They have built the houses and limited facilities. This area is then called as the informal city. It is easy to find the informal residential areas in Indonesia, even in Jakarta as the capital of Indonesia.

Java as the main island of Indonesia has the higher density of residents [7] compared to others caused by people movement. People from other cities or islands attempt to find job and seek a better living, and choose to migrate to Java. However, to find a good job often needs some time, but life never stops. This situation has forced people to live in informal residential area, as there is no legal procedure to be followed. In other words, people does not have any legal documents to proof the land and house ownership.

Yogyakarta has a special case. Most of lands are still owned by the traditional owner of the land: Karaton Ngayogyakarta Hadiningrat, the Sultan Palace. The King of Yogyakarta often gives people a formal letter called Kekancingan [8] to permit people to live in Sultan’s land, even in so called informal city. The ownership of the Sultan’s land is quite contradictive with the aforementioned PP No 38/2011.
2.2. **Water Springs Profile**

There is no clear statement when people discovered springs around Terban neighborhood. What people know is that there is a water spring they can use to support their life for laundering, bathing, and drinking, without any awareness whether the water is clean and consumable. Maharika in 2014 [4] introduced a water filtering technology - installed in a water cleansing house as shown in Figure 4. Since then, people have managed to consume water from Bank Air Kami and sell it to surrounding people.

There are about nine water springs on the slope of Kali Code, the Code River, one of which is called Belik Ayu. This spring is where Bank Air Kami is located. When this research was conducted, most of the water springs were found built with a small squared tank to collect water.

2.3. **Challenges**

Böhlen in [4] placed the first milestone of this potential research in Terban Bawah by installing a water filtering facility equipped with an e-coli assessment system situated in Puskesmas Gondokusuman, a local health care close to the springs. In turn, this research was conducted to observe more data from Terban Waterscape springs. We have placed various kinds of water sensors to get the picture of water, and built data management facility to be accessed remotely by water consumers and researchers.

As stated in Indonesia Ministry of Health Decree No 492/MENKES/PER/IV/2010 about consumable water quality, water production system should obey the water quality specifications below:
Table 1. Consumable water quality specification

| No | Parameters         | Unit          | Max Threshold          |
|----|--------------------|---------------|------------------------|
| 1  | pH                 |               | 6.5 – 8.5              |
| 2  | Turbidity          | NTU           | 5                      |
| 3  | Temperature        | °C            | 10 °C – 15 °C          |
| 4  | Salinity           | %             | 0.05                   |
| 5  | Coliform per 100 ml sample |            | 0                      |
| 6  | E. Coli per 100 ml sample |         | 0                      |

The water source of Bank Air Kami would be monitored and reported to the system and focused on the first four parameters above.

3. Water Quality Data Management Sensors and Ubiquitous Computing

During the early step of the research, we conducted data and functionality analysis soon after the interview stage. This process resulted in the design of the system, which must have several parts: ranging from data collection units to datacenter and Bank Air Kami Knowledge Management System. Figure 5 shows the architecture of the system.

The figure illustrates the process flow of data collection by a set of sensors to procedure of data saving in the datacenter. We deployed pH sensors, water flow sensors, turbidity and ultrasonic range finder sensors. Data from sensors were managed by a microcontroller, and processed to get the data in some standardized units and saved into the local database.

The local database kept the data from all sensors located in water springs temporarily, since the final data saving was in the datacenter. The local database enabled a controller to save real-time data nearby. The aim of placing this facility close by was to avoid any data loss during the communication between components. A mechanism was installed between the local database and datacenter to sync the data between those two parties. In the end, data saved in the datacenter would become the data supplier to Bank Air Kami’s knowledge management system (KMS).

The KMS [9] manages and visualizes the data in various formats: graph and table. Data are also available to be downloaded in PDF, TXT, or CSV formats for further data processing.

4. KMS design and deployment

4.1. Actors and its role

This system has been designed for various actors: water consumers, researchers, and Bank Air Kami employees as the administrator. The system has been designed into four parts: (1) sensors and controller system to produce data, (2) robust synchronization system to ensure that the local saved data have been sent to datacenter successfully, (3) robust network between sensors and controller to central system, and central system to datacenter, (4) and last but not least, the web-based information system itself as an interface for the end user to consume data. Figure 6 shows the users and their role to the system.

Here, the administrators are able to manage the user’s login, add or remove sensors, manage the list of monitored water springs and its locations. The other users (researchers and water consumers), meanwhile, can monitor and download data.
4.2. System features for researchers and water consumers

The main interface shows the water data quality based on sensors we have deployed. The users are possible to find data by applying various data filters (Figure 7) based on the water spring names, range of time, and water quality data parameters. IoT produces more data than other systems do [10]. In this case, an interface shows data in the form of an easy-to-see mini dashboard at the top of the page, and brief table in the middle of the page with an available download button. To see further data in details, another interface is provided as shown in Figure 8.

4.3. Dashboard for Bank Air Kami administrator

Administrators play an important role at the beginning of new added set of sensors in a water spring to the data management and output. This system was designed for multi-location and multi-devices support. At the beginning, we deployed two sets of sensors placed in Belik Ayu as the central system and Mata Air 4 chosen as the water spring to communicate with.

The details of water springs e.g. latitude, longitude, location description, and sensors specifications needed to be registered to the system. System was then ready to accept data sent by the controller. During its operations, administrator could add more data collection units to be placed in water spring area, and did a similar procedure to register it to the system. When data started to arrive, system would visualize it as shown in Figure 9.

4.4. Usability Test
Usability test began with a step to write the set of questions, and applied the validity and reliability test to ensure the questions used proper in this test. The groups of locals were involved to help us to test the prototype of information system. We did a set of usability tests to ensure that our system could work well and was beneficial. The result shown in Table 2 depicts that system was able to fulfill stakeholder’s needs, although there might be a need for further improvement.

| No | Question  | Mark |
|----|-----------|------|
| 1  | Learnability | 4.2  |
| 2  | Efficiency  | 4.1  |
| 3  | Memorability| 4.3  |
| 4  | Errors     | 4.1  |
| 5  | Satisfaction| 3.9  |

5. Conclusion

System is able to show the real-time water quality data in various formats: table and graph, and provided data downloadable in a bulk mode. Turbidity, temperature, pH, and salinity sensors worked well to send data for visualization in KMS Bank Air Kami. Learnability, efficiency, memorability, and errors within usability test showed a good result. In general, it can be stated that system is quite usable to facilitate the stakeholder’s needs for water quality data.

Acknowledgement

This research is a part of PTUPT (Penelitian Terapan Unggulan Perguruan Tinggi) Indonesia Government funding plan No. 03/ST-DirDPPM/70/DPPM/Penelitian Terapan Unggulan Perguruan Tinggi Kemristekdikt/I/2017 by Dr. Ilya Fadjar Maharika, IAI as the team leader, and Ari Sujarwo, S.Kom., MIT (Hons), Medila Kusriyanto, ST., M.Eng. and DR.-Ing. Widodo B.Msc as the team members.

References

[1] Böhlen M and Maharika I F 2018 Learning from WaterBank vol 10 no 2 pp 138–56
[2] Arum H R T, Sastrosasmita S, and Iskandar D A 2006 Clean water governance in a small community: a case study of community development approach in the water provision in Yogyakarta, Indonesia Proc.: Regional Conf. on Urban Water and Sanitation in Southeast Asian Cities p 61
[3] Seftyono C 2017 Dilema Implementasi Kebijakan Pembangunan Bantaran Kali Code-Yogyakarta Master Thesis (Yogyakarta: Gadjah Mada University)
[4] Böhlen M, Maharika I, Yin Z and Hakim L 2014 Biosensing in the Kampung 2014 Int. Conf. on Intelligent Environments (IE) pp 23–30
[5] Letaifa S B 2015 How to strategize smart cities: Revealing the SMART model J. Bus. Res. vol 68 no 7 pp 1414–9
[6] McCallum D and Benjamin S 1985 Low-income urban housing in the third world: broadening the economic perspective Urban Stud. vol 22 no 4 pp 277–87
[7] Yulianto F, Tjahjono B and Anwar S 2014 Detection settlements and population distribution using GIS and remotely sensed data, in the surrounding area of Merapi Volcano, Central Java, Indonesia Int. J. Emerg. Technol. Adv. Eng. vol 4 no 3 pp 1–10
[8] Kurniadi B D 2009 Yogyakarta in decentralized Indonesia: integrating traditional institution in democratic transitions J. Ilmu Sos. dan Ilmu Polit. vol 13 no 2 pp 190–203
[9] Alavi M and Leidner D E 2001 Knowledge management and knowledge management systems: conceptual foundations and research issues MIS Q. pp 107–36
[10] Jernigan S, Ransbotham S and Kiron D 2016 Data sharing and analytics drive success with IOT MIT Sloan Manag. Rev. September