

Study on Benefits and Economic Feasibility of Smart Water Distribution System

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Abstract—Today total availability of water resources in India is currently under stress because of less rainfall and climatic changes. On other hand there is continuous increase in the demand of water due to increase in population. Particularly Maharashtra witnessed some severe drought condition in last few years. As a result growing city like Pimpri Chinch wad is facing problem to supply sufficient quantity and good quality of water for domestic use. To tackle this problem and decrease the percentage of non-revenue water they have proposed to upgrade their existing water distribution system by smart 24x7 water distribution system. In this they are proposed to use smart technique such as SCADA and smart metering. Lot of research are done on this type of project worldwide. From literature review it is clear that implementation of such smart technique showing good result in terms of water savings by reducing water leakages as well as water theft. While researchers divided in opinion about the economic feasibility of such projects. Thus to study benefits and economic feasibility of proposed water distribution system by PCMC we have followed seven steps under research methodology. In this research paper some recommendations are given to PCMC to make this system more efficient and smart. Outcome of this research are encouraging as this proposed system considerably reduces the water loss due to water theft and leakages. As a result there is decrease in the percentage of non-revenue water, it ultimately increase the revenue generated from water.

Keywords— Smart; Water; Distribution System; Non-revenue water; Smart meter; SCADA.

I. INTRODUCTION

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, 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.

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. 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. LITERATURE REVIEW

A. Gupta, Sudhir Mishra, Niraj Bodke, Kishor Kulat (April 2016), "Need of Smart Water Systems In India"

In this paper they have underlined need of smart water distribution system. Today 50% of world total population is under high water scarcity as per report of World Water Development (UN). Countries of Africa and Asia like Bangladesh, Cambodia, China, and India which are still developing are likely to face more water scarcity. It was expected that till 2050, total 70% of population of India will leave in cities. So it is very important to take some early steps towards water conservation and effective management of available water sources.

B. Prof. D. B. Madihalli, Prof. S. S. Ittannavar (Oct 2014), "Smart Water Supply Management"

In this research work, Proposed that the usage of theft control arrangement for drinking water supply system. By implementing these type of system in a real time water supply system; definitely it will be able to control the water theft in the commercial as well as domestic areas. With the today's economic growth, the water demands of cities are also increasing. The smart and effective monitoring of water resource for these cities can prevent the stealing of water and leaking of water effectively.

C. *Mircea Dobriceanu, Alexandru Bitoleanu, Mihaela Popescu, Sorin Enache, Eugen Subtirelu (OCT 2008) “SCADA System for Monitoring Water Supply Networks”*

The implementation of smart solutions in an effective functioning of the storage reservoir, distribution system and pumping stations in the public water distribution system implies the existence of some controlling and management systems based on smart computational technology. To obtain this information, based on analyses and solution of the technological process, there is proposed an SCADA type smart system which gives an optimum drive of the smart technological process and a more safety about the water distribution system with the purpose to good improvement in the quality and services offered to people.

III. RESEARCH OBJECTIVE

- To identify the troubles in existing water distribution system of PCMC.
- To study the components of smart water distribution system and their role in increasing the efficiency water distribution system.
- Calculate the possible increase in the revenue for next 15 years due to implementation of 24x7 water distribution system.
- Give recommendation to make distribution system smart and increase efficiency of proposed distribution system to achieve least possible non-revenue water percentage.

IV. METHODOLOGY

For today’s water scarcity There is one solution to solve those problems in existing water distribution system is implementation of Smart technique system as a tool to help and manage our existing water distribution systems. PCMC proposed to upgrade their existing water distribution system to 24x7 pressurized water distribution systems using smart technique such as smart metering and SCADA. So we have to study the possible effect of this proposed water distribution system and its economical benefits.

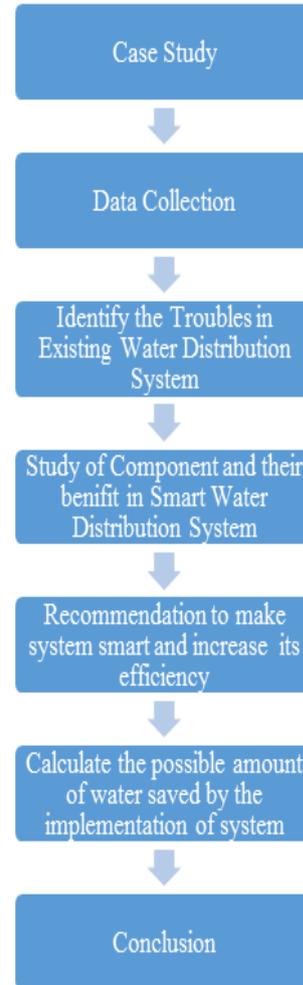


Fig. No. 1: Flow Chart of Methodology

A. Case Study

Pimpri Chinchwad is a city of 1730133 populations in 2011, Pimpri-Chinchwad Municipal Corporation (PCMC) is provide water and sewerage services to the city. PCMC have four treatment plants. PCMC having 90 elevated reservoirs to supply water to distribution network. PCMC supply a total 430 mld of water city with the help of 1800 km network.

B. 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 form PCMC water supply department.

C. Identify the Troubles in Existing Water Distribution System

Water supplied to the end user in PCMC area in morning and evening hours and total duration of water varies from 2-6

hours. Some month in summer alternate day water supply is done due to less availability of water. In some area water quality of water supplied is very poor due to such contaminated water supply there is risk of spreading water borne diseases. Pressure in some area of PCMC is very less due to this system enable to provide require amount of water to the customers in supply hours. And there are several small as well as big leakages in the water distribution system which is take place at pipeline joins, metering point, mains and sub mains. Some of these leakages are not even visible for eyes. Due to this large amount of water is wasted. Around 20 percent of water is wasted due to these leakages. Along with this it triggered the process of water contamination through these leakage and pipeline joints as outside contaminated water entered in pipeline and contaminate treated water. Water theft is again important problem regarding existing water distribution system. Due to stolen water customers who are actually paying for water will not get sufficient amount of water and PCMC also not getting any revenue from this stolen water. Problem of water loss and water theft largely contribute to the non-revenue water. According to PCMC there is around 40 percent of total water is non-revenue water which leads to large financial loss to PCMC.

D. Study of Component and Their Working in Smart Water Distribution System

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.

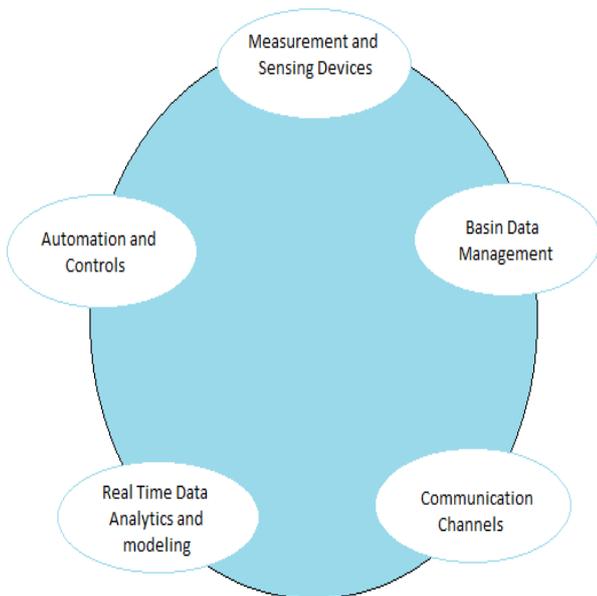


Fig No.2: Component of Smart Water Distribution System

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.

- Measurement and sensing devices
- Automation and controls
- Basin data management
- Real time data analytics and modeling
- Communication channels.

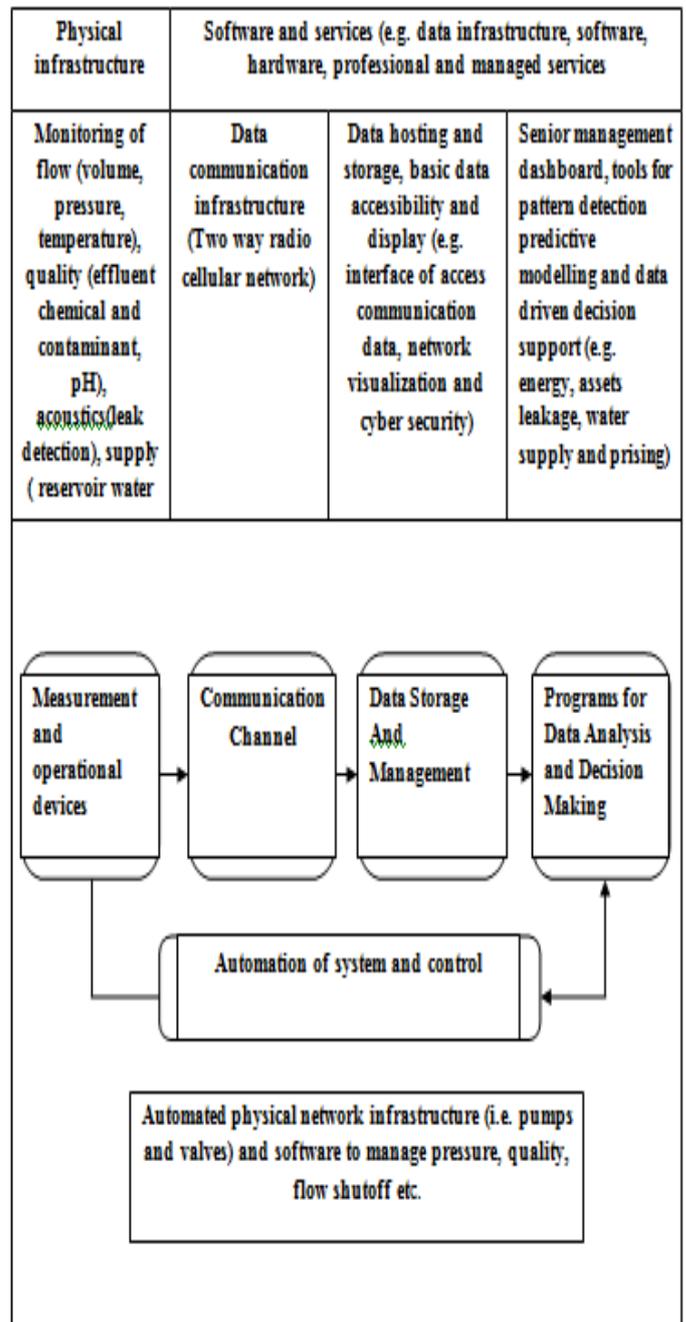


Fig No.3: Component and Their Working in Smart Water Distribution System

E. Study of Benefits of Smart Water Distribution System

a). Reduce Consumer Leakages

SCADA and 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. It also able to identify the

b). Increase Operational Efficiency

Meters have to be installed to read water consumption regularly for water revenue to be generated. AMR positively effect 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.

c). 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.

V. RECOMENDATIONS

- PCMC should establish separate control room for the monitoring of distribution system so that good coordination among the various elements in management system. Also it will provide the central common place for reporting of all elements in system. Along with this it will give orders to respective teams in case of maintains.
- PCMC water department should prepare the list of time limit for various works so that all employees should follow these time limits to complete that particular work.
- To avoid water theft PCMC should established quick reaction team to take action on such illegal connections. This team should locate the illegal connections on the basis on information from control room as well as from frequent checking of such suspected areas. Early action should be taken on such theft as it is going to increase the theft water as time passes.

- PCMC should established quick reaction team for maintains propose. It should be equipped with all type of tools which are required for maintains of distribution system with skilled labor. This team should act in predetermined time limit so that problem of any type of maintains should complete as early as possible.
- PCMC should collect reading of water consumption on monthly basis as system having AMR meter so it is easy to collect these reading on monthly basis. Whereas in existing system collecting meter readings on yearly basis.

Control room should monitor the quality of water in all areas of water distribution system. If it is found that quality of water is poor in some area then control room should give information to on field team and on field team should find the causes of water contamination and suitable remedial measures should be taken as early as possible to avoid further contamination.

VI. ANALYSIS AND INTERPRETATION PF RESULT

According to PCMC water supply department current non-revenue water (NRW) is 40 percent of total production. From this study we can say that this percentage of non-revenue water can reduced to 15 percent step by step after implementation of water distribution system. For calculation we have considered next 5 year NRW. Daily water requirement of water is calculated by taking water requirement per capita per day 175 lpcd. And we assumed that project completed in one year in 2017.

A. Percent of Non-Revenue Water

Percentage of non-revenue of water considered in calculation of revenue generated from water is obtained from water supply department of PCMC. Percentage of NRW for without implementation case is assumed as given below Percentage of non-revenue water considered in both case is given in table below.

Sr. No	Year	Population	NRW % after implementation	NRW % Without implementation
1	2017	2020508.67	40	40
2	2018	2072232.64	30	35
3	2019	2124907.48	20	30
4	2020	2178533.18	20	25
5	2021	2233109.75	15	20
6	2022	2288637.19	15	20
7	2023	2345115.49	15	20
8	2024	2402544.66	15	20
9	2025	2460924.70	15	20
10	2026	2520255.60	15	20
11	2027	2580537.37	15	20
12	2028	2641770.00	15	20
13	2029	2703953.50	15	20
14	2030	2767087.87	15	20
15	2031	2831173.10	15	20

Table No. 1: Percent of Non-Revenue Water

B. Expected Revenue

With the help of above information revenue calculation is carried out and results are tabulated below

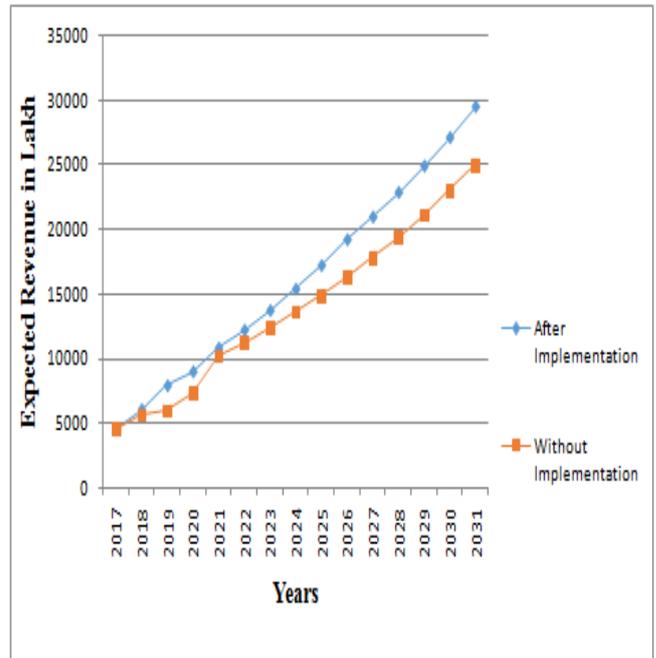


Fig. No. 4: Expected Revenue

Year	Revenue Without Implementation in Lakh	Revenue After Implementation in Lakh	Increase in Revenue in Lakh
2017	4540.07	4540.07	0.00
2018	5651.57	6086.30	434.74
2019	5956.55	7942.06	1985.5
2020	7330.79	9022.51	1691.7
2021	10213.59	10851.93	638.35
2022	11262.22	12232.02	969.80
2023	12386.79	13745.89	1359.1
2024	13590.64	15402.72	1812.0
2025	14882.90	17218.68	2335.7
2026	16273.28	19211.51	2938.2
2027	17766.23	20974.02	3207.7
2028	19366.30	22862.99	3496.6
2029	21096.80	24905.93	3809.1
2030	22963.77	27110.00	4146.2
2031	24979.95	29490.22	4510.2
Total			33335.4

Table No. 2: Calculation of Revenue.

For calculation purpose we have considered that this water is used for domestic purpose. As rate of water in 2017 is 5.5 Rs per kl. And PCMC proposed to hike 0.50 Rs. Per year after implementation of this system.

VII. CONCLUSION

- Proposed use of this 24×7 smart water distribution system in Pimpri Chinchwad is potential benefits include improvement in leak management, water quality monitoring and energy savings.
- From the study it is clear that the percentage of non-revenue water decreases by 20 - 25 percent and collection efficiency increases.
- Results shows that total estimated cost of this project is Rs. 144.5 crore while increase in revenue of this project is Rs. 333.35 crore when revenue of 15 years is considered which surely justifies the investment.
- Implementation of this project and recommendations effects on several factors like water loss, water quality and fast complain solving system it ultimately leads to customer satisfaction and productivity of water distribution system.

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