

Study on Benefits of Smart Water Distribution System

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Abstract- Today total availability of water resources for drinking purpose is currently under stress because of climatic changes and there is continuous increase in the demand of water due to the increase in global population and on other hand conventional water distribution system is deteriorating due to ageing and increase in workload because of increase in population. Water distribution systems are vast and include of various components pipe network, pumps, valves, etc. These components vary in age, and material type. As increase in age their performance and efficiency going to decrease, due to this network prone to leaks and failure. Water distribution systems are so vast and hard to access; some municipalities may not have a complete inventory of their assets, or be aware and take care of leaks in existing water distribution systems. In today's hard economic crises, funding of such water distribution system is limited, which sets water distribution system lower on a priority list of authorities. However, ignoring maintenance of water distribution system infrastructure sometimes may results in significant failures and main breaks that can cause other damage or disruptions to the main components of water distribution system. In addition, lost water due to leakage and theft does not bring any revenue this may increases water scarcity problems in city. There is one solution to solve those problems in existing water distribution system is implementation of Smart Water distribution system as a tool to help and manage our existing water distribution systems.

Keywords- Smart Water Distribution System, Water, Sensors, Network.

I. INTRODUCTION

Smart Water distribution system is a two-way real time network with devices and sensors that continuously and remotely manage and monitor the water distribution system. Smart water meters can monitor many different parameters such as flow rates, pressure, temperature, quality and others. A overview of the advantages of smart distribution system is presented in the view of water conservation and effective management of water resources. The importance of a Smart water distribution system is explained in the context of aging water infrastructure. Current water distribution systems have large number of leakages. Locating leaks, identifying missing

water and illegal connections in water distribution system can lead to increase in revenue from water.

Replacing and updating parts of the current water infrastructure can be expensive. Smart water distribution system cannot substitute for basic water distribution system. However, these costs could eventually be regained by savings obtained from the implementation of smart water distribution system. Setbacks include higher initial costs and a lack of economic incentives. In some cases, a lack of public awareness leads to negative public opinion. Some people might have health problems associated with wireless data transmission. The reliability of quality and quantity of water at the source is also discussed with respect to the network vulnerabilities. The smart Water distribution system with natural systems such as lakes, rivers and reservoirs is also a key element of a “smart” way to the use of water resources. Natural components are subjected to climate changes and single events can affect daily operations. Droughts, floods and disasters can affect the quality of water at the source. Deep knowledge and understanding of the network problems and preparedness for disaster prevention and action can contribute to the “smart” reputation of water distribution systems in many ways. Several projects throughout the world have implemented Smart Water distribution system into their conventional water distribution systems and have seen encouraging results. This smart water distribution system helped to monitor and manage many variables and decrease water losses, water theft and also promote water conservation.

II. RESEARCH OBJECTIVE

To identify the troubles in existing water distribution system:

Conventional water distribution system is deteriorating due to ageing and increase in workload because of increase in population. It directly affects the quality and quantity of water which is to be supplied to the end user. There is necessity of study and identification of problem related to theses water distribution systems to overcome these problems.

To study the components of the smart water distribution system:

Smart water distribution system helped to monitor and manage many variables and decrease water losses, water theft and also promote water conservation and it improves the water quality and quantity. So it is important to study the components of smart water distribution system so that we can identify the impact of each component on the water quality standards.

To draw the schematic diagram this includes important component of water distribution system:

It is important to study function and application of each element in the water distribution system. Schematic diagram gives us all information about working of smart water distribution system using the diagrammatic representation.

III. METHODOLOGY

Based on the study and the literature reviewed methodology for research work is outlined below. This chapter highlights and gives detailed information about methodology of research and Study area details.

As mentioned in the scope of research; five steps are taken into account for research and study purpose. Methodology is broadly divided into five steps as shown below in fig. no. 3.1

Case Study:

Mumbai is a financial capital of India and also state capital of Maharashtra. As mention above total area of Mumbai is 437.71 Sq. Km. Population is about 12.5 Million people (2011) having Population density of 27,209 persons per Sq. Km. As such as with such a large area and population it is very difficult to study whole water distribution system. Total area of Mumbai is divided in 24 wards. I choose Andheri East ward for study purpose. Total population of Andheri East ward is 80,6360. Having total area is 28 sq. km.

Data Collection:

For identifying problem it is important to prove its existence. There is need to analyse the problem fully before moving to factors that can contribute to solve the problem. Data collection for this study will be done in form of onsite photographs, reports generated at site etc.

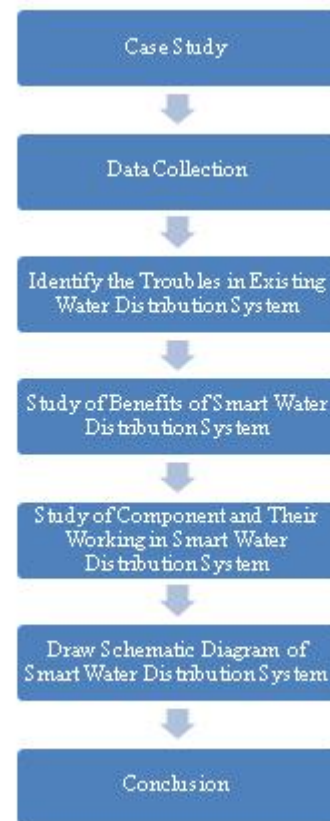


Fig. No. 3.1

Identify the Troubles in Existing Water Distribution System:

We can identify the problems in existing water distribution system and the impact of that particular problem on whole water distribution system. We have to identify that how these problems are affecting whole water distribution system in terms of quality standard, operation and efficiency of water distribution system. So we can focus on the solution of these problems.

Study of Benefits of Smart Water Distribution System:

Try to solve these problems by the study of smart water distribution system. It possible use of this smart water distribution system in Mumbai and having Potential benefits include improvement in leak management, energy savings, water quality monitoring, and intelligent drought management. So we have to study benefits of smart water distribution system to know the potential benefits after its implementation.

Study of Component and Their Working in Smart Water Distribution System:

From a technical perspective, the smart water distribution system is a highly complex combination of and integration of number of digital and non-digital technologies

and systems. We have to study each and every component to know its working and importance in the smart water distribution system.

Draw Schematic Diagram of Smart Water Distribution System:

Schematic diagram is important to know the structure of smart water distribution system it includes. A smart water distribution system starts at the water source, where smart pumps, smart meters, smart valves, and flood sensors are installed. Water continues its flow through water treatment with more smart meters, valves, and pumps. In the city smart water distribution system, contaminant sensors are used in addition to other sensors in smart water distribution system.

Conclusion:

We can get conclusion from above study regarding the improvement in the water infrastructure due to the use of smart water distribution system.

IV. IDENTIFY THE TROUBLES IN EXISTING WATER DISTRIBUTION SYSTEM

Water Leakages



Water leakages are one of the big issues which city is facing. It comes under type of physical losses in water distribution system. A water leakage takes place due to aging of pipeline which corrodes. Excavation across the road for different purpose also causes damage to the pipeline. Pipelines with high pressure also cause bursting of pipeline. Small leakages are hard to detect as they are in the pipelines which was underground. In major developing countries like India there is no infrastructure automatic detection method of leakages. In India leaks in pipes are detected by the local workers if it is visible to eye. There is so much lost in economy for finding invisible leakages in pipelines and fixing them. Leakages in pipeline will also affect the pressure present in the pipeline. This problem of leakages may also reduce the

efficiency of water distribution system during the high peak hours.

A Right to Information (RTI) query has revealed that there were as many as 1,031 cases of pipes bursting or leaking in 2014, draining the city of millions of liters of water. "Around 20 % of water supply is lost in the distribution network due to leaks and pilferage. The main reason for leakage is the age of the pipes; most of them are almost 100 year old". (Times of India 2010). Given the total supply of water 3350 MLD to the city, the 20 % lost means loss of 670 MLD. This is nearly equal amount of water required to bridge the gap between demand and supply. According to recent data available there is 25 % of water loosed due to leakage and theft of treated water. In 2015 total demand of water supply is 4200 mld against the 3750 mld availability of water. 30 % loss of water means 1050 mld which is more than double of water deficit in supply and demand of water.

Contamination of Treated Water

Having apparent long-term improvement in the quality of water supplied by the Brihanmumbai Municipal Corporation, results of a survey have revealed that around 4.31 per cent of the supplied water is contaminated in the city. The water contamination levels in 2013-14 and 2012-13 were 10.84 per cent and 19 per cent, respectively.

From April 2015 to March 2016, the civic body collected water samples from all wards. Tests on these showed that 4.31 per cent of the samples were unfit for consumption. While this is a little higher than 2014-15 (last year) results when the contamination levels were 3.87 per cent of the tested samples, the percentage of samples found unfit has over the years declined from 18 per cent about a decade ago to 16 per cent.



Woes of the Service Provider

The Water Utility Department of the MCGM too faces innumerable difficulties basically because the demand for services outstrips supply. The planned/unplanned development and growing slums require increase in the length of distribution network, besides carrying on regular

maintenance work of pipelines and attending to frequent breakdown on a war footing. Under the economy measures, no new recruitments are made, while workload keeps mounting with the expansion of the services; this results in low efficiency and poor performance of the staff. The Department is not able to handle the complaints from the citizens. Often, materials for repairs and maintenance are lacking. The field difficulties are even graver, especially in thickly populated slums. Often, the number of water pipes run in bunches through narrow passages and side gutters in slums. Under these circumstances, it is extremely difficult to locate the fault or leakage and fix problems, especially in water contamination cases.

The concretisation of roads has added its share of woes for the Maintenance Department. Though a systematic approach for diversion of existing water mains and other utilities prior to concretisation was necessary, it was not given any thought. So, spotting and repairing leakages or pipeline bursts is very difficult, as it requires breaking through the concrete. Attending to contamination problems in the mains below the concrete roads is also difficult. It has also become very difficult to take action even after detecting cases of pilferage or theft as the staff is threatened. During the action, entire labour force has to leave aside their work and attend to the problem. MCGM officials hope that the citizens become aware of these hardships in bringing water from 100km and distributing in complex environment so that they can lend a hand and fulfill their duty of paying for the services and conserve scarce water resources.

V. STUDY OF BENEFITS OF SMART WATER DISTRIBUTION SYSTEM

Reduce Consumer Leakages

The last part of the distribution system is the consumer premise which is mostly known as the part of the distribution system where we can identify a lot of small leakages which causes wastage of water permanently. Most of the time it is depends on where the meter point is placed, without any awareness of the consumer. A smart water meter is capable of detecting unusual consumption of water such as a permanent leak located downstream. Depending on the smart metering infrastructure this leakage in pipe may be reported to consumer after only a few hours. Also, advanced smart meters are capable of delivering important additional information which can be the date and time when the leak in pipe started and the amount of loss of water through this leak.

Increase Operational Efficiency

Meters have to be installed to read water consumption regularly for water revenue to be generated. AMR positively affect on meter reading operations by avoiding the need of physically access to the meters and minimizes the probability of field errors. On-demand AMR gives field readings which minimize field visits for off-cycle and special reads. AMR is particularly adapted in case of hard-to read meters, like in flooded pits, or meters located in hard to access places.

Improve Customer Satisfaction:

The 3rd main advantage of smart water distribution system is its positive impact on customers. This is one of the most important points for management of smart water distribution system as an engineer.

Delivering Professional Services for the Water Utility:

With smart water distribution system, payment and bills are based on actual consumption of water. Estimation of bills is no longer necessary and billing time cycle is reduced considerably. Accurate estimation of bill also results in reduction of customer complaints due to faulty meter reading problems, thus reducing customer frustration. In addition, smart water distribution system avoids unnecessary entry of workers to customer property to read the meters reading. Smart water distribution system also help to solve complains against water leakages and poor quality of water as early as possible. All this results in giving the customers the satisfaction of having professional services delivered to them.

VI. STUDY OF COMPONENT AND THEIR WORKING IN SMART WATER DISTRIBUTION SYSTEM

Components of Smart Water Distribution System and Their Working

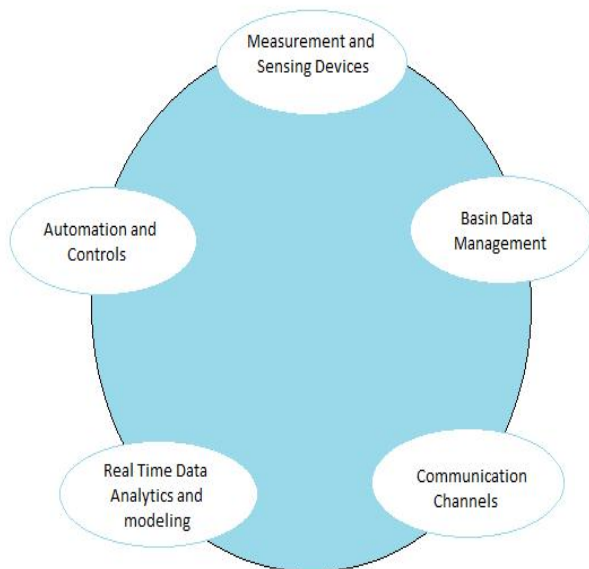
A smart water distribution system starts at the water source, where smart pumps, smart meters, smart valve, and different type of sensors are installed in the system. In smart water distribution system of city, contaminant sensors are installed in addition to other sensors such as flood sensors. At the last stage of system such as end-users at homes, schools apartments, public building and business hub, end-use sensing devices are installed e.g. smart irrigation controllers, contaminant sensors and smart meters.

From a technical view, the smart water distribution system is a highly complex in nature as it includes combination of multiple digital and non-digital component and systems. i) measurement and sensing devices ii) automation

and controls iii) basin data management iv) real time data analytics and modeling v) communication channels.

From a solution perspective, the smart water distribution system is characterized by:

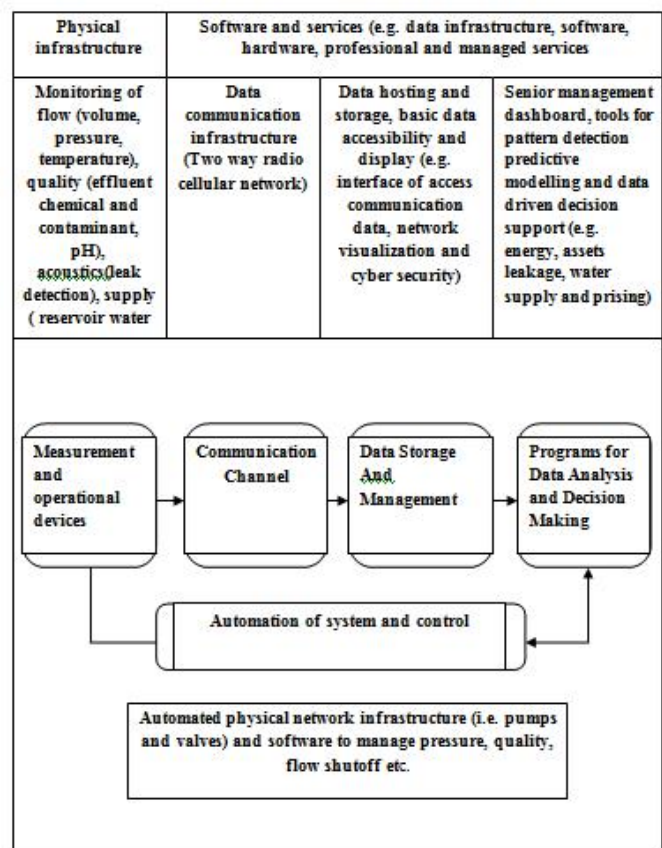
- * More efficient and effective water distribution as a result an minimum water usage, it reduce the need for excess quantity and increases the water quality and security.
- * Improved control and monitoring of energy and components of water distribution system.
- * It is highly automated in nature and responsive smart network with seamless coordination between all parts of the water distribution system.



Sensus (2012a) has given this solution into five layers. First layer is a set of Measurement and operational devices they collect data and help to detect the abnormalities in the water distribution system. Second layer consists of communication channels. These are wirelessly and continuously getting information from first layer in the water distribution system (measurement and sensing devices). These are two-way communication devices which can also perform actions on those devices (i.e. shut down of valve). Once the data is collected from first layer, it needs to be analyzed and presented in the suitable manner. This is the main function of the third layer in water distribution system – Data storage and management. Its goal is to show data via different tools such as GIS, spreadsheets and graphing tools. A customer information system is the part of this data management software.

Forth layer is a Program for data analysis and decision support. Its purpose is to enable utilities to draw

conclusions and gain information based on the collected data. It will be a central source of evaluation of economic value of smart water networks. This software will aid personnel in detecting patterns to determine false alarms versus genuine concerns. In return, this will aid utilities to responds effectively and proactively to any future scenarios. The last layer of Automation of System and Control, which ties with communication channel in the second layer, is automation and control tools. The goal is to enable utilities remotely and automatically conduct measurements and managements of devices in the network. Many utilities utilize SCADA systems, which can be tied with smart water distribution system to further enhance and improve control of water distribution networks.



Drawing Schematic Diagram of Smart Water Distribution System:

To solve these problems of Mumbai’s water supply we can use new technologies which are available today. As technology is advancing now days, new systems, tools and techniques can be used to help water distribution system to run more efficiently and effectively. A Smart Water distribution system is a two-way real time network with devices and sensors that continuously and remotely manage and monitor the water distribution system. Smart water meters can monitor many different parameters such as flow rates, pressure,

temperature, quality and others. An overview of the advantages of smart distribution system is presented in the view of water conservation and effective management of water resources. The importance of a Smart water distribution system is explained in the context of aging water infrastructure. Current water distribution systems have large number of leakages. Locating leaks, identifying missing water and illegal connections in water distribution system can lead to increase in revenue from water.

The information collected by smart meters is transmitted wirelessly to a tower and then it transmits this information to a utility authority company, or other main station location. Smart water meters can gives information several times a day. With smart water distribution technology, we are able to know the real time consumption and performance of the smart water distribution system. Based on the information collected in smart water distribution system from smart meters, we can further help analyze data and identify unusual consumption or changes in the distribution. Due to this, this would help and prevent upcoming failures, and decrease response time to detect the failure.

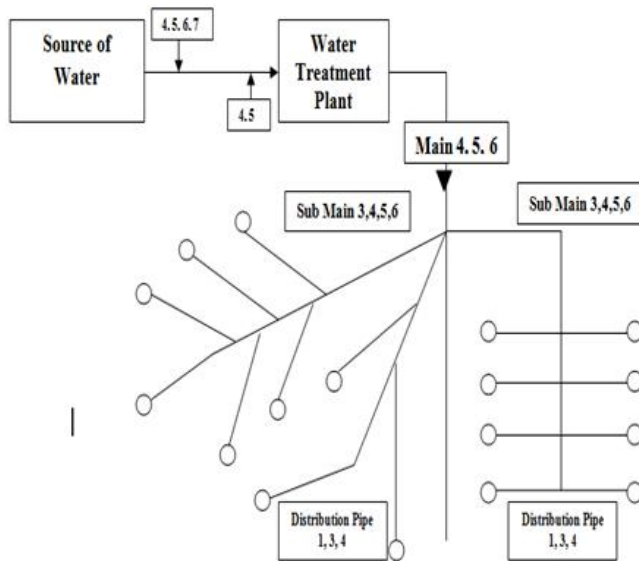
SYMBOL	DESCRIPTION
○	End user
1	End-user Sensing Device
3	Contaminant sensor
4	Smart Meter
5	Smart Valve
6	Smart Pump
7	Flood Sensor

VII. CONCLUSION

In many ways this paper is deficient about the information and technically biased as well. Water supply to the Mumbai is deteriorating day by day. At the same time deficient rainfall would worsen the situation in near future. In view of this there is a need of some concrete action to be taken by MCGM to improve the situation.

Possible use of this smart water distribution system in Mumbai Potential benefits include improvement in leak management, water quality monitoring, intelligent drought management, and energy savings. It is not yet well understood how different implementations of smart water distribution system yield what benefits and costs, but it surely optimize cost and manpower required for management of water distribution system, By using smart meters, sensors and automated pumps and valves.

We argue that integrative analysis of multiple benefits for larger-scale smart water grid systems could help pave the way for the future. For example, while viewing the smart water distribution system purely as a way to reduce water losses might not justify the investment, considering water losses and drought management might tip the balance. It improves factor like water loss, water quality and fast complain solving system it ultimately leads to customer satisfaction and productivity of water distribution system.



REFERENCES

- [1] Michele Mutchek and Eric Williams, (May 2014), “Moving Towards Sustainable and Resilient Smart Water Grids”, “*Challenges* 2014, 5, 123-137; doi:10.3390/challe 5010123 ”.
- [2] Prashant Mehta, (APR 2012), “Impending Water Crisis in India and Comparing Clean Water Standards Among Developing And Developed Nations”, “Scholars Research Library Archives of Applied Science Research, 2012, 4 (1):497-507”
- [3] Aditya Gupta, Sudhir mishra, Niraj Bodke, Kishor kulat (April 2016), “Need of Smart Water Systems in India”, “International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 4 (2016)”
- [4] Prof. D. B. Madihalli , Prof. S. S. Ittannavar (Oct 2014), “Smart Water Supply Management”, “International Journal Of Emerging Trends In Electric And Electronics” Volume 10, Issue, 9 Oct 2014.
- [5] Kumura Takahiro, Suzuki Naofumi, Takahashi Masatake, Tominaga Shin, Morioka Sumio, Ivan Stoianov (April 2013), “Smart Water Management Technology with Intelligent Sensing and ICT for the Integrated Water Systems”
- [6] Thomas Boyle, Damien Giurco, Pierre Mukheibir, Ariane Liu, Candice Moy, Stuart White and Rodney Stewart (MAY 2013), “Intelligent Metering for Urban Water: A Review”, “Water 2013, 5, 1052-1081; doi:10.3390/w5031052”
- [7] Pratiksha Hattikatti1, Savita Karwande, Poonam S. Rode Mrunalini Bhandarkar (MAY 2015), “PLC Controlled Water Distribution System”, “International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering” Vol. 4, Issue 5, May 2015
- [8] Kousik Maity, Purnendu Chakraborty, Bidisha Goswami, Sk. Ekram Ali, Arkodyti Sarkar (8 AUG), “Control of Urban Water Systems using SCADA System”, “International Journal of Computer Applications (0975 – 8887), Volume 76– No.16, August 2013”
- [9] Mircea Dobriceanu, Alexandru Bitoleanu, Mihaela Popescu, Sorin Enache, Eugen Subtirelu (OCT 2008), “SCADA System for Monitoring Water Supply Networks”, “WSEAS TRANSACTIONS on SYSTEMS, Issue 10, volume 7, OCT 2008.
- [10] Satish Palaniappan, Raghul Asokan, Srinivas Bharathwaj, Sujaudeen N (APR 2015), “Automated Meter Reading System -A Study”, “International Journal of Computer Applications” Volume 116 – No. 18, April 2015.