



RESEARCH ARTICLE

IMPACT OF WATER MANAGEMENT WITH SPECIAL REFERENCE TO SMART ENVIRONMENT AND SMART CITIES FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

Indian economy is prominently driven by the cities. Cities in India have its own challenges and opportunities in itself. These challenges are economical, infrastructure related and also social. As per the census 2011, the urban population residing in the various cities in India accounts for approximate 30% of its total population and contributes approximate of 65% of its total GDP. This is posed to increase to 40% and 75% respectively by 2030. In light of this situation, one has to investigate these posed challenges and also look into the opportunities so as to make these cities *Smarter*.

One of the noticeable challenges is of Water and Waste Water Management of the cities, which need to be studied with respect to the current operational difficulties and expected changes as per the guidelines of the *Smart City*. Annual per capita water availability would be decreased by almost 25% by 2050 in India. Currently most of the cities of India are missing the appropriate sewage treatment facilities and the suitable sanitation. As per the guidelines of Smart City, the research is focused to understand the basic requirements of Water and Waste Water Management.

Purpose: The purpose of the study is to understand the gap between the proposed *Smart City* requirements and the existing infrastructure. This paper also investigates specifics about the Water and Waste Water Management of proposed *Smart City* requirements vis-à-vis prevailing systems.

Methodology: This research paper is descriptive in nature. The primary data is collected through interview method. The primary facts were gathered through the discussions with the municipal authorities involved in water and waste water management. The content analysis method is used to evaluate the secondary data related to the guidelines of *Smart City* and existing records.

Findings: The major finding of this research assignment reflects the enormous gap between the current systems and expected transformation into *Smart City*.

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INTRODUCTION

The world economy is currently facing number of challenges like rising levels of debts (personal, corporate as well as Governments), discouraging consumption, volatile resource prices, reduced purchasing power and increased business cost. However, the considerable upsurge of urbanization rolling across the developing world is truly counteracting against these encounters. As per the United Nations, more than half of the total world population lives in the cities today and by 2025, more than half of global population will live in the Asian

cities (Richard Dobbs, March, 2011)¹. Over the centuries, the governing bodies of the country/state always offered better living standards in the cities than the rural areas. The average income of the resident of the cities is always greater than the average income of the rural area dweller. In the present situation, average urban income of countries like China and India is three times greater than their rural income. In advent of rapid urbanization and industrialization in India, India's urban areas are under stress in terms of poor air and water supplies resulting in health related issues. There is ample amount of pressure exerted on the demand of right infrastructure which could handle the stress.

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¹Richard Dobbs, S. S. (March, 2011). *Urban World: Mapping the economic power of cities*. McKinsey Global Institute.

On the other hand, India's infrastructure that has not kept the pace with the urbanization resulted in constrains in managing the water, food, electricity, transportation and air pollution. (Proquest, 2016)². There is a significant impact on the earth's ecosystem due to the human persuaded alteration and amendments in the natural resources like land, air and water. This is because of the hasty and rapid urbanization. Day by day it is becoming a big task for the local city governing bodies to manage its resources like water and waste water properly (Graniel CE, 1999)³. The large number of people from developing countries lives in the urban areas without adequate provision of safe drinking and usage water and sanitation facilities. In most of the developing countries like India, Africa etc., the failure of public utility systems to serve the urban population living in the settlement areas and slums. Population density and per capita resource use have vividly increased over last century. As per the Government Census 2001, the percentage of slum population increased to 41% from around 20% in the year 1981 in the urban areas with a minimum population of 10 lac.

Present-day water resources and its challenges in Indian cities

Water resources in these cities of India are diminishing not only because of urbanization or because of increased population but also because of wasteful consumption pattern and also due to neglecting the importance of water conservation. With industrial and urban growth in India, large portion of waste water enters in the river. At the other hand, the water quality is also deteriorating due to various reasons like, due to droughts there is less amount of water is available for dilution of waste water, increased precipitation due to higher temperature, human intervention in polluting the water bodies, industrial waste put into the rivers and on open land without treating the water.

The climate change is also one of the reasons for the quality and quantity of water management. Due to additional pressure on the waste water management results into higher precipitation and which results into localized flooding and sewer flow, which might in turn negatively impact the water quality. Smart City's requirement of effective management of water and waste water is through various technological up-gradation and improved utilization of the resources. "Smart Water and Waste Water Management" includes the up-gradation of existing system through the Information and Communication Technology (ICT) intervention. Integrated water management includes rain water harvesting, water reuse/recycle and green drainage systems. 24X7 Smart Water Supply which includes efficient distribution is on the cards of the Smart Cities in India along with small Smart STP's. Smart water system implies transforming wastewater treatment plants into resource recovery facilities and engineering alternatives to design of the drainage network. Water consumption in the agricultural sector has increased after the Green Revolution with the introduction of new assortments of crops with better yields. Irrigation is one of the major factors leading to over-exploitation of groundwater sources, which is causing

depletion of water tables. Although there are no reliable facts about the industrial water consumption, but it is closely estimated at 6 to 8% (The Water Management Sector in India : an overview of research and activity, 2011)⁴.

Existing Water Management infrastructure in the Indian Cities

The water sectors in India are considered by some significant questions:

- Is Indian urban population is accessed to adequacy of safe water?
- Are there certain Institutional challenges in managing the water in India?
- How are the service provisions related to water management by the governing bodies in the urban areas of India?
- Are over-extraction of groundwater and improper distribution of water caused quality problems to the usage water?
- How important are the financial and management constraints to these governing bodies?
- Are there any Water conflicts in sharing the water in India?

The water supply sector in India is plagued with severe shortages in terms of availability, quality, and equity of services. About 30% of the total population from India lives in urban areas. This is expected to be doubled by 2050, by growing economy and changes in the lifestyle there is ample amount of stress on the water use and management. Most of the cities under water stress and no city in India does exists 24X7 water supplies. Besides, in cities with more than 10 lac people, the official water supply after 35% loss in leakages is just 125 liters/day per capita which is noticeably lower than the demand of 210 liters/day per capita. Infrastructure development and regulations have not kept pace with population growth and urbanization and as a result wastewater management has become a major challenge. Due to scarcity of available fresh water, most of the urban cities are dependent on the ground water. (Brikkés, 2015)⁵. As of 2010 only two cities from India - Trivandrum and Kota gets 24X7 water supply (Reporter, 2010)⁶. Another fact of about the Indian urban cities is that only 55% of the urban household has direct piped water home connectivity (Ramanujam, 2011)⁷. The above table gives a clear idea about the Indian water consumption pattern. This situation is a result of improper distribution, storage and networking of the piping system along with the administrative management failures.

⁴(2011). *The Water Management Sector in India : an overview of research and activity*. Indo-Italian Business Conference (IIBC), Indo-Italian Chamber of Commerce and Industry (IICCI). Mumbai and Bengaluru: European Business and Technology Centre (EBTC).

⁵ Brikkés, B. F. (2015). *Water and Waste Water International*. Retrieved November 17, 2016, from <http://www.waterworld.com/>: <http://www.waterworld.com/articles/wwi/print/volume-30/issue-2/technology-case-studies/urban-water-management-in-india.html>

⁶ Reporter, B. S. (2010, March 23). *Business Standard*. Retrieved November 18, 2016, from <http://www.business-standard.com/>: http://www.business-standard.com/article/economy-policy/-only-2-indian-cities-have-continuous-water-supply-110032300101_1.html

⁷ Ramanujam, V. B. (2011). *Addressing the Challenge of Financial Sustainability in Urban Water Supply Services—Role of Performance, Monitoring, and Planning*. New Delhi, India: Oxford University Press.

²Proquest. (2016, July 6). Retrieved November 13, 2016, from search.proquest.com: <http://search.proquest.com/docview/1801731311?accountid=38883>

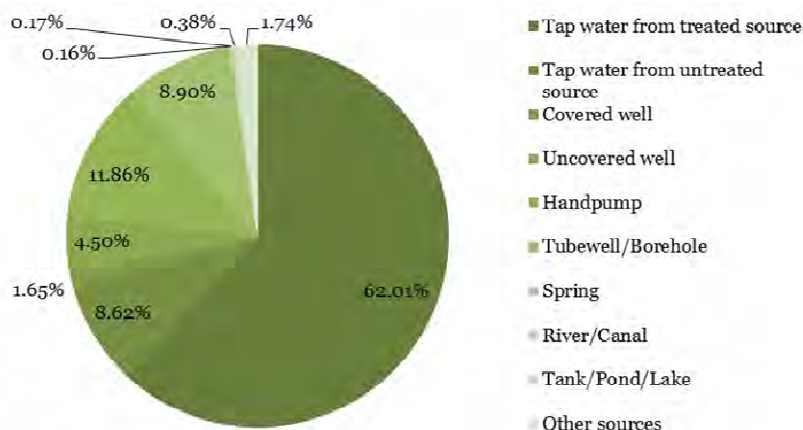
³Graniel CE, M. L. (1999). Effects of urbanization on groundwater resources of Merida, Yucatan, Mexico. *Springer-Verlag*, 37(4), 303-312.

Water Produced	Authorized consumption	Billed and authorized consumption	Billed and metered	Revenue water	Collected
			Billed and unmetered		Uncollected
		Unbilled authorized consumption	Unbilled and metered	Non-revenue water	Unbilled
			Billed and unmetered		
	Water losses Unaccounted for water	Apparent losses	Customer meter errors		
			Data errors		
			Theft		
		Real losses	Storage losses		
			Transmission losses		
			Service connection leakage		

Source: IDFC PE Research

The above table gives a clear idea about the Indian water consumption pattern. This situation is a result of improper distribution, storage and networking of the piping system along with the administrative management failures.

Distribution of household according to source of water



Source: Analysis of Census 2011 data

The above graph reflects that only 49% of the urban area household gets piped treated water in their premises. Due to poor standards of supply and services of water, most cities do not provide the quantum of water according to existing per capita norms. In addition to inadequate quantity, the water supply in almost all cities is irregular and often of questionable quality. As a consequence of poor service standards, the households need to engage in a range of coping mechanisms. The biggest one of these coping mechanisms is dependence on multiple sources of water. Household depend either on small-scale private players like tankers or on self-provisioning, typically through tube-wells or hand-pumps. The water quality is one of the biggest concerns of the urban areas.

Urban area encounters the certain challenges in terms of water management like

- Incomplete coverage
- Inadequate infrastructure for distribution and supply
- Distribution losses
- Improper operations and maintenance
- Dominance of informal supply chain
- Longer distances between the cities and the water sources
- Exhausting ground water tables

The standard for efficiency in supplying the water is indicated by allocating only two staff for every 100 connections, whereas in India it is 12 to 14 staff per 1000 connections in most of the mini-metros and which is doubled and sometimes it is 33 per 1000 connections in Mumbai Delhi

(McIntosh, 2003)⁸. Most of the survey reveals that the Water Supply stands second in the list of urban citizen's concerned area amongst the Public Transport System, Road Infrastructure, Solid Waste Management, Health Facility, Sewage/Sanitation, Storm Water Drainage System, and Education Facility

Smart Environment

India is poised to the striking growth in near future with economy is growing at a 7 to 8% per annum. At the same time the policy maker that is government's efforts are there to transform the traditional city models into the smarter cities which are smart enabled environment. The cities are self-possessed to change the existing environment to look forward to achieve more with less effort through smart usage of the technology.

The main objectives of creating smart environment are entail utilization of advanced technology, rationalization of existing as well as planned infrastructure, optimum utilization of all resources and transparency in the government working. There was a strong wish which existed since a decade to create smart environment in the country. There were so many researches undergone to understand the nuances of the smart environment. This was possible due to introduction of smart and portable devices, wireless mobile communication, prevalent computing, wireless sensor networking, robotics, and human computer interface.

⁸McIntosh. (2003). *Asian Water Supplies: Reaching the Urban Poor*. Asian Development Bank. London: IWA Publishing.

Smart environment and water management

In Smart environment the policy maker focuses on sustainable development, natural resource utilization -optimal use of water resources and energy, balance between built and green areas.

A smart environment is a small world where sensor-enabled and networked devices work continuously and collaboratively to make lives of inhabitants more comfortable. A definition of “smart” or “intelligent” is “the ability to autonomously acquire and apply knowledge”, while an “environment” refers to our surroundings. We therefore define a “smart environment” as one that is able to acquire and apply knowledge about an environment and to adapt to its inhabitants in order to improve their experience in that environment (Das, 2005)⁹. The significant features of the smart environment are that it possess a degree of autonomy, adapts to the changing environment and communicate human in natural way. With special reference to the water management of the smart cities by utilizing the smart environmental solutions, various measures can be taken in terms of water distribution, arresting water leakages, transparency in the local level governance etc.

Usage of smart solutions for effective water management

In this research paper few cities’ water management systems studied through the Supervisory Control and Data Acquisition (SCADA) software. Deloitte Touche Tohmatsu India Private Limited (DTTIPL) studied in their presentation titled “100 Smart Cities in India: Facilitating Implementation” to Indian Chamber of Commerce which has organized a “100 Smart Cities: Need for Innovation and Integrated Approach” workshop on 10th February 2015. The presentation from Deloitte was mainly covered the cities like Pimpri-Chinchwad, Surat, Bangalore etc. where the municipal corporations tried to implement the SCADA water management system(100 Smart cities in India Facilitating implementation, February, 2015)¹⁰. SCADA based solution permits collection of water flow / pressure related data at different points at different locations of the transmission and distribution network in the city. This is used to control the water flow in the network through valves and pumps. The data collected through a SCADA system is integrated through a back end ICT solution with customer / participant feedback collected through other sources like social media, service delivery call centers, websites, etc. Through this the automated responses can be generated and smart water solutions can be achieved. It is therefore possible that the cloud based ICT solution which is capable of integrating data from various sources and generating smart reports and smart solutions. It has certain benefits which are listed below:

- Savings in hardware and application cost
- Overcoming technical constraints
- Standardization of business processes
- Standardization of operating processes
- Open data standards
- Central data mining for all states
- Optimum utilization of physical resources

Analysis and discussion

Based on the literature review and the personal interview method, the data was collated and analyzed. Following are some of the important points of discussion:

- Majority of the local governing bodies failed to manage the effective distribution of water in the urban areas.
- Only 7 to 10% of the water tax is being collected against the water distributed.
- The total population residing in the urban areas is facing a challenge of getting a clean and safe drinking water supply.
- There are certain challenges ahead of urban population in India in terms of water management such as incomplete water distribution and water leakages during the distribution.

Following are few suggestions to improve the efficacy of the water management in the proposed smart cities.

1. **Reduce and/or improve the maintenance and establishment cost of water supply:** This can be accomplished by implementing the SCADA system in the various cities. This system is effective which would reduce the burden of the infrastructure cost of maintenance and management.
2. **Enhancing the availability of water per capita:** Current scenario of the water per capita in the urban areas is wretched. This situation could be improved further by implementing various plans such as mandatory rain water harvesting system to be implanted at society level, usage of sewage treated water for secondary purpose like gardening, flushing etc., and arresting the leakages in the distribution.
3. **Household with tap water:** The task of having every household tap water is challenge in-front of local governing bodies. To address this effective piping system to be used with different distribution points. Further to this one has to study the existing distribution system and Geographic’s of the city.
4. **Differential water tariffs:** this recommendation is required to collect the maximum water tax which was till date was not being paid by the users on account of various reasons. This would also improve the revenue collection, which in turn could be utilized for creating the infrastructure.
5. **Usage of universal metering and Smart Meters:** it is proposed to the local bodies to use smart meters and universal metering technique to arrest the tampering of meters and to plug leakages. This system is backed up by Geographical Information System (GIS) tool, which could be used to avoid the leakages and meter tampering.
6. **24X7 assured Water Supply Scheme:** To accomplish the assured 24X7 water supply to the urban cities in India requires the effective utilization of all water resources. This also includes taking care of all resources and managing the water tables all the time. The distribution systems need to be reworked and new effective and efficient distribution systems need to be implemented.
7. **Rain Water Harvesting:** The major reason for not having an effective water management in India is due to unavailability of water to the whole population. India’s

⁹ Das, D. J. (2005). *Smart Environments: Technology, Protocols, and Applications*.

¹⁰ (DTTIPL), D. T. (Ed.). (February, 2015). 100 Smart cities in India Facilitating implementation. “100 Smart Cities: Need for Innovation and Integrated Approach”. New Delhi: Indian Chamber of Commerce.

dependency of fresh water is mainly on the seasonal rain which is either collected in the dams, lakes, ponds or water flows through the rivers. The shortage of water could be bettered through rain water harvesting. Local governing bodies can make mandatory to the societies to install the rain water harvesting systems to improve the water tables.

8. **Dual piping system:** Some of the developing countries have already implemented the dual piping system, which can be effectively improving the usage pattern. In the dual piping system the supply of fresh drinking water and usage water distributed through different piping, hence it reduces the usage of fresh water for other purposes.
9. **Reduction in the visual leakages within 24 hours:** This suggestion need to be implemented on the priority basis as it would help in arresting the wastage of unutilized water volume. This can be implemented by using SCADA or GIS technology.
10. **Water quality monitoring:** Water quality in India is a major concern and must be addressed so as to improve the quality of water supplied. On regular intervals the local governing body should carry out required tests to know the quality of water. SOP (Systematic Operating Practice) need to be worked on and implemented.
11. **Water bodies in and around the cities should be free from mixing of drainage water or industrial waste:** In India there is no well-organized and competent monitoring and control mechanism of management of domestic drainage and industrial waste water flow, which is generally mixed with water bodies in and around the cities. Regulations and rules of disposing the domestic and industrial waste water need to be made more stringent. Heavy fine to be levied on the breaking the rule of disposal of waste water. The industries and societies should install the waste water treatment plants and after treating the water only they should be allowed to dispose the water.
12. **Techniques of finding the availability of water:** To calculate the availability of water in the marked urban area is to be mapped on Google Maps, so as to know the total volume of water available. This can be used to optimize the utilization of water.

Conclusion

With the sustained economic and social growth in India for last two decades, there is growth in the working population and headway in the industrial expansion. This has resulted in the higher demand of water. This paper studies the various factors in connection with the Smart City and Smart Water Solution. Rapid urbanization in India leads to significant challenges in terms of infrastructure, water management and transport. At present, India is poised to convert their traditional urban cities in Smart Cities. One of the big concerns in this connection is of providing smart water solution to the residents of these urban cities. In this research paper the researcher studied and analyzed the current situation and suggested things like having a SCADA or GIS systems for monitoring the water distribution and management. Water harvesting, recycling and reuse of water are the today's mantras of effective water management of the water bodies. The ultimate aim of a smart water solution is to provide 24X7 water supplies to the Smart Cities.

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