WATER CONSUMPTION MONITORING IN PUBLIC AND COMMUNITY TOILETS

[1] Dr. Shanta Sondur, [2] Gaurav Makhija, [3] Nikita Talreja, [4] Mohit Alias Moksha Akash Manchandani

[1] Professor, [2] Student, [3] Student, [3] Student
[1] Information Technology,
[1] V.E.S Institute Of Technology, Mumbai, India

Abstract: Swachh Bharat is a national mission and the move is afoot to build a broad alliance of politicians, corporations, Non-Governmental Organizations, and civil society to spread its awareness, evolve it into a people's movement and fight the social evil: Open defecation. To achieve the Swachh Bharat's target of making about 12 crore toilets by 2019. Keeping track of the amount of water consumed by people in the toilets manually is a difficult task. People reject or delay the payment of the amount of water consumed. In this paper, a solution is presented to automate the process of water auditing in public and community toilets using technology based on the Internet of things. A mobile application and a website application are developed to support end-users and Community Based Organization, Municipal Corporation of Greater Mumbai officials respectively. The system measures water consumed by an individual as well as one family, water consumed in one unit on a daily and monthly basis. The proposed solution also aims at resolving the issue of leakage due to taps being left open after use. This system provides aid to people to pay only for the amount of water that they actually use

IndexTerms -**Water auditing, Swachh Bharat, React Native, Laravel, Internet of Things.**

I. INTRODUCTION

One of the main objectives of Swachh Bharat Abhiyan is eliminating open defecation. Construction of individual household toilets is not possible because of space restrictions. Therefore, the construction and usage of public or community toilets become highly important. A community toilet(CT) is a facility used by the residents of a particular area and can be only used by them whereas a public toilet(PT) is facilities that are present at places such as stations, markets, and public areas and there is no restriction on whom can use the facility. In some of the areas, the operation and maintenance of these toilets are undertaken by the government whereas in other areas it is done by community-based organizations (CBO). The conduct of using them like charges, maintenance varies from place to place. In the current scenario, charges are fixed for using facilities. The charges of using are also not uniform. Hence there is a need for a system that can be implemented at these places which require low maintenance.

About 91% of the slum dwellers are using public toilets. Overall 12 % households reported that they do not have either public or private toilet facility and thus adult members use open space for defecation. This percentage is substantially high, that is 27 %, among unauthorized households, indicating that there is scarcity of public toilet facilities. Ninety percent unauthorized households' disposes of child's stool in open spaces and drains. On an average, this practise is observed among 58 % of the households in Mumbai slums. Perceived unsafe condition of public toilet at night is a major issue of concern, wherein 67 % authorized households and 87 % unauthorized households reported to have fear of being unsafe in public toilets. Irregular water supply in the public toilets is very frequent, mentioned by 85 % of the households.[1]

The proposed solution monitors the water consumed by each family member on a daily and monthly basis and also monitors the water usage per CT. After one month a bill is generated. Users need to pay only for the amount of water used similar to electricity consumption. This can promote more and more use of community toilets. The system checks if the bill is paid by the user or not. Hence reducing the need for manpower for jobs like checking whether the bill is paid by the user or not. It brings transparency between users and the government regarding the usage and maintenance of toilets. The system will help the government in understanding the amount of water required for these facilities and if there is a huge demand for water then the rates can be decreased depending upon the demand and supply.

II. LITERATURE SURVEY

In most slums, the only sanitation option for the majority of the residents is the community toilet (CT) blocks built predominantly by the Maharashtra Housing and Area Development Authority (MHADA) under Local Area Development funds of local/state level political leaders. The 'Mumbai Sewage Disposal Project I' (MSDP-I), of the mid-1990s, aided by the World Bank, was geared towards augmenting and improving the overall city sanitation infrastructure and also included a 'Slum Sanitation Program' (SSP). Latrines built under the SSP had many innovative features: they set superior service standards and proposed partnerships between government departments, non-governmental organisations (NGOs), and beneficiary CBOs. Currently, as the MSDP-II continues with the same approach of its predecessor, the SSP forms the only model for sanitation delivery in slums. The city-wide, World Bank aided 'Slum Sanitation Program' (SSP), currently being executed in the city approaches sanitation as a complete 'hardware' and 'software' package.[2]

Smart Meter for water utilization using IoT[3] gave a solution for water consumption for household requirements. Using Node MCU and a water flow sensor they measured the water used by each family. The water flow sensor works on the principle of hall effect. The output of this meter is in pulses.

Automated water usage monitoring system[4] makes use of Arduino, WiFi module, Solenoid valve, water flow meter if the tap is continuously open for more than one minute then an alert message will be sent to the user and the water supply will be stopped. If water is used more than the determined limits then a warning will be sent to the user.

Smart Water Monitoring System Using IoT[5] at Home represents a solution to check the quality of water and prevent the wastage of water through leakage along with measuring the quantity of water used for household applications. The system makes use of two flow sensors to detect the leakage in the pipe.

Developing Smart toilets using IoT[6] proposed a solution for keeping the toilets clean by using a Figaro sensor. If the smell is found in the toilet by the Figaro sensor then an alert is given to the caretaker of the toilet. The presence of the caretaker is detected using an RFID reader. The system is mainly concerned with the hygiene level of the toilet.

IoT Water Consumption Monitoring & Alert Systems[7] proposed is a system to monitor the amount of water usage in domestic households per day, per week, and per year in real-time on mobile phones or laptops. It gives notification if there is some leakage. The system uses a water flow meter and Intel Edison Boards.

Smart water usage monitor[8] represents a solution where water flow meters are installed at various nodes on pipes to monitor the flow and the data will be sent to the server and users can check the consumption on the mobile application to view their monthly/weekly/daily usage, estimated cost, etc.

A field visit to one of the community toilets (CT) was done for understanding the current system of water usage. Every family is provided with a yellow card. The card contains details about the number of people in the family, the number of males, the number of females, address. On the other side of the card, it contains details of the entries or date on which the bill is paid. Every month each family of five members has to pay 50RS. 10RS for each family member. For some extra members of the family, they have to pay 10 RS for each. There were a total of 10 units. 8 washrooms, 1 washroom for disabled people, and one unit for bathing. If a person without a yellow card wants to use the unit then the person has to pay 2 RS for urination, 5 RS for defecation, and 15 RS for bathing. A person who is employed for the maintenance of units stays above these units. Each unit has a separate supply. An overhead tank supplies water to these units. PVC pipes are used. Water motor is used for storing the water in the overhead tanks. A bill of using a motor is also sent to the area. Boring water is supplied for washing and cleaning purposes. Drinking water is directly supplied to their houses.

In the current scenario, there is no provision for monitoring water consumption per person or per unit, monthly consumption per unit. Some systems measure water consumption for household purposes. Currently, no systems are available which measure the consumption of water in community toilets.

III. PROPOSED SOLUTION

3.1 Methodology

The system measures the amount of water consumed by every individual of the family as well as the whole family on a daily and monthly basis. The system also measures water consumed in a single unit. For this purpose, each family is given 5 RFID cards. Whenever a person wants to use PT/CT they have to carry RFID cards along with them. In front of every PT/CT, there is an RFID reader to uniquely identify the person. The person needs to scan the RFID card. After scanning the tag, the system checks if the old bill is paid by the family or not. In case if the bill is not paid or if anyone tries to use someone else RFID card then a red led will blink and an error message will be displayed on an LCD screen indicating there is some problem. By default, the solenoid valve is closed. If there is proper authentication from RFID then the solenoid valve inside the unit gets the voltage and water starts flowing from the tap. Indigenously made ultrasonic based water meter is connected to the solenoid valve. DN - 15 water meter model is best suitable for the application. The meter has a flow rate of 30 liters/hour to 3000 liters per hour. The working voltage of the sensor is 2.5V. After the usage of the unit, the data in the database is updated using ESP32.
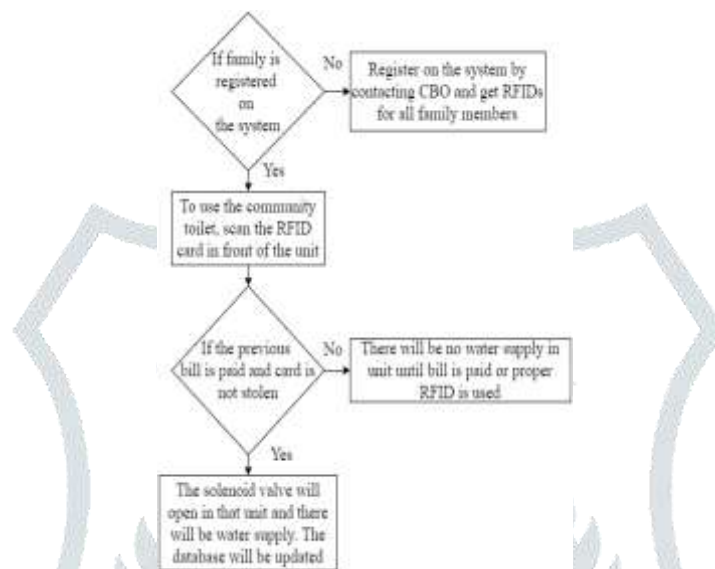

Fig 1. Flowchart of the System

The image below shows the complete connection of the system. In front of every door, an EM-18 RFID reader and an LCD is attached. Behind every unit, on the pipe, a solenoid valve and a water meter are connected. From the water tank, there are different connections for water supply and hence for every unit, there is a different water meter, solenoid valve, RFID module. These are all connected to an ESP-32 module that will send the data collected from these components to the server for various processes such as authentication of the user via the RFID card, get the bill payment details, and storing new water usage details for that trip that the community resident makes to the community toilet. And after that details are updated and can be seen by the user on different platforms. The RFID cards used for the system are non-writable cards. DN -15 water meter sends data every 3 seconds. It sends the output in digit format. To get the quantity of water used in a particular session, the system subtracts the water quantity at the start of the session from the water quantity at the end of the session. In the solenoid valve, there are two ½ inch outlets one is connected to the water tank and the second outlet is connected to the water meter. When a 12-volt dc current is applied the valve opens and water flows through it.
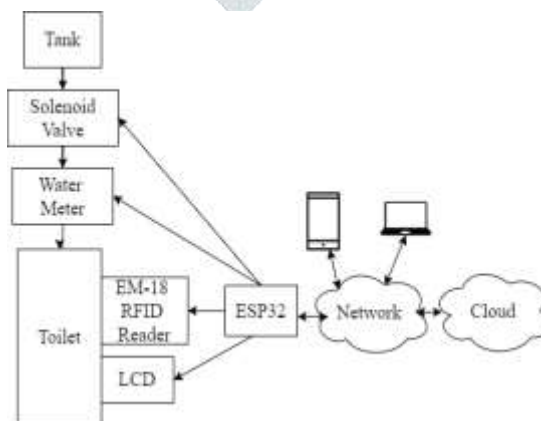

Fig 2. Block diagram of the System

3.2 Functionalities of Web Application

1. Community-based organizations (CBOs) can add new users to the system and also update the details of users.
2. They can allocate RFIDs to users and similarly modify the information if needed. They can enter details of new RFID card
3. After the user has entered some complaint using the mobile app, CBOs can verify if the complaint was genuine or not and they can update the status of the complaint i.e. whether the complaint is resolved or not.
4. They can check who has paid the bill, the amount of water consumed, and the logs of cleaning. The web application dashboard gives information in a graphical manner about bills paid, number of families registered in the system, the number of complaints

3.3 Functionalities of Mobile Application

1. After logging into the mobile app, the user is displayed with family member details.
2. They can check the amount of water used by each member of the family on a particular day.
3. Users can log complain along with the image and provide the complete description regarding the same.
4. They can view the bill generated on the app.
5. Users can provide feedback for the complete system in the form of rating i.e. from 1 to 5. 1 indicating Poor and 5 indicating excellent.

IV. RESULTS

4.1 Hardware Connection

A The below figure shows the hardware connections. The system architecture follows a master-slave architecture where the ESP32 module is the master through which all the communication and data transfer is done, the other components are the slaves which provide data to the master as and when required. The solenoid valve is connected to the water meter. By default, the solenoid valve is closed. As the RFID card is scanned and validated the LED screen will display the family name of the scanned user and the solenoid valve will open and there will be water flow. If the scanned card is not authenticated because of the previous bill being not paid or if the card is stolen the LED will display the corresponding message.

Fig 3. Hardware Connection

4.2 Web Application

A The web application is made using Laravel. The below image shows the dashboard of the web application where the CBOs can see the overall data in a graphical manner. The dashboard displays the total number of users, complaints, families in the system. The dashboard also displays the number of families who have and haven't paid the bill. A graph also shows the amount of water consumed on a monthly basis.
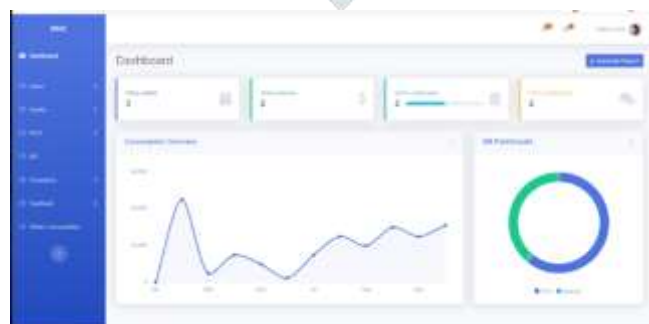

Fig 4. The Dashboard of the Web Application

The below figure shows a form to add a new family to the system. Any addition or modification on the web portal can be done only by government bodies like CBOs, people belonging to Municipal Corporation of Greater Mumbai (MCGM).

Fig 5. Add New Family Page

The following can be used to display the bill details of the family. The family name is displayed along with the amount consumed, the month for the consumption, and whether the bill is paid by the family or not.
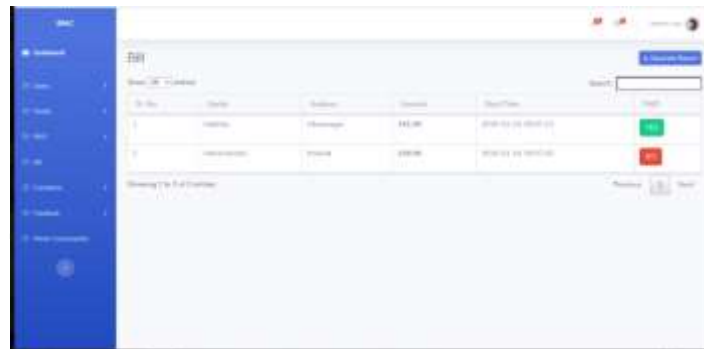

Fig 6. Displaying Bill of Each Family

4.3 Mobile Application

The mobile application is made using React Native. The image shows the home page of the mobile application. It displays the head of the family's name at the centre. The address, contact details, the family number, RFID card number of that member. After that, it shows the description of the rest of the family members.
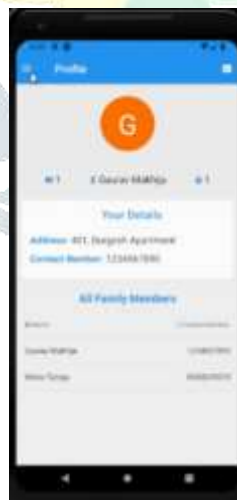

Fig 7. Home Page of Mobile Application

The below image shows the feedback screen of the mobile application, the screen has two input fields for entering the rating and the message of the feedback.
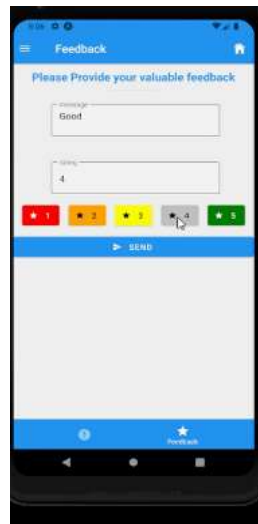

Fig 8. Feedback Page of Mobile Application

By using the daily consumption page, the user can check the amount of water consumed by different family members on a single day. For a particular session, it shows details like the card from which the water was consumed, the amount of water consumed in liters, and the type of unit used (Indian/Western). The user can select any past date to check the consumption of water on that date

Fig 9. Daily Consumption Page of Mobile Application

V. Conclusion

This project helps the great initiative started by Prime Minister Modi. As more and more PTs/CTs are built there is more requirement of human power. This project will reduce the use of human power to a great extent. People will be able to rely on the system and may lead to efficient use of PTs/CTs and thus thereby reducing ODF. Since the system measures the exact amount consumed by family, people need not pay more. The system is able to measure the exact amount of water consumed by an individual member, family, and the water consumed in a single unit on a daily and monthly basis. The system successfully identifies families who have paid the bill for the previous month. Instead of scanning the RFID tag on the reader the tag can be read by the smartphone and hence hardware overload can be reduced in the future.

REFERENCES

[1] Paper on Sanitation in slums of Mumbai, August 2014.

[2] Aparajita Chattopadhyay, Aparna Mukherjee, G Sudha, "Prevailing basic facilities in slums of greater Mumbai", ResearchGate, 2016.

[3] D.Anandhavalli, K.S. Sangeetha, V. Priya Dharshini, B. Lukshana Fathima, "Smart Meter for water utilization using IoT", International Research Journal of Engineering and Technology (IRJET), Vol. 5, pp.1002-1005, 2013.

[4] Sajith Saseendran, V. Nithya, "Automated water usage monitoring system", in 2016 International Conference on Communication and Signal Processing.

[5] Gowthamy J, Chinta Rohith Reddy, Pijush Meher, Saransh Shrivastava, Guddu Kumar, "Smart Water Monitoring System Using IOT at Home", International Research Journal of Engineering and Technology (IRJET), Vol 5, pp. 1170-1173, 2018.

[6] Mrs.K.Elavarasi,Mrs.V.Suganthi,Mrs.J.Jayachitra "Developing Smart toilets Using IoT", Published at International Journal of Pure and Applied Mathematics, Vol. 119, pp. 3061-3068, 2018.

[7] Zainal Hisham Che Soh, Muhammad S. Shafie, Mohd. Affandi Shafie, Siti Noraini Sulaiman, Mohammad Nizam Ibrahim, Syahrul Afzal Che Abdullah, "IoT Water Consumption Monitoring & Alert System", in 2018 International Conference on Electrical Engineering and Informatics.

[8] Bhagya VD, Hemalatha NM, Nethra K, P Vaishnavi, Shyamala G, "Smart Water Usage Monitor", published at International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS), Vol. 7, pp. 259 – 261, 2018.