Profitability and Operating Efficiency of Piped Water Systems in Biguli Sub-county

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Introduction

This brief note presents the main findings of an analysis of the operating efficiency of piped water systems built by Water For People in Biguli Sub-county, Kamwenge District, Uganda, with the financial support of the Conrad Hilton Foundation (CHF). Two piped systems were analyzed: a system serving the villages of Bitojo, Byantumo, and Nyabubale and another serving the villages of Kabale, Keishunga, and the whole of Kabuye Parish. Both were completed in 2017, apart from the extension to Kabuye which was finalized in late 2018. The systems currently provide water to more than 14,000 people. The period under analysis was December 2017 to April 2019, with data provided by the systems' owner, Uganda's Mid-Western Umbrella of Water and Sanitation. The Kabuye extension represented a large increase in water production of the Kabale system, and it is operated by a different operator, but individualized data was not available. Therefore, for Kabale, only data up until October 2018, the last month before Kabuye was commissioned, was used. While the analysis focused on Bitojo and Kabale, it also referenced four other systems built by Water For People in Biguli, with support from the Stone Family Foundation – Busingye, Malere, Rwebishahi, and Biguli-Kirinda –for more robust findings to be drawn. The analysis includes an overview of the main recommendations made by Open Capital Advisors (OCA) in a 2017 study requested by Water For People for these four systems and updates on their implementation.

Given the small number of systems analyzed, all findings should be taken as anecdotal.

Findings

Figure 1 shows the average monthly revenues and operating costs of each system.

Figure 1: System Monthly Revenues and Costs (UGX)

	Busingye	Kabale	Malere	Rwebishahi	Bitojo	Biguli-Kirinda
Revenues						
Billed	329,603	806,755	417,500	439,703	1,433,277	5,100,285
Collected	258,166	464,178	370,285	346,753	1,213,998	5,251,514
Costs						
Fuel	283,882	471,909	413,824	249,765	96,941	1,589,429
Maintenance	111,429	141,429	122,017	111,429	111,429	111,429
Staff	271,847	295,782	271,847	271,847	271,847	778,529
Transport & admin.	56,949	64,436	56,949	56,949	56,949	155,294
Operating profit w/ billed revenues	**-394,507**	**-166,804**	**-447,140**	**-250,289**	**896,110**	**2,465,603**
Operating profit w/ collected revenues	**-465,944**	**-509,381**	**-494,355**	**-343,239**	**676,831**	**2,616,831**

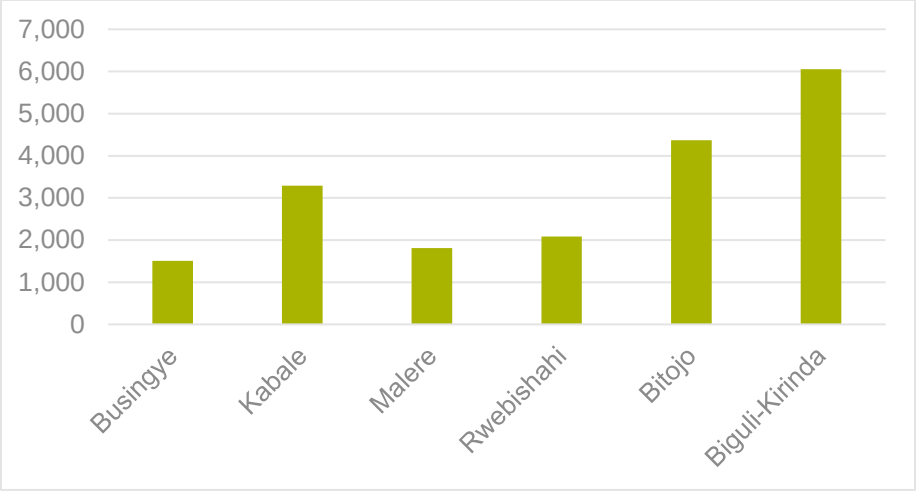
Note: Maintenance costs refer to material and spare parts only. Labor is included in staff costs.

Only Bitojo (financed by CHF) and Biguli-Kirinda generated a monthly profit. The remaining four systems made losses. Biguli-Kirinda is operated by the private operator Biguli Traders Association (BTA) whereas Bitojo is operated by Power Technical Services (PTS). PTS operates Bitojo together with the other four systems as a cluster, thus making a combined monthly loss of approximately UGX 362,000 in terms of billed revenues and UGX 1.14 million in terms of collected revenues. The fact that the two individually profitable systems are run by different operators, and that the same operator runs both profitable and loss-making systems, suggests that operator capacity to run the systems efficiently may not be a major factor in explaining water system profitability, and that other factors may be at play.

Population Served

Figure 2 shows the average estimated number of people served by each system.

Figure 2: Number of People Served



The two profitable systems also serve the most people. In contrast, the two least profitable systems in terms of billed revenue, Malere and Busingye, serve the fewest people. This supports the notion that there are economies of scale to be reaped from piped water systems; as systems expand and serve more people, revenues from water sales increase proportionally whereas operating costs increase less than proportionally, leading to higher profitability. In other words, in terms of the number of users, marginal revenues (i.e. the increase in revenue from selling water to one additional customer) exceed marginal costs.

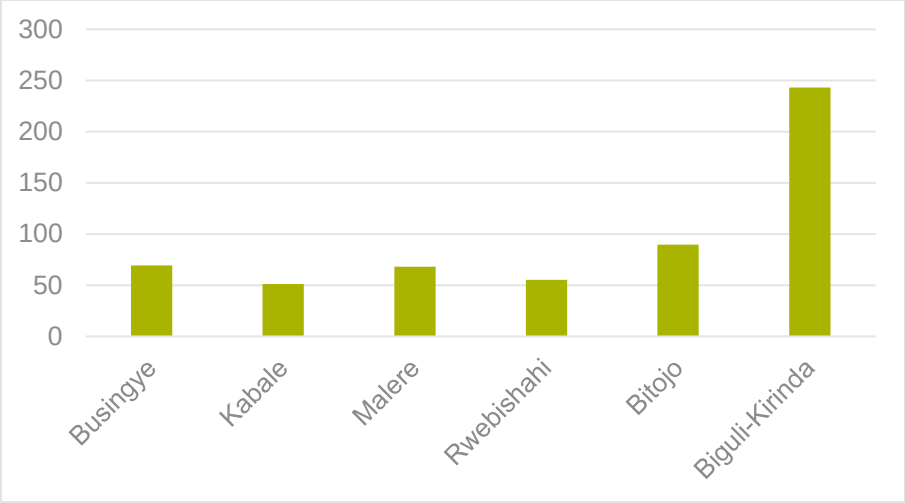
The need to increase system scale as means to achieve cost efficiency – decrease unit costs and overcome fixed cost barriers – and improve profit margins was one of the key recommendations made by OCA in 2017. Eight new private connections were installed in Busingye and Rwebishahi since then, but no new public kiosks/standpoints or institutional connections. This small increase in scale, far below the Umbrella's set target of five new connections per month, has not been sufficient to make these systems profitable, as is also the case with Kabale and Malere.

Water Consumption

Figure 3 shows water consumption by the users of each system on a per capita basis. The main types of connections through which water is supplied to users are public kiosks/standpoints, standpoints in institutions (mainly schools), and private connections in households and yards.

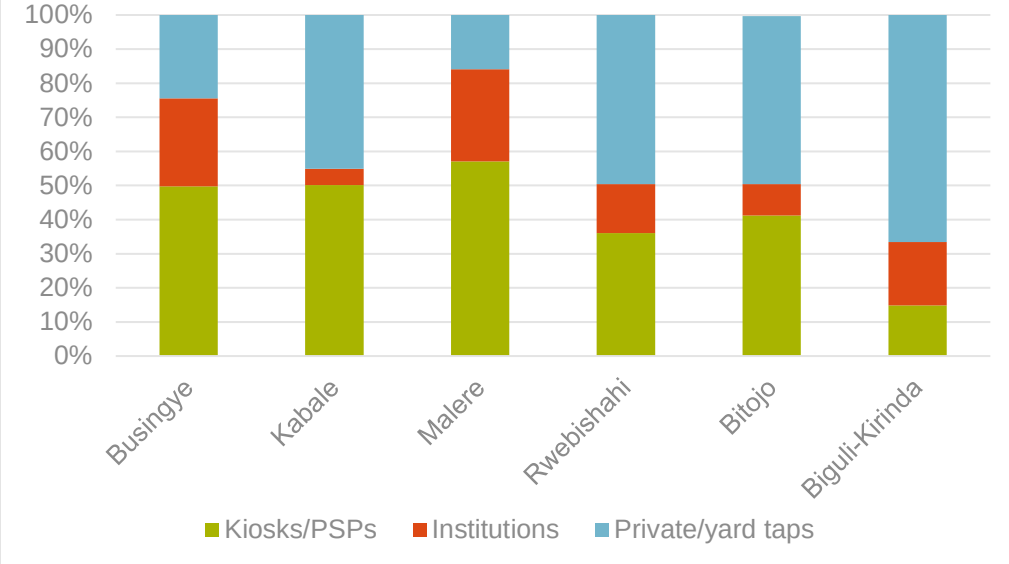
The most profitable system, Biguli-Kirinda, has the users with the highest per capita consumption. This further supports the idea of economies of scale, now in terms of water consumption by users.

Figure 3: Monthly per Capita Consumption (L/person)



The reason why per capita consumption in Biguli-Kirinda is higher than in the other systems may be related to the high prevalence of users with private connections. Figure 4 shows that in Biguli-Kirinda, two thirds of users are connected to the system through private taps in households or yards, compared to one third, on average, in the other four systems. This suggests that system profitability is bolstered by private connections, as these lead to higher per capita user consumption by users.

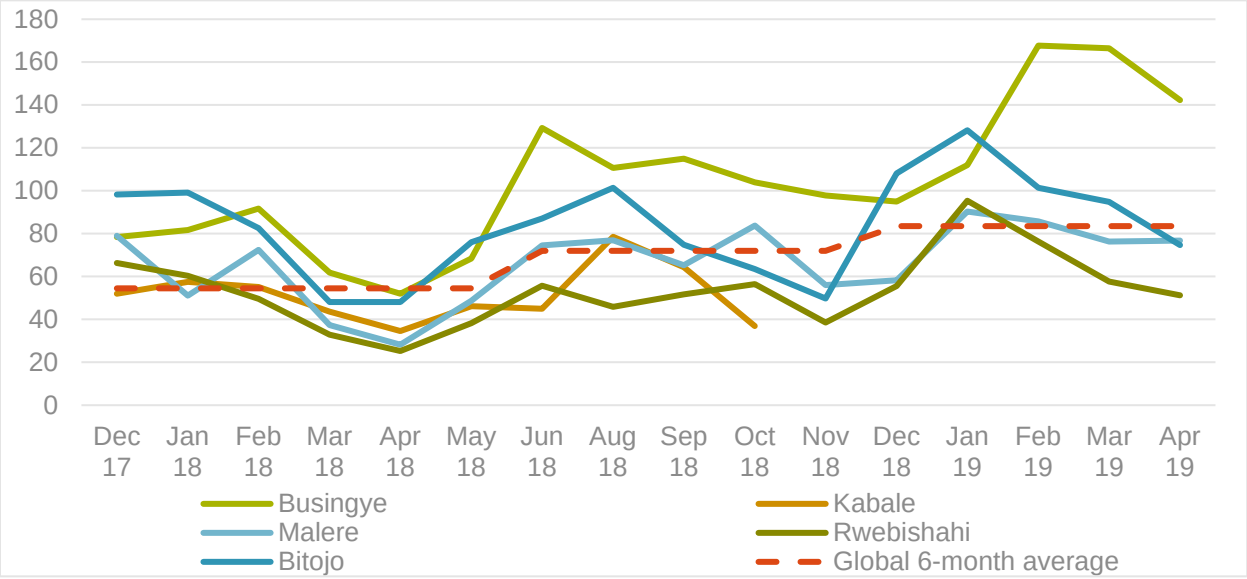
Figure 4: Proportion of Users Served per Type of Connection



The OCA study recommended increasing the number of private connections in systems by running marketing campaigns among households and facilitating payment of connections either through credit or installments. Since 2017, campaigns were indeed launched and household group loans were offered, but overall, the number of private connections has not increased significantly.

An additional factor influencing per capita consumption may be the tariff charged. In September 2018, the Umbrella harmonized the tariffs charged in the various types of connections in the different schemes (there had previously been differences in tariffs) and reduced them. This may explain the global increase in water consumption per capita in the systems – represented in Figure 5 by the dashed red line – notably when comparing the average consumption from January to April 2018 with the same period in 2019. Overall, however, such increase in consumption was insufficient to be translated into profits in the loss-making systems.

Figure 5: Monthly per Capita Consumption (L/person)

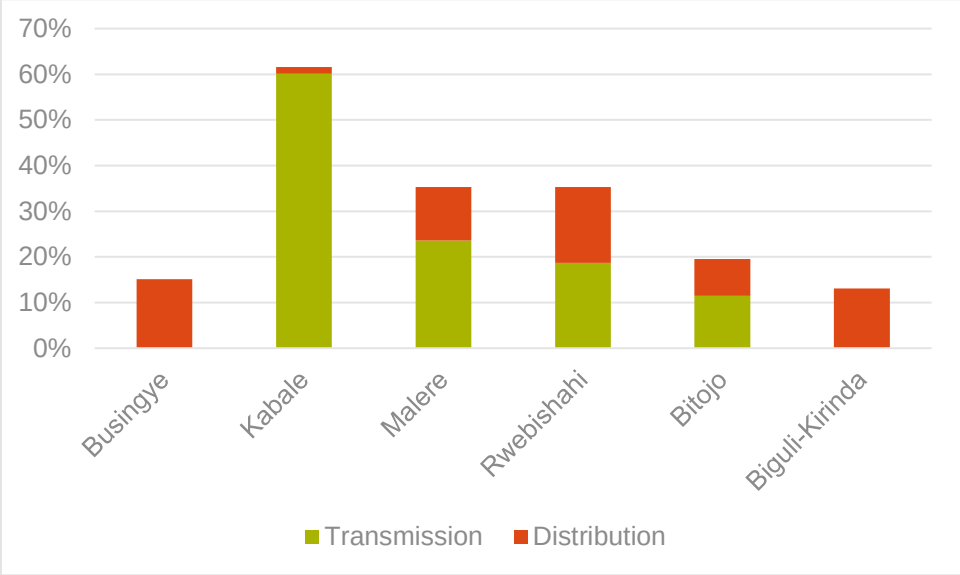


Water Losses

Piped systems usually experience some degree of water losses due to leakages from pipe bursts. Naturally, this is something that should be minimized. In Biguli's piped systems, where an underground pump pumps water up to a reservoir tank, where it is fed down to distribution points, there are two broad stages where leakages can occur: between the pump and the tank (transmission) and between the tank and the distribution points (distribution).

Figure 6 shows the estimated proportion of water produced (pumped) in each system that is lost either in transmission or in distribution.

Figure 6: Proportion of Water Produced that is Lost



Biguli-Kirinda is again ahead of the remaining systems for having the lowest water losses – 13% in total – all occurring in distribution. Busingye, with the second lowest losses at 15%, is the only other system without losses in transmission. But despite having higher water losses than Busingye, Bitojo is profitable because it serves a far higher proportion of users through private connections (49% compared to 24%). This proportion is similar in Kabale where average monthly water production is also on a par with Bitojo's (455m^3 and 487m^3 respectively). In this case, it is water losses that explain the difference in profitability – Kabale experiences by far the highest losses of all systems, especially in transmission.

Overall, the systems display a relatively high level of water losses. Average losses during the period under analysis were 30%, 24% if Kabale is excluded, both of which exceed the national guideline and Umbrella target of 20%. In some systems, not only in Kabale, losses reached 50-60% of water produced in specific months. Although the Umbrella accepts the existence of water losses in distribution, it stated that apparent water losses in transmission could in fact be the result of inaccurate meter readings taken by the operators. However, it did not rule out the possibility that they occur. It seems unlikely that inaccurate readings would affect transmission but not distribution. Water losses, and specifically losses in transmission, should be carefully investigated, and if confirmed, measures must be put in place to minimize them. The issue of possible inaccurate meter reading by operators deserves attention as well.

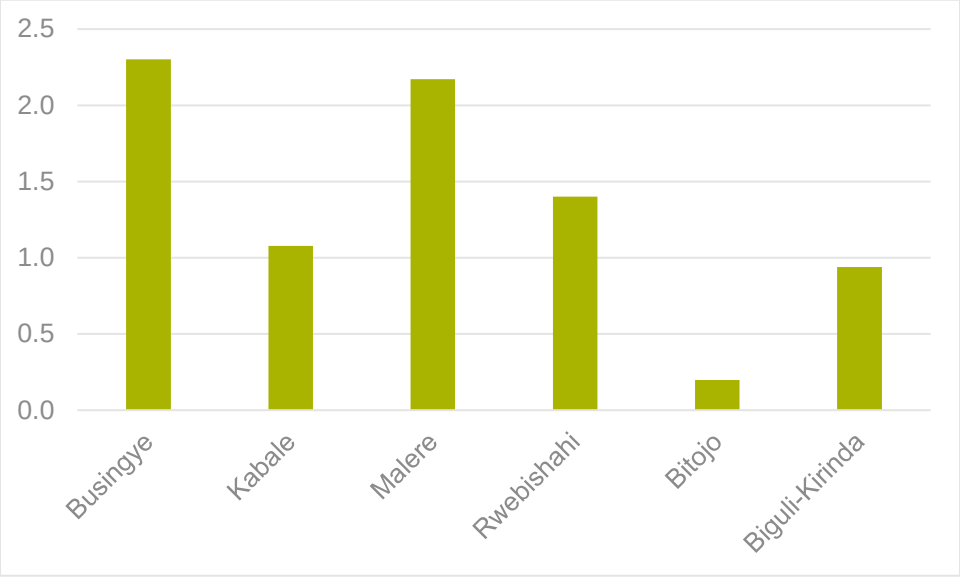
Fuel Efficiency

Resource efficiency is the level of expenditure of a given resource needed to produce one unit of output. In this case, the systems' fuel efficiency was analyzed. Busingye and Malere currently rely solely on diesel; all other systems use solar energy with diesel as back-up. The switch to solar was recommended by OCA in 2017 and has been an important achievement in Biguli.

As shown in Figure 7, the two profitable systems are also those with lowest fuel cost per liter of water produced. Bitojo is particularly efficient in this regard. Busingye and Malere have the highest

fuel expenditure, which concurs with the fact that they do not employ solar power technology (currently being installed in Malere). The four systems that use solar energy show significant variance in fuel efficiency, from UGX 0.2 per liter in Bitojo to UGX 1.4 per liter in Rwebishahi. It could be useful to investigate the reasons for such variance in greater detail.

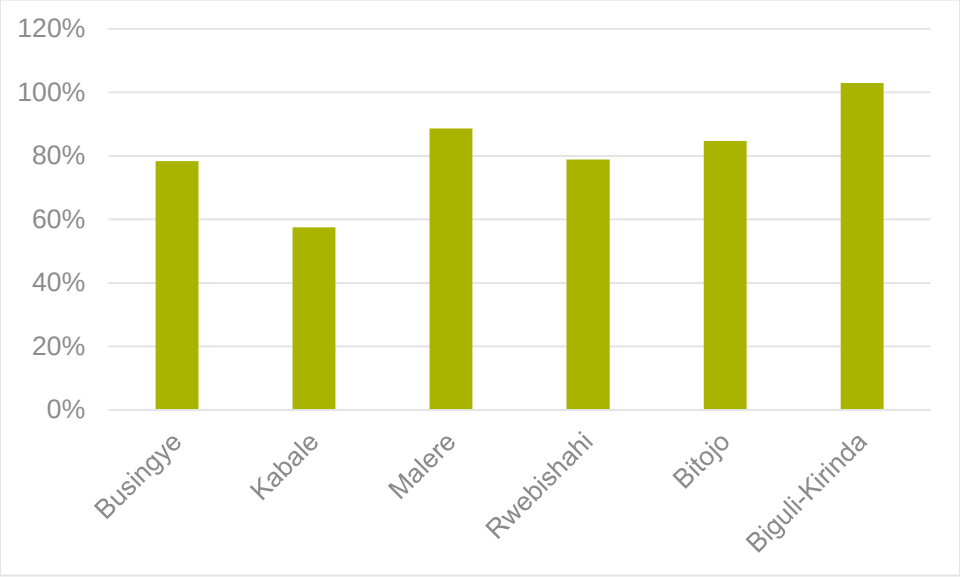
Figure 7: Fuel Cost per Liter of Water Produced (UGX)



Collection Efficiency

Collection efficiency refers to the amount of revenue that is collected by operators compared to the amount billed to customers. If customers do not pay their bills on time, the two will differ. Figure 8 below shows collection efficiency per system.

Figure 8: Collection Efficiency



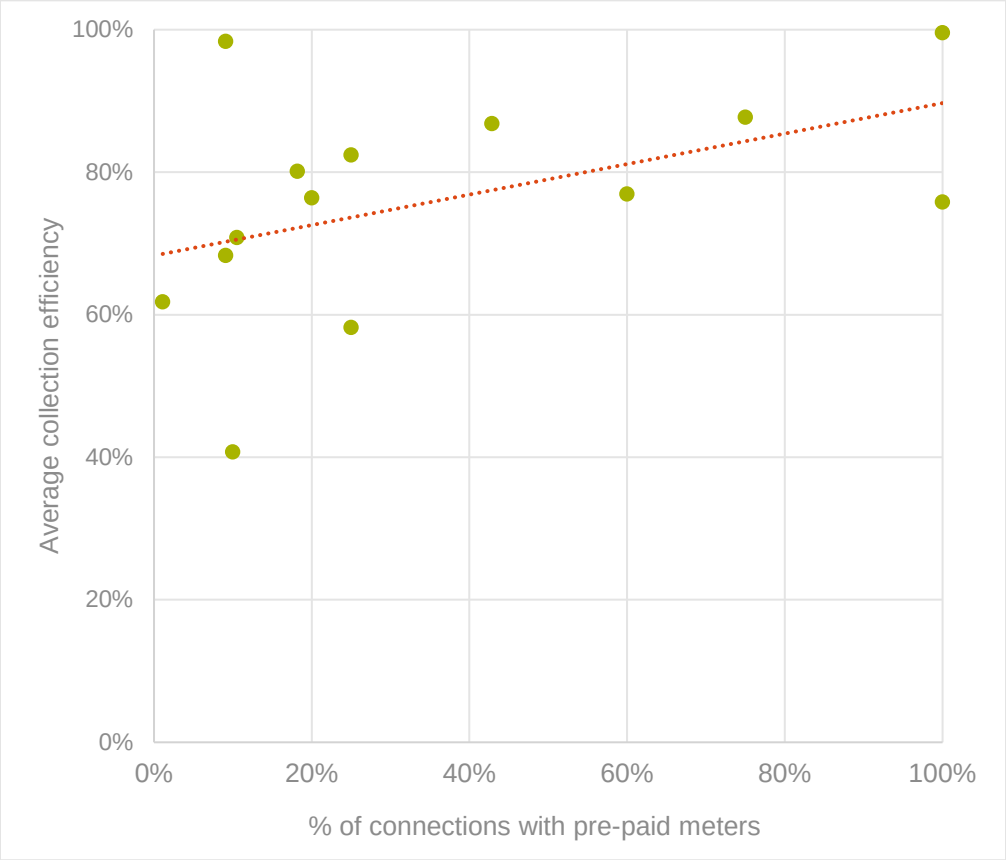
Note: Collection efficiency may exceed 100% because collected revenues include arrears from previous periods, which combined with revenues collected from the current period can exceed billed revenues for the period.

At 103%, the highest collection efficiency in Biguli-Kirinda is likely to be another factor explaining its high profitability compared to the remaining systems. In contrast, Kabale's 58% average collection efficiency probably contributes importantly to the fact that it is the least profitable system in terms of collected revenue. The target set by the Umbrella for collection efficiency is 90%.

Possible factors affecting collection efficiency were investigated. One potential factor is the type of connection – whether collection efficiency significantly differs between public kiosks/standpoints, standpoints in institutions, and private connections in households and yards. This seems to be the case. Average collection efficiency was 85%, 79%, and 65% on kiosks, institutions, and private connections, respectively.

Another factor considered was the type of meter in the connection, with the hypothesis that collection efficiency is on average higher with customers who have connections with a pre-paid water meter than with those that have a post-paid meter. With pre-paid meters, water is supplied only once the customer has paid for it. To investigate this hypothesis, average collection efficiency was calculated for each system and for each type of customer connection. Efficiency was calculated with respect to the billings of each month only; arrears collected were excluded. The values were then compared with the number of pre-paid meters, as a proportion of the total number of meters, in each connection type category in each system. Combinations of systems/connection types with 4 or fewer connections in total were not considered as they could skew the results, which are shown in Figure 9.

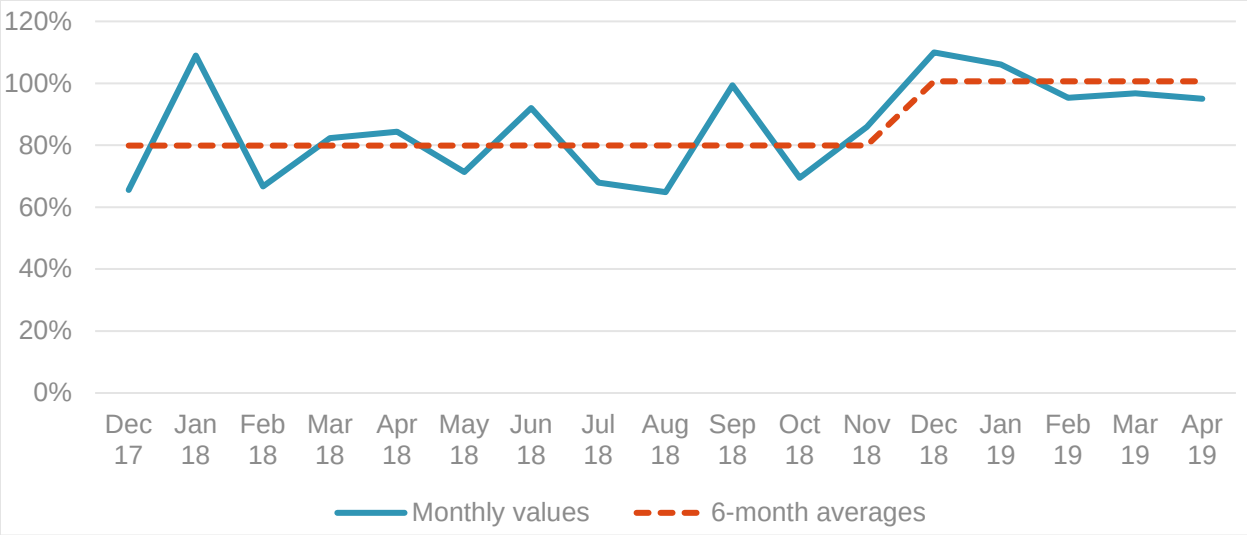
Figure 9: Collection Efficiency vs. Proportion of Pre-paid Meters



A positive correlation is observed between the proportion of pre-paid meters in a system for a given connection type and the average collection efficiency over time for that category. The correlation is 0.46 and is represented by the dotted red line. This finding indicates that replacing post-paid with pre-paid meters may help to increase collection efficiency, and thus system revenues and profitability.

Figure 10 shows the average collection efficiency of all systems. Collection efficiency in each month is represented by the straight blue line. Because it displays substantial variance, 6-month averages were calculated to evaluate the possibility of trends over time (5 months for December 2018 – April 2019). These are represented by the dashed red line.

Figure 10: Global Collection Efficiency



The overall trend is that average collection efficiency increased from 80% in December 2017 – November 2018 to 101% in December 2018 – April 2019, surpassing the target set by the Umbrella of 90%. This trend is possibly the result, at least partially, of Water For People's efforts regarding capacity building of the operators. It should also be acknowledged, however, that in all systems, except for Biguli-Kirinda, average collection efficiency over the entire period was less than 100%, which translated into increasing cumulative customer arrears.

To their credit, the Umbrella and the operators have, since 2017, implemented most of OCA's recommendations concerning revenue collection. Implemented measures comprise: i) hiring of collection assistants, ii) changing bill payment deadline for customers from the 15th of each month to the end of the month, and iii) establishment of strict disconnection policies for customers who do not pay bills by the set deadline. In addition, of its own initiative, the Umbrella has implemented a mobile money system for bill payment by customers. The major recommendation by OCA that was not implemented was that all new system connections added since 2017 should have pre-paid meters. As discussed above, this could have brought about significant further increases to collection efficiency. It is not known whether operators pay variable bonuses to staff who collect cash from bills based on the amount they can collect, as was also proposed by OCA.

Recommendations

The broad conclusion of the analysis is that 4 out of the 6 systems analyzed are currently not operating at a profit. Among the 2 profitable systems, one is financially supported by CHF (Bitojo).

In view of these findings, the following recommendations are made to improve system profitability:

- *Increase the number of people served by the systems, especially in Busingye and Malere.* The profitable systems are those that serve the most people, which points to economies of scale and to the need to expand the loss-making systems in terms of people served. This was one of the analysis' key findings and OCA recommendations. In Busingye and Malere in particular, the estimated proportion of people served by the systems compared to the total population in the service areas is 69% and 59%, respectively. Increasing these proportions could entail adding new distribution points and/or sensitizing households who use surface water and unprotected sources to the benefits of switching to infrastructure.
- *Increase the number of private household/yard connections.* The analysis found that users who have private connections consume more water per capita. Expanding the number of such connections should thus increase total water produced and sold, and consequentially increase revenues and scale. The promotion campaigns and credit facilities to households must be continued, and additional mechanisms, such as payment of connections by installments, should be explored.
- *Decrease water losses.* The most profitable system, Biguli-Kirinda, registered the smallest proportion of produced water that was lost, whereas the least profitable system on a collected revenue basis, Kabale, registered the highest losses. Overall, the systems show higher losses than desirable, especially in transmission, and the reasons for this must be examined in greater detail. The planned training by the National Water and Sewerage Corporation of the operators' technical staff in detecting pipe leakages must be carried out. In addition, the scope for using specific software or equipment for leakage detection should be assessed by Water For People and the Umbrella.
- *Complete the transition to solar energy.* This is already underway in Malere. As for Busingye, the plan is to connect it to the Kabale pump and PV panel system, so that standalone panels would not be necessary in Busingye (with the existing diesel generator kept as back-up).
- *Gradually replace post-paid with pre-paid meters.* Revenue collection efficiency is a relevant variable in explaining system profitability. The analysis found that a relevant factor in determining collection efficiency appears to be the proportion of pre-paid meters in user connections. The replacement of post-paid with pre-paid meters is something that should be considered, once the payback time for the meters has been properly estimated.
- *Improve the quantity and quality of monitoring data.* One pervasive issue that should also be addressed is the scarcity and lack of reliability of the monitoring data provided by the Umbrella and the operators, not only on system production and supply, but also more generally on the systems' costs and revenues. Again, capacity building and the use of specific software may be important in leading to improvements in this regard.