Enhancing Financial Sustainability of Urban Water Supply Systems in Bhutan: A case study of Thimphu Thromde (Municipality).

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Abstract: In almost all existing Urban Water Supply systems in Bhutan, one major issue confronting the sustainability aspect is the lack of adequate financial resources thereby failing to achieve the intended level of performances in terms of service delivery. Recognizing the poor financial scenario of the systems at the moment, it is deemed necessary to adopt necessary measures/interventions to help improve the existing financial situation and to ensure the optimum level of operation and maintenance. To further substantiate the findings and assessments, a case study for Thimphu Water supply systems was carried out through a conventional approach to examine specific interventions that are deemed vital to address key issues and challenges. In conclusion, based on overall findings and assessment, recommendations have been proposed that are in principle, implementable across all existing urban water supply systems in Bhutan because of the reasons that all water utilities across the country are managed/operated in the same manner as Thimphu Thromde including the organizational set-up of the existing water supply management, mode of financing, availing donor assistance for capital investments, seeking tariff revisions, system designs, amongst others and such parameters are regulated by the Ministry of Infrastructure and Transport. The adoption of the proposed measures, particularly addressing of the 'non-revenue water' and conduct of advocacy measures on water conservation would significantly help the water utilities enhance the financial sustainability of the systems thereby resulting in overall improvement in the delivery of water services to the consumers.

Keywords: Financial, sustainability, service delivery, water pricing, water supplies, and non-revenue water.

Introduction

Bhutan is known to be water abundant, with one of the highest reported water per capita availability in the region, when assessed at the level of basins and districts with the total outflow of the rivers estimated to be 109,000 m^3/capita/year. However, issues with water accessibility continue to persist across the country due to insufficient source management, inadequate infrastructure development and issues in management and governance. As per, Bhutan Living

Standard Survey, Vol 5 (2023), 83 % of the total households have access to 24x7 drinking water supply with urban area having coverage of 60.61% and rural 65.35%. Similarly, National Environment Commission (2019) Water Flagship Program: Access to 24x7 safe drinking water with Irrigation report indicates that from the total cultivable land of 403,013 acres, only 276,522 acres are cultivated indicating lack of water available for field Irrigation.

Water is a fundamental human right and an essential resource that supports life and livelihoods. Potable water is required for drinking and sanitation, food preparation and maintaining personal hygiene. As per the National Environment Commission (2011) and the National Environment Commission (2014), water for drinking and sanitation is the priority for water allocation. Therefore, the provision of adequate and reliable, clean drinking water is an essential service that the state needs to ensure its citizens. The development and management of water supplies especially in developing countries have been heavily constrained due to financial constraints faced by most water utilities. Thus, mechanisms to address Non-Revenue Water will help enhance revenue by increasing the amount of water that can be billed while reducing wastage. This situation will increase revenue generation and improve investment plans for the future. In addition to making available more water for consumers thereby significantly enhancing the financial sustainability of the water utilities.

The primary contributor towards achieving financial sustainability of water supply systems is the water tariff charged for the water that is supplied to the consumers through the provision of piped and potable water. The water rate is levied on the services provided by the utility board to provide potable water to its consumer rather than on the water, which is a public good. The revenue generated through the levy of water tariff from the customers will help water utilities to build infrastructures such as water treatment plants, storage tanks, and piping works, and transport water to their homes besides sustaining the operation and maintenance of these infrastructures. The revenue is also used to pay workers who provide the delivery services.

Water tariffs vary widely in its structure and level between countries, cities and sometimes between user categories - residential, commercial, industrial or public buildings. The mechanisms to adjust tariffs also vary widely. The tariff revision is generally carried out on a periodical basis to enable the water utility to sustain their services to the desired optimum level in terms of both technical as well as financial aspects, such that the basic operational and maintenance costs are recovered. However, failure to consider water tariff revision at regulated intervals, particularly to take into account the market inflation, amongst other factors, would result in a low level of development, poor operation and maintenance (O &M) practices, and low staff morale.

The primary objective of this study is to examine the key issues and challenges being confronted by the Thimphu Thromde and similar other water utilities across Bhutan and recommend appropriate recommendations in financially sustaining the desired level of services delivery that is required of to ensure overall sustainability of the water supply systems.

The paper highlights the importance of having a realistic and regulated water pricing structure for all urban water supply systems for achieving financial sustainability which will further help promote holistic devolvement and management of water supplies, especially in developing countries such as Bhutan. With the available data/information on water utilities, the rationale for tariff setting and general guiding principles applicable across all utilities have been developed to facilitate tariff revision and sustain at least the operation, maintenance and establishment costs.

Literature Review

Most water utilities, particularly in developing countries, struggle to deliver the intended services to the consumers effectively and efficiently owing to the lack of adequate financial resources. The issue of tariffs usually constrains the overall development and management of water supplies which eventually results in poor operation and maintenance practices, low staff morale and low level of development. Achieving financial sustainability of the water supply systems would enhance and ensure the overall performance including the physical state of the systems and their associated components. Relevant available literature related to the enhancement of financial sustainability of the water utilities have been collected and reviewed.

Water pricing.

According to McIntosh (2003), tariffs and recovery rates continue to remain critical issues in nearly all developing countries, notwithstanding the evidence that in most cases people have been willing to pay for water supply above existing tariff levels and that tariffs can be structured to appropriately blend equity and efficiency objectives. The difficulty has been that there is general political resistance to tariff increases and to maintaining tariff levels in real terms.

Theoretically, water pricing may serve the following purposes (Unver & Gupta, 2003):

- Financial: to cover capital investment and operation and maintenance costs of water services.
- Efficiency: to inculcate in the users, awareness of the intrinsic value of resources and delivery systems and to discourage water wastage, strengthen institutional capacities and improve the quality of services.
- Equity: to reduce income distribution gaps and thereby achieve social justice.

The issue of pricing is central for three reasons. First, clarity about who is paying for what, and what the resources are being used for, is an essential requirement for accountability and participation. Second, pricing is a key element in reducing waste and environmental degradation. And, third, pricing is central if the required significant increase in investments in the sector is to occur (Biswas, 2000). The value of water in alternative uses is important for the rational allocation of water as a scarce resource whether by regulatory or economic means. Charging for water is applying an economic instrument to affect behavior toward conservation and efficient water usage, to provide incentives for demand management, to ensure cost recovery and to signal consumers' willingness to pay for additional investments in water services (GWP, 2000).

Water has not only an economic value, but also social, religious, cultural, and environmental values, and these are interdependent. It is understood that the needs of vulnerable groups, children, local communities, people living in poverty and the environment must be fully considered when using economic instruments for allocating water (UNEP, 2002). It is proposed to improve cost recovery for all infrastructure sub-sectors. Cost recovery should aim at covering all operation and maintenance costs and a reasonable portion of future investments. It is proposed to make the delivery of urban services, poverty and equity sensitive by reviewing tariffs and city taxes, which may include cross-subsidization to make user charges affordable for the poorer segment of the residents.

According to the WHO, households in developing countries can afford to pay about 4% of their income for water supply. When sanitation is added, the World Bank and ADB often assume 5-6% as the affordability level. According to Rogers (2001), increased price leads to sustainability as it reduces demands on the resource base; reduces pollution loads (due to recycled industrial water), and makes more water available for the ecosystem.

The policy on tariffs for such a vital service as potable water must take account of human needs and the social and economic conditions of the population, while not forgetting the urgent requirement to send clear signals that combat waste and strengthen the weak finances of the bodies that provide the service (Pimentel, 2003).

According to Abu-Zeid (2001), water service charges are potentially important and useful, as they are expected to contribute to the recovery of costs from beneficiaries, which will relieve the government of financial burden and provide revenues to support the operation and maintenance of the water supply system. In addition, linking payment to the services should also encourage higher efficiency in both the provision and the use of the resources. In many cases, water pricing is viewed as a key to improve water allocation and encourage conservation.

Water Demand Management.

Mylopoulos et al. (2003) stated that demand management strategies use both structural and non-structural measures. Structural measures include leak detections, indoor water-saving devices, and infrastructure control while non-structural measures comprise the use of economic and legal instruments in the form of incentives or disincentives. Loe et al. (2001) reported that demand-side management is being used increasingly by Ontario municipalities as a way to improve the efficiency of water use, defer the costs associated with constructing new water treatment works, and minimize the environmental impacts associated with supplying water. Six broad categories of demand-side measures being implemented in Ontario municipalities are:

- Water pricing and metering.
- Municipal by-laws (ordinances) that promote water conservation.
- Operational and maintenance measures to reduce water losses and consumption.
- Water-saving plumbing fixtures and devices.
- Public participation programs that encourage water conservation.
- Other measures, such as water audits.

The Thimphu Thromde has not been able to adopt much of the demand-management measures as of now except for water metering which is strictly implemented. Therefore, it is vital that the Thromdes initiate the adoption of some of these measures to improve efficiency of water use, especially with the use of water-saving plumbing fixtures/devices and water conservation programs.

Non-Revenue Water (NRW).

According to Asian Development Bank et al. (2010), non-revenue water is defined as the difference between the amount of water put into the distribution system and the amount of water billed to consumers. It is a good indicator for water utility performance and high levels of NRW generally indicate a deteriorating water supply system/ distribution network. According to Cortes and Alejo (1997), water loss can be a limiting factor in the development of distribution networks. Of the many causes, the most important is leakage. The cause of leaks is related to soil type, water quality, technology and materials used in network construction, operating pressure and age of the system, and the operation and maintenance practices followed. According to Rudolf &Ronald (2010), one major challenge facing water utilities is the large proportion of water loss in the distribution networks. If a large proportion of water that is supplied is lost, meeting consumer

demands is much more difficult. Since this water yields no revenue, heavy losses also make it harder to keep water tariffs at a reasonable and affordable level.

For most developing cities in the Asian region, reducing NRW should be the first option to pursue when addressing low service coverage levels and increased demand for piped water supply. Expanding water networks without addressing water losses will only lead to a cycle of waste and inefficiency. Therefore, reducing NRW is important to overall efficiency and functional sustainability, since it provides additional revenue and reduces costs.

According to McIntosh, A.C. (2003), the benefits of reducing non-revenue water include:

- The need for less water to be produced, treated, and pumped, translating into the postponement of the expansion of capacity- producing less water also translates immediately into cost savings on operation and maintenance due to savings in energy and treatment costs.
- Reduction in apparent losses, which will result in more water being billed and more revenue for utilities-it has also been shown that water metering and adequate rates reduce wasteful consumption, which will likely decrease total consumption.
- Adequate understanding of consumption patterns which will allow utilities to optimize distribution systems.
- Better knowledge of real consumption which will improve demand projections, and
- Reduced sewage flows and pollution.

These benefits depend on adequate pricing of water adequacy and services. Based on the various literatures reviewed, it is conclusive that water pricing and other demand management measures are vital in ensuring the financial sustainability of the water utilities thereby resulting in their enhanced performance in terms of effective and efficient delivery of customer water services. According to the study conducted by Water and Management International (2021), Bhutan has one of the highest NRW levels in the world ranging between 40 and 50%. The same report also mentions that Thimphu Thromde has NRW as high as 51%, which is very significant given the limited water availability in the face of increasing population in the capital city.

Methodology

At the outset, the existing performance scenario of various urban water supply systems across the country was studied considering various relevant parameters such as water tariff rates/structure, revenue generated and the expenditures incurred to operate and maintain the

systems. The financial data of the water sector of the municipalities was collected from various municipalities in Bhutan to obtain a general overview of their financial performance.

To further substantiate the data/information received from the municipalities, comprehensive data/information related to the urban water supply systems under Thimphu municipality was collected to facilitate a specific study confined to one major municipality in Bhutan. The salient data included the population served, water tariff structure, past and existing tariff rates, financial data indicating the revenue generation and the expenditures incurred, total water production and water billed consumption, level of NRW and other demand management parameters in practice. All data/information was collected from the Thimphu Thromde Water Supply section.

The study primarily focused on the measures/interventions that needed to be put in place to achieve cost recovery leading to the overall financial sustainability of the urban water supply systems across Bhutan. To this effect, a comparative study was carried out between the generated revenue and the overall operation and maintenance costs of the systems including establishment costs to ascertain the status of the overall cost-recovery mechanism. Other associated parameters contributing to the overall system sustainability have also been considered during the study.

It is important to note that data collection was very challenging and difficult, especially in the water supply and sanitation aspects in view of the fact that data /record keeping has not been practiced holistically due to lack of human resources and other constraints. Although several infrastructures have been built in these sectors in Bhutan overtime, the actual assets and inventory records of such infrastructures in Bhutan is limited and almost non-existent in some utilities due the available data not being updated on a regular basis. Similarly, the data on financial performances of the Water utilities were not readily available separately and thus required significant amount of time in determining the accuracy of the data that was collected.

Current Scenario and Rationale for Water Tariff Revision.

Financial Sustainability aspects applicable to Urban Water Supply Systems in Bhutan.

While several indirect factors contribute to achieving financial sustainability of urban water supply systems, the primary contributor is the water price (tariff) that needs to be either introduced or properly regulated in the already existing urban centers to be able to holistically sustain the water supply systems. It is deemed as a primary requirement to recover costs to the maximum extent possible. Increased water prices will help reduce excessive consumption and waste of water which in the form of water savings will further help eliminate intermittent water supply and lead to service improvements in terms of meeting 24-hour water supplies. Every water supply system must be

able to at least meet the operation and maintenance costs from the tariffs to secure self-sustenance in the long term.

Adequate water pricing and its proper regulations will help the water utilities to undertake programs to reduce NRW that is contributed mainly through leaks, illegal connections and unbilled authorized consumption which are existent in most water utilities in Bhutan. The unbilled authorized consumption includes both metered as well as non-metered consumption that is not billed but authorized by the water utility.

Current Situation

While there is an established water tariff structure in the four biggest municipalities in Bhutan namely Thimphu, Phuentsholing, Gelephu and Samdrup Jongkhar, the tariff system is not regulated or non-existent in most of the other smaller urban centers/towns. In few of the urban towns like Lhuentse, Zhemgang and Punakha, a flat-water rate is charged irrespective of the quantity of water that is supplied to the consumers, which is not economically determined and not that desirable. The Water tariff was first introduced in four major urban towns in Bhutan in July 1996 following which these municipalities have been able to sustain their services to a major extent while making constant efforts to improve the delivery aspect of services being rendered. The present Water tariff structure in Thimphu is a 'Flat rate system' covering Residential and Commercial categories and includes sewer charges as a 'surcharge' at 50% of the water bill which came into effect in July 2022. Before this, the structure adopted was a progressive block system including similar sewer charges.

Most of the Urban water supply utility agencies in Bhutan presently cannot provide 24x7 water supplies and hence the supplies are mostly intermittent. Primary factors contributing to high consumption by the consumers at the extremely low tariff, high level of NRW (which averages to approx. 50% in bigger towns), and inadequacy of hydraulics of the distribution systems. Besides, the conservation of water is not pronounced given very low tariff which is reportedly one of the lowest in the world. Illegal connections are also seen to be prominent that contribute significantly to a high level of NRW and thus result in less availability of water for supply to the paying consumers. Leakages in the pipe transmission/distribution mains and water overflows from storage reservoirs are commonly faced issues that contribute heavily to the 'unaccounted for water'.

The Water tariff for Thimphu Thromde (municipality) has not been revised until the year 2022 since its last revision in 2013. It is recommended that the tariff be revised periodically to help achieve full recovery of at least the operation and maintenance costs to sustain the system over

time. The additional revenue, if any can be used to meet a portion of future capital investment costs and repayment of capital costs incurred for the provision of infrastructures (loan + interest). This will further help reduce dependency on the 'Capital subsidy' that is currently being provided by the Government to the Local Governments. The Water billing system for the Thromdes (municipalities) in Bhutan was introduced in 1996 following the commissioning of 'Urban Water Supply and Sanitation Projects' funded by DANIDA in six towns. The Tariff Structure adopted then was 'increasing progressive block rate' with two categories namely Residential and Commercial. The present tariff is a flat-rate system with sewer charges at 50% of the water bill which translates to 1/3rd of the total billed amount.

The rationale for tariff setting/revision.

The rationale for periodic revision of tariff is to:

- Achieve financial viability;
- Encourage demand management measures;
- Serve the urban poor using lifeline rates (applicable for water consumption within 20 cum as indicated in the water tariff structure, refer Table 6);
- Meet operation and maintenance costs of the waters supply systems; and
- Promote water conservation.

The revision shall take into account salient aspects such as the (i) 'affordability to pay' (ATP) by consumers and (ii) 'willingness to pay' (WTP) and at the same time ensure 100 % metering. However, management /improvement measures need to be put in place for the existing system which includes: (i) addressing metering inaccuracies (ii) enhancing the efficiency of the billing system/ collection (iii) implementing demand management measures and (iv) water conservation activities, amongst others. The affordability level and willingness of the consumers to pay for water are very important aspects while recommending tariff revision while at the same time recognizing the economic value of water.

The water tariff levied for the provision of piped and potable water including its regulated revisions will help achieve the following:

- Reduce water losses and wastages at consumer levels. A very low tariff will encourage users to use water judiciously.
- Reduce water demand and promote water conservation: The overall water demand will considerably reduce as users would be prompted to use water optimally.

- Reduce capital requirements for new water expansion programs. The present need for capital investments can be deferred through such interventions.
- Generate revenue to meet routine operation and maintenance costs resulting from inflation that will impact the cost of materials, equipment, etc, an increase of staff salaries, electricity costs, and chemical costs, amongst others.
- Gradually establish (i) Capital Investment Fund (CIF) for future capital works including major repairs to the water supply system (ii) debt servicing (will include capital repayment of loan inclusive of interest) and (iii) cover depreciated costs of assets as cost recovery options.
- Carry out major rehabilitation/augmentation works such as replacement of old and leaking pipes including realignment of pipes which would help curb water wastages/losses and the overall non-revenue component.

The Tariff Revision usually depend on the Government Policy as to whether the Water Tariff should recover either; (i) only the O & M costs (ii) a portion of future Capital costs or (iii) full future capital investment costs.

The operation and maintenance costs (particularly of the water treatment plants) form the most significant component of the revenue that is required to sustain the effective and efficient functioning of the urban water supply systems. Failure to consider water tariff revision at certain intervals, particularly to take into account the market inflation, amongst other factors, would result in a low level of development, poor Operation and Maintenance (O &M) practices, and low staff morale.

General Guiding Principles that may be adopted while preparing Proposal for Tariff Revision:

Achievement of full O&M cost recovery to sustain the system overtime shall be the prime reason for proposing a water tariff. To be able to financially sustain the water supply systems, the O&M costs must be recovered in full which will cover all direct and indirect costs involved. Additional revenue if at all generated, shall be utilized for meeting future capital investment costs and repayment of capital (loan plus interest). The affordability to pay (ATP) aspect shall be taken into consideration. Affordability can be estimated by comparing the consumer's ability to pay based on his/her disposable income, household expenditure, and additional spending for other indispensable services (electricity, etc.) and the amount of his/her water and sewerage tariff payments.

Gradual reduction of 'Capital subsidy' received from the Government: The Local Governments shall aim to sustain the O&M costs for the water and sewerage schemes under their operations as well as to generate additional revenue for capital investments, if possible so that the dependency on the Government for capital subsidy is reduced overtime. Ensuring that management /improvement measures are put in place for the existing system shall be of paramount importance. These shall include, (i) 100 % metering, in place (ii) addressing metering inaccuracies (iii) efficiency enhancement for billing system and collection (iv) adoption of demand management measures and (v) promotion of water conservation activities etc.

Case Study of Thimphu municipality (Thromde).

Study Area.

Thimphu is the Capital city and the largest municipality in Bhutan. The Population and Housing Census of Bhutan (2017) estimates the present population to be at 150, 000. The development of the city is guided by the 'Thimphu Structure Plan', which was developed in 1998 to protect the fragile ecology of the valley and to promote integrated growth. There are seven Demkhongs (constituencies) within the Thromde.

Thimphu is spread over an altitudinal range between 2,240 and 2,648 msl with the surrounding hills rising over 3800 msl. With a total area of 26.13 sq. km under the jurisdiction of Thimphu municipality, the city is linearly spread along the Wangchu river. The city stretches about 15 km in length & 3 km in width starting from Dechencholing in the North and ending at Serbithang in the South. The city part of the valley enjoys a warm, temperate climate with an average rainfall varying between 500-1000mm. (Ministry of Works and Human Settlement, 2008; Department of Urban Development and Engineering Services, 2008).

General Information on Water Tariff System/Scenario of Thimphu Thromde

There are two categories namely (i) residential (domestic) and (ii) commercial which include Hotels, Industries and Institutions. The Tariff Structure presently adopted is a 'Flat rate system' which came into effect in July 2022. Before this, the structure adopted was 'increasing progressive block rate' since the year of inception in 1996 to promote cross-subsidy. The average inflation rate is considered as 7% per annum as per National Statistics Bureau.

Data/Information on the existing scenario.

Table 1.

Water Production and Related Parameters (TTWSS, 2023).

System Input volume (Design capacity)	32.9 MLD (million liters per day)
Production capacity	28.4 MLD
Billed Consumption	14.27 MLD
Average Water Demand	24.30 MLD
Average NRW	50 % (or 2.8 cum/day/ connections
Operating ratio	84% (0.84)
Total metered connections	5065
Total reservoir capacity	10.91 MLD
Bill collection efficiency	100% (approx)

The maximum NRW was recorded in August 2020 corresponding to 50.15% which was unusually high. Annual Information Bulletin (2020) states that the total reservoir capacity is 10.91 MLD which approximates 38% of the daily production capacity of 28.4 MLD which is slightly low. The recommended storage volume is about 40-50%of the total water production.

Data/Parameters to be considered/collated to understand the present financial performance and enable projection of future financial scenarios;

- Service coverage (%): This represents the supply coverage against the total area under the jurisdiction of the municipality.
- Total water demand: This will constitute Domestic, Institutional, Industrial, Unaccounted for water, firefighting demands and other special demands, if any. The domestic demands shall focus on the 'per capita consumption' adopted in terms of liters per capita per day or 'lpcd'.
- System Input Volume (cum): The volume of treated water input to that part of the water supply system to which the water balance calculation relates.
- Total billed water consumption: It includes those components of authorized consumption that are billed and produce revenue (also known as billed authorized consumption).
- Average Tariff (Nu/cum): Total annual billing/ Total annual consumption
- Unit production costs (Nu/cum): Annual O&M costs/ Total annual production
- Operating ratio: Annual O&M costs /Annual billing. It is construed as good if it is less than 1.0
- Storage capacity (hrs): Storage capacity/ Daily production
- Collection efficiency (%): It relates to efficiency of bill collection.

- Non-Revenue Water (NRW): Those components of system input that are not billed and do not produce revenue. This is equal to unbilled authorized consumption plus physical and commercial losses.
- Affordability to pay (ATP) by Consumers: A reasonable benchmark is about 5 % of household income on affordability for water and sanitation services.
- Willingness to pay (WTP) for new Thromdes/ Urban centers: It depends on the tariff, the household income and the volume consumed.
- The number of metered connections.
- O&M costs incurred which shall include costs related to: (i) Operation costs: power consumption, chemicals, minor repairs, purchase of spares and equipment) + Establishment costs (salaries, human resources etc.)
- Revenue generated from the sale of water through a metering system.
- Capital subsidy received for new activities/ investments.
- Proper identification of dwellings: residential and/or commercial.
- Accuracy of water meters- may need calibration and test bench.
- The rate of annual Inflation.
- The trend of O&M costs: There could be a steep increase at times due to the initiation of projects under the 'Design. Build, Operate and Transfer' or DBOT mechanism as the operational costs for new investments are paid to the contractor for a certain number of years.
- The number of public education and awareness programs conducted.

Water Production Capacity vs. Water Demand (2023).

Table 2 indicates the present data regarding production capacity of the existing Water Treatment Plants against their design capacities which will help understand the under-production rate and enable diagnostic study to identify the causes. The production deficit amounts to about 4.5 MLD which is largely significant.

Table 2.
Design Capacity vs. Production Capacity (TTWSS, 2023).

Water Treatment Plant	**Design Plant Capacity (MLD) (MLD=Million liters per day)**	**Production Capacity (MLD) (MLD= Million liters per day)**
Motithang	6.5	8.0
Jungshina	6.5	3.5

Water Treatment Plant	Design Plant Capacity (MLD) (MLD=Million liters per day)	Production Capacity (MLD) (MLD= Million liters per day)
Dechencholing	1.4	1.4
Megoypang/Chamgang	6.5	3.5
Boreholes near Flyover Bridge (Groundwater)	2.0	2.0
Taba/Dodena	10.0	10.0
Total	**32.9 MLD**	**28.4 MLD**

Table 3.
Present Water Demand (TTWSS).

Population (2023)	Average rate of water supply (lpcd)	Average water demand (MLD)	Remarks
150,000	162	24.30	Population based on *PHCB, 2017 and considering 1.3 % growth rate per annum+Floating population (@15%)

**PHCB: Population & Housing Census of Bhutan.*

Table 4.
Non-Revenue Water (Source: TTWSS, 2021).

Total Annual production (cum)	Total Annual Billed consumption (cum)	Average NRW (%)
10,366,000 (=28.4 MLD)	5,210,298 (=14.27 MLD)	**50**

Population scenario.

- Population (PHCB, 2017) of Thimphu Thromde: 114,551.
- Projected population in the Year 2023: 123,782 (considering a population growth rate of 1.3% per annum for 6 years using the Geometrical increase method).
- Floating population: 25,000 (considering 20 % of the total population).
- Total Projected Population in 2023: 148,782 (say 150,000). … (A)

- Domestic demand@ 135 lpcd.
- Adding 20% to cover Institutional demand, Industrial demand, Un-accounted for water (UFW) (@15%), fire-fighting demand (@5%).
- Total per capita consumption rate of water supply: 162 lpcd. … (B)

Total Average Daily water demand (2023): (A) x (B) = **24.30 MLD.**

Revenue vs. Expenditure Scenario

As indicated in Table 5, the annual average surplus (after meeting basic O&M costs) during the period from 2017-2019 was recorded as Nu.5.53 million. However, considering that there are several water supply schemes that were recently built on the 'DBOT' (Design, Build, Operate and Transfer) model through external funding for which the O&M costs are built in the contracts, there may be additional fund requirement in the next few years. The current 'operating ratio' stands at 0.84 which is indeed a good indicator for water utility, being less than 1.0 (1 USD =82 Bhutanese Ngultrum). In simple terms, the operating ratio indicates that the O&M costs are equivalent to only 84% of the total revenue generated while the rest 16% is a surplus amount.

The Thimphu Thromde has been outsourcing the construction of treatment plants, both for water as well as wastewater plants through the 'DBO/DBOT' model under which the contractor is required to carry out the complete design, build the plant as designed and operate the plant for 2-3 years and finally hand over the project to the client upon successful operation. This model is primarily adopted due to a lack of required expertise on the part of the client to design, build and operate such treatment plants of fairly large magnitude. This model has been successfully implemented to date and both the parties involved have mutually benefitted.

Table 5.
Revenue generated vs. Expenditure scenario for Thimphu Thromde 2020.

Year	Total Revenue generated (water + sewerage) (Nu. in million)	Current Expenditure (includes O&M+ Establishment costs) (Nu. in million)	Surplus (+)/ Deficit (-) (Nu. in million)
2017	21.01	23.91	(-) 2.90
2018	32.96	25.14	(+) 7.82
2019	47.09	35.41	(+) 11.68
Annual Average	**33.87**	**28.15**	**(+) 5.53**
	Operating Ratio		83.57 % (or 0.84)

The average current expenditure in the year 2023 is projected close to Nu.37.00 million/annum, considering inflation of 6 % per annum for 5 years (from 2019 to 2023). A multiplication factor of 1.3 is applied to the average base cost of Nu.28.15 million to arrive at the projected cost of Nu.37.00 million/annum in 2023.

Water tariff scenario (July 2013 to June 2022).

The water tariff rates were not revised during the period from July 2013 until June 2022.

Table 6.
Water Tariff structure (Water Bill/ TTWSS, 2022).

Water consumption/month (cum)	Residential (Nu/cum)	Commercial (Nu/cum)
0-20 (Lifeline block)	2.90	2.90
21-40	3.50	5.80
>41	4.35	11.60

Considering that one household of five members consumes an average of 20 cum of water per month (@135 lpcd), the water bill (inclusive of 50% surcharge as sewer charges) per household translates to Nu.87.00/- per month which is fairly affordable. The per capita consumption of 135 lpcd is derived from the 'Manual on Water Supply Design, Ministry of Communications, 2003'.

Present Water tariff scenario (since July 2022).

Since July of 2022, the tariff rates are flat rates irrespective of the volume of consumption as shown in Table 7.

Table 7.
Tariff structure (Water Bill/ TTWSS, 2022).

Water consumption/month (cum)	Residential (Nu/cum)	Commercial (Nu/cum)
For any volume	4.35	11.60

Considering that one household of five members consumes an average of 20 cum of water per month (@135 lpcd), the water bill (inclusive of 50% surcharge as sewer charges) per household translates to Nu.131.00/- per month which is deemed as affordable. The per capita consumption of 135 lpcd is derived from the Manual on Water Supply Design, Ministry of Communications (2003).

Revenue generation Scenario in 2023

The average billed consumption presently stands at 14.27 MLD which is equivalent to 428,100 cum per month. Considering that the consumption ratio between residential and commercial category is 80:20, the residential and commercial billed water volume works out to 342,500 and 85,600 cum per month respectively. Therefore, based on the prevailing water tariff, the total billed amount inclusive of 50% sewer charges is projected to be Nu.44.69 million/annum with the following cost break-down:

- Residential: 1.5x 342,500 cum/month x Nu.4.35/cum x 12 months = Nu.26.82 million/annum.
- Commercial: 1.5x 85,600 cum/month x Nu.11.60/cumx12 months = Nu.17.87 million/annum
- Total projected revenue generation using present tariff rates/Annum= Nu.44.69 million
- Total projected present O &M costs/Annum (Table-5)= Nu.37.00 million

The projected revenue generation of Nu.44.69 million per annum is observed to be fairly sustainable in terms of meeting the projected basic O&M costs of Nu.37.00 million annually (refer to Table 5). The additional surplus amount can be used for meeting the costs for planned maintenance works and as supplementary for capital expenses.

Proposed Recommendations.

Ensure sustainability of water utilities through realistic/suitable water pricing policy and tariff projection plans, corresponding to their performance and status. Increasing water tariffs, preferably on a periodical basis shall form an important tool for water demand management. All urban water supply systems should strive towards meeting at least the O&M costs from the tariff to self-sustain in the long term which can gradually enable funding of new capital investments in the future. With the increasing trend in the inflation rate, the O&M costs also increase correspondingly, and therefore, its recovery through tariff is deemed essential, which in effect, requires periodic revision of the tariff. However, the affordability to pay by the consumers need to be extensively studied considering their income levels before effecting any tariff revision such that its impact is minimal. Concurrently, the water utility is mandated to provide water of good quality and in adequate quantity to the consumers to garner their confidence in the Utility. Besides, the water utility need to maintain the tariff revision as low as may be possible while the capital subsidy will continue to be provided by the government to ensure long-term sustainability.

Implement Demand management measures through (i) realistic water pricing (ii) strict metering (100%) (iii) public awareness on water conservation (iv) promotion of the use of water-saving/efficient devices and (v) reduction of non-revenue water which will help assure 24 hr piped water supply with even less water.

Undertake reduction /management programs vigorously to reduce NRW to an acceptable level of 25% or less as compared to the existing high levels of NRW through appropriate measures such as leakage control mechanisms and curbing illegal connections. While some system losses in urban water supply systems are inevitable, setting up this target level is seen as pragmatic and doable as strived by most water utilities across the world, and is considered as being acceptable. Proper management and reduction of NRW will help generate sufficient revenue to cover operation and maintenance costs sustainably, curb water wastages, and encourage conservation.

Identify/ classify all buildings/entities under two broad categories, namely residential and commercial to appropriately align with the water tariff structure to help boost revenue collection.

Ensure that the installed water meters are accurate and necessary meter calibrations are carried out for defective meters. Besides, all illegal connections need to be identified and curbed by instituting a proper mechanism such as a household survey to ascertain if water meters have been installed and also if the meters are functional. Besides, GIS data/ mapping of each building with their corresponding water meter registration number can be established. Further, the water supplies to places like municipal labor camps, crematoriums, parks and public toilets/ amenities, and public water stand posts within municipalities are presently not billed considering these spaces as public.

Carry out digital mapping of all water supply assets and prepare inventories -pipeline mains and distribution network systems, valves, water treatment plants, reservoirs, etc. including their GIS coordinates.

Initiate the creation of 'hydraulic pressure zoning' or DMAs (District Metered Areas) to optimize the distribution network and reduce losses arising out of pipe bursts and leakages. This will help reduce system leakages resulting in the availability of more revenue water and enhancement of hydraulic performances as well.

Adopt smart billing/SCADA (Supervisory Control and Data Acquisition) and suitable automation system that will help monitor water loss through bulk and individual water meters, and ensure proper billing mechanisms and monitoring systems are in place.

Facilitate preparation of appropriate 'Tariff Policy guidelines' at the National level to enable the Local governments to adhere to mandatory requirements as well as adopt appropriate parameters to suit their local requirements. The policy will help water utilities to suitably undertake tariff revisions and prepare tariff projection plans considering the anticipated capital investments that may be required as well as the O&M costs.

Other general recommendations as follows could also be adopted, with a view to improve the service delivery aspects in addition to enhancing the financial viability of the water utilities:

- Initiate Private Sector Participation (PSP) in water supplies and its associated sectors to improve performance and efficiency, particularly in-service delivery in terms of O&M of the water supply systems. However, suitable modalities have to be developed to suit local conditions through development of appropriate policy and legal formwork to encourage participation by private firms. Similarly, community participation in water and sanitation services needs to be fostered and encouraged.
- Enhance institutional, technical and managerial capacity of the water utilities, with emphasis on the O&M aspects.
- Conduct regular education and advocacy programs to raise awareness amongst the consumers on water conservation.
- Prepare Inventory of Water and Sanitation Infrastructures to develop and manage a comprehensive data base.

Conclusion.

It is fairly evident from the literature review as well as the case study that financial sustainability is the key driver to achieving the intended overall performance of the systems, particularly in meeting the O&M costs adequately and in ensuring safe and reliable water supply to the consumers. While the primary objective for any water utility would be to meet the routine O&M costs, there is a need to periodically review and revise the water tariff to enable realization of not only the basic operation and maintenance costs but also generate additional revenue to meet some portion of the capital investments, depreciation costs and debt servicing in the long run.

In case of Thimphu Thromde, the study has indicated that the existing water tariff is only marginally adequate at the moment to generate revenue in meeting the basic O&M costs.

Additionally, it is observed that substantial revenue is being lost owing to uncontrolled and high level of NRW. This situation can be gradually addressed through adoption of simple NRW reduction measures and strategies which will help bring the NRW to an acceptable level.

Thimphu Thromde has in the recent past, been adopting the DBO (Design, Build, Operate) modality in provision of water infrastructures with its own capital investments through private contractors/firms but for limited O&M period of 1-2 years. While such mechanism is encouraging, it may be financially more viable on the part of the water utility to engage private parties/entities in providing the needed infrastructures through their own capital investments and at the same time allow them to operate and maintain the built systems for a longer period to ensure optimal financial returns on their part.

Most of the existing water infrastructures were built several decades ago and thus have become fairly old over the years thereby undermining the system performances, particularly the pipelines and its accessories which requires replacement in a phase-wise manner. Therefore, it is vital that additional revenue is generated in order to meet the capital investments that is necessary to ensure improved and regulated service delivery.

The existing water tariff in Thimphu Thromde is relatively low as compared to those of other countries. Low level of Water tariff is regarded as one of the primary causes that constrain the development and management of water supplies in the developing countries.

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