Working Paper 505

Benchmarking of Bangalore Water Supply and Sewerage Board (BWSSB)

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Published and Printed by: Institute for Social and Economic Change
Dr V K R V Rao Road, Nagarabhavi Post,
Bangalore - 560072, Karnataka, India.

ISEC Working Paper No. 505 December 2020

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ISBN 978-81-951228-3-7

Working Paper Series Editor: **M Balasubramanian**

BENCHMARKING OF BANGALORE WATER SUPPLY AND SEWERAGE BOARD (BWSSB)

Kavya Shree K[1] and Krishna Raj[2]

Abstract

This paper attempts to assess the performance of the urban local body, Bangalore Water Supply and Sewerage Board (BWSSB), by applying international benchmarking standards. The performance of BWSSB is assessed for the periods 2015-16 and 2017-18. The benchmarking indicators are drawn from IBNET, World Bank and ADB. There are two components of indicators used for the assessment –firstly technical and operational indicators and secondly financial indicators. The secondary data for the study was collected from BWSSB and one-to-one discussion was held with its officials for in-depth understanding of the performance of BWSSB. For cross verification of BWSSB data, supplementary data from Census 2011, BBMP and Karnataka Slum Clearance Board were collected. Based on these data sources, the technical and financial performance indicators were calculated to assess the performance of the board. The overall efficiency of BWSSB is assessed with respect to actual versus the potential water supply for the years 2016 - 2018. The results of benchmarking for technical, operational and financial indicators show that BWSSB does not meet most of the international benchmarking indicators for the study period.

Keywords: *Water Supply, Bengaluru water, BWSSB, Performance, Benchmarking, Technical-Operational Indicators, Financial Indicators, IBNET, World Bank*

Introduction

Cities are places where much of the economic activity and interaction is concentrated regularly on a small piece of land. Today, much focus and economic development flows towards metropolitan cities which have a core area with a large population nucleus, together with adjacent communities that have a high degree of economic and social cohesion with the core. As the economic activity gets crowded into a small piece of land, the demand for efficient delivery of services, especially public utility services, reaches a crescendo. Along with the increasing demand, these public utilities such as water and electricity attract huge capital investments in order to increase their supply. But the policies which are drafted to allocate these resources are not based on Pigovian Taxes or Coasian Property Rights or in general any economic rules. These services are often forced to be provided either free or at a subsidised price as they are considered as public goods which ideallyshould not attract a market price.

Water as a commodity and its delivery attract two kinds of externalities – One, the government has to provide potable water to a majority of its consumers. If they fail to do so, then access and consumption of unhygienic water by even a small percentage of people in the city might expose consumers to communicable diseases. Another externality occurs when water is supplied from a common public water supply system. Apart from the public piped water supply system, high income households also have access to private water sources such as borewells, open-wells, water tankers etc. Fresh water availability in the case of wells, borewells etc. is subject to short run extraction: the more water one pumps from a private borewell, the deeper another person has to drill to get access to water.

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In such cases, there is a high possibility of brackish underground water seeping into the water table, thereby affecting the health of everyone using the water. So, people are better off if they use public piped water supply rather than relying on aprivate source of water.

Both the externalities mentioned above work on the principle of second best. According to this principle, the price of such commodities should be lower than their Marginal Cost. The same applies to water as well. Both the externalities highlight the need to consider water as a common pool resource and distribute it using a natural monopoly. In the case of Bengaluru, the natural monopolist responsible for supplying water to the city is the Bangalore Water Supply and Sewerage Board (BWSSB). Another perspective of looking at this could be that due to the status of a natural monopoly enjoyed by the institutions supplying public goods, often the need for benchmarking the institutions does not arise due to lack of competition. This may result in inefficiency and thereby wastage of limited available public goods. In such a case, annual benchmarking of these natural monopoly institutions becomes imperative.

Benchmarking of public utilities is a common process in developed countries, especially in Europe and North America, where public utilities are benchmarked annually (Cabrera *et al*, 2013). Benchmarking ensures the public utilities are aware of their performance and take remedial steps to achieve benchmark targets in areas in which they are under-performing. This also brings in efficiency. Unfortunately, this process is not adopted by Indian public utilities and isworse with respect to metro cities. The main reason for not benchmarking public utilities is the unavailability of authentic continuous data and technical expertise to do it. This paper attempts to fill this research gap by benchmarking BWSSB's performance for the years 2015-16 and 2017-18 against international targets. Annual benchmarking starting from the year 2015-16 was not possible due to unavailability of data. Hence only for the two static time periods mentioned above is BWSSB benchmarked for its performance.

To set a background for the benchmarking, the first section of the paper provides information about the study environment with respect to water resource including water source, water gap and the water distribution system followed by BWSSB.

Study Area – Bengaluru

Bengaluru has a total population of 65,37,124 as of Census 2011.Of this, the Urban population accounts for 90.94 per cent with 57,59,987 persons residing here. From the past few years, the population in the city has been exponentially expanding, thereby putting more stress on the already strained water sources.

Bengaluru lies in the catchment of the Cauvery river basin, which is the main water source for the city. The city receives approximately 1310 million litres of water per day (MLD). This is then distributed to the entire city, which covers an area of about 758 km^2. Prior to the dependence on Cauvery, 20 per cent of the city's water was supplied from Arkavathi river, which has two reservoirs, the Hesaraghatta and the Thippagondanahalli (T G Halli). Unfortunately, due to overexploitation of groundwater, poor maintenance of its watershed and the changing land use pattern, the reservoirs have gone dry (Singh & Singh, 2002). Hence the city's lone water source is Cauvery. In 1969, to meet the increasing need for water, the Cauvery Water Supply Scheme project was commissioned with the IV

Stage Phase2 under implementation. The city receives a total gross water supplyof 1310 MLD, which gets treated at the Torekadanahalli (T K Halli) Water Treatment Plant, then pumped to Harohalli plant and later to Thatguni plant before finally reaching the city reservoirs. The break-up of water received through CWSS Stages is mentioned in table 1 below. From the reservoirs, it is then supplied to the end users with a complex distribution network of 8746 km.

Table 1: CWSS Water Source to Bengaluru City – 2018

Sl No.	Sources	Year of Commissioning	Distance to Bengaluru (Kms)	Installed Capacity (MLD)	Present Supply (MLD)
2	Cauvery Stage I	1974	100	135	135
3	Cauvery Stage II	1982	100	135	135
4	Cauvery Stage III	1993	100	270	270
5	Cauvery Stage IV Phase-I	2002	100	270	270
6	Cauvery Stage IV Phase-II	2012	100	500	500
	Total Supply			**1310**	**1310**

Source: BWSSB reports

The important aspect to note with respect water supply in Bengaluru is the water treatment plant at TK Halliwhich is at an elevation to 540 m when compared to the city's reservoirs. Also, the distance between the water treatment plant and reservoir is about 100 km. This long distance increases not only the operating costs but also the probability of water leakage and seepage.

Gap Between Demand and Supply of Water

Quantity of Water Demanded and Supplied

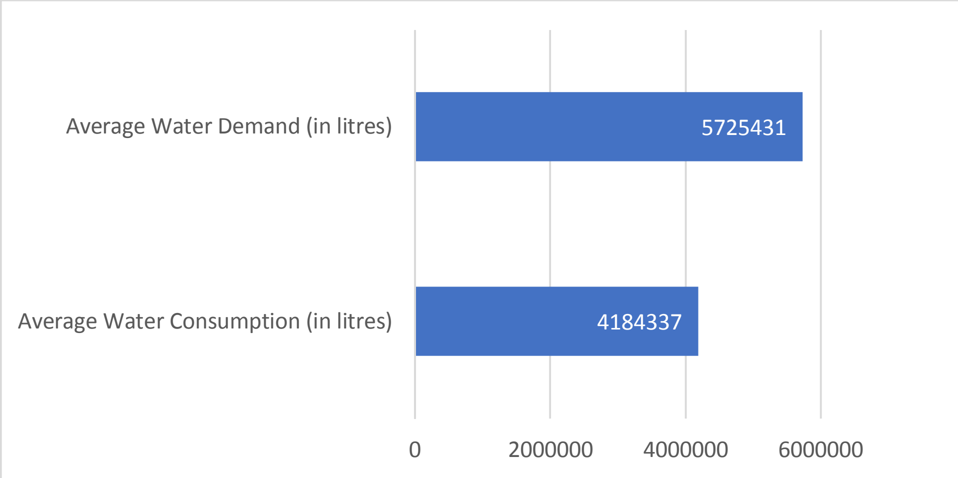
Bengaluru suffers from acute shortage of water especially during the summer season. Further, the intensity of water requirement and shortage for the city is evident from the increased number of private water tankers supplying water to the city in an unsustainable manner. Water shortage is also highlighted from the fact that the supply of water to the households, which was on alternate days earlier,has now been reduced to a supply of once in three days.

Growing Gap between Water Demand and Supply

The following section details the gap between water demand and water supply for various zones of Bengaluru. The demand for water is calculated at both standards – WHO standard of 150 lpcd and MoUD standard of 135 lpcd.

The water demand is calculated by multiplying the average population of urban Bengaluru with 135 lpcd of water. Average water consumption is calculated using the ward-wise water consumption data given by BWSSB. The gap between the two is shown in Figure 1 below:

Figure 1: Water Demand and Consumption Gap for Bengaluru Urban at 135 lpcd – 2018



Source: Author's Calculation using BWSSB data

The gap accounts for 23 percent, which means that there is water shortage in Bengaluru to the extent of 23 per cent.

Bangalore Water Supply and Sanitation Board – Institutional Framework

According to the Bangalore Water Supply and Sewerage Board Act 1964, the task of providing formal water supply to the Bengaluru city resides with the urban local body, Bangalore Water Supply and Sewerage Board (BWSSB). Prior to setting up of BWSSB, water supply to the city was provided by Bangalore City Corporation and Karnataka Public Works Department (KPWD). The two bodies were merged to create BWSSB. BWSSB's service area covers the entire Bruhat Bengaluru Mahanagara Palike area of 800 sq. km, which comprises Bengaluru core area of 245 sq. km, 8 urban local bodies of 330 sq. km (7 city municipal corporations, 1 town municipal corporation and 110 villages of 225 sq. km.)

With respect to administration, the board has a Chairman and the State Government appoints the other seven members of the board. Three Chief Engineers in the board are appointed by the State Government – one for Maintenance, Water Supply & Sewerage system, one for Project Wing of the board, one exclusively for the Cauvery Project. On day-to-day matters of administration, the financial adviser, CAO-Secretary, Additional Secretary, Personal Manager, Public Relations Officer, CAO [R] and other officers assist the Chairman.

The Act also clearly stipulates the board to be financially self-sufficient through user-fees. According to the clear mandate in the board Charter, the BWSSB enjoys both budgetary and personnel management autonomy. But studies show that BWSSB is making losses financially for more than a decade now (Sastry, 2006);(Smitha & Sangita, 2008); (Raj, 2013); (Mukherjee *et al*, 2015). Since water cannot be considered as a purely economic good, pricing of the good always falls short of the economic principles. But it must be remembered that the board incurs a huge cost in providing the required water service to the city. The BWSSB Act 1964, amended in 1966, also mandates that the board should levy rates, fees, rentals and other charges from time to time to provide sufficient revenue to cover its operating and maintenance expenditure, depreciation costs, for repayments of loans and other borrowings along with annual new capital improvements; but this has not been achieved, mainly due to frequent changes in political affiliations and interventions in providing water to the city. The second most important challenge causing a huge financial burden to the board is the high infrastructure cost in delivering water to the city. This is because treated water has to be delivered to the city from a distance of 100 km and a height of 540 meters, imposing a very high electricity cost to the board. **As on February 2017, for one million litres of water pumped, the electricity charges which were paid to KPTCL were Rs. 8411.18**. For 2014-15, the total electricity charges account for 39 per cent of the total expenditure.

Apart from political interference and high infrastructure costs, the major challenges facing the board area rapid increase in demand for water due to unplanned urbanisation, increasing operation and maintenance costs, poor governance, (most importantly) high percentage of unaccounted for water due to water theft and illegal connections. Such concerns directly affect the efficiency of the board, thereby finally affecting the welfare of the consumers.

BWSSB Water Distribution and Management

To ensure efficient distribution and better management of water supply, BWSSB has divided Bengaluru into eight zones.Each zone consists ofa number of reservoirs. Apart from reservoirs, for water storage, a number of overhead tanks have also been constructed by BWSSB in each zone.

Bengaluru lies in the catchment of the Cauvery river basin. With its 81,155 km^2area, the Cauvery basin covers around 24 % of the surface of India. The river is the fourth largest in India and is a perennial river flowing from the Western Ghats for almost 800 kilometers before it drains in the Bay of Bengal. The flow in the river is highly dependent on the rainfall, and is highest during the southwest monsoon period from June to September. During this period, the Western Ghats, where the river originates, get about 2000-2500 mm of rainfall, whereas the area in the middle part of the basin where Karnataka is located gets 700-1000 mm of rainfall annually (Anand, 2004).

The Cauvery Water Supply Scheme as a whole is expected to provide 870MLD of water. The first stage of theCauvery Water Supply Scheme supplied 135 MLD of treated water. This water is pumped from T.K. Halli to the South End Circle terminal point at Bengaluru. The second stage after completion is capable of supplying 300 MLD. Water started flowing in 1982 from the second stage. Together, both stages accounted for 270 MLD of additional water withdrawal. With the construction of both stages, the standard quantity of drinking water, which was 150 MLD, could not be supplied to the people of Bengaluru; hence CWSS Stage II was taken up in 1985-86 to provide an additional quantity of 270MLD water. The total potential of CWSS Stage I, II and III was 540 MLD. By 2004, the population of Bengaluru city increased to nearly 60 lakh because of which the supply of water was inadequate. In 2001-02, CWSS Stage IV Phase I and in 2013 Stage IV Phase II were taken up to provide 270 and 500 MLD water respectively. CWSS Stage IV Phase II construction finished in 2012, which added 500 MLD water to the total available water supply. Currently, BWSSB is conducting a survey in the BBMP area to assess the requirement of water for planning the Cauvery 5th Stage of work. But according to Anand

(2004) the amount of water flowing in the river Cauvery is characterised by a high variability, which makes it difficult to calculate the quantity of water available as a fresh water resource each year.

Apart from the variability in water availability, the question about the quantity of water available for extraction from the Cauvery river has for long been a source of conflict between the four States depending on the river's resources (Anand, 2004). As a way of solving the conflict, the Cauvery Water Disputes Tribunal was set up in 1990, and set out to decide which areas had the right to what amount of water, for agricultural, industrial and domestic purposes. Their work ended in a ruling in 2007 which gave Karnataka the right to 8.1cr million litres of water per year, less than 13.95cr million litres per year the state sought to get (Agoramurthy *et al*, 2008); (Cauvery Water Disputes Tribunal, 2007). About 8.1cr million litres of water was set aside annually for Bengaluru Urban and Rural districts, meant for both domestic and industrial usage in the city and its rural surroundings. From this quantity of water, Bengaluru Urban obtains approximately 900 million litres of water every day (Agoramoorthy *et al*, 2008); (Anand, 2004).

Alarge quantity of groundwater is consumed in the city and it is about 35-40% of the piped water supply. Out of these borewells, the board maintains about 6750 borewells in the city for public water supply purposes and around 750 are high yielding borewells which are equipped with submersible pumps. The majority of the borewells are hand pumped. (AusAID Annual Report 2001-2002, n.d.). Among these borewells, some have a very low yielding capacity and some borewells are dry. Hence again, the question about sustainability of water source for Bengaluru becomes more prominent.

Data and Methodology

Globally, performance benchmarking in the water and sanitation sector is a relatively new concept, but there have been numerous attempts to develop and standardise the approach to benchmarking in the water sector. The most prominent and successful efforts were done by AWWA (Cabrera, 2011), IWA (Alegre *et al*, 2000, Alegre *et al*,2006 and Matos *et al*, 2002) and IBNET of World Bank (Berg & Danilenko, 2011). Apart from the above-mentioned entities, ADB has also facilitated the development of utility data books, especially at the regional level in Asian countries.

Amongst the mentioned entities, the first global benchmarking standard for water and sanitation assessment was done by IBNET which is funded by the Department of International Development (DFID), UK and jointly administered by Water and Sanitation Programme (WSP) and the Water Anchor of the World Bank (Berg & Danilenko, 2011). The three entities mentioned above have developed the framework and a comprehensive set of indicators to assess the performance of water utilities. The International Organisation for Standardisation (ISO) has also developed standards and guidelines for developing performance indicators. (ISO 24510, ISO 24511 and ISO 24512).

This study investigates the performance of BWSSB using the international benchmark indicators developed by IBNET of World Bank primarily since it is the global international standard framework. Along with IBNET indicators, additional indicators identified inthe literature on benchmarking public utilities from AWWA, IWA and ADB have also been used. The indicators are calculated for the years 2015-16 and 2017-18. The performance indicators used in the study include technical and operational efficiency indicators along with financial sustainability indicators. (CEPT University, 2010, M. Mehta & Mehta, 2010, Gonzalez de Asis *et al*, 2009, Baietti *et al*, 2006).

The data for the study has been collected from BWSSB. Many of the officials in BWSSB were also interviewed to collect information about the board. Apart from the data given by BWSSSB, other sources of data are from Census 2011 reports, BBMP reports and Karnataka Slum Board reports. Data collected were then analysed and the technical and financial performance indicators were calculated to assess the performance of the board.

Literature Review on Benchmarking Public Utility Service Providers

The practice of benchmarking utilities in the water sector wasinitially practiced in Europe and North America. Infact, considerable efforts have been made to standardise the approach towards benchmarking in the water sector. The most prominent efforts are that of the Asian Development Bank, International Water Associationand IBNET of the World Bank. These frameworks provide ready-to-use indicators, standardised platform for data collection, analysis and interpretation of results. The momentum for adopting benchmarking was soon picked up worldwide, and today we can observe many countries, especially the developing countries, adopting performance benchmarking to track and increase the efficiency of public utility service providers, especially among governments. The gist of some of the studies available on benchmarking public utilities in India is mentioned below.

Theoretically, there are four methodologies available in the literature for benchmarking. They are:

- **Core Overall Performance Indicators** – This approach uses pre-determined indicators and targets to assess the performance of the entity and is the most popular among benchmarking studies.
- **Performance Scores based on Production and Cost Estimates** – This approach allows quantitative measurement of utilities. Then the best and weakest performers are identified. Some of the variables used in this approach are cost efficiency, scale efficiency, allocative efficiency, engineering efficiency and so on.
- **Engineering/Model Company Approach** – This approach is relatively complicated as it attempts to first develop an ideal baseline utility and then the optimisation process is arrived at using assumed coefficients.
- **Process Benchmarking** – This approach is mainly used by the entities who are looking for potential benchmarking partners. This approach is more disaggregated as it focusses on benchmarking individual production processes in the vertical production chain so that attention can be given to identified non-efficient stages.
- **Customer Survey Benchmarking**– The key difference with respect to this approach is that it gives prime importance to customer perceptions relating to the service in the study. Nevertheless, it is an important factor, but many other factors must also be given prime importance to benchmark the utility which this approach does not encapsulate.

Empirical Literature Review

With respect to empirical literature review on benchmarking water utilities, it was only in 1989 that the process of benchmarking organisations for performance and to encourage competitiveness was explained and used by Camp (1989). Later, De Witte and Marques (2009) conducted around 22 benchmarking studies from 1986 to 2006. In 2010, Singh *et al* (2010) studied, benchmarked and assessed the performance of 13 urban water utilities from different countries. In 2010, Berg conducted benchmarking studies on eight urban water utilities from Peru, Australia, Romania, Vietnam, Italy, Brazil, England & Wales and Moldova.

In India, World Bank (2008) developed indicators and ADB indicators are the most used in the studies conducted. The first such study was done by Kulshreshta in 2005 followed by Singh *et al* in 2010 and Vishwakarma and Kulshreshta in 2010. A prominent challenge observed by the benchmarking studies in India is the unavailability of authentic data. Tsitsifli and Kanakoudis (2009) identify that fora robust evaluation process, the quality of data and its collection techniques are most crucial. Similarly, Charalambous and Hamilton (2011) opine in their paper that for all kinds of water audits, the accuracy of results depends not just on the data available but most importantly on the method used to collect the data. Cabrera *et al* (2013) on the other hand, while benchmarking water utilities, observe that for the efficiency of water utilities to improve, the utility managers must be aware of the characteristics of utilities but often they do not possess such information.

Until recently, benchmarking studies have heavily relied on simple indicator-based studies developed by the World Bank Water and Sanitation Program, Water Engineering Development Centre, International Water Association etc. It is only now that the methods of benchmarking are seen adopting sophisticated mathematical and statistical modelling. The most prominent methodology adopted is the Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). These methods, with the usage of data, identify the best performing utility and form a frontier and then all other utilities are compared to this frontier and then ranked.

Results and Discussion

Performance Indicators

Technical-Operational Performance Indicators

Core technical and operational and financial performance indicators for BWSSB have been calculated for the year 2015-16 and 2017-18. The results of the same are mentioned in relation to the targets from World Bank indicators in table 2 and 4 below.

Table 2: BWSSB Technical-Operational Performance Indicators

Technical-Operational Performance Indicator	Description	International Standards	Results for BWSSB	
			2015-16	2017-18
Unaccounted for Water	Volume of water 'lost' as a % of net water supplied	<20%	45.87%	36.35%
Percentage of Metered connections	No of connections with operating meter as a % of total connections	>85%	94.38%	94.83%
Percentage of Household Metered connections	No of household connections with operating meter as a % of total connections	>85%	85.04%	83.83%
Staff/1000 connections	Ratio of inputs to outputs	<5	4.88	3.22
Staff/1000 people	Ratio of inputs to outputs	<5	4.66	3.4
Water production and consumption	Supply to meet demand, lpcd	>150 lpcd	76 lpcd on an average	106 lpcd on average
Population served	% of population with either direct or within reach of service connection	100%	95.18%	70.85%
Continuity of water supply	Continuity of supply is measured as the average number of hours of pressurised water supply per day.	24 hours	4-5 hours on alternate days	4-5 hours on alternate days
Spatial variations in coverage of water supply connections (Sub division wise)	This indicator captures the variations in coverage of connections across asub division within an ULB. *Coefficient of sub division values for "total households connected to the water supply network with a private (not shared) service connection, as service connection, as percentage of total households"*	Spatial variation with a CV value '0' implies there are no variations in coverage across the sub division in the city.	0.25	0.37
Spatial variations in Per Capita Water (sub division wise)	This indicator captures the variations in per capita supply across sub division within an ULB. *Coefficient of variation of sub division values for "Total treated water supplied into the distribution system expressed by population served per day of water supplied"*	Spatial variation with a CV value '0' implies there is no variations in per capita supply across the sub divisons in the city.	0.21	0.29
Spatial variations in coverage of water supply connections (Ward wise)	This indicator captures the variations in coverage of connections across wards within an ULB. *Coefficient of variation of wards values for "total households connected to the water supply network with a private (not shared) service connection, as service connection, as percentage of total households"*	Spatial variation with a CV value '0' implies there are no variations in coverage across the wards in the city.	0.50	0.48
Spatial variations in Per Capita Water (Ward wise)	This indicator captures the variations in per capita supply across wards within an ULB. *Coefficient of Variation of ward values for "Total treated water supplied into the distribution system expressed by population served per day of water supplied"*	Spatial variation with a CV value '0' implies there is no variations in per capita supply across the wards in the city.	0.61	0.48

Source: Author's calculation using BWSSB data

Ideally the entire population i.e. 100 per cent population, which comes within the service jurisdiction of a public utility, needs to be provided with water connection. This is measured by the indicator **'Population served'**, which measures the percentage of population with either direct or within reach of a water service connection. In the case of Bengaluru, BWSSB served 95 per cent of the population with piped water in 2015-16 while the percentage dropped to 71 per cent in the year 2017-18. The reason for this could be the addition of 110 villages to the BBMP jurisdiction in 2007. Metering is not importantjust for fully accounting for water production and consumption, but also to reduce Unaccounted for Water (UFW). Of the entire connections offered by BWSSB, the **percentage of metered connections** was 94.38 per cent in 2015-16 and in 2017-18 it was 94.83 percent, which is above the critical limit of 85 per cent. In thecase of household connections as well, the board is performing well, wherein the **percentage of household metered connections** accounts for 85.04 per cent in 2015-16, conforming to the benchmark of 85 per cent. But in 2017-18, it hasbeen reduced to 83.83 percent, which falls below the critical value of 85 per cent. One of the reasons identified for not achieving 100 per cent connections is the jurisdictional increase from BMP to BBMP absorbing 8 urban local bodies and 110 villages within the BWSSB jurisdiction. But it must be noted that though the board is performing relatively better with respect to population coverage, it does not conform to the **frequency of water supply** benchmark, which should be 24 hours daily. It must be noted here that any water supply authority in India does not achieve the benchmark of 24 hours' supply, the longest duration of supply is in Chandigarh with 12 hours' supply. (ADB & MUD, GOI 2007). Residents of Bengaluru city receive water for 4-5 hours on alternate days. In summer, the frequency is worse where water is supplied once in three days for the same or even lower time period.

Besides indicators like the percentage of metered connections and household connections, which gives a macro picture of water supply by a utility, what needs to be observed is the **amount of water supplied to a person**. According to World Health Organisation (Water, WHO, 2000) the minimum requirement of water per person is stipulated at 150-200 lpcd for metropolitan cities across the world. In the case of India's regulation, according to Central Public Health and Environmental Organisation, Govt. of India (CPEEHO) the critical limit is set at 135 lpcd. An assessment of the total volume of water supplied to Bengaluru city with its demand shows that the quantum of water supplied to a person daily is only 76 litres as of 2015-16 and is 120 litres as of 2017-18. This is much less than the per capita water supplied to more a populated metro city like Mumbai where the supply is 191 lpcd. (ADB & MUD, GOI, 2007).

With per capita supply of 76 lpcd, the supply is not the same across all parts of the city. There is huge variation across the city with respect to the per capita water supplies which is shown in table 3 below:

Table 3: Per Capita Water Supply BWSSB Zone-wise for the year 2015-16

Zones	Central	East	West	North	South	South East
Per Capita Supply (lpcd)	54.64	42.01	36.9	155.4	93.75	74.31

Source: Author's Calculation using data from BWSSB

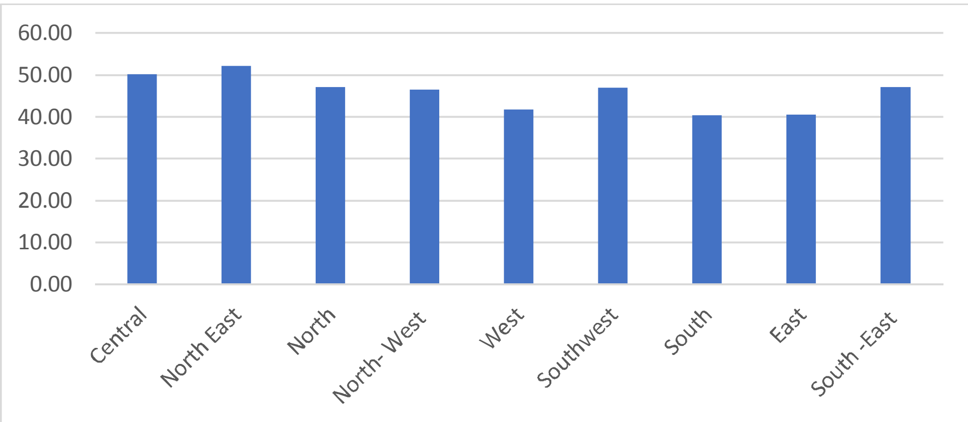
The per capita supply values shown above in the table takes into account both domestic and non-domestic connections.

Since the data for zone-wise residential water consumption was not available, the calculations for residential per capita water could not be arrived at. Also, since the data was available only for 2015-16, the analysis could not be done for 2017-18. However, for the year 2015-16, the total non-domestic water consumption for the city accounted for 19427.83 MLD out of the total supply of 223910.6 MLD, which account for only 9 per cent of the total consumption. Hence the majority of water supplied is for residential purpose only.

On an average, the city is supplied with only **76 lpcd**, which is almost 50 per cent less than the stipulated norm. Further, it can be observed from the table that NorthZone consumes the maximum water daily, along with conforming to the stipulated water quantity by CPEEHO and WHO which is 150 lpcd while West is not supplied even half the quantity. This inequality in water supply that some studies have recorded is due to the water pressure variations observed at different consumer ends which in turn is attributed to undulating land terrain both within and between zones.

But it must be noted here that though on paper West is supplied the leastwater, according to the Karnataka Slum Board data collected and analysed out of 15 slum locations in Bengaluru, 6 of the locations are located in West Bengaluru accounting for a population of 92,832 as per the2011 Census. This might imply that the unaccounted for water (UFW) might be higher in this zone. To analyse the same, zone-wise **UFW** was calculated for the year 2016. The results of the analysis are shown in Figure 2 below, which is rather contradictory.

Figure 2: Zone-wise UFW (%) for 2015-16



Source: Author's Calculation using data from BWSSB

As can be observed from the graph, West falls among the zones where the lowest UFW is recorded while the North-East which has no slum locations records the highest. This tells us that it is not right to assume that where there is a slum, UFW is relatively higher. On the whole, BWSSB suffers from a **very high percentage of UFW.** The city as a whole accounted for 45.87 per cent UFW on an average for the year 2016 and in 2017-18, it accounted for 36.3 per cent while the benchmark indicator for UFW was less than 20 per cent. In the year 2007, UFW was 48 per cent (Raj, 2013). Almost a decade has passed, yet there is not much improvement in the UFW percentage. The improvement in

NRW percentage in 2017-18 when compared to 2015-16 is because BWSSB had launched a project in 2003 along with Larsen & Toubro and SMPL Infra to check and correct for water leakage, water theft and replacing of old worn out pipes in Bengaluru. There definitely is a reduction in the UFW percentage but the overall results are unsatisfactory. Also, the project has been completed now with all the sanctioned fund exhausted but the UFW reduction has not been able to keep pace post the project completion. To top it all, the project was demarked for 14 wards out of 198 wards. There is a need for assessing and correcting UFW in the remaining 184 wards.

Another important indicator, which is a quick guide to assess the extent of under-manning or over-manning in a water utility, is **'staff per 1000 connections'**. The indicator basically tries to gauge the output per input in terms of labour employed. The utility is said to have employed efficiently if the value of staff per 1000 connections is less than 5. In 2015-16 for BWSSB, the ratio is close to the margin at 4.88 thereby hinting at over-staffing while in 2017-18, the indicator is at 3.22. This shows animprovement. Another indicator, which measures the same but facilitates international comparisons is **'staff per 1000 population served'**. In 2015-16, the ratio for BWSSB is at 4.66 and in 2017-18 it is at 3.4 indicating that in both the years, the ratio falls below the critical limit of 5. The most crucial limitation with respect to both the indicators mentioned is that the analysis includes only permanent BWSSB staff and does not take into consideration the contractual workers.

BWSSB Financial Performance Indicators

Table 4: BWSSB Financial Performance Indicators

Financial Performance indicator	Description	International Standards	Results for BWSSB	
			2015-16	2017-18
Average tariff per 1000 litres	Actual amount billed per litre of water	Rs 46.30 or $ 0.72	Rs 36.13	Rs 31.54
Unit Operating cost per 1000 litre sold	Ratio of total annual operating expenses and the total actual volume of water sold	< average tariff per 1000 litre	Rs 36.44	Rs 39.72
Operating Cost Coverage Ratio (OCCR)	Ratio of total annual billed revenues to total annual operating costs (excl. interest and depreciation)	> 1	0.9914	0.794
Collection Ratio	Ratio of actual revenue collected and total billed revenues	>73 %	0.60	0.54
Working Ratio (1/OCCR)		<1	1.0086	1.259
Cost recovery in water supply services	The total operating revenues expressed as a percentage of the total operating expenses incurred in the corresponding time period. Only income and expenditure of the revenue account must be considered, and income and expenditure from the capital account should be excluded	100%	85.93%	92.26%
Capital Expenditure per connection (Rs/connection)	Ratio of total capital expenditure by total number of connections	More the better	599.01	2270.51
Ratio of Industrial to Residential Tariff	Ratio of industrial to residential tariff = [total billing of commercial and industrial users (Rs) / total volume sold to commercial and industrial users (litres daily)] / [total billing of residential users (Rs)/ total volume sold to residential users (litres daily)]		4.5	2.31
Overall Efficiency Indicator	**Ratio of total volume for which the utility collects revenue and the total volume of water it produces**	**> 66 %**	**48%**	**54%**

Source: Author's calculation using BWSSB data

The objective of fixing domestic tariff low might be justified on welfare grounds, but it must atleast reach upto the global average water tariff level to ensure the sustainability of the board. The **'average tariff'** for BWSSB turns out to be Rs 36.13 per 1000 litres in 2015-16 and in 2017-18 it is Rs 31.54 while the benchmark tariff is Rs 46.30 or $0.72. Though the tariff charged in Bengaluru is less than the average global tariff, yet within India, it is actually the highest. Inspite of charging high, the board is unable to recover its operation and maintenance costs due to the high transaction cost involved in water supply coupled with a high percentage of Unaccounted for Water. The board has made investments in increasing water supply, but there has been very limited investment done on reducing the transaction cost of water. Globally, there have been innovations done in order to reduce the cost of electricity, especially with respect to the water pump. There is apromising technology known as Geothermal Heat Pump, also known as Water-Source Heat Pump (EPA, 2017) which has proved to reduce the costs of electricity for public water utilities. There is a need for BWSSB to look for and adopt newer technologies in order to reduce the transaction costs of water supply.

To assess further whether the revenue from tariffs covers the operational costs of BWSSB, another indicator was calculated which is the **'Operating Ratio' also known as 'Operating Cost Coverage Ratio (OCCR)'.** The indicator is calculated by taking the ratio of total annual billed revenues to total annual operating costs (excluding interest and depreciation). If depreciation and interest costs are included, then it shows if the board has the capability to expand coverage through tariffs without the grants given to the authority. If the value of the ratio is above 1, then it implies the authority is able to cover its operating costs through tariff revenue. The OCCR for BWSSB for the year 2015-16 was 0.99 and in 2017-18 it is 0.79, thereby confirming the above conclusion that the board is unable to cover its costs with tariff revenue and hence resorts to loans and grants to cover its costs. The large amounts of loan taken by BWSSB can been seen by the huge amount of interest payments the board makes every year. In the year 2015-16, the interest payments alone accounted for 24.89 per cent of BWSSB's expenditure and in 2017-18 it accounts for 19 per cent of the total expenditure. Other water utility boards in the country apart from water tariff source also resort to collecting additional source of revenue in the form of water tax. Water tax is collected from the consumer as a part of the property tax. A pre-agreed percentage of property tax goes to the water board. This ensures that there is no additional cost which needs to be borne by the consumer and it can also feed in as additional revenue to BWSSB. This option has not been explored by the board.

Billing consumers is different from getting paid by consumers. In order to understand how much arrears are built up by the utility, **'Collection Ratio'** is calculated which shows the efficiency of the board in collection of water related charges. The indicator is calculated by taking the ratio of actual revenue in a current year by the total billed revenue in the same year. The benchmark percentage is 73 per cent and more. For BWSSB **collection ratio is only 60 per cent** in 2015-16 and in 2017-18 it further reduced to 54 per cent, thereby indicating inefficiency in collection of water related charges and also the extent of unaccounted for water.

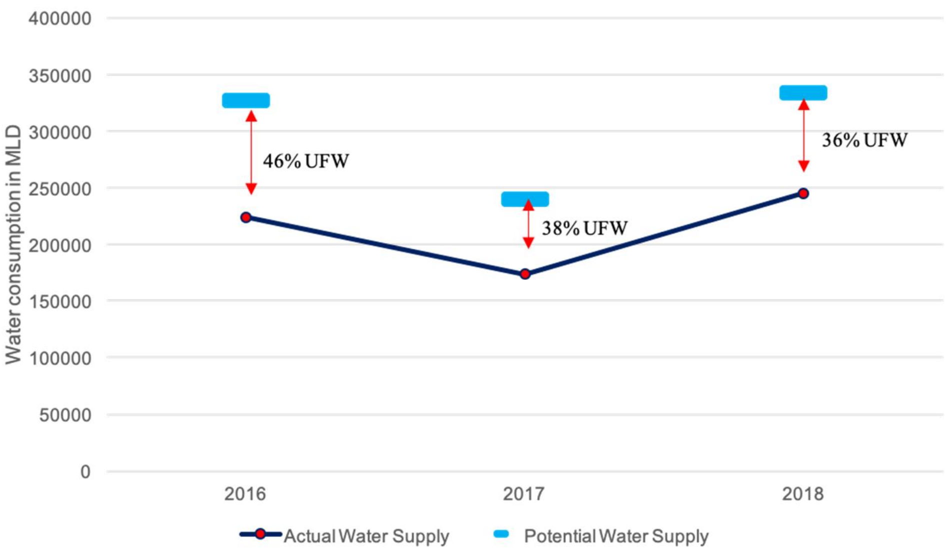
Another indicator, which measures the financial health of a utility is the **'Working Ratio'**, which is measured by taking the inverse of OCCR. The benchmark for the indicator is less than 1, but in the case of BWSSB the result turns out to be **1.01 in 2015-16 while it worsens for 2017-18 with**

the ratio being 1.26, indicating BWSSB is not functioning efficiently with respect to financial indicators. This could be due to a low revenue collection ratio, high UFW and increasing operational costs and also the addition of 110 villages to BBMP jurisdiction and hence BWSSB's duty to extend services to them. Due to the high working ratio, the board often resorts to large amount of loans, which again forms a debt trap with high interest payments.

Overall Inefficiency of BWSSB

On the whole, the urban local body's efficiency can be assessed by looking into the extent of difference between the potential water supply and actual water supply. The actual water supply data is collected from BWSSB for the years 2016, 2017 and 2018. It is a summation of both domestic and non-domestic water supplied. The Unaccounted for Water (UFW) data in the form of percentage of the total water supplied is also collected from BWSSB for the above mentioned years. The difference between the actual and potentialsupply is arrived at by adding the UFW water quantity which could have been supplied by BWSSB to the actual water supplied data. This difference highlights the inefficiency of BWSSB as shown in Figure 3 below.

Figure 3: Actual vs Potential Water Supply by BWSSB



Source: Author's calculation using BWSSB reports

The increasing UFW has been a problem for BWSSB as discussed in the above section. The major factor leading to high UFW is the high transaction cost involved in supplying water such as the long stretch of pipes needed to transport water from 100 kms and pumping from a considerable height of 540m which again involves ahuge electricity expense. Considerable progress has been achieved in reducing the UFW after the project with L&T. However, since this project did not cover the whole BWSSB jurisdiction and was restricted to only 14 of the 198 wards, there has not been considerable reduction in UFW across the city. The extension of the project to all the 198 wards involves a huge cost for the board and hence it must look at alternatives for raising revenues.

Along with the above-mentioned project, BWSSB has also partnered with IBM for creating an operational dashboard based on IBM's Intelligent Operations Centre (IOC) to reduce the UFW in the city. The technology using GIS maps helps BWSSB to monitor, administer and manage the water supply in a real-time distribution network. This project was initiated in 2015, but unfortunately the project does not seem to have provided any success; yet, since the UFW for the following years also seems to be high i.e. for 2016-17 UFW was 46 per cent and for 2017-18 it was at 38 per cent and in 2018-19 it fell to 36 per cent.

BWSSB Performance from 2012 to 2015

The entire discussion in the previous sections adheres to the years 2015-16 and 2017-18. Benchmarking the performance of a utility for a specific time no doubt helps one to understand the extent of efficiency or inefficiency of the utility, but it does not facilitate comparisons. In order to understand the performance, it becomes necessary to calculate the indicators over a time frame and then to compare their values over the time period. Hence the above-mentioned indicators have been calculated and analysed for the BWSSB from 2012 to 2015.Due to the unavailability of continuous data, the analysis is restricted to the time period from 2012 to 2015.
The results are shown in table 5 below.

Table 5: Performance Indicators of BWSSB from 2012 to 2015

Indicator	Target	2012	2013	2014	2015
Water Supply Connections		8328294	9177121	9825238	9889269
No of Employees	750	2387	2258	2208	2146
UFW	20%	40%	50%	48%	45.87%
Operating Cost Coverage Ratio (OCCR)	> 1	0.61	0.63	0.65	0.99
Working Ratio (1/OCCR)	< 1	1.64	1.59	1.54	1.01
Staff per 1000 connections	< 5	3.48	4.06	4.44	4.88
Collection Ratio	73%	96%	97.05%	93.77%	60%
Average Domestic Tariff per litre	Rs 46.30	21.17	23.18	27.91	36.13
Cost Recovery in Water Supply services	100%	74.82%	64.15%	81.61%	85.94%

Source: Author's Calculation using data from BWSSB

From the table above, the performance of BWSSB over the years for most of the indicators is not conforming to the respective targets. The UFW shows unsatisfactory reduction though an exclusive project with huge cost is earmarked in association with Larsen & Toubro to identify and rectify water loss. It seems like a paradox wherein though BWSSB is able to achieve 95 per cent population coverage with piped water along with 94 per cent connections being metered, yet UFW is as high as 46 per cent. It thus becomes important to identify the cause of water loss because from the analysis, water theft or illegal connections do not seem to be the root cause.

Over the years, though BWSSB has been able to reduce the staff number, yet when compared to the target, they donot seem to be anywhere close. In a labour intensive economy like India, it becomes difficult not to provide jobs, especially in the government sector, but it must also be remembered that in an effort to achieve the welfare motive, the utility must not become burdened both financially and in terms of inefficiency by the extra employees. Staff per connections ratio relatively seemed to be better in 2012 when compared to 2015, thereby hinting towards overstaffing in BWSSB.

In terms of financial indicators, BWSSB does not seem to be performing better over the years. Though average tariff per litre has increased when compared to 2012, yet it lies far behind the target tariff. The percentage increase in tariff is also very slow, which could be due to political interference in the functioning of the board, especially with respect to pricing, since water is a very sensitive commodity. Because of the average tariff being less, the board is unable to recover its full costs. As observed from the cost recovery in water supply indicator, BWSSB is able to recover 86 per cent of the cost incurred. This has definitely improved when compared to previous years, especially 2013 where it could recover only 64 per cent.

The surprising result is the OCCR value over the years which assesses if the board is able to recover its operational costs from tariff revenue. The OCCR ratio which was 0.61 in 2012 has drastically improved to 0.99 in 2015. However, when OCCR is observed over the years, the value for 2015 does not seem consistent. But since the data used for calculation is collected from BWSSB itself, any apprehension about the result needs to be removed.

The worst performing indicator is the collection ratio. From 2012 to 2015, the collection ratio shows a declining trend. A ratio which was 97 per cent in 2013 drastically falls to 60 per cent in 2015 which indicates a wide gap between what is billed and what is collected.

Comparing BWSSB with Other Urban Metropolitan Water Bodies in India

The last section of the paper attempts to compare BWSSB with other metropolitan water bodies with respect to two most crucial indicators – Average tariff and new connection fees. Table 6 below shows the comparison.

Table 6: Comparison of Average Water Tariff and Connection Charges among the Metropolitan Cities

	Bengaluru	**Chennai**	**Ahmedabad**	**Kolkata**	**Mumbai**
Average Tariff (Rs/m^3)	20.55	10.87	1.39	1.13	4.60
New Connection fees	1,740	1,930	100	1,000	660

Source: Krishna Raj (2013)

There appears to be a paradox, where the average tariff per cubic meter of water is the highest for Bengaluru when compared to other metropolitan cities as seen from the table above. Also, connection charges in Bengaluru are second only toChennai. Inspite of water charges being the highest, BWSSB runs a deficit, which is again something to be researched on.

The second aspect to be recognised in the case of BWSSB is that in spite of charging the highest average water tariff compared to other metropolitan cities, yet it is running on deficit since more than a decade. The latest estimates on year-on-year percentage surplus/deficit of BWSSB total income and expenditure (Revenue account + Capital account) shows for the year 2016-17 the annual percentage deficit works out to be Rs.154.81. The reason for such a huge deficit is that on an average per kilolitre, BWSSB charges Rs.8 as on 2017 while the cost involved for supplying the same kilolitre of water is Rs.16. So, the revenue collected by BWSSB is just 50 per cent of the cost. Such a gap in water revenue and expenditure is due to water transaction and distribution costs and also the high UFW.

Conclusion

On the whole, from the above analysis, the following conclusions can be drawn:

* Overall inefficiency of BWSSB is observed by the difference between actual water supply and potential water supply. Though the extent of inefficiency measured in terms of UFW is reducing as the years pass from 2016 to 2018, yet it is much above the national average.
* BWSSB fails to achieve the targets of most of the performance indicators for the year 2015-16 and performs worse in 2017-18 in most of the indicators.
* On water coverage, both with respect to population and metered connections, the board is performing relatively well when compared to other utilities in the country.
* Disappointing are the operational expenses of BWSSB which seem too high. But these costs are inevitable due to the logistics involved in water transportation and pumping. The board must look for sustainable alternatives, especially power consumption in order to reduce its expenses.
* BWSSB is incurring huge losses for more than a decade, which is confirmed by the financial indicators results, especiallythe average water tariff and collection ratio being low compared to the target.
* BWSSB is not able to reduce the UFW percentage inspite of investing heavy amounts on projects demarcated for its reduction.
* The board is on the brink of over-staffing; hence, attention must be given in future hiring and also efforts must be taken to increase the efficiency of the existing staff.
* Compared to other metropolitan water boards, BWSSB has the highest average tariff per $m^3$of water and second highest new connection fess but still the board has been under deficit from more than a decade.

Policy Implications

Globally, there have been many countries which have adopted performance benchmarking with respect to Urban Water Supply and Sanitation at various levels of governance. Some countries such as the United Kingdom are vigorously promoting the process of benchmarking to be adopted as a regulation. The Review of Performance Benchmarking: Urban Water Supply and Management report published in 2013 elaborates on the usage of benchmarking not just as an annual exercise but as a policy and some as regulation. The table in annexure 1 shows the countries which have adopted performance benchmarking with respect to urban water utilities, in what form and for what objective they have adopted.

With respect to India's urban water and sanitation, the performance benchmarking process has been successfully attempted since the past decade in a series of pilot studies. There are three prominent efforts made to benchmark and measure theperformance of urban water and sanitation utilities in selected cities by NIUA (National Institute of Urban Affairs), CRISIL (Credit Rating Information Services of India Limited) and ADB (Asian Development Bank). However, literature also suggests that the results of the three studies do not match, hence showing the unavailability of reliable data. Also, there have been attempts made at the national level to standardise the benchmarking process and arrive at national targets which could be applicable to all states and cities, so that performance comparisons could be made amongst states and also amongst cities. At the national level, there are two main objectives for which benchmarking is done, for performance monitoring and performance-based funding. There are two programmes where the process of performance benchmarking has been taken up by the Government of India – JNNURM (Jawaharlal Nehru National Urban Renewal Mission) which is now succeeded by AMRUT (Atal Mission for Rejuvenation and Urban Transformation) and the second programme isthe Service Level Benchmarking (SLB) programme started in 2009. In the case of JNNURM, the performance benchmarking is linked to funding, while in the case of SLB, the main objective is to develop a common minimum framework for monitoring and reporting of indicators along with the operational plan to improve and implement the framework. Apart from these two programmes at the national level there has been little effort made by the urban utilities themselves to benchmark their utilities annually. This paper is an attempt to benchmark BWSSB with respect to its performance which includes technical, operational and financial indicators. There is a wealth of information generated after the process, since it clearly shows the BWSSB where it is under performing and how the same can be rectified. Hence this process must be made an annual exercise where BWSSB uses the unaudited data to self-assess its own performance and identify inefficiency areas and also compares its performance with other urban water bodies.

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Annexure I

Usage of Performance Benchmarking Around the World

Country	Coverage			Frequency of Performance benchmarking	Objective of benchmarking			
	Utility Association	Government Level	Regulation		Promoting Performance Monitoring	Annual Performance Monitoring	Performance based Funding	Performance based Contracts
Australia	✓	✓		Annual		✓		
Netherlands	✓			Once in 3 years	✓			
United Kingdom			✓	Annual				✓
India		✓		Annual		✓	✓	
South Africa	✓	✓		Annual		✓		
Canada	✓			Annual	✓			
Vietnam	✓			Annual	✓			
Tanzania		✓		Annual		✓	✓	
Indonesia	✓			Annual	✓			
Malaysia			✓	Annual				✓
Bangkok			✓	Annual				✓
Brazil			✓	Annual		✓		
Ecuador			✓	Annual			✓	
Uganda		✓	✓	Annual			✓	✓

Source: Compiled after reviewing "A review of Performance Benchmarking, Urban Water Supply and Sanitation, 2013"

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ISBN 978-81-951228-3-7

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