Addressing Delhi's water supply problems: taking lessons from Singapore's water management experience

P. Jain
Global Water Intelligence, New Delhi, India
prakhar.jain13@gmail.com

KEYWORDS
Delhi, water supply, reforms, Singapore, water management

ABSTRACT
Delhi is a very important metropolitan city growing at a tremendous pace in terms of population and its need for efficient and sustainable water services. Singapore is considered to be a successful water management model. It started its transformation in 1960s-1970s when it was entirely dependent on Malaysia for its bulk water requirements. That period of Singapore's water problems and other issues strike resemblance to those Delhi faces in the present- dependence on other states for raw water, polluted water sources and many others. There are numerous positive elements in the Singapore success story that can be emulated in cities such as Delhi. This paper seeks to find out whether Delhi's water reform process can match Singapore's model in key principles and the critical conditions for success of this process. The paper first reviews the Singapore water story- from a state with engraved problems of water services to establish itself as a water hub and successful model in water management. It assesses the reasons for success of efforts in Singapore. The next section discusses the Delhi water problems- the need for reforms, proposed reforms and what happened. The analysis draws on the information sourced from interviews with key stakeholders, documents available, and personal experience as a witness of the process. The paper concludes with presents key recommendations for Delhi to achieve efficient and sustainable water services taking lessons from the Singapore experience.

1. INTRODUCTION

Despite India's impressive economic growth in the last few years, it lags far behind in providing basic services to its population including quality education, healthcare and most importantly reliable and affordable water services. Access to safe and clean drinking water is one of the key elements for human development. Leave aside rural areas, the water supplies in most of the Indian cities are intermittent and inequitable. These problems can be attributed to inefficient government bureaucracy, lack of adequate policies, institutional arrangements and poor service delivery.

Given this context, there is an urgent need to rethink the way to deliver water services. This paper illustrates the case of the urban water sector in Delhi, the capital of India, wherein there is a big gap between demand and supply of drinking water with the rising population. In 2011, the total water supply was 845 million gallons per day (MGD) as against the demand of 1080 MGD (Babbar and Singh, 2011). Only 72% of the total population is covered and the average water supply per day is between two to three hours as on March 2011 (Aijaz, 2011). There are some reforms entailed, for improved service delivery but never an integrated approach has been used thus lacking in coordination among agencies and widespread corruption in the system. Therefore, there is very little success on the ground level till date. Singapore on the other hand, is one of the highly rated success model of water management. The national water utility Public Utilities Board (PUB) in Singapore is financially sustainable and provides excellent uninterrupted services to 100% of the population (Ministry of the Environment and Water Resources, 2012).

The Singapore story is well researched and documented. However, the situation for Delhi is quite the opposite. Most of the official data and documents available in public domain remain difficult to access due to dysfunctional websites, improper and mismanaged documentation in government offices. Given the lack of data available, qualitative research methods were also employed apart from quantitative tools. Key informant interviews and observational research were the primary research method used, with targeted document analysis employed as a secondary tool. Fourteen semi-structured formal and five informal unstructured interviews were conducted in total including interviewees from Delhi Jal Board (DJB), Government of NCT of Delhi, Ministry of Urban Development (MoUD) Government of India, World Bank, and two resident welfare associations. These interviewees were asked questions

after assessment of key elements in Singapore's success and their relevance in the Delhi context.

Drawing from the learning of the Delhi and Singapore experiences, the paper seeks to address the question: Will Delhi be in a position to achieve effective and sustainable water services by adopting an integrated policy approach based on the Singapore model? Even though the conclusions are in context of the Delhi, they do highlight the key considerations to be kept in mind while embarking on similar cases of developing cities in future.

2. SINGAPORE- AN EXEMPLORY CASE OF WATER MANAGEMENT

Singapore is a city-state in Southeast Asia with a population of 5.2 million and a land area of 714 square kilometres (km) in 2011 (Department of Statistics Singapore, 2012). The country receives good annual rainfall of about 2500 millimetres (mm) (Department of Statistics Singapore, 2012). However, there is limited catchment area to collect and store rainwater. Considering its geographical location, which has neither natural aquifer nor underground water, Singapore faces a serious challenge of freshwater scarcity as its population grows rapidly. In 1965, when Singapore's population was 1.9 million, the domestic demand for potable water was around 32 MGD (Tan et al., 2009). By 2011, the domestic demand rose to around 175 MGD (Department of Statistics Singapore, 2012). The total demand in 2011 including domestic, non-domestic potable water and non-potable water was around 380 MGD (Public Utilities Board Singapore, 2012).

Before gaining independence in 1965 from Malaysia, Singapore signed two bilateral agreements with the Government of Malaysia in 1961 and 1962 for import of water from the state of Johor. Under these agreements, Singapore can transfer water from Johor till 2011 and 2061 respectively at a very low price. These agreements have been in negotiations for revisal but been a huge issue of contention due to increasing water demand in both the countries.

To tackle this and become self-sufficient in water needs, Singapore adopted an integrated and innovative approach, which, together with careful planning and hard work over more than 40 years, enabled it to overcome water supply constraints and attain sustainable and cost-effective water management.

PUB is the national water agency, responsible for the collection, production, distribution and reclamation of water in Singapore. Earlier till 2001, PUB managed potable water, electricity and gas but later responsibilities of sewerage and drainage were also transferred from the Ministry of Environment. Today, its entire population enjoys continuous access to high-quality piped water. Selected indicators of Singapore's achievement are shown in Table 1.

Table 1. Performance indicators for PUB in 2011

Indicator	Value
Water supply duration per day	24 hours
Access to drinking water	100%
Access to modern sanitation	100%
Wastewater collected and secondary treated	100%
Drinking water quality (meeting WHO standards)	100%
Proportion of water consumption metered	100%
Unaccounted for water (UFW)	5%
Domestic water consumption per day	153 litres
Revenue collection efficiency	99.8%

Source: Ministry of the Environment and Water Resources, 2012

Singapore's UFW level is one of the lowest in the world. It declined from 9.5% in 1990 to 5% in 2011 Singapore's law doesn't allow anyone to make illegal connections as heavy penalties are involved if caught.

2.1. Achieving a Clean Environment- Land and River Clean-up

Singapore's independence in 1960 was followed by rapid industrial and economic development. Economic activities generated lot of waste thereby polluting the land and water. Over the years, the Singapore River and the Kallang Basin became highly polluted from the urban environment due to

population growth, explosive industrialization and unregulated discharge of domestic and industrial waste into the catchment area (Tan et al., 2009).

In 1969, the dynamic and visionary Prime Minister of Singapore Lee Kuan Yew, ordered all the relevant departments involved to engage themselves in the river clean up program (Joshi et al., 2012). By 1977, the progress was minimal on this front and the Prime Minister gave orders to expedite the process and gave a definite target. Within eight months, a master plan was prepared for the cleaning of Singapore River and Kallang Basin (Chou, 1998). The plan recognized that just using the engineering solutions to reduce the pollution are not going to work and pollution has to be stopped at the source. This included strict law enforcement for industries and relocating the hawkers, boat repair shops, and other commercial activities. By 1986, all the activities in the master plan were implemented and resettlement was complete. The government developed this area into parks, waterfronts, hotels, and other recreational spaces. The river started flowing again and fishes returned in it. The Singapore River and Kallang Basin cleanup program is a model example of strong political will and inter-agency coordination turning a highly polluted river into a beautiful and clean river.

2.2. Closing the Water Loop

Being a water scarce country, the best bet for Singapore is to reduce wastage of water to minimum. PUB successfully manages the complete water cycle from sourcing, collection, purification and supply of drinking water, to treatment of used water and turning it into NEWater, drainage of storm water.

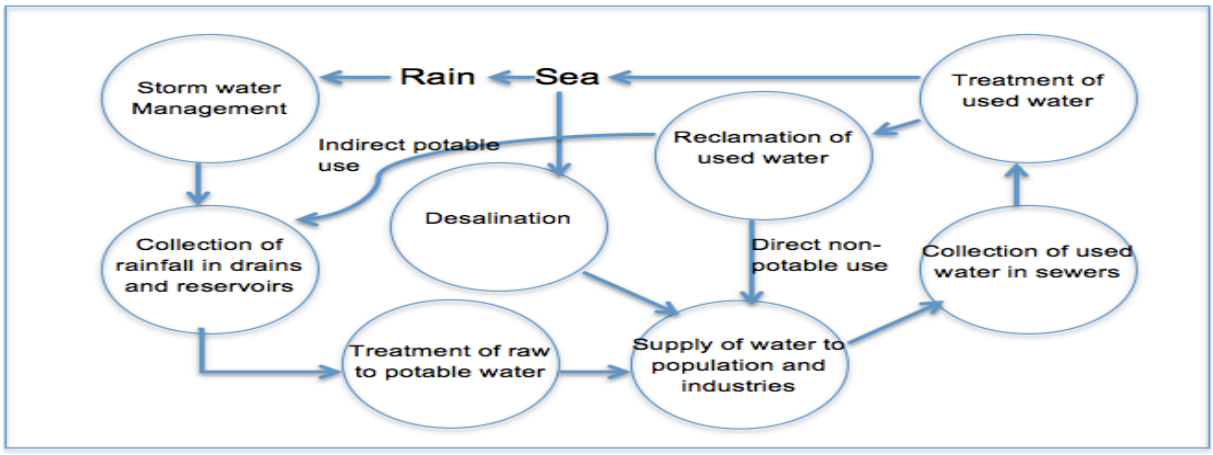

Figure 1. PUB's water loop

Singapore water strategy is founded on four pillars

2.2.1. Supply management
After 2003, to become self-reliant for it's water needs, Singapore diversified its water supply sources and established the Four National Taps, which comprise water from local catchments, imported water from Malaysia, reclaimed water (NEWater) and desalinated water.

2.2.1.1. Local catchments
Local catchment water is a very important component of Singapore's water supply. Having constraints in land area, many dams and reservoirs were built over the major rivers. In 2007, almost half of the country's area served as water catchment. By 2011, this increased to 67% of the total area due to opening of Marina, Punggol and Serangoon Reservoirs (Public Utilities Board Singapore, 2012). Singapore is also looking to use a technology that can treat water of variable salinity that will boost the catchment area to 90% by 2060 (Public Utilities Board Singapore, 2012). Effective land use planning and strict law enforcement for industries and commercial centers ensures catchment water to remain non-polluted.

2.2.1.2. Imported water
Singapore has been importing water by purchasing it from the State of Johor in Malaysia under two bilateral agreements of 1961 and 1962. The 1961 agreement expired in August 2011 that allowed Singapore to draw water at Gunong Pulai, the Tebrau River, and the Scudai River. The second

agreement runs till 2061. Negotiations to renew the first agreement were unsuccessful after Singapore denied to pay more prices than mentioned in the agreement. Singapore plans to become self-reliant after the expiry of the second agreement in 2061, if necessary, by further developing other sources of water through reclamation, desalination and increasing its catchment capacity.

2.2.1.3. Reclaimed water

In the late 1990s, major improvements were made in the membrane technology, which made it cost-effective to reclaim high quality water from used water (Tan et al., 2009). After extensive testing and successful trials, PUB in 2003 launched a large-scale water reclamation project using advanced dual membrane and ultraviolet treatment methods (the reclaimed water was branded as NEWater). The major chunk of NEWater produced was supplied to industries and other commercial customers for direct non-potable uses such as cooling, landscaping, manufacturing processes while a small amount was mixed in the reservoirs, before being further treated for indirect potable use. In 2011, after the completion of the latest and the largest reclamation plant at Changi of 50 MGD capacity and adding the previously existing four plants, NEWater constitutes 30% of the total water supplied (Public Utilities Board Singapore, 2012). PUB plans to triple the capacity by 2060, so as to meet 50% of the future water demand.

2.2.1.4. Desalinated water

Singapore is an island, there is ample amount of seawater, and so the fourth source of water is desalinated water. In 2005, with the opening of Asia's largest desalination plant in Tuas, Singapore jumped into desalination foray. The capacity of this plant is 30 MGD, which is almost 10% of country's demand. It is a privately operated and uses the technology of reverse osmosis (Public Utilities Board Singapore, 2012). Extensive R & D Is being done in this area to lower the production cost of desalinated water. In 2013, second plant of 70 MGD will be commissioned, supplying water at reduced price to PUB (Public Utilities Board Singapore, 2012). By 2060, desalinated water is projected to meet 30% of country's demand (Public Utilities Board Singapore, 2012).

2.2.2 Demand management

Singapore has adopted a very sharp pricing strategy with provisions for the poor. PUB's policy is to recover all the cost from water extraction, treatment and supply as well as to reflect the scarcity of water. The current structure of tariff for potable water includes a water tariff, water conservation tax (WCT), waterborne fee and sanitary appliance fee. Sanitary appliance fee and waterborne fee are levied to offset the cost incurred in treating sewage and maintain and operate the sewerage network (Public Utilities Board Singapore, 2012). Government progressively increased the tariffs between the period of 1997 and 2000, remaining unchanged thereafter.

PUB has used many public campaigns and awareness programs to encourage water conservation amongst the masses. As early as in 1971, "Water is precious" campaign was launched. There are numerous other examples such as water-efficient homes (WEH), 10-liter challenge, water voluntary groups, water efficiency fund and 10% challenge.

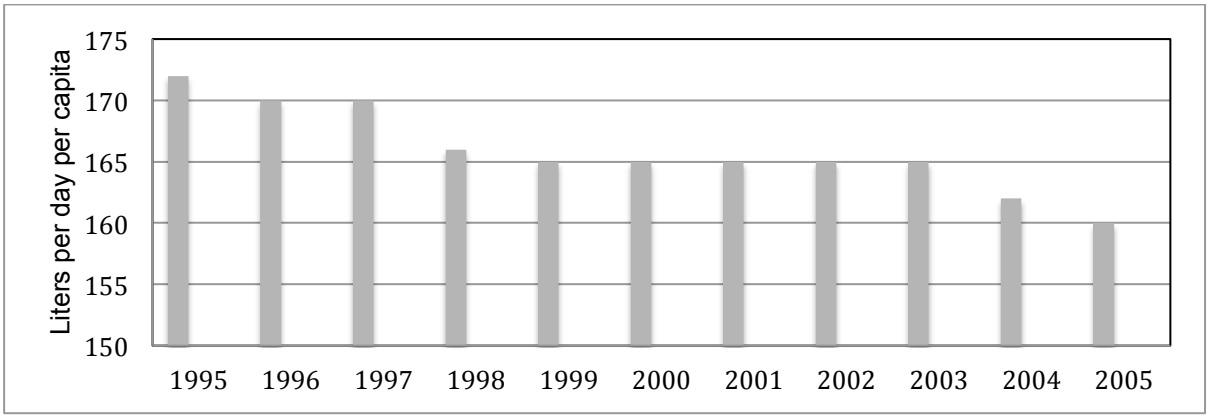

Figure 2. Domestic Water Consumption, 1995-2005 (Source: Tortajada, 2006)

Figure 2 shows a steady decline in per capita domestic water consumption over the period 1995-2005 because of the implementation of demand management practices.

2.2.3. Wastewater management

Singapore has come a long way from using night soil buckets to one of the most advanced wastewater management system in the world. In 1965, when the country gained independence, only 45% of its population had access to proper sanitation. A sewerage master plan was developed in the late 1960s and by 1997, Singapore was 100% covered with modern sanitation (Tan et al., 2009). Heavy investment was made in wastewater infrastructure.

Wastewater is collected through a network of underground sewers that is sent to the sewage treatment plants also known as Water Reclamation Plants (WRPs) where they are secondary treated, a portion is directed to the NEWater plants as its feed and the rest is disposed in the sea (Tan et al., 2009).

PUB is developing a Deep Tunnel Sewerage system (DTSS) as part of its continued efforts for efficient wastewater management. DTSS is being used to centralize the wastewater treatment at two large WRPs- Changi WRP at the eastern end and Tuas WRP at the western end of Singapore. Two tunnels called as South Tunnel and North Tunnel will crisscross the island and connect with these WRPs. This centralization helps in greater economies of scale and cut costs in treatment in the long term.

2.2.4. Storm water management

Singapore has a bad history with floods. Floods were very common during 1950s-1970s. Huge investment of more than $1.6 billion was pumped into improving drainage in a span of 30 years before 2008 to build large-scale infrastructures such as Bukit TImah scheme and Marina barrage (Public Utilities Board Singapore, 2012).

3. DELHI WATER WOES: NEED FOR REFORMS

Delhi is the capital city of India with a population of 16.7 million (Census2011, 2012). The National Capital Territory (NCT) of Delhi covers an area of 1486 sq. km. with an urban area of 525 sq. km. Municipal Corporation of Delhi (MCD) governs 94% of the total urban area while New Delhi Municipal Corporation (NDMC) and Delhi Cantonment Board (DCB) governs 3% of the area each (Babbar and Singh, 2011). Delhi Jal Board (DJB) was constituted in 1998 though Delhi Jal Board Act after scraping the erstwhile Water Supply and Sewerage Department to manage water and wastewater services in the MCD area. In New Delhi Municipal Corporation (NDMC) and Delhi Cantonment areas, treated water is supplied in bulk by DJB with responsibilities of water distribution and sewage collection lying with the respective local bodies.

Delhi's raw water needs are met by both surface water and groundwater sources. Water from Yamuna River, Ganges River, Ravi-Beas River and groundwater adds to 915 MGD of raw water availability for Delhi.

DJB has commissioned 10 Water treatment plants (WTPs) with total installed capacity of 932 MGD. However, not all WTPs are functioning currently. Most of the WTPs are located in East Delhi and North Delhi so, for intra-city distribution and rationalize it, Underground Reservoirs (UGRs) as storages have been planned. Water from the rising mains of WTPs is sent to UGRs and further distributed from there through Booster Pumping Stations (BPSs). Entire Delhi is divided into 107 UGR command zones. Out of 107, 90 UGRs are already commissioned, 12 UGRs are under construction, and 5 UGRs are in the tender or land acquisition process. However, there are still some direct connections from the rising mains and have to be disconnected in due course of time (Babbar and Singh, 2011).

3.1. Present Status

Selected performance indicators of DJB are shown in Table 2.

Table 2. Performance indicators for DJB in 2011

Indicator	Value
Water supply duration per day	2-3 hours
Access to drinking water	72%
Access to piped sewers	55%

Drinking water quality (meeting WHO standards)	99%
Proportion of water consumption metered	55%
Non-revenue water	52%
Domestic water consumption per day	191 litres
Cost recovery	42%
Efficiency in Complaint redressal	73%

Source: Babbar and Singh, 2011

Delhi's non-revenue water (NRW) level is one of the highest in the world.

3.1.1. Service delivery

There is a big gap in the water demand and water supply for Delhi due to rapidly rising population. The DJB has predicted the demand and supply for 2021 based on the numbers from 1990 to 2010 shown in Figure 3.

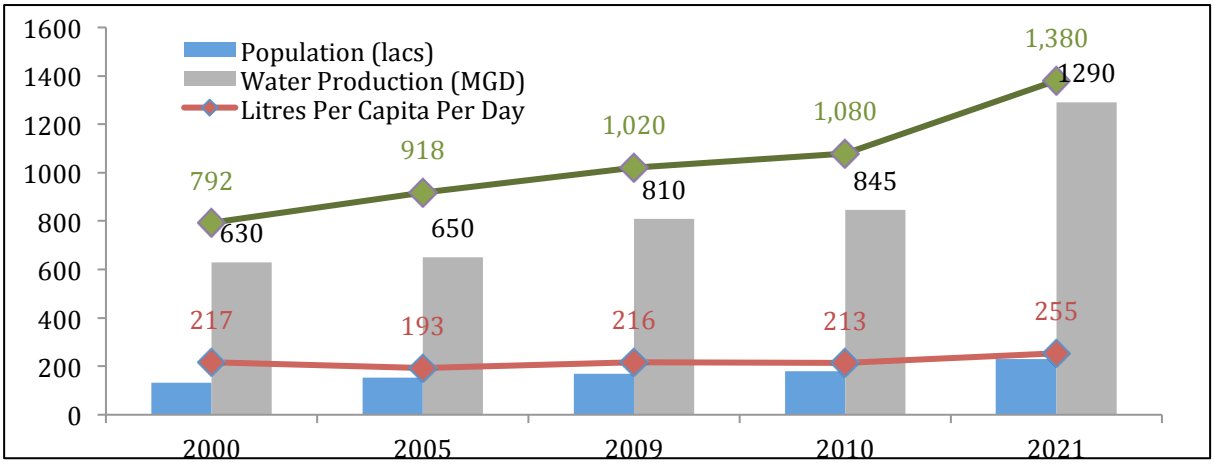

Figure 3. Supply-demand gap, 2000-2021 (Source: Babbar and Singh, 2011)

Figure 3 shows Demand for water in 2010 was 1080 MGD and supply was 845 MGD (including the water after optimization of WTPs to operate above installed capacity). The actual water supply to consumers taking into account losses in distribution is even lesser, intermittent and inequitable.

Wastewater management in Delhi is highly inadequate with only 55% of the population covered by conventional sewerage system and 15% of the population with onsite sanitation systems (AECOM, 2011). Of the estimated 640 MGD wastewater generation, only 360 MGD is getting treated at the 18 Sewage Treatment Plants (STPs), which have installed capacity of 514.4 MGD (Delhi Jal Board, 2012). Rest is released in River Yamuna without treatment. Sewers are in bad shape due to over-silting. Also there is no proper separation between stormwater drains and wastewater sewers that causes overflowing in them.

The infrastructure of water pipes, sewers, drains, and pumps is in very bad condition and need to be rehabilitated on an urgent basis. Some sewers are as old as 40-50 years.

3.1.2. Financial sustainability

Over the years, there is a persistent deficit in revenue account of DJB. This deficit is funded through loans from the Government of NCT of Delhi or multilateral development agencies and donors such as World Bank, Asian Development Bank etc. making the utility debt-ridden. According to an estimate by Japan International Cooperation Agency, $2 billion would be required in the next 10 years to continue with the reform projects such as refurbishment of old infrastructure, complete restructuring and rezoning, construction of new WTPs and STPs, etc. (Babbar, 2012).

DJB revises the water tariffs on a regular basis. Revenue earned through tariffs is still not enough due to low level of metering and high number of leakages, pipe bursts, unauthorized and unbilled connections.

3.1.3. Institutional structure

DJB suffers from grave institutional problems with respect to autonomy and accountability. Almost

every major decision has to be approved by the political class in Delhi. Although, DJB has full mandate to decide tariffs, it is generally difficult for them to do it independently. Presence of an independent economic regulator is required for full cost recovery and protects interests of consumers.

DJB is highly overstaffed that lacks accountability at all levels. There is no proper system in place to monitor their performance and give them performance-based bonuses and compensations.

3.2. Proposed or Ongoing Reforms

Several reforms have been proposed over the years by different agencies working with DJB. Many of them have already been initiated while others are in pipeline or some are rejected.

3.2.1. Private sector participation

In the early 2000s, DJB decided to rope in World Bank and a consulting firm PricewaterhouseCoopers (PwC) to prepare a report as part of the reform process. The report proposed to give Operation and Maintenance (O&M) contracts of two command zones to private players. Tariffs were also increased in December 2004 after a gap of 6 years to make the utility financially viable (PricewaterhouseCoopers, 2005). However, a strong campaign by local action groups in later half of 2005 managed to force the government to put the privatization on hold.

Since then, DJB has continued with the reform process quietly. Recently, it implemented three pilot projects in Malviya Nagar UGR, Vasant Vihar UGR, and Nangloi WTP on the public-private-partnership (PPP) model. Proposals for outsourcing meter reading and billing, privatization of tanker water supply are doing the rounds (Sampat and Koonan, 2012).

DJB is taking these reforms very cautiously. However according to Urban Water lead at World Bank Water and Sanitation program in New Delhi, “Opposition to privatization is bound to happen but seeing the bad condition of services now people are realizing that something has to be done and there is general increase in acceptance to private sector involvement in the country”. She elaborates further by adding that, “It is very important to use right terminologies, the pilot projects are not even PPP but service delivery based management contracts where assets, tariff setting will lie with DJB and O&M by private companies. Fee will be given to these companies by DJB based on performance based milestones” (Bhatnagar, 2012).

3.2.2. Three-tier supply system

The Water Master Plan 2021 (WMP21) being prepared by Japan International Cooperation Agency (JICA) for DJB has proposed a three-tier system for uninterrupted and equitable water supply. The system will also ensure extension to outer areas, reduction in NRW and lesser energy consumption. The city of Delhi would be divided into 15 WTP command zones. Those zones would be further divided into 125 UGR zones each having population of around 200,000 people and 40,000 connections. And then these UGR zones would be divided into 1,000 to 2,000 District Metered Areas (DMAs) each having population of around 10,000 to 20,000 people and 2,000 to 4,000 connections. Each WTP command zone, UGR command zone and DMA would be connected to SCADA system, flow and control meters (Babbar and Singh, 2011).

3.2.3. Supply augmentation

Considering the future raw water needs, three dams have been proposed upstream on the River Yamuna namely Renuka Dam in Himachal Pradesh, Kishau and Lakhwar Vyasi Dams in Uttrakhand. These dams when completed will provide additional 865 MGD (Delhi Water Board, 2012).

However, these projects are stalled due to one reason or another. The previous Minister of Environment and Forests (MoEF) Mr. Jairam Ramesh said in 2010, “Delhi must learn to use the tougher options that are available. It simply cannot be parasite on the rest of the country” (Jebraj and Ramachandran, 2010).

DJB is banking on these projects to augment its water supply. But the uncertainty of their completion, in a country like India, is very high. A Chief Engineer at DJB argues that NGOs and environmentalists are very active in India and they don’t let these multipurpose projects get through very easily. DJB should consider alternatives of this scenario (Babbar, 2012).

3.2.4. Water reclamation

A water reclamation project began in 2012, to carry the untreated wastewater from the Coronation drainage zone to a new 40 MGD Water Reclamation Plant (WRP) through proposed Burari Sewage Pumping Station linked to the interceptor sewer (Temasek Foundation, 2012). This project is aimed to augment the Delhi's water supply though recycling treated wastewater on a sustainable basis. The treated water will be pumped about 12 km to River Yamuna near Palla so that the same can be mixed with the river water and taken up at Wazirabad for further treatment and distribution to the consumers. When asked about the rationale of mixing reclaimed water into a polluted River Yamuna, Chief Engineer of DJB clarified that this will further add to self-purification through aeration and the important thing to note is River Yamuna is fairly clean in this stretch without considerable pollution (Tyagi, 2012).

3.2.5. Institutional restructuring

PricewaterhouseCoopers (2005) suggested establishment of a regulatory commission for the purpose of economic regulation (setting tariffs), framing and enforcing service standards, and policy support to various agencies involved. This regulatory commission would be independent, fully autonomous, transparent and accountable. All the information to remain in public domain and proper consultations with various stakeholders were recommended.

DJB has been very progressive regarding computerization of various systems. Project monitoring system (PMS), MIS, customer service centers, personnel information and payroll management system, digital mapping using GIS and revenue management system are some of the projects DJB has undertaken over the years. According to Superintendent Engineer in Reform Project Cell of DJB, DJB has written a new success story in terms of IT reforms (Singh, 2012).

A communication plan will be designed and implemented that ensures effective consultation and engagement with all the stakeholders-external and internal. They include consumer associations, B employees, government agencies, NGOs, donors, and media. The plan shall try to reduce information asymmetry between the stakeholders.

4. DISCUSSION AND CONCLUSIONS

There are some intriguing parallels between Singapore of the late-1970s and Delhi of the present. Poverty, economic uncertainty, and a living environment defined by polluted rivers and streams, unmanaged catchments, water rationing, unhygienic street hawkers, and smoke-emitting/effluent-discharging industries were a reality faced by Singapore in 1970s. The transformation of Singapore from such a state to the present prosperous city has taken in the last 40 years. Singapore invested heavily to promote economic growth, embarking on an aggressive strategy of industrialization. However, the interesting part here is that Singapore despite of rapid industrialization and urbanization, managed to turn itself into a clean and green city.

It is worth noting that Singapore is one of the most densely populated countries in the world and faces a scarcity of raw water to meet the ever-increasing demand, similar to Delhi. The solutions to water management emerged from a strong leadership providing a clear vision of achieving environmental and water sustainability. The water story of Singapore is remarkable.

Delhi water reforms are nowhere close or match Singapore's integrated water management model due to multiple problems most notably lack of effective planning and execution. There are some recommendations from the research for Delhi to improve its water services and bring reforms:

4.1. Land-use planning

Taking lessons from Singapore's long-term land-use planning, the first step for Delhi should be to start with the clean up of River Yamuna- main source of water for Delhi. Also the problem of slums and JJ clusters has to be solved on an urgent basis by regularizing the unplanned colonies and making alternative settlements simultaneously. Effluent and solid waste discharges from industrial and commercial activities have to be regulated with effective policy implementation and law enforcements. A comprehensive plan should be developed giving all the relevant agencies a framework with their respective targets. Instead of just using engineering or hardcore technological solutions, the main target must be to stop the pollution from entering the river by looking at soft management solutions as well.

4.2. Have Effective Institutional Management

Delhi needs a strong leadership with political will and that works towards the vision of making water services in the city sustainable and efficient. This kind of leadership was quite visible during Singapore's transformation first by the Prime Minister Lee Kuan Yew and later by others. According to Meadows (2000) Singapore enjoys benevolent dictatorship in which the authoritarian government exercises political power for the benefit of the whole population. This makes easier for the leadership to make quick decisions and law enforcement for the benefit of the public while India being in a multi party democratic set-up, has ineffective and slow implementation of policy. At the same time politicians should limit themselves in policy matters and not interfere in day-to-day operations of DJB by clearly separating policy and delivery. DJB should become the nodal agency for all work related to water and sewerage services.

DJB as an institution need radical restructuring. It should work like a corporatized public. The Chief Minister of Delhi should not be the defacto chairperson of DJB to shield itself from direct political interference. Other board members should also be selected from industry, academia or Indian Administrative Services (IAS) and who are competent for the job based on merit. The intelligent thing to do is to make few senior bureaucrats from agencies that work hand in hand with DJB (such as MCD, NDMC, DCB, DDA, PWD, Upper Yamuna Board) as Board of Directors. These people must be apolitical and work only towards the betterment of DJB.

PUB attracts, nurture and retain talent through effective human resource policies. Remuneration packages of PUB employees are equivalent to private sector employees. In 2004, PUB moved from fixed salary approach to performance based salary and incentives. Promotions are also based on employee's performance and potential, irrespective of the seniority.

PUB invests heavily in training programs, scholarships to employees for further education, leadership programs. It also gives scholarships to young students to study in the field of water management to create future water leaders. Employees are given exciting opportunities such as sending them abroad to work with other organizations or attached with other departments in the government to realize their true potential and keep them motivated.

Similar things can be easily done at DJB. Officers and executives at all other levels also should be selected on the basis of merit and given competitive salaries and other incentives so as to create a "work culture".

4.3. Adopt Integrated Approach

DJB have to look at the problems and try to solve them in an integrated manner. In the context of Delhi, it means closing the water loop by effective wastewater management. Wastewater generated has to be treated to better standards and fed back in the system for potable or non-potable uses. Water reclamation looks very promising and can be the next "Aladdin's lamp" for Delhi.

"More water syndrome"- DJB's main focus is augmenting its water supply capacity. It is now accepted worldwide that for smooth running of a water utility, demand management is equally important as supply management (Rouse, 2012). India's father of the nation, Mahatma Gandhi rightly said, "There is enough for everybody's need, but not enough for anybody's greed". To put it objectively, while Singapore is investing so much energy, time and focus in demand management through water conservation, Delhi has no such vision.

Demand management can be handled in multiple ways. First, extensive water conservation programs should be launched by DJB, bringing in Bollywood stars to promote them and tailoring them to suit the public creating a win-win situation for both the utility and consumers.

4.4. Attain Sustainable Cost Recovery

Consumer is to be made pay for every drop of water since it can't be considered a free commodity as there are costs involved in extraction, treatment and transmission. Full cost recovery of water and wastewater services makes a utility viable and helps it to run and operate smoothly without any financial constraints.

DJB should make water pricing an effective instrument to recover costs. Many surveys have proved that consumers are willing to pay more if they get improved services. The second thing that has to be done is NRW reduction by reducing losses and tapping unauthorized and illegal connections.

4.5. Ensure Stakeholder Participation- Especially the Consumers

There is a need for proper stakeholder mapping before embarking on any reform project. The mapping identifies the stakeholders, their payoffs, and their resources for influencing the outcome. The aim of DJB should be to enhance the influence of those who are supporting the reforms, inform and satisfy the neutrals and closely manage and accommodate those who are opposing them.

Public participation is very important and fruitful in most scenarios. PUB for example, to create awareness and enhance public acceptability of NEWater created a whole new marketing strategy. A NEWater visitor center was established where school students, tourists, government bureaucrats and other people visit to learn about NEWater, witness its production process and understand its role in the overall water strategy. Kiosks were placed in malls and public areas for public to taste NEWater. Recently in 2006, PUB kick started another massive program called ABC (Active, Beautiful, Clean) waters. ABC waters program is of 20 years length and is to develop communal spaces near the beautiful and clean rivers, streams and reservoirs. Many recreational parks, water sports facilities, and other areas have been built as part of this program.

These initiatives bring public closer to water and they appreciate the value of water, conserve it and clean it.

4.6. Bring in Innovation

To meet future demands; DJB should invest in R&D of new technologies and available techniques as Singapore have been doing. Also transfer of technology from countries like United States of America, Singapore, Israel, Japan, and Korea can be made easier with bilateral partnerships with the governments and industries. R & D centers can be set up with the help of premier technical hubs of the country such as Indian Institute of Technology (IIT), Indian Institute of Science (IISc) and National Institute of Hydrology.

Although, the entire picture is not gloomy and there are some positive signs but still a lot more can be learned from the Singapore model. Lastly, one has to be proactive and learn from past mistakes. It is very difficult to bring any good in India especially in public services because of the environment. But with determination and hard work everything is achievable. The paper would have served its purpose if it contributes to that end.

ACKNOWLEDGEMENT

This paper is extended version of the masters thesis research done in 2012. Grateful acknowledgement is made to the Delhi Jal Board of Delhi and Public Utilities Board of Singapore, for providing up-to-date information on which some of the analyses are based.

REFERENCES

AECOM, 2011. Consultancy Services for Preparation of Master Plan for Sewerage System of Delhi for the Year 2031 (Monthly Progress Report). New Delhi, India.

Aijaz, R., 2011. Water crisis in Delhi [WWW Document]. India seminar. URL http://www.india-seminar.com/2011/626/626_rumi_aijazi.htm

Anil Bhardwaj, 2012. .

Babbar, V.K., 2012. .

Babbar, V.K., Singh, V., 2011. Towards rational capital water supply system.

Census2011, 2012. Delhi Population Census data 2011 [WWW Document]. URL http://www.census2011.co.in/census/state/delhi.html

Chou, L.M., 1998. The cleaning of Singapore River and the Kallang Basin: approaches, methods, investments and benefits. Ocean & Coastal Management 38, 133–145.

Delhi Jal Board, 2004. Delhi Water Supply and Sewerage Sector- Reform Project.

Delhi Jal Board, 2012. Water Supply and Sanitation.

Department of Statistics Singapore, 2012. Yearbook of Statistics Singapore 2012.

Dutta, V., Chander, S., Srivastava, L., 2005. Public Support for Water Supply Improvements: Empirical Evidence From Unplanned Settlements of Delhi, India. The Journal of Environment Development 14, 439–462.

Jebraj, P., Ramachandran, S.K., 2010. Environment Ministry blocks Renuka Dam project. The Hindu 04.
Joshi, Y.K., Tortajada, C., Biswas, A.K., 2012. Cleaning of the Singapore River and Kallang Basin in Singapore: Economic, Social, and Environmental Dimensions. International Journal of Water Resources Development 28, 647–658.
Meadows, D., 2000. Singapore Leads the Good Life Under a Benevolent Dictator [WWW Document]. Sustainability Institute. URL http://www.sustainabilityinstitute.org/dhm_archive/index.php?display_article=vn210singaporeed
Ministry of the Environment and Water Resources, 2012. Key Environment Statistics.
PricewaterhouseCoopers, 2005. Delhi Water Supply and Sewerage Project- Project Preparation. Delhi Jal Board.
Public Utilities Board, Singapore, 2012. PUB Annual Report 2010/11. Public Utilities Board, Singapore, Singapore.
Rathore, S.S., 2012. .
Rouse, M., 2012. Demand management for a water utility.
Sampat, P., Koonan, S., 2012. Delhi Water Supply Reforms: Public-Private Partnerships or Privatisation? Economic and Political Weekly XLVII.
Singapore. Ministry of Communications and Information. Information Division, Singapore. Ministry of the Environment, 1987. Clean rivers : the cleaning up of Singapore River and Kallang Basin. Ministry of the Environment, Singapore.
Tan, Y.S., Lee, T.J., Tan, K., 2009. Clean, Green and Blue: Singapore's Journey Towards Environmental and Water Sustainability. Institute of Southeast Asian Studies.
Temasek Foundation, 2012. Singapore Shares Its Experience In The Planning And Design Of Recycle And Reuse Of Treated Sewage / Wastewater And Development Of Public-Private Partnerships (PPP) Framework With Delhi Jal Board, India [WWW Document]. Temasek Foundation. URL http://www.temasekfoundation.org.sg/news-media/news-releases/details/singapore-shares-its-experience-in-the-planning-and-design-of-recycle-and-reuse-of-treated-sewage-wastewater-and-development-of-public-private-partnerships-ppp-framework-with-delhi-jal-board-india-
The Times Of India, 2012. Renuka dam project faces delay. The Times Of India.
Thind, V.S., 2012. .
Tortajada, C., 2006. Water Management in Singapore. International Journal of Water Resources Development 22, 227–240.
Tyagi, R.S., 2012. .
Vandana Bhatnagar, 2012. .
Vikram Singh, 2012. .
Zérah, M.-H., 2000. Water: Unreliable Supply in Delhi. Manohar [and] Centre de Sciences Humaines. n.d. .