

Final report

Understanding demand and funding for piped-water supply in Mandalay City

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ABBREVIATIONS

AMR Automatic Meter Readers	CapEx Capital Expenditure	IDI In-Depth Interview	MCDC Mandalay City Development Committee
MMK Myanmar Kyat	MSME Micro, Small and Medium Enterprises	NRW Non-Revenue Water	OpEx Operational Expenditure
PPS Probability Proportional to Size	UNDESA United Nations, Department of Economics and Social Affairs	WASH Water, Sanitation, and Hygiene	WHO World Health Organization

SECTION

1

INTRODUCTION

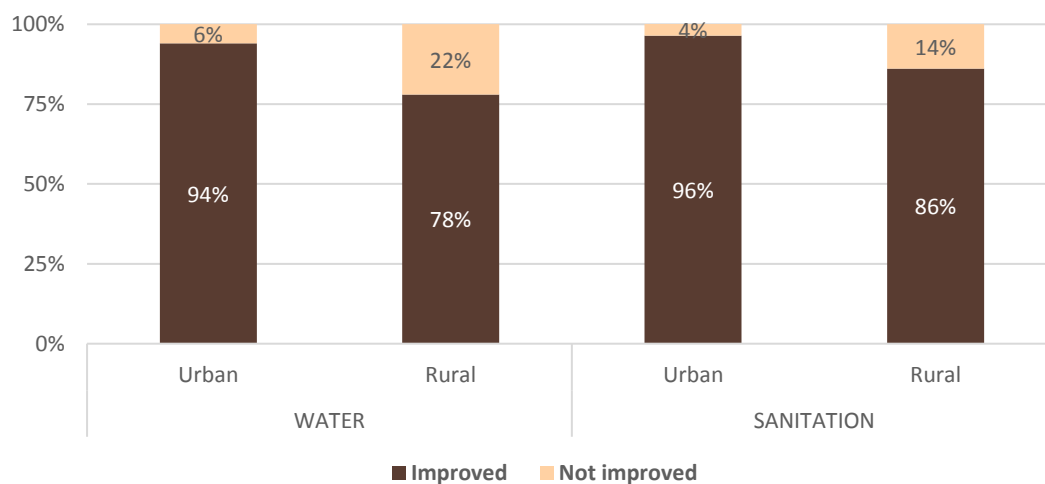
1. INTRODUCTION

1.1. Background

Safe water is crucial to growth and development. Yet, over 2.1 billion people did not use a safely managed drinking water source in 2015.¹ While the world has made substantial progress in access to water, sanitation and hygiene (WASH), 29% of the world's population still lacks reliable access to a safe source of water. Much of this population lives in rural areas, but rapid growth in large and secondary developing countries has left many city governments and utilities unable to meet the increased demand. Access to safe water is also strongly correlated with income levels, as "the vulnerable and disadvantaged, who are typically not connected to piped systems suffer disproportionately from inadequate access to safe drinking water and sanitation services, and often pay more for their water supply services than their connected counterparts".²

Like other countries at similar income levels, access to safe water and sanitation in Myanmar is correlated to both geography and income, with rural areas and poor urban citizens lagging behind (Figure 1).

Figure 1: Percentage of population with access to water and sanitation in Myanmar



Source: Myanmar Living Conditions Survey 2017 - Key Indicators Report.

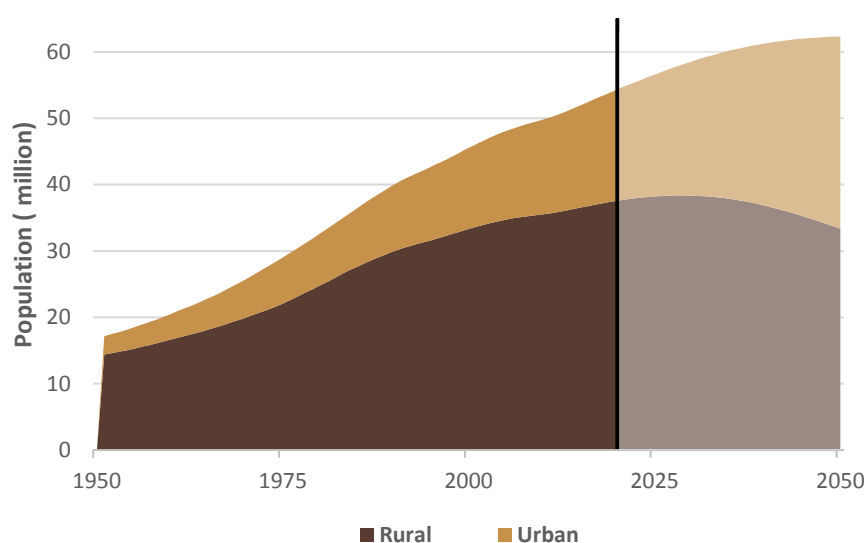
While the majority of the population remains rural (70%), urban populations are growing at a faster rate and total urban population has grown from 13.9 million in 2007 to 16.5 million in 2018.³ It is expected that by 2050, almost half of the country's population will live in urban areas (Figure 2). If tax regimes, accounting, and collection are improved, greater economic activity in cities can be funded through public revenues.

¹ The World Water Development Report 2019 defined safely managed as "drinking water from an improved water source that is located on premises, available when needed and free from fecal and priority chemical contamination" – improved includes: piped water, boreholes or tube wells, protected dug wells, protected springs, rainwater, and packaged water.

² WWAP (UNESCO World Water Assessment Programme), *The United Nations World Water Development Report 2019: Leaving No One Behind*. (Paris, UNESCO, 2019), 87.

³ United Nations, Department of Economic and Social Affairs (UNDESA). "World Urbanization Prospects: The 2018 Revision".

Figure 2: Urban and rural population in Myanmar (1950-2050)



Source: UNDESA, 2019. "World Urbanization Prospects: The 2018 Revision".

Mandalay is Myanmar's second largest city and the capital of the Mandalay Region. The city is governed by the Mandalay City Development Committee (MCDC), which is responsible for the delivery of services and infrastructure. The Mandalay Regional Government has a limited role and approves infrastructure projects and tariff regimes. In 2015, a group of multilateral and bilateral donors led by the Asian Development Bank, provided a loan to MCDC to extend and improve the water supply network, improve wastewater and drainage management, and strengthen the capacity to plan, design and manage services.

Around 90% of the piped-water supplied to domestic and industrial users is sourced from groundwater, which is understood to be increasingly limited, whereas the remaining 10% come from fresh water sources. At present, the piped-water network serves a fraction of the population, treats a negligible amount of sewage and runs at a considerable loss (approximately K3,700 million in 2016-2017). Revenue losses can be attributed both to breaks and leaks in pipes and to non-payment of tariffs and fees. MCDC simultaneously faces shortages of funds and skilled staff to maintain the network and to collect revenue. All this represents a huge loss in terms of water resources and financial revenue. Because water tariffs are one of the largest sources of income for MCDC, it is urgent that the rates, metering and collection be rationalized so that new infrastructure investments are sustainable.

Mandalay's problems are similar to those of many other cities in the developing world. City authorities or utilities face rising costs of expanding networks to serve an ever-growing population of migrants in their peripheries. At the same time, tariffs are kept low so that everyone can afford piped water. Even with low tariffs, the reality is that the poorest households remain unconnected because they cannot afford the high upfront costs of connecting to the network or they are unable to pay regular utility bills because of uncertain incomes from informal employment.⁴ With low revenues and rising costs, most utilities forgo making investments in maintenance and upgrading operations, thereby shortening the effective life of

⁴ Mitlin & Walnycki, 2019. "Informality as Experimentation: Water Utilities' Strategies for Cost Recovery and their Consequences for Universal Access". *The Journal of Development Studies*, 1-19.

their capital investments. In this context, the urban population with access to safe drinking water and sanitation is actually declining in many parts of the world.

1.2. Objectives of the study

This report responds to a request by the Mandalay City Development Committee (MCDC), the governing body of municipal Mandalay, Myanmar, to help better understand how to set water tariffs, improve financial viability of their water services department, and extend improved water services to its population. To that end, this investigation aimed at answering three questions:

- 1) How much water, from varied sources, do households and businesses currently consume, and how much do they pay for it?
- 2) Whether and how much can current water tariffs be increased without serious negative impacts on affordability for the poor?
- 3) In addition to tariff increases, which policy and programmatic reforms should be prioritized to improve financial viability?

To further understand demand and funding for piped-water supply in Mandalay City, the study used a mixed-methods approach: , a household survey administered to 1,480 households across six townships in Mandalay, and qualitative interviews with representatives of MCDC and other relevant stakeholders. This report outlines study findings, along with a brief synthesis of the relevant literature on tariff setting and other non-tariff mechanisms for funding water provision. Based on these findings, we present possible recommendations for improving funding for water provision in Mandalay..

SECTION

2

Literature Review

2. Literature Review

2.1. Water Demand in Developing Countries

Water demand is the measure of the total amount of water used by the customers within a water system. World water demand is projected to increase 20 – 30% above current levels by 2050.⁵ Developing countries and emerging economies contribute the most to the rise in demand, stemming from growth in populations, socio-economic development, and changing consumption patterns.⁶

Various issues make studying water demand in developing countries difficult. Most prominently, unmetered connections and unreliable meter readings persist in growing urban areas. For example, households consume 72 liters per capita per day (lpcd) in Cambodia⁷ and 135 lpcd in Southwest Sri Lanka from piped water connections⁸ but this difference may be attributed to the fact that households are using a variety of water sources other than publicly-piped water. Modelling demand for water therefore requires data from these alternative sources – often unavailable or hidden in informal markets.⁹

Despite these difficulties of aggregating across heterogeneous, substitutable sources, experts agree that total water demand remains relatively inelastic.¹⁰ Own-price elasticity – the percentage change of quantity demanded divided by the percentage change in the price – is inelastic in developing countries as in developed. Importantly, since piped water and nonpiped water are substitutes,¹¹ households with access to multiple water sources, such as water vendors or tubewells, may be more sensitive to price changes than those relying solely on piped water.

User willingness to pay (WTP) is fundamental to establishing a sustainable service system. Household income is positively correlated to WTP for improved water. Additionally, households tend to be more willing to pay for private water connections than public ones. Furthermore, WTP for proposed improvements in water access declines as a household's baseline access to other water services improves.¹² The present study aims to contribute to the knowledge of understanding water demand patterns in emerging economies with multiple water sources available to households.

2.2. Tariff and Service Provision in Developing Countries

While central governments often step in to fund large, bulky and upfront capital infrastructure to deliver public services, municipal governments are typically held responsible for raising sufficient revenues to

⁵ Burek, P., Y. Satoh, G. Fischer, M. T. Kahil, A. Scherzer, S. Tramberend, L. F. Nava, et al. 2016. *Water Futures and Solutions - Fast Track Initiative (Final Report)*

⁶ WWAP (UNESCO World Water Assessment Programme). 2019. *The United Nations World Water Development Report 2019: Leaving No One Behind*

⁷ Basani, M., J. Isham, and B. Reilley. 2008. "The Determinants of Water Connection and Water Consumption: Empirical Evidence from a Cambodian Household Survey." *World Development* 36 (5): 53-68

⁸ Nauges, C. and C. van den Berg. 2009. "Demand for Piped and Non-Piped Water Supply Services: Evidence from Southwest Sri Lanka." *Environmental and Resource Economics* 42 (4): 535-49

⁹ Nauges, Cé and Dale Whittington. 2010. "Estimation of Water Demand in Developing Countries." *World Bank Research Observer* 25 (2): 263-294

¹⁰ Ibid., 277

¹¹ Ibid., 535-49

¹² Van Houtven, George L., Subhrendu K. Pattanayak, Faraz Usmani, and Jui-Chen Yang. 2017. "What are Households Willing to Pay for Improved Water Access? Results from a Meta-Analysis." *Ecological Economics* 136: 126-135.

cover the costs of their operations. These costs are supposed to be covered through a combination of local taxes (including income, property, sales tax for example), tariffs and fees.¹³

Tariffs are user fees, imposed on households or businesses for the private consumption of a service. In addition to a fee for consumption which is imposed for economic recovery of costs, tariffs can also reflect environmental costs and equity goals. Water tariffs, for example, may be composed of a fixed charge, a volumetric component, and additional charges which may vary city by city.¹⁴ Furthermore, some cities may have just one tariff related to water, which also pays for sewage collection and treatment. Others may impose a separate charge to reflect that cost.

Responsibility for the day to day delivery of services can either lie within a department of the government, a corporatized semi-autonomous body, or a purely private sector provider which maintains its independence from the local government. Political relationships and governance arrangements have a large impact on incentives and the ability of service providers to raise and spend resources as they determine what level of priority the city will receive in the central budget.¹⁵

In many developing countries a host of issues including “poor governance and management of utilities (here used interchangeably with service provider), low tariff rates, limited capacity among many families to pay even those low tariffs, large system losses because of breakages and theft, poor information and management systems, and rapidly growing urban populations, leave many service providers unable to even cover ongoing maintenance.¹⁶ A recent study by the World Bank suggests that of the countries for which utility benchmarking data is available, only 35 percent are able to cover operations and maintenance costs of providing services.¹⁷ Without regular maintenance, breakages and leaks worsen, leading to a vicious cycle of neglect and non-revenue water losses.

Most urban areas that face large gaps in water services typically also face other problems such as “low income, energy poverty, poor education, and high rates of respiratory illness due to poor air quality.”¹⁸ Tariff-setting is often a political exercise, and not one based on financial, environmental or social costs. Tariffs are kept low on the premise that everyone should be able to afford piped water. Even with low tariffs, the poorest households remain unconnected because they cannot afford the high upfront costs of connecting to the network or they are unable to pay regular utility bills because of uncertain incomes from informal employment.¹⁹ Thus, low tariffs end up being regressive as they subsidize the consumption of relatively wealthier households who can afford the connection costs and are able to pay a regular bill.²⁰ Under these conditions, poorer households rely on a range of sources to satisfy their household needs,

¹³ Nagpal, Tanvi, Ammar A. Malik, Matthew Eldridge, Yoori Kim, and Chloe Hauenstein. 2018. *Mobilizing Additional Funds for Pro-Poor Water Services*: Urban Institute

¹⁴ Silva Pinto, F. and R. Cunha Marques. 2015. "Tariff Structures for Water and Sanitation Urban Households: A Primer." *Water Policy* 17 (6)

¹⁵ Boex, Jamie and Benjamin Edwards. 2014. *Triggering Increased City-Level Public Finance for Pro-Poor Sanitation Improvements*. Washington, DC: Urban Institute.

¹⁶ Nagpal et al., 2018, p 3.

¹⁷ Andres, Luis A., Michael Thibert, et al. 2019. *Doing More with Less: Smarter Subsidies for Water Supply and Sanitation.* World Bank, Washington DC. p. xiii

¹⁸ Houtven et al, What are Household's Willing to Pay, 126.

¹⁹ Mitlin, Diana and Anna Walnycki. 2019. "Informality as Experimentation: Water Utilities' Strategies for Cost Recovery and their Consequences for Universal Access." *The Journal of Development Studies*: 1-19.

²⁰ Van den Berg and Danilenko, 2017, 20

using a combination of open, unimproved sources such as ponds and lakes and safe sources such as deep wells or purchased bottled water. According to the most recent estimates from UNICEF and WHO, inequality in access to safely managed water remains a challenge for many urban areas. Between 2000 and 2017, water quality in rural areas improved from 42% to 53% free from contamination, while water quality in urban areas remained largely unchanged.²¹ The poor who lack access to piped water in their homes are thus much more likely to be consuming water of poor quality.

When there is a commitment to serving everyone, service providers have to look beyond tariffs alone to raise revenues. While city governments may not have the authority to change tax policy nationally, there are certain areas of taxation that typically fall under their jurisdiction. These include land and property taxes, one-time betterment fees and levies, and taxes based on higher land values (land value capture). All of the above are premised on an understanding of land markets, property values, household income and consumption patterns. A combination of flat fees, volumetric or increasing block tariffs (IBT) and other charges based on income, can then be used by municipal authorities to begin strengthening service provider performance. Even in resource-constrained settings it is possible to incrementally improve performance and build trust so that consumers can see that they are paying for better services over time.²²

Table 1: Water Tariff Structure in other Asian countries

Country	City	Tariff structure
Bangladesh	Dhaka	Flat Rate - Connection Fee + Consumption Tariff. Universal Subsidy on tariff
Bhutan	Thimphu Valley	Flat rate (residential); IBT (non-residential)
China	General practice	IBT; 4 components (Water resource fee + Raw water fee + Wastewater treatment charge + Water Supply price)
India	Ahmedabad	Flat Rate (30% of Property Tax)
	Bangalore	Fixed Connection charge + IBT. Full cost recovery
	Chennai	Fixed connection charge + IBT (for metered users) and Flat rate (for unmetered users)
	Delhi	Fixed Connection charge + IBT. 50% of consumption charge is levied towards sewerage maintenance
	Hyderabad	IBT (metered users) / flat rate based on pipe size (unmetered users)
Indonesia	Jakarta	IBT/ Uniform Volumetric Charge; Flat rate (sewerage)
Japan	Yokohama	IBT; 2 categories- Domestic and Commercial
Malaysia	Kuala Lumpur	IBT/ Flat Rate
Philippines	Manila	Volumetric (+ CERA+ FCDA+ EC+ SC+ MSC+ MWSI+ VAT)
Thailand	Bangkok	IBT; 2 categories- Domestic and Commercial

²¹ *Progress on Household Drinking Water, Sanitation and Hygiene: Special Focus on Inequalities*. 2019. New York: United Nations Children's Fund (UNICEF) and World Health Organization (WHO) P. 72.

²² *Soppe, Gerard, Nils Jansen, Scarlett Piantini (2018) Water Utility Turnaround Framework: A Guide for Improving Performance. The World Bank Group* <http://documents.worldbank.org/curated/en/515931542315166330/pdf/Water-Utility-Turnaround-Framework-A-Guide-for-Improving-Performance.pdf>

SECTION

3

**APPROACH &
METHODOLOGY**

3. APPROACH & METHODOLOGY

The team reviewed existing literature to collect preliminary insights on the key study objectives. For each of the objectives, a set of associated input indicators was identified and mapped to secondary and primary sources for data collection. Table 2 lists the various sources of input data points used to attain the research outcomes.

Existing literature included previous relevant studies as well as documents shared by external stakeholders and MCDC. These insights were then utilised to refine the sampling, identify relevant stakeholders, and design the survey instruments

Table 2: Overview of the objectives and their linkages with research design inputs

Research outcomes	Research Inputs			
	Desk Research	In-depth interviews	Household Survey	MCDC Billing data
How much water, from varied sources, do households and businesses currently consume, and how much do they pay for it?		✓	✓	✓
Whether and how much can current water tariffs be increased without serious negative impacts on affordability for the poor?			✓	✓
In addition to tariff increases, which policy and programmatic reforms should be prioritized to improve financial viability?	✓	✓		

The research design is therefore based on mixed methods involving a set of a preliminary in-depth interviews (IDIs) with MCDC officials and other relevant stakeholders such as VEI WaterWorx, Gret, and Suez. This was followed by a quantitative survey of household and businesses using an application-based research instrument. Finally, the team conducted a second set of validation interviews with officials and gathered administrative data from MCDC on tariffs.

3.1. IDIs with External Stakeholders and MCDC officials

Household surveys and detailed interviews with MCDC officials provided information on the following:

- Challenges, issues and experience in the provision of piped-water supply in Mandalay City
- Consumer perspectives of the cost, quality and reliability of alternative water sources
- Current initiatives and future priorities of MCDC Water & Sanitation Department and Water Revenue Department
- Previous relevant reports and studies on piped-water supply in Mandalay City.

3.2. Quantitative Survey

The quantitative survey was conducted to understand water use patterns within Mandalay City, and to capture behavioural aspects such as perception, satisfaction, and expectations from piped-water supply.

The survey was conducted across six townships. Due to the absence of credible data on the proportion of businesses per household at the township-level, it was assumed to be proportional to the ratio at the city-level. Therefore, as per Probability Proportional to Size (PPS) sampling, the number of surveys administered followed an 80% households/20% businesses ratio. The table below provides a comparison between the initial sampling plan and the population actually captured by the survey (

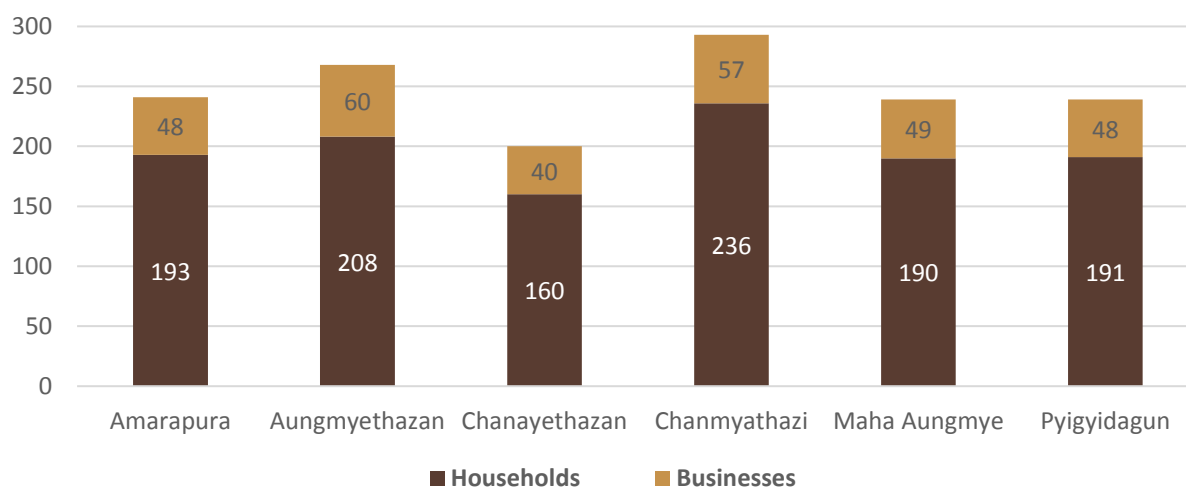
Table 3).

Table 3: Sampling Plan and Survey Data Comparison

Township	Sampling Plan			Actual Survey		
	HHs	MSMEs	Total	HHs	MSMEs	Total
Amarapura	193 (80%)	48 (20%)	241	193 (80%)	48 (20%)	241
Aungmyethazan	215 (80%)	54 (20%)	269	208 (78%)	60 (22%)	268
Chanayethazan	159 (80%)	40 (20%)	199	160 (80%)	40 (20%)	200
Chanmyathazi	230 (80%)	57 (20%)	287	238 (81%)	57 (19%)	293
Mahaaungmye	194 (80%)	49 (20%)	243	190 (80%)	49 (20%)	239
Pyigyidagun	193 (80%)	48 (20%)	241	191 (80%)	49 (20%)	239
Total	1,184 (80%)	296 (20%)	1,480	1,178 (80%)	302 (20%)	1,480

A total of 1480 respondents were randomly selected across the 6 townships, including 1178 (80%) households and 302 (20%) micro, small and medium enterprises (MSMEs), distributed proportionally to the actual population (Figure 3).

Figure 3: Survey distribution in Mandalay City (N=1480)



Following obtention of the Institutional Review Board (IRB) approval, the quantitative survey tool was developed into an application for mobile data collection. This tool allowed geo-tagging of respondent houses/businesses across the six townships. Eighteen enumerators were identified based on educational qualification, sector experience, and geography. The tool was pre-tested, and enumerators were trained over an interactive four-day training workshop in Mandalay. The training included domain knowledge sharing, administering the survey through tablets, and survey ethics. A Field Management Plan was developed with the data collection team to set up clear mechanisms for survey monitoring, quality checks and field level trouble shooting protocols. As the survey could be monitored using an API, weekly updates on the survey progress were provided to the International Growth Centre.

SECTION

4

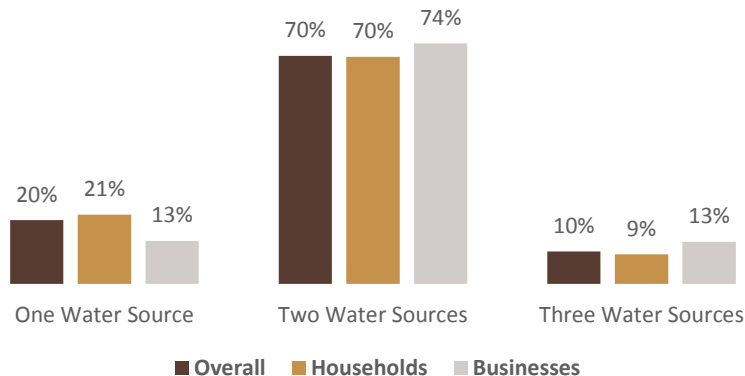
STUDY FINDINGS

4. STUDY FINDINGS

4.1. Understanding the sources of water

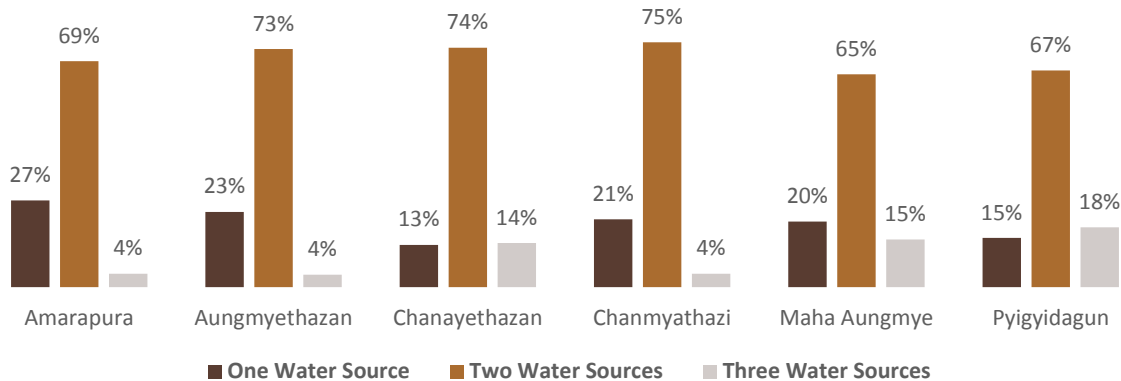
A majority (about 80%) of households and businesses use water from two or more sources (Figure 4).

Figure 4: Number of Water Sources, by user type (N=1480)



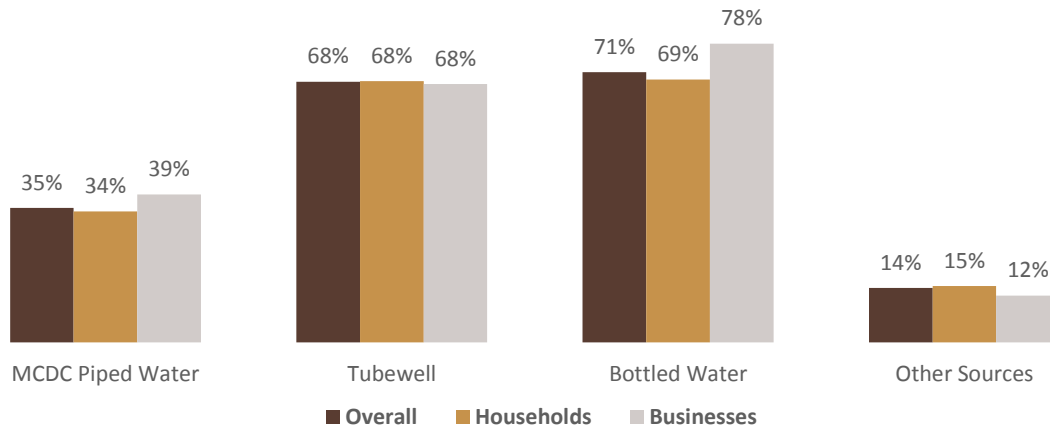
This pattern is similar across all townships (Figure 5). Chanayethazan displays the highest proportion (about 87%) of households and businesses that use water from multiple sources, while Amarapura has the least with only 73% of its inhabitants using water from more than one source.

Figure 5: Number of Water Sources, by township (N=1480)



Moreover, water sources are used in similar proportions across households and businesses (Figure 6). Overall, the most common sources of water are water bottles (71%) and tubewells (68%), while only 35% of respondents reported obtaining water through MCDC piped-water system.

Figure 6: Water Source in Mandalay (N=1480)



However, across townships, access to water sources differs greatly. In Amarapura, 96% of the households use water from tubewells, while this is the case for only 44% of households in Maha Aungmye. In terms of MCDC water connections, Maha Aungmye has the highest proportion of connections with 65% of the households connected to MCDC, while Amarapura has the lowest proportion of households with MCDC connection (none of the respondents in Amarapura reported having a connection). Therefore, there seems to exist an inversely proportional relationship between MCDC piped-water and tubewells. The same is true for businesses as well (Figure 7 and Figure 8).

Figure 7: Water Sources - Households (N=1178)

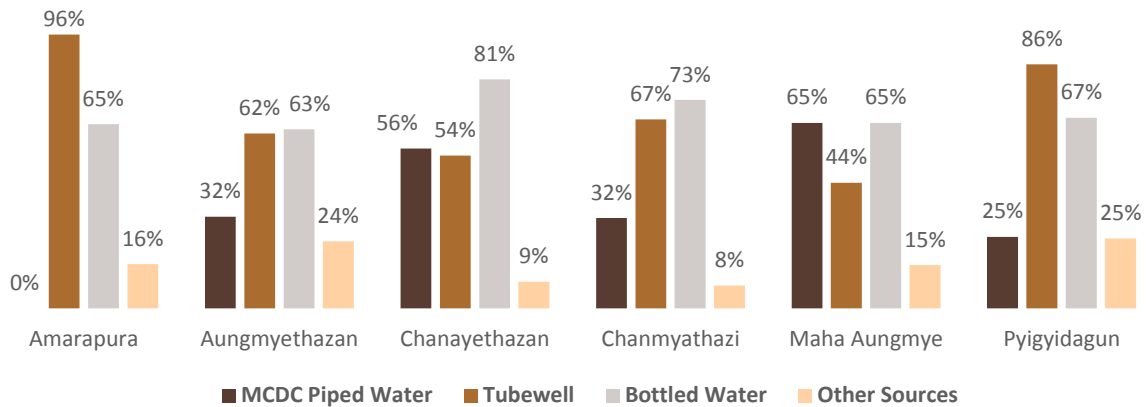
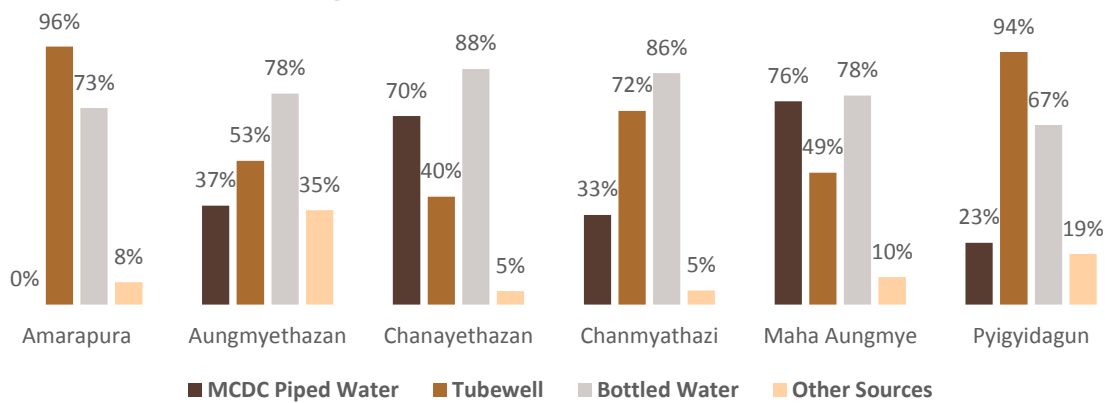
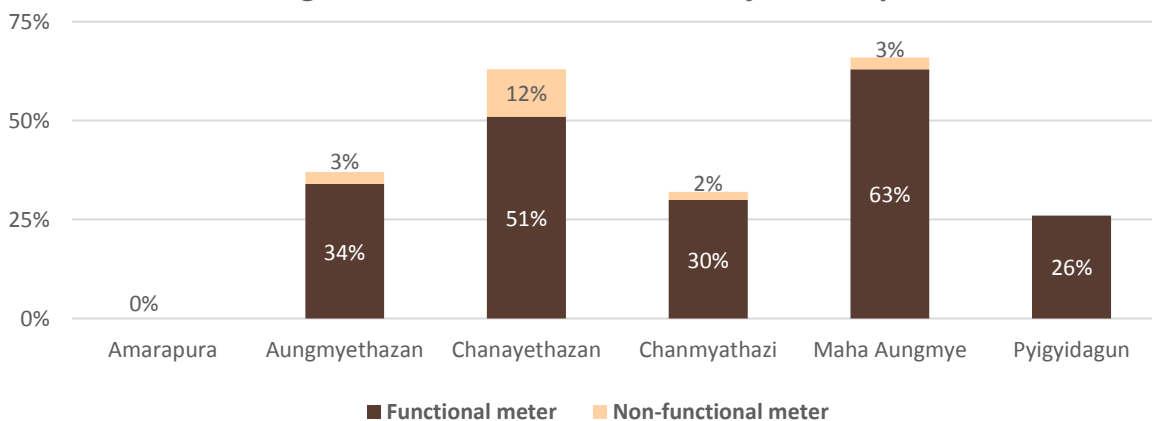


Figure 8: Water Sources - Businesses (N=302)



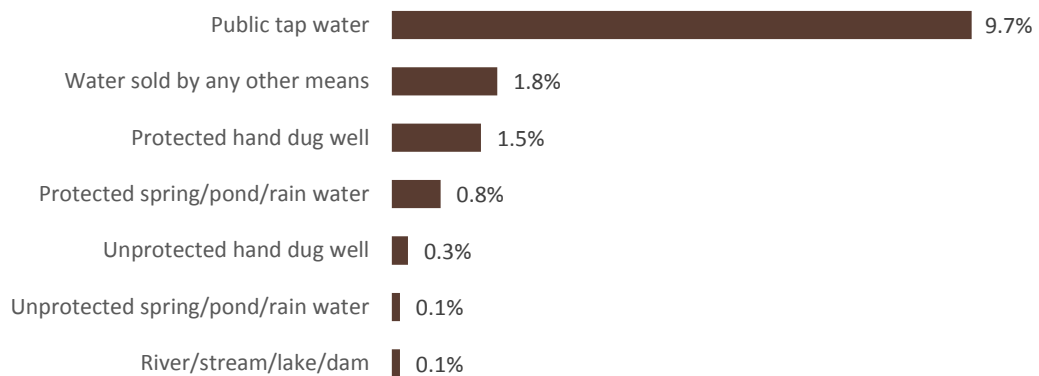
At the township level, Maha Aungmye and Chanayethazan have the highest proportion of MCDC piped-water connections (respectively 66% and 63%). The latter also displays the highest proportion of non-functional meters (12%), while all respondents in Pyigyidagun reported having functional meters (Figure 9).

Figure 9: Status of Water Meters - By Township (N=521)



As mentioned earlier, the main sources of water for households and businesses are tubewells, commercial bottled water and MCDC piped water. However, there is a small proportion of respondents (about 14%) who get water from other sources, including 9.7% who obtain water from public taps. The detailed breakdown of these other sources is presented in Figure 10).

Figure 10: Breakdown of Other Water Sources (N=1480)



About 92% of those who use public taps collect water from the taps daily. On average, public tap users spend about 12 minutes per trip to collect water (Figure 11 and Figure 12).

Figure 11: Public Tap - Frequency of Water Collection (N=124)

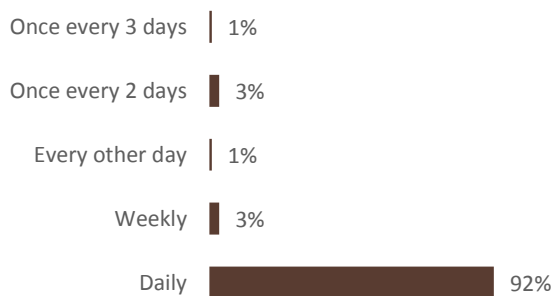
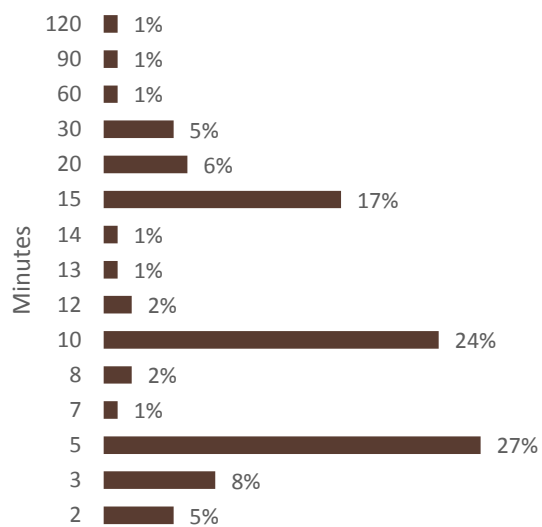


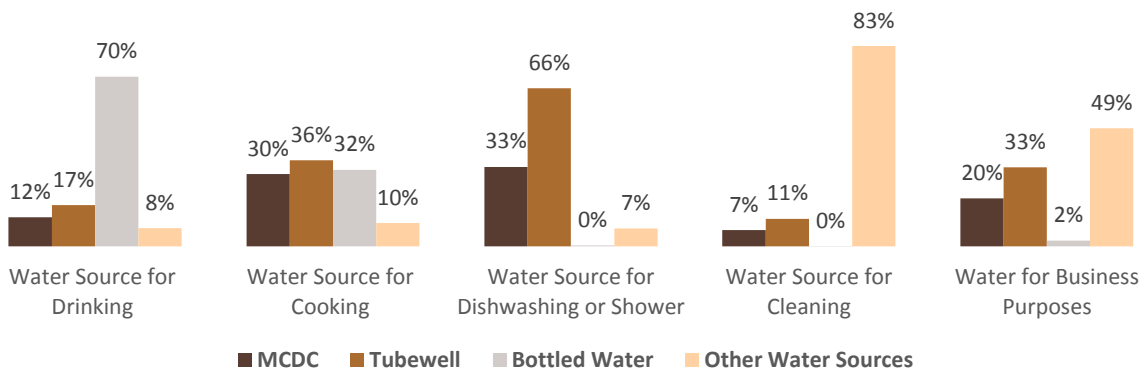
Figure 12: Public Tap - Duration for Collecting Water (N=124)



4.2. Understanding water use patterns

This section provides an assessment of how households and businesses value and use different water sources. Figure 13 describes how Mandalay’s households and businesses use water from different sources. As expected, bottled water is the most preferred source of water for drinking (70%), but it is interesting to see that a sizeable proportion also use tubewells (12%) and MCDC piped-water (17%) for drinking water. Tubewell water and MCDC piped-water are used for the same purposes - primarily cooking, showering and dishwashing, while water from ambient sources is preferred for cleaning and business purposes.

Figure 13: Water Source Used for Different Purposes (N = 1480)



A closer look at Amarapura and Maha Aungmye supports the hypothesis that tubewell and MCDC water are close substitutes as they are often used for very similar purposes (Figure 14 and Figure 15).

Figure 14: Amarapura - Water Source Used for Different Purposes (N = 48)

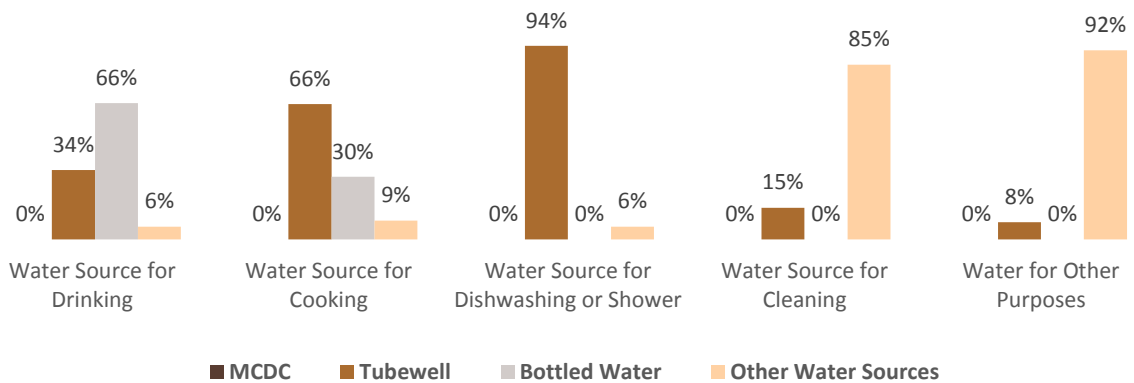
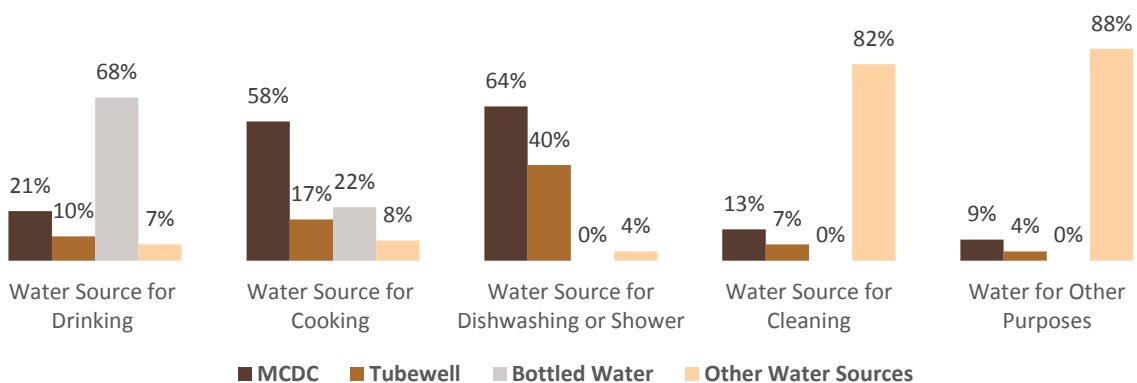


Figure 15: Maha Aungmye - Water Source Used for Different Purposes (N = 49)

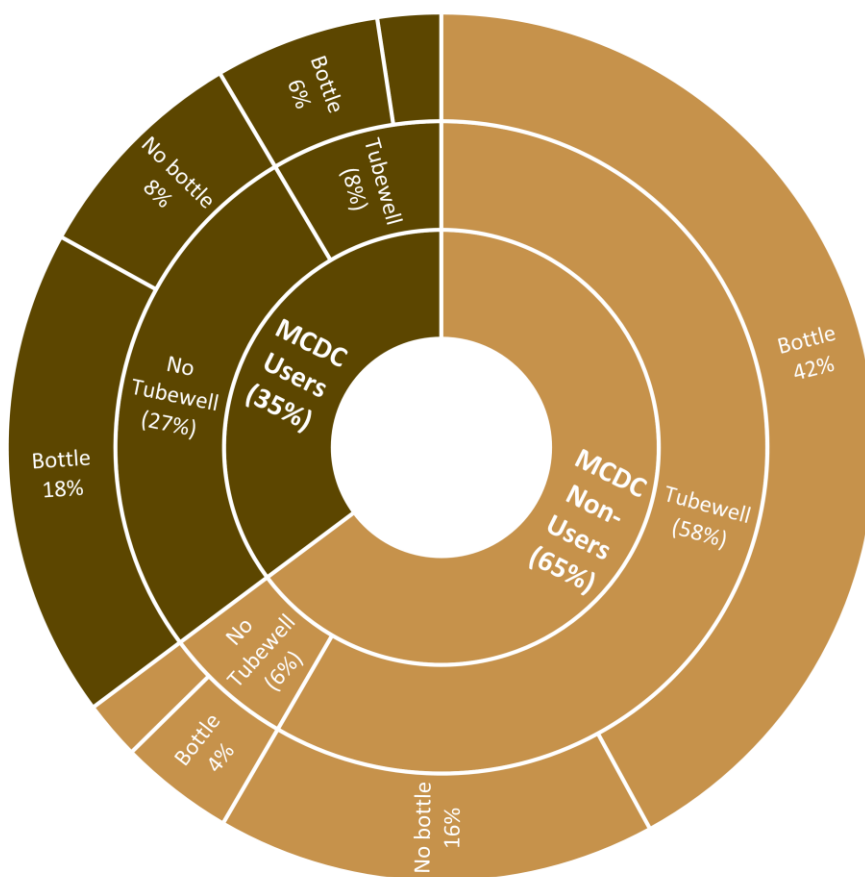


4.3. Understanding the various users and their profiles

An analysis of the various types of water users is presented below to provide a deeper understanding of the diversity of MCDC piped-water users. Primarily, respondents are divided into two categories, namely, MCDC users (households/businesses with MCDC piped-water connection) and MCDC non-users (those without a piped-water connection). MCDC users are further subdivided into four main categories based on the major alternative sources of water they have: MCDC users with both tubewells and bottled water supply, MCDC users with tubewells but not bottled water supply, MCDC users without tubewells but with bottled water supply, and finally, MCDC users who neither have tubewells nor bottled water supply.

Figure 16 summarizes the share of each user type mentioned above. Most MCDC piped-water users do not use tubewells (27% out of 35%), which again suggests that tubewells may be used as a substitute to MCDC piped-water. On the other hand, most MCDC piped-water non-users have a tubewell (58% out of 65%). While MCDC piped-water and tubewells are substitutes, bottled water seems to be a complementary source to both MCDC piped-water and tubewells. Most MCDC piped-water users also use bottled water (24% out of 35%).

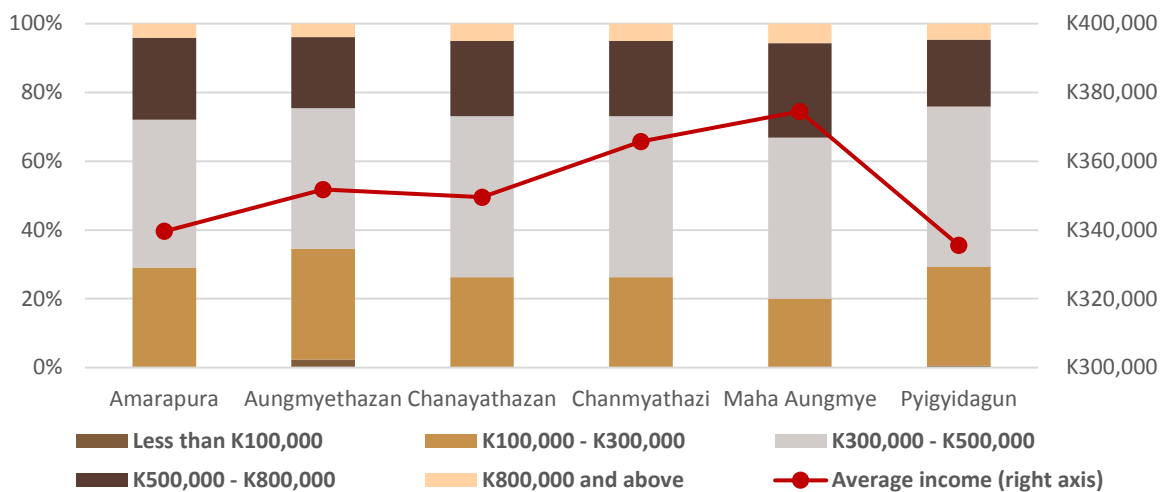
Figure 16: Additional water sources – MCDC Users vs. Non-Users (N=1480)



Income distribution of the various User Types

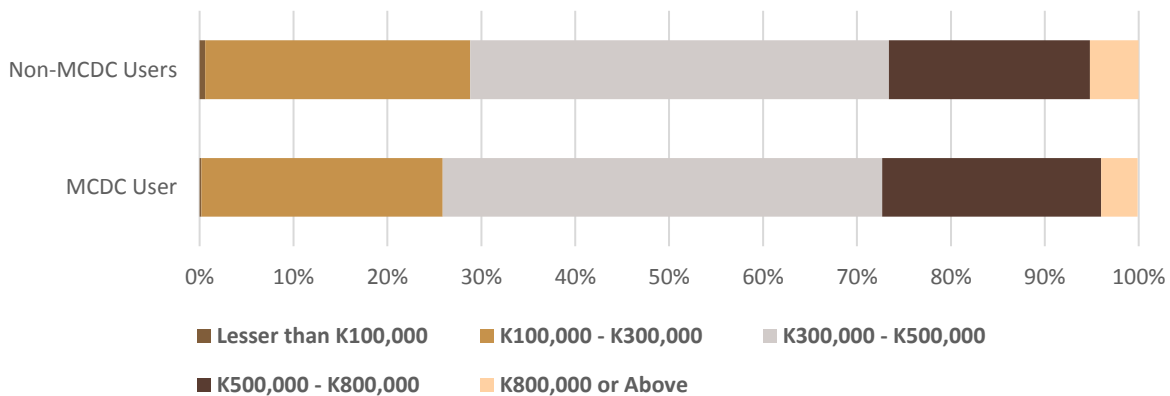
Household income distributions are very similar across most townships. The average income is higher in Maha Aungmye than in other townships, and Pyigyidagun has the lowest average income (Figure 17). However, these differences are marginal and not significant enough to be relevant towards the expansion strategy of MCDC's piped-water network.

Figure 17: Monthly household income - By Township (N=1178)



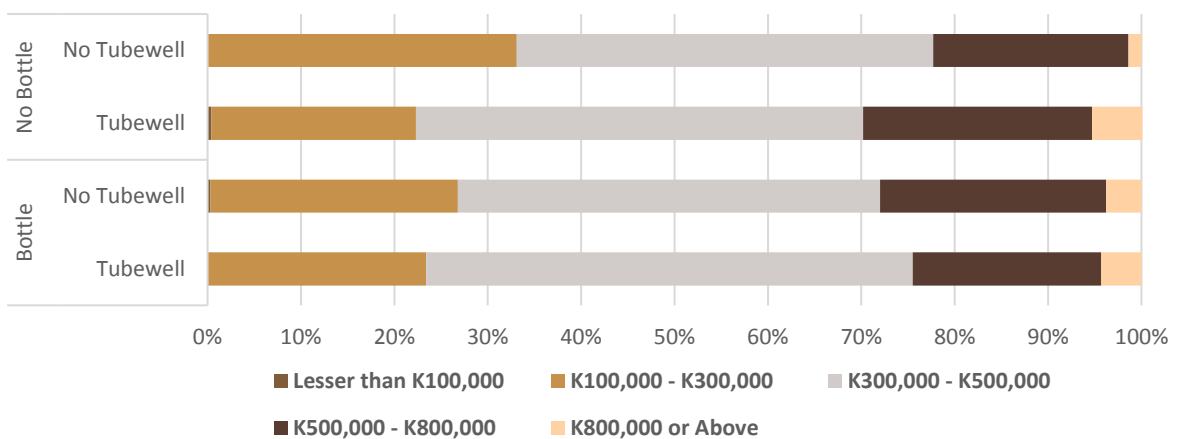
Interestingly, the income distributions between households who have access to piped-water supply and those who do not (hereinafter referred to as 'MCDC users' and 'MCDC non-users') are also similar (Figure 18). Therefore, income may not have an important role in households' access to MCDC piped-water.

Figure 18: Monthly Household Income - MCDC Users vs. Non-Users (N=1178)



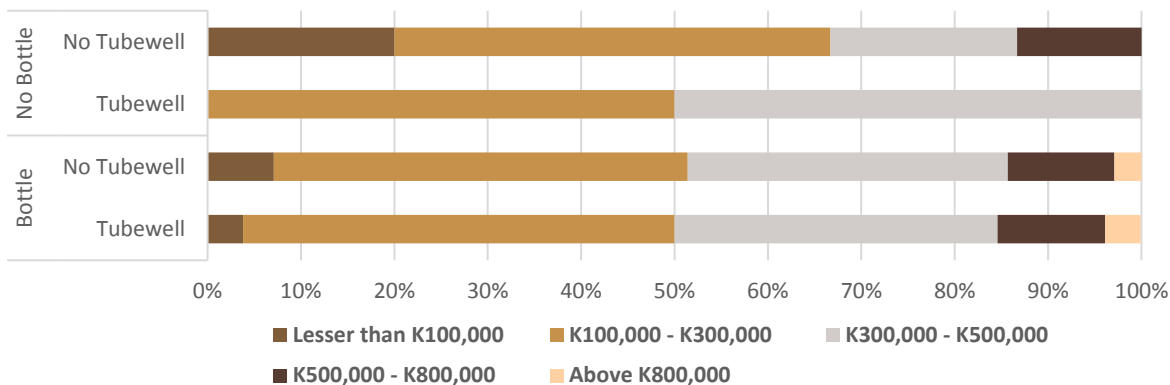
Given the lack of significant household income differences between MCDC users and non-users, Figure 19 provides a comparison within the different categories of MCDC users as presented previously in Figure 16. Again, the differences are marginal (Figure 19).

Figure 19: Household Income - MCDC Users (N=401)



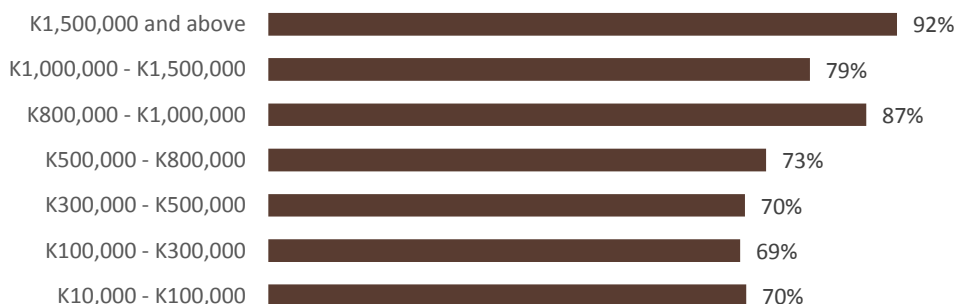
On the other hand, there is considerable heterogeneity in the case of businesses, where the difference in the distribution of business income is wider (Figure 20). However, the size of the sample accounting for businesses with MCDC water is small, which is likely to lead to such higher variations.

Figure 20: Business Income - MCDC Users (N=118)



Similarly, the proportion of bottle users across income ranges varies very little: at least 70% of the population earning between 10,000 and 800,000K use bottle water (Figure 21).

Figure 21: Proportion of bottle users by income range (N=1480)



On average, households spend about 10,000 MMK on bottled water every month, which is a significant expense for those earning less than 500,000 MMK per month (70% of the population).

4.4. User perception and satisfaction

One of the crucial set of questions in the survey covered the relative importance of price, quality, reliability and accessibility of water supply. Understanding what users value most is critical if MCDC is planning to expand supply and raise tariffs. The overall results for MCDC users and non-users are presented in Figure 22-25.

The preference patterns between MCDC piped-water users and non-users is very similar, in all dimensions. Overall, the most important aspect is the quality of water, followed by the reliability of water supply, accessibility, and lastly price. This means that the inhabitants of Mandalay may be willing to consume and/or pay more if the quality, accessibility, and reliability of piped-water supply are improved upon. They may also be willing to change their water source from tubewell to MCDC piped-water if the water was of better quality (assuming that tubewell have a very high Capex but very low Opex). It is worth noting that price could start to matter if either the price of bottled water or the tariff for piped water increases further.

Figure 22: Importance of Water Price - MCDC Users vs. Non-Users (N=1480)

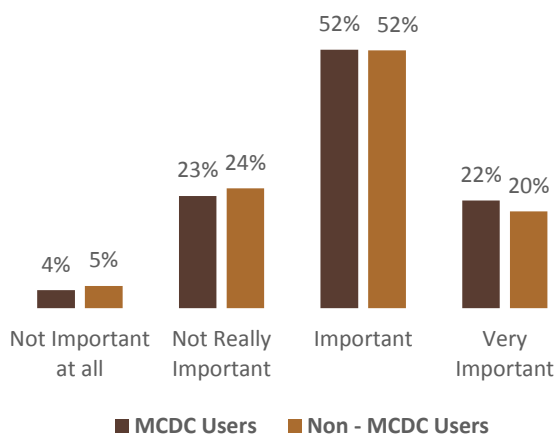


Figure 23: Importance of Water Quality - MCDC Users vs. Non-Users (N=1480)

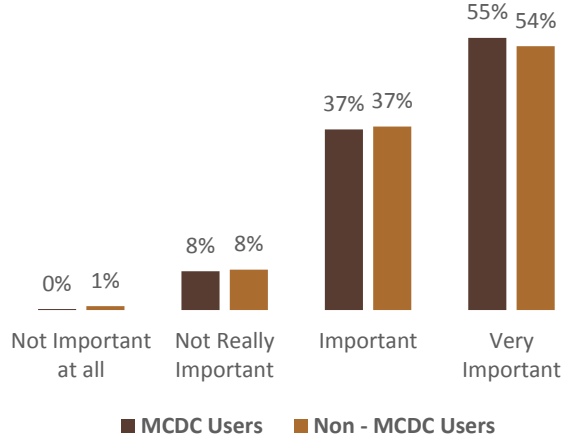


Figure 24: Importance of Water Accessibility- MCDC Users vs. Non-Users (N=1480)

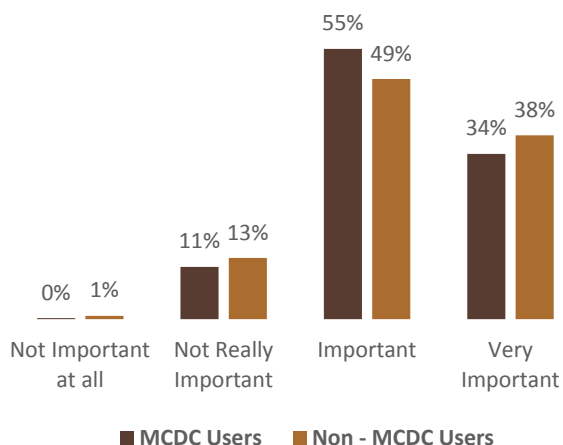


Figure 25: Importance of Supply Reliability- MCDC Users and Non-Users (N=1480)

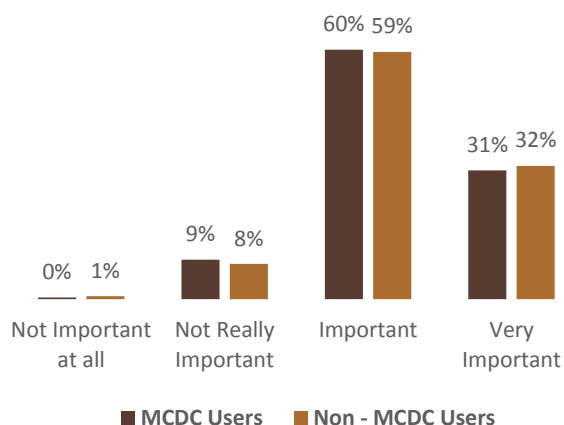
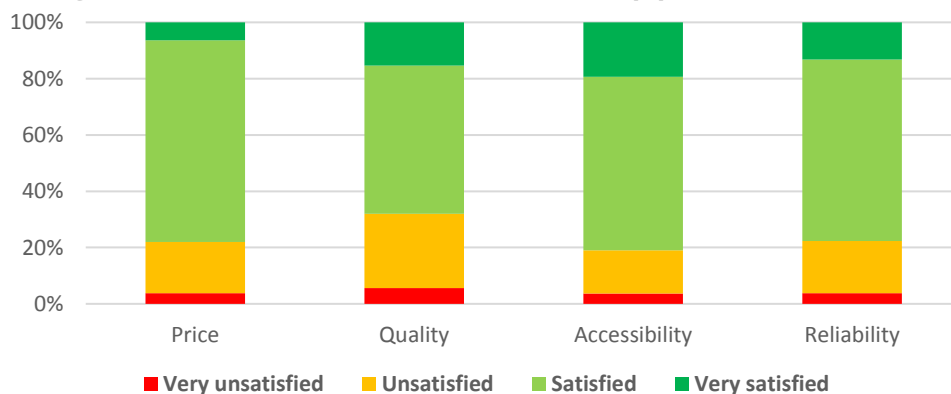


Figure 26 provides the level of satisfaction with MCDC piped-water as reported by households. Overall, the population seems satisfied with MCDC piped-water for its current purposes (cooking, showering, dishwashing). The highest level of dissatisfaction pertains to the quality of water (32% are unsatisfied or very unsatisfied).

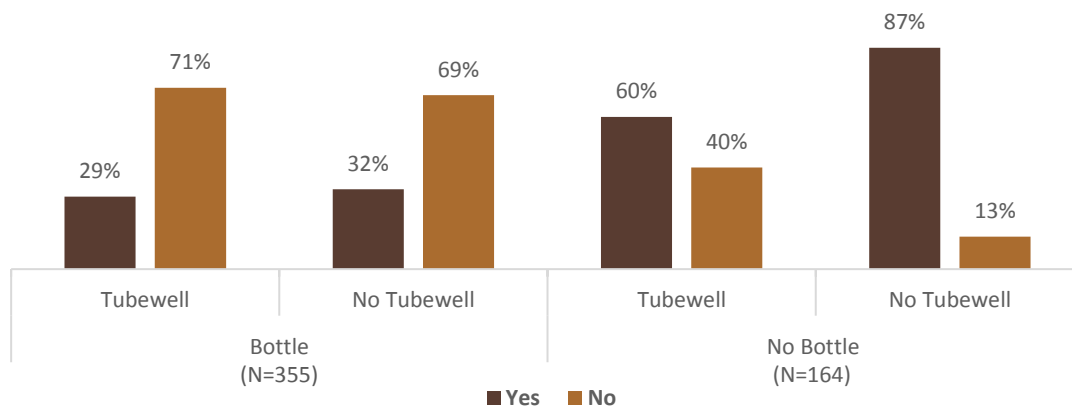
Figure 26 : Levels of satisfaction with MCDC piped-water (N=1178)



When asked if MCDC piped-water is safe to drink, greater proportions of MCDC users with access to alternatives such as tubewells and bottled water tend to believe that MCDC piped-water is not fit for drinking (Figure 27). Only those who do not use bottled water believe that MCDC piped-water is safe to

drink, especially if they do not have a tubewell either. Thus, users with available alternatives would choose not to drink MCDC piped water even if it were available, as they consider it unsafe for consumption. Only a small number of people who lack access to tubewells and cannot afford to purchase bottled water reported that MCDC water was safe to drink.

Figure 27: MCDC Users - Is MCDC piped-water Safe to Drink? (N=519)



4.5. Reaction to tariff changes and elasticity of demand

Using data obtained from MCDC Water Revenue Department, this section describes the reaction of consumers to tariffs changes and provides estimates on the expected response of demand to future tariff changes. Over the period 2012-2019, two tariff changes happened, in 2015 and 2017. In 2015, the tariff increased from 55 MMK to 85 MMK (+54.5%), and in 2017 from 85 MMK to 200 MMK (+135.3%). Figure 28 presents the average unit price paid by consumers on a quarterly basis over the entire period. It appears that the unit price actually paid by consumers closely matches the official tariff for most quarters.

Figure 28: Comparison between Official Tariff and Unit Price paid by Consumers

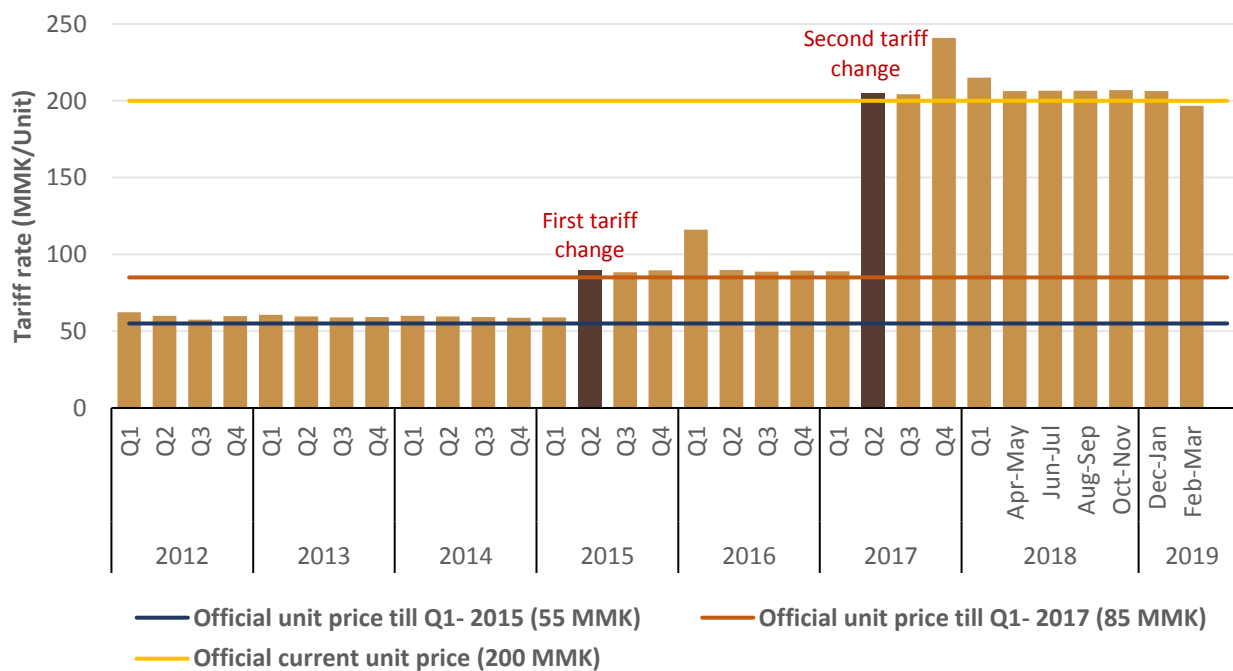
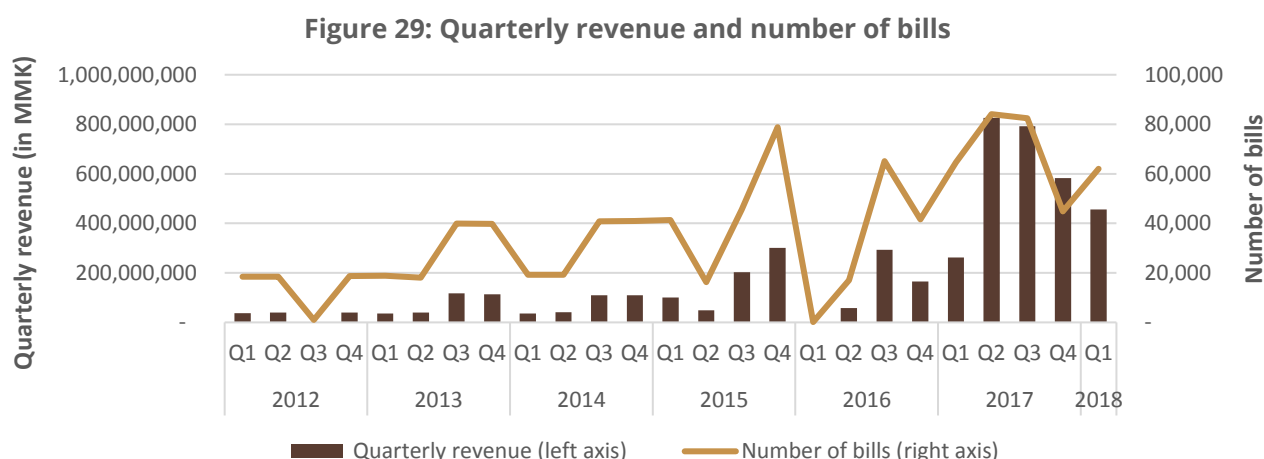


Figure 29 presents MCDC’s quarterly revenue based on billing data, along with the number of meters billed. Due to the lack of consistency in terms of coverage, and the ‘artificial’ revenue increase generated by new meter connections, it is not possible to make any rigorous inferences from the trend.



To estimate the effectiveness of these two tariff changes, revenue figures were aggregated for households where data was available before and after the tariff change. This means that households that did not have a connection to MCDC piped-water system and those who had a non-functional meter on either period were excluded, thereby ensuring that the calculation was done for a fixed set of households:

- In 2015, the tariff increased by 54.5%, which led MCDC revenue to increase by 47.1%. Therefore, this tariff change was 86.4% effective due to households’ consumption being negatively affected by 2.4%.²³
- In 2017, the tariff increased by 135.3%, but the revenue only increased by 74.1%. This is because households’ consumption dropped by 28.6%. As a result, the tariff change effectiveness was limited to 54.9%.²⁴

While water is generally considered a relatively inelastic good (i.e. demand does not react strongly to price variations), this is not the case in Mandalay due to the widespread access to sources of substitution (e.g. tubewells). It is expected that further increases of the tariff will have a limited contribution to MCDC piped-water Revenue Department due to decreasing marginal returns (the more the tariff increases, the more the decline in consumption is significant). Therefore, the more the tariff increases, the less it is effective.

Figure 30 describes this dynamic by providing estimates of the expected revenue to be generated from 5 MMK tariff increases. Three ranges of tariffs with important implications in terms of revenue generating potential have been identified:

- Below 140 MMK/unit – the tariff is so low that tariff increases do not affect negatively households’ piped-water consumption. As a result, for a 5 MMK increase of the tariff rate, the revenue generated is above 5 MMK.
- Between 145 MMK and 390 MMK/unit – households react to the tariff change and reduce their piped-water consumption, thereby reducing the net gain in terms of revenue.
- Above 390 MMK/unit – households reduce their consumption to such an extent that the marginal gains becomes negative, resulting in a net loss in terms of revenue.

Based on these results, it appears that increasing the tariff rate beyond 385 MMK/unit would affect piped-water consumption to such an extent that the marginal revenue generated would be negative. Even past 285 MMK/unit, the marginal revenue gain for an increase of the tariff of 5 MMK decreases to less than 2 MMK. This poses the risk of significantly affecting the households’ consumption of piped-water for a

²³ Calculated for households between Q1 2015 and Q4 2015, over 10,302 meters.

²⁴ Calculated for households between Q1 2017 and Q1 2018, over 24,747 meters.

limited net gain in terms of revenue. Future tariff changes should be cognisant of that fact if they aim at maintaining a 'pro-poor' aspect to ensure piped-water access for all. Nonetheless, the curve is likely to move up in the future as Mandalay's income per capita increases, resulting in a higher tariff rate threshold in a few years.

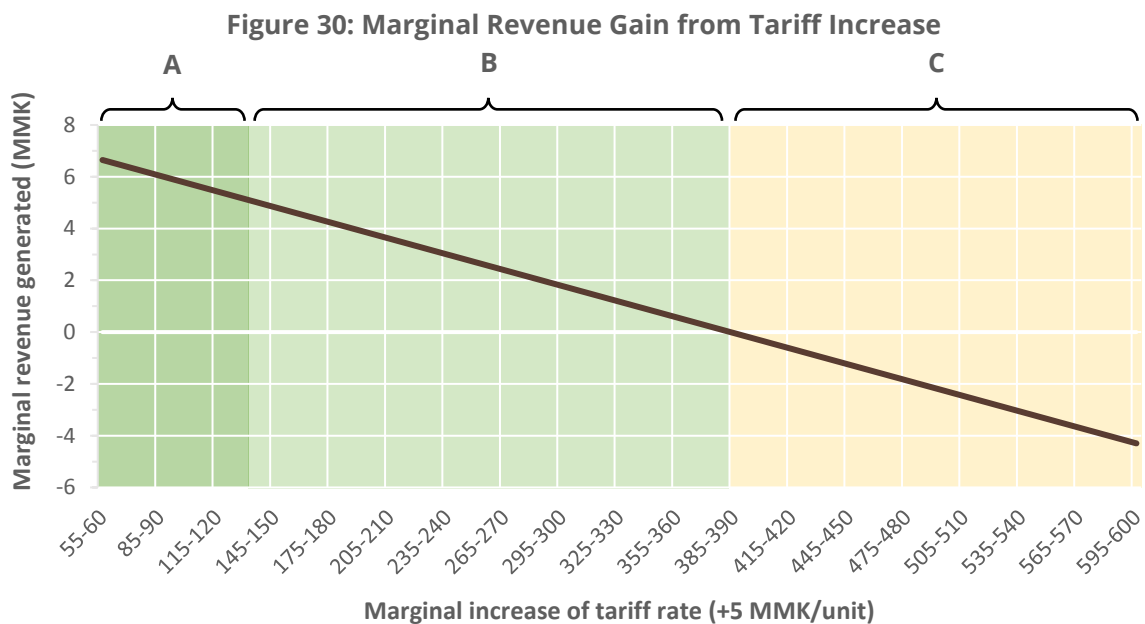
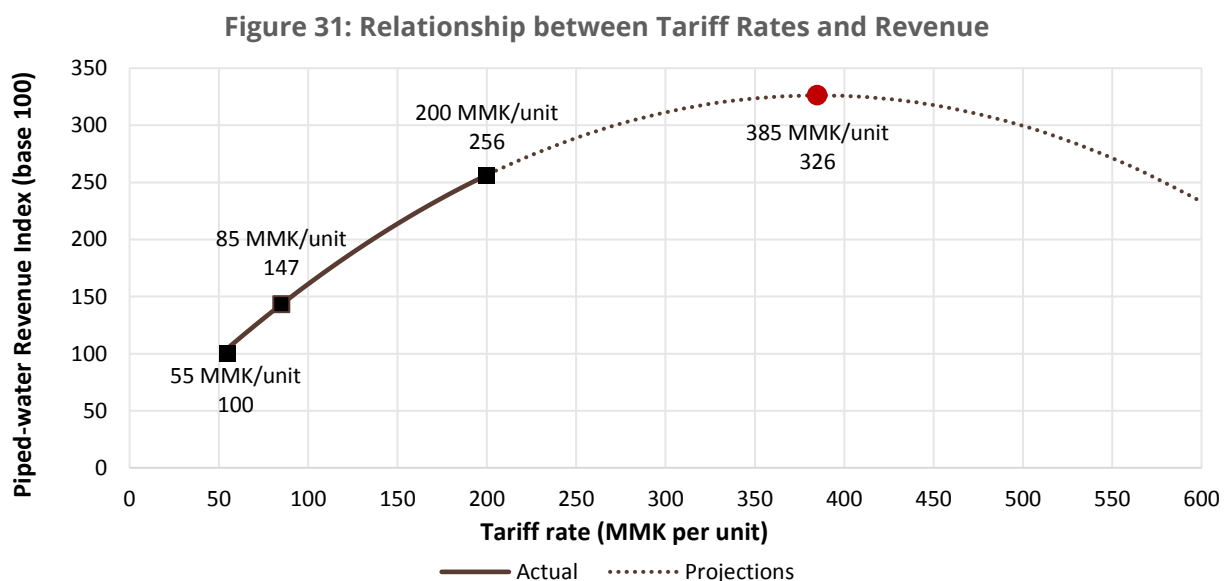


Figure 31 synthesises these findings through the use of an index representing revenue, with a reference value set at 100 for the original tariff rate of 55 MMK/unit. Cumulatively, both tariff-changes in 2015 and 2017 resulted in an increase in revenue for MCDC Water Revenue Department of 156% (from base 100 to 256). As previously shown in Figure 30, revenue starts decreasing for tariff rates that exceed 385 MMK/unit. This value can therefore be considered as a threshold representing the maximum value at which piped-water tariff for household can be increased.

Between the current tariff (200 MMK/unit) and the threshold (385 MMK/unit), the index for piped-water revenue displays an increase of 27.3%. Therefore, since piped-water revenue between Q2 2017 and Q1 2018 amounted to MMK 2.656 billion, it is estimated that an increase of the tariff rate to the threshold would bring revenue to MMK 3.382 billion, an increase of over MMK 720 million.



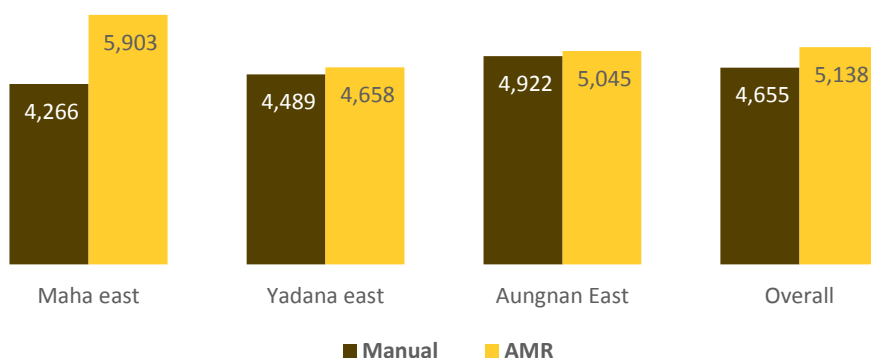
Transition to Automatic Meter Readers (AMR)

Previous independent studies reported a high rate of dysfunctional or broken meters. Between 2017 and 2018, MCDC Water & Sanitation Department progressively replaced manual meters with automatic meter readers (AMR) meters in Maha East, Yadana East, and Aungnan East. MCDC expected that this replacement would lead to a doubling of revenue. In order to estimate the real impact on revenue for MCDC Water Revenue Department, various sources of bias were removed from the associated billing data such as:

- Not all the meters were changed at the same time in each of the three areas – this means that revenues had to be weighted based on the proportion of AMR meters in each area.
- Several bills were higher than consumption due to customers who previously had negative balance (credit) and had to regularise their situation following the installation of AMR meters, resulting in inflated revenue - it is therefore impossible to compare the first period following the installation of AMR to the previous period.
- Billing changed from a quarterly basis to every two months – therefore, the data had to be estimated on a monthly basis.
- New piped-water connections happened during the period, resulting in inflated consumption and revenue figures following the installation of AMR.
- A number of new AMR broke down during the period, resulting in inaccurate revenue figures.

For each of the three areas, the average monthly water bill with AMR meters was then estimated and compared to the average monthly bill with the manual meters (Figure 32). On average, Automatic Meter Readers (AMR) increased revenue by 10.4% as compared to the previous manual meters (from a monthly average bill of MMK 4,655 to MMK 5,138). Therefore, replacing all manual meters in Mandalay City with AMR meters has the potential to increase revenue by MMK 320 million (based on data for the year 2018). However this does not take into consideration the actual cost of purchasing, installing or maintaining the meters.

Figure 32: Average Monthly MCDC Bill - by Type of Meter



SECTION

5

RECOMMENDATIONS

5. RECOMMENDATIONS FOR SHORT TO MEDIUM TERM

5.1. Observations and Water Tariffs

In Mandalay, MCDC manages the operation and maintenance of public infrastructure. Empirically, costs for operation and maintenance (OpEx) should be covered through a combination of local taxes, sale of property, tariffs and fees.²⁵

Tariffs – the user charges imposed on households or business for the private consumption of a service – may solely recover economic costs of consumption and use, or they may also reflect environmental costs and equity goals. They can be uniform and fixed, or graduated with a volumetric component. Water tariffs may also include treatment and sewage costs.²⁶

The majority of households in Mandalay do not receive water from MCDC and thus pay no tariffs. Most of those who are connected pay a flat fee, as the meters may not work accurately. Those who could be connected but prefer to continue using tubewells are levied a small use fee.

Currently, tariffs do not cover even the cost of limited water provision in Mandalay.²⁷ This is not unusual: one estimate suggests that of the countries for which data is available, only 14 percent of utilities cover the total economic cost of service provision, and 35 percent are able to cover the minimum expenditures related to operation and maintenance.²⁸ Without regular maintenance, breakages and leaks worsen, leading to a vicious cycle of neglect and water losses.

One of many reasons for high costs and low revenues of water provision is non-revenue water (NRW). NRW is the difference between the volume of water put into a water distribution system and volume that is billed to customers. This includes physical losses (through leaks and overflows), commercial loss (unregistered meters, data-handling errors, or theft), and unbilled authorized consumption (used by utility provider, water used for firefighting, and water provided for free to certain consumer groups). In Mandalay, NRW is estimated at close to 52 percent, which is higher than the average in countries with similar incomes (35 percent).²⁹ It is estimated that about 70 percent of Mandalay's NRW stems from physical losses and about 30 percent from commercial loss – specifically faulty meter readings. Authorities within MCDC were unsure of exact sources of NRW. They also reported significant unbilled but authorized consumption for monasteries and government buildings.

MCDC aims to progressively connect the entire population in six townships, and is presently working with many development organizations and NGOs to expand its network. From our research, it is clear that users who connect to the network will continue using their existing source of water to some level. Given this reality MCDC faces two critical challenges:

- 1) It must progressively cover operation and maintenance costs of current system

²⁵ Nagpal et al, Mobilizing Additional Funds, p2.

²⁶ Pinto & Marques, 2019, Tariff structures for water.

²⁷ We do not have actual administrative costs related to water provision as these costs are not separated from other service provision costs. However, other researchers have reported that NRW is very high and this was confirmed in our interviews with administration officials.

²⁸ Andres, Luis et al (2019) p.xiii

²⁹ Kingdom, Bill, et al. 2006. *The Challenge of Reducing Non-Revenue Water (NRW) in Developing Countries: How the Private Sector can Help: A Look at Performance-Based Service Contracting*. Washington, DC: World Bank

- 2) It must strategically maximize the usage of new connections by reducing reliance on alternative sources, especially bottled water and new deep wells.

5.2. Recommendation #1 – Reduce Operational Expenditure (OpEx)

Prioritize the assessment and reduction of NRW. Water lost to breakages, billing errors and theft represents both environmental costs and economic inefficiency. Reducing NRW can increase cash flow for utilities, which may then expand the supply network without squandering water resources.

Implementing a loss prevention and reduction program may, however, require significant investments. A detailed assessment of NRW components, and the costs and benefits associated with reducing them would be first step for MCDC.

The following are associated short to medium term recommendations:

- **Meter all unbilled authorized users, including monasteries and government offices, to get an accurate assessment of total production costs and subsidies.** Although charging these entities may not be politically or socially feasible, understanding the cost of supplying water to all users is important to budgeting accurately for maintenance and upgrades.
- **Meter all businesses and use graduated tariffs, especially for those using large amounts of water.** As Mandalay grows and attracts more businesses it is critical that their use of all services be regulated. Unregulated tubewell drilling is likely to lead to groundwater depletion and future water access problems. **MCDC itself relies on deep wells and an expansion of the piped network will deplete these sources.**
- **Promote accurate meter readings and data-handling.** This could be done by creating payment schedules for users unable to afford their regular bill and by rewarding reader teams for increases in accurate bills collected based on a benchmark.
- **Incentivize meter readers and users to report damaged meters, and technician teams to repair broken meters.** Meter readers have no incentives to report broken meters as they continue to charge families based on prior use. It is unclear whether MCDC or households are responsible for repairs and replacement.
- **Gradually switch to reliable automatic meter readers (AMRs).** AMRs are expensive and there is little capacity within MCDC to repair them. In addition, there is a risk that households will switch to other sources if they perceive that they are paying more with AMRs. Thus, MCDC should prioritize large users (businesses) and areas where there is lower substitutability between piped and groundwater.
- **Install backflow prevention to prevent and minimize additional breakages and corrosion.**

5.3. Recommendation #2 – Raising Water Revenues

Water tariffs are the second largest source of revenue for MCDC. As indicated by the research, tariff levels can only be raised to approximately 386 MMK per unit at current income levels. Beyond this, a tariff increase will not yield an economically efficient return, but instead penalize the poorest consumers who rely on MCDC water.

Alternative methods to raising revenue without another tariff hike include:

- **Keep tariff at the current level for the first consumption block, increase it for the second and consecutive blocks** (especially as meters are upgraded). In the long term, especially as meters are upgraded, it may be possible to move from flat, volumetric tariffs, to

block tariffs. In this case, the first block consumed could be at the current rate with higher rates charged for second and consecutive blocks. Block tariffing would also help with conservation and reduce waste.

- **Create a GIS registry of tubewells.** This could allow MCDC to increase its collection of permitting fees by charging a monthly water abstraction fee based on the size of the property, the number of inhabitants, or electricity usage. Non-registered wells could be fined and capped to prevent over-abstraction and wastage. *In many areas where there are no MCDC pipes, homes and businesses rely entirely on tubewells. There are thousands of shallow and deep wells in Mandalay. While MCDC has mapped many, and charges a permitting fee to owners for digging a well, it is unclear if all new and old wells are mapped or monitored.*
- **MCDC's water department, in collaboration with the health department, could consider regulating bottled water distribution both as a source of income and to ensure that such water is safe for consumption** (if bottlers are indeed using either piped or groundwater and treating it before supplying it to households). Private water provision is big business in Mandalay, as most homes depend on bottled water (bulk drinking water included) for drinking. It was outside the scope of this study to understand the bottled water market, sources and income but MCDC does not currently regulate this market.

5.4. Recommendation #3 – Consider Other Critical Costs

Mandalay endeavors to improve WASH infrastructure and service provision through the construction of sewage treatment plants and expanding its piped water network. These initiatives will come with additional capital, operating and debt servicing costs.

MCDC should include in its cost-benefit analysis the following critical costs:

- **Debt servicing and sustainability.** MCDC has multiple loans for the construction of new sewage treatment plants and to expand its piped water network. All loans will need to be serviced and this debt servicing will place an additional burden on MCDC in coming years.
- **Climate change and water shortages.** Mandalay is located in the central dry zone of Myanmar and is already experiencing the effects of climate change with a longer dry season and lighter monsoon rains. Freshwater sources dry up in the long dry season and more businesses and households are turning to ground-water abstraction. If unchecked, excessive use of groundwater will lead to its depletion and associated environmental issues.
- **Electricity** comprises a significant portion of operating costs for MCDC's water provision. By some accounts from MCDC officials this reached approximately 40 percent of OpEx, or approximately K3.5 billion annually. Expanding the piped-water supply network and changing to AMR will add significantly to these costs. MCDC should accurately assess current electricity charges for its network and factor these in future cost-benefit analyses.

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