PERFORMANCE REVIEW OF WATER ATMS AND SMART WATER DEVICES IN OXFAM PROGRAMMES

GHT PHE ADVISORY TEAM

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TABLE OF CONTENTS

Front Cover Photograph: A Susteq water ATM in Kyaka II refugee settlement

FINDINGS

Despite encouraging anecdotal feedback, in the majority of examples the investment in prepaid water dispensers (water ATMs) has not resulted in the intended outcomes and therefore the financial cost is difficult to justify.

Driving factors for introducing ATMs were that they are a novel technology and seen as a solution by WASH teams grappling with water governance and sustainability issues. However initial positive feedback from users on functionality and water service providers on the potential to improve accountability and tariff collection, has not translated into clear and improved cost recovery.

ATMs add an additional layer of complexity into water infrastructure that service providers are already struggling to maintain so there is a risk that instead of contributing to solving problems, they exacerbate them. There are multiple different brands of dispenser with varying quality, but reliability seems to be a common theme. Maintenance and sourcing of spare parts can be problematic and expensive. Based on sites visited during this review the Lorentz (SmartTAPS) appear to stand out in terms of reliability and robust build, however further analysis is required to confirm this as the sample size is so small.

The trial of ATMs in a camp (Kyaka II refugee settlement, Uganda) has failed to provide any evidence that ATMs are appropriate in a displacement context. The limited extent of the trial created a "two class" system, while full coverage would be prohibitively expensive to achieve. Significant technical reliability issues were experienced with the ongoing cost of repair and maintenance of ATMs exceeding the revenue generated from water sales.

There is no technological fix or shortcut to good management and governance. Water ATMs are only a tool and to be beneficial, the foundations of a professional water service provider need to already be present in advance. This could be in the form of a pre-existing billing system, existing key performance targets, active monitoring of non-accounted for or non-revenue water and a committed, adequately resourced team. If these are lacking, it is probably unlikely that the introduction of ATMs is justified or a priority.

The benefits of ATMs are greatest in urban areas being managed by existing utility companies. In Nairobi, network upgrades including automated pre-paid dispensers, have been able to reduce the cost of water to residents by providing an alternative to private vendors. They have reduced non accounted for water but there hasn't been a return on investment, so they still need funding from donors or cross subsidy from elsewhere.

The state of water infrastructure is likely to influence the performance and reliability of ATMs. Suspended solids and air within a pipeline will clog valves and affect reliability. A World Bank review of ATMs in 6 Countries recommended that 24-7 water and a pressurised pipeline should be a minimum requirement before ATMs are introduced. Only one Oxfam system (Harare) met this threshold. Where water must be rationed and consequently ATMs only operate for limited hours, serious questions should be asked about whether it is a wise investment, or limited financial resources should be prioritised elsewhere.

The experience of Oxfam projects reflects external reports and evaluations. Reliability issues of pre-paid water meters are widespread. According to a World Bank report, most service providers

under-estimate what pre-payment entails, and the resources required for maintenance, support and monitoring. There is more that can go wrong, and effective management of a pre-payment system may need more staff, not less, which typically doesn't happen. Modelling within the same report suggests that introduction of ATMs for a typical water service provider is a net loss maker.

Except for the most recent ATM installations in Kenya (post 2020), all ATM installations were justified as piloting new technology. With innovation, there is an understanding and acceptance of risk with learning being equally as important as the outcome. In crude terms the majority of ATMs installed in Oxfam programmes are not working.

ATMs can no longer be considered a new technology, the time for trials and pilots is over and future ATM installations must be more critically thought though. The following guidelines provide suggested minimum requirements before ATMs should be considered.

- Reliable water within the water system, preferably 24-7 but as a minimum all day opening to spread peak demands.
- Evidence of good governance and management systems already present within the water service provider, if not address these before introducing a new complexity.
- A clear commitment from the water service provider on the need and purpose of ATMs. This should include a realistic business plan of how ATMs will be maintained, without assuming ATMs will generate additional revenue.
- Full consideration of other higher priority interventions which will have greater impact or need to be in place first.
- Consideration of other means to achieve a similar outcome, e.g. improving billing management, performance of kiosk attendants, management structure.
- Consultation and buy in from water users is equally as important with the water service provider,

Whilst ATMs have generated the greatest amount of interest within Oxfam programmes, other examples of attempts to use smart devices for remote or real time monitoring related are discussed in this report. These include drought early warning, groundwater level and production monitoring and water trucking monitoring.

1.0 INTRODUCTION

The first automated, pre-paid water dispensers (or water ATMs) in an Oxfam programme were introduced in Kenya in 2015, since then water ATMs have been installed in Bangladesh, Zimbabwe, Uganda, South Sudan and DRC. ATMs are a powerful tool with potential to improve water access, equity, accountability, transparency and revenue collection. Initial feedback after installation has generally been positive but this is based on anecdotal observations and feedback from users and service providers. It has not analysed impact on service levels and couldn't consider durability and longer-term performance.

This review revisits projects, known to GHT WASH Advisory team (so it is not necessarily a comprehensive review), several years after completion and attempts to critically review the performance of this emerging Smart technology. The main focus is ATMs which have attracted most interest within Oxfam WASH programmes, but other initiatives incorporating "Smart" or "Internet of things" (IoT) technology is also discussed. These are presented as Country case studies written based on available information provided by Country teams and visits to Kenya, Zimbabwe, Uganda and South Sudan (2-5 years after installation) in 2022 and 2023. It complements existing material on ATMs posted on oxfamwash.org including a technical briefing note on Water ATMs.

1.1 BACKGROUND AND RATIONALE FOR ATMS

Oxfam has trialled multiple different brands of automated water dispensers within its programmes with Susteq and Lorentz accounting for the majority of installations. Different brands have different functionality. At a basic mechanical level, automated dispensers are an efficient way for users to collect water from public tapstands and positive post implementation observations feedback and observation confirm this has been achieved. However the bigger impact and stated aim of all pilot Oxfam ATMs initiatives has been to contribute to sustainability and equity. This can be achieved through the following (many of which are interlinked):

1) Improve revenue collection.
2) Reduction in water wastage and non-revenue or unaccounted for water.
3) Improve transparency and accountability.
4) Improved monitoring data which can be used to flag and address problems and contribute to achieving key performance indicators.
5) Contribute to professionalization of water services.

These take longer to achieve and measure. It is also important to note that ATMs are only a tool and improvements to water service delivery is contingent on the potential of the equipment being fulfilled, starting with data being utilised and informing decision making, which required commitment and resources. For example, to calculate water wastage and non-revenue water in addition to knowing the quantity of water dispensed and revenue generated from ATMs, you need an accurate record of overall water production in the system, plus output readings of any other water outlets (private connections, institutions, animal troughs etc. Assuming all this data can be accurately monitoring, it then needs a person/people to collect it and analyse it. To look at equity and track water consumption requires every user having their own unique electronic tag. As some of the following case studies show it is not uncommon for multiple households to share tags. Transparency and accountability need segregation of roles, and

development of business systems. If the same people who have been mismanaging and profiting from conventional waterpoints are still overseeing the management and revenue from ATMs, it would be naive to think that suddenly things are going to improve and managers will suddenly be more accountable or professional.

Potential benefits of IoT and Smart technology

Current monitoring approaches are piecemeal and varied. Where insecurity restricts access, identifying operational issues in a timely, accurate manner or even knowing how much water is being delivered and to who, can be a challenge. Average per capita water consumption masks inequalities between households and neighbourhoods. Consolidating manual data from different sources/formats/locations so that it can be analysed and inform decisions is time consuming and resource intensive. Consequently, a lot of valuable data (if collected) is not utilised. Manual data collection is open to human error as well as abuse and fraud. Without reliable data, Key Performance Indicators (KPIs) can't be set which are foundations of a successful water scheme.

Data provided by Smart water systems will result in improved service delivery which will directly benefit vulnerable populations. Automated alerts can identify where problems occur and facilitate carrying out remedial action. This could be adjusting chlorine dosing, opening control valves to ensure sufficient water is available to all neighbourhoods. Smart taps ensure every household (via their unique user tag) have a minimum water allocation and monitor whether that is being utilised. It gives a whole new level of visibility and information that household surveys or other tools cannot currently provide to ensure equitable access to water.

In the longer term, structural weaknesses can be identified and addressed and development of KPIs can help improve and sustain reliability of the water service. Applying tools which ensure fair distribution, allocation and equity of water, avoiding wastage and removing opportunities for corruption is all to the benefit of water end users. Access to data will enable optimal operation, reducing costs and maximizing revenue returns. It will also enable development of costed business models thereby removing uncertainty and risk which is currently a barrier for humanitarian agencies handing over services to local and national institutions.

Figure 1: Proposal submission to Canadian Grand Challenge Fund – Oxfam, UNHCR and Lorentz 2021.

2.0 KENYA

ATMs were introduced into Oxfam's programme in Northern Kenya as a tool to improve water governance. Rural water systems entrusted to community water committees commonly have weak accounting systems, suffer from financial mismanagement, adversely impacting on willingness to pay. There are wide disparities between stated tariffs, water supplied, and revenue generated. ATMs were seen as a technology that could provide a digital audit trail to improve management and identify malpractice.

2.1 WAJIR (1ST GENERATION ATMS)

Oxfam in Kenya piloted its first ATMs in partnership with a water utility company in two rural trading centres in Wajir County in 2015 – Griftu, which had eight water kiosks, and Arbajahan (four). The pilot was a partnership with a Kenyan start-up company "Maji Milele" which specialized in Water ATMs. The original plan to source ATM hadware from a Dutch company (Susteq) had to change due to production delays. The replacement (Indian brand) proved to be of poor performance and quality with four out of eight breaking down within the first months of installation. Acceptance was stronger in Griftu and plans for the second village were put on hold, with the ATM units purchased for Arbajahan, used to replace or provide spare parts in Griftu. Apart from the overall lack of robustness and durability, the most notable design flaw of the unit was that customer credits would be deducted when there was no water in the system and users tried to use the dispenser.

At a total cost of approximately £5,000 per retrofitted kiosk, the ATMs did not justify their worth, however there was sufficient positive feedback from the water utility company and water users to suggest the concept was worth pursuing.

Figure 2 – the first ATMs installed in an Oxfam Programme

2.2 WAJIR AND TURKANA (2ND GENERATION "SUSTEQ" ATMS)

In 2016 under the DFID SWIFT payment by results project, ATMs were installed in two large market centres (Lodwar and Kakuma), with different results. In both locations the ATMs followed improvements to water supply through development of new boreholes and solar pumping schemes which provided the double benefit of boosting water production whilst reducing operating costs.

2.2.1 LODWAR

A total of 6 ATMs were installed at public kiosks in 2016. In the months following the completion of SWIFT project "hardware" phase, informal feedback from LOWASCO (water utility company) confirmed a significant boost to revenue which enabled pay rises to staff and investment in the business, including new uniforms and motor bikes to enable field staff to move about more effectively. Some of which is documented in this review

Figure 3 – A Susteq ATMs in Lodwar

5 out of 6 ATMs were still functional in 2023, although at the time of visit none were dispensing water due to repair and maintenance on the main borehole and transmission line, which had disrupted the water supply. It is worth noting that in the intervening years (since 2016), Lodwar has been one of the most rapidly expanding towns in Kenya following devolution and discovery of oil in the County. This may have been reflected in responses when interviewing water users at dry kiosks who when asked what they thought of the ATMs responded that their priority is access to water and the mode of delivery (cheap tap or expensive ATM) is secondary.

It has not been possible to quantify in monetary terms the impact of ATMs or differentiate between the supply improvements (through new solarised boreholes coming online) vs introduction of ATMs, which occurred in parallel. Nevertheless, the fact that the utility is maintaining them is a good indicator of their worth.

2.2.2 KAKUMA

Contrasting the successful installation and positive feedback from Lodwar, a total of 9 ATMs have been installed in Kakuma and none were functioning by the start of 2023. KAWASEPRO (the water service provider for Kakuma town) is a legally registered entity with its own office in Kakuma town but bears more similarity to a village water management committee than a professional utility company. During the initial planning consultations, despite community representatives and leaders publicly expressed an interest in ATMs, several were physically sabotaged and destroyed within weeks of installation. A rumour linked to traditional views about witchcraft was reported to Oxfam staff as a reason for the lack of acceptance of ATMs within the community. Oxfam concluded that these had been started or encouraged by prominent people within the town whose interests are better served by a status quo (and lack of transparency).

Figure 4 – A water kiosk in Kakuma

Later attempts to install ATMs (after change in leadership within KAWASEPRO), have also experienced problems. Lodwar and Kakuma are both large towns with water provision being managed directly or indirectly by County Government, but Kakuma context is complex with water cartels present and the refugee operation inevitably creating some dependency syndrome and reluctance to pay for water. Ultimately the main difference between the two locations is the commitment of those managing the systems. The Lodwar (LOWASCO) team had a system in place to top-up water credits and were technically conversant with the maintenance and repairs of the ATMs. In Kakuma the Sub-County Water Officer (Emanuel Echapan) explained that because of the workload created by the drought, ATMs were not his priority and he had delegated responsibility to his officers, but the most experienced person trained on O&M had left the organization. Water users also reported having difficulty to top-up water credits.

Figure 5 – A Grundfos AQtap, near Lodwar

The most recent ATM (Grundfos AQTap) was installed in Natapar Kakono, a satellite village of Lodwar. It was installed within a solar pumping system in Nov 2022 but stopped functioning within 2 months and was not working during the review visit in 2023. Another AQTap was procured for installation in another village (Kaputia) but the community were against the initiative and told Oxfam that they would break it if installed.

2.2.3 WAJIR

Although not visited as part of this review, it is understood that none of the water ATMs funded by Oxfam in Wajir are still functioning. The author was directly involved in the first 2015 pilot so has firsthand knowledge to confirm that this is despite considerable effort to ensure buy in from County Government and the water Utility (WAJWASCO). This has not been documented by the Kenya team but when asked, they indicated that the incoming administration (following elections), did not have the same commitment and ownership that the outgoing Government officials.

2.3 NAIROBI

Figure 6 – A water kiosk in Nairobi

The most successful ATM programmes in Kenya are almost certainly found in Nairobi low income/informal settlements which have been implemented by Oxfam peers and partners, including WSUP. In 2021 Oxfam mapped 177 functional ATMs. According to WSUP they have reduced non-revenue water (NRW) within informal settlements and there is strong ownership from Nairobi Water Company. There are however examples of illegal connections bypassing ATMs, so they are only one tool and not a solution in themselves without continued monitoring and enforcement. A meeting with former Oxfam WASH Coordinator (Simeon Ogamba), now with Child Investment Fund Foundation (CIFF), confirmed that the ATMs are working very well in Kibera where CIFF is supporting Nairobi Water by building elevated water networks which reduce the risk of cross contamination of water and make illegal connections more difficult. Tariffs are low (0.5KSH per jerrycan) so ATMs have not necessarily increased revenue for the service provider, but they have reduced unaccounted for non-revenue water and also reduced the incentive for illegal connections, making water more affordable to water users.

As a cost effect method of subsidising water access for vulnerable households during the Covid pandemic, Oxfam Kenya transferred cash to top up customers credits on ATM accounts.

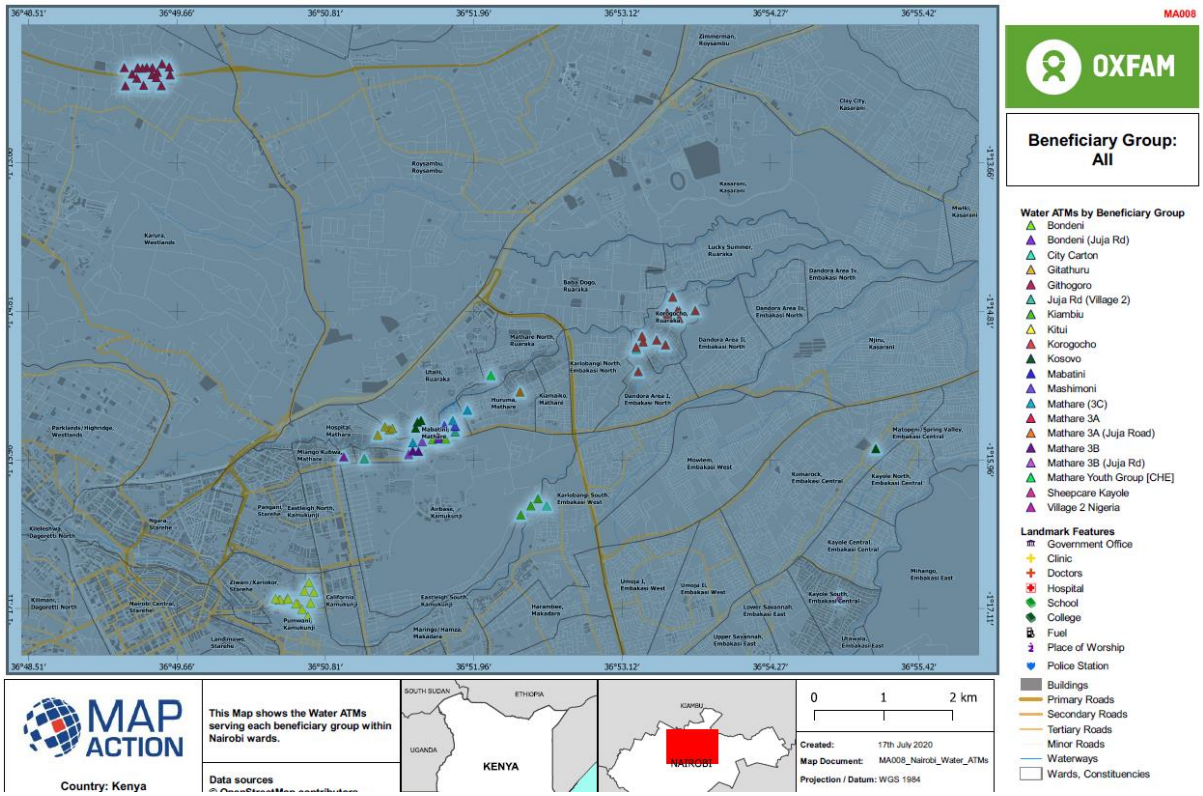


Figure 7 – Mapping of ATMs in Nairobi used to subsidise water access for vulnerable households

2.4 SUMMARY

Kenya has a longer history of ATMs than anywhere else and these have been installed in multiple different locations with differing levels of success. A brainstorm within the WASH team highlighted the following influencing factors:

- Institutional support and buy in is essential for rolling out ATMs. It is present in Lodwar and Nairobi but lacking elsewhere. The long term failure of ATMs in Wajir is also shows the fragility of some of our work to external factors, other stakeholders and issues beyond Oxfam's control.
- "If it is not broken, don't fix it". Some villages prefer a flat monthly fee. It is counterproductive to introduce a system unless there is strong buy-in from the community itself. Previously we have focused too much on getting buy-in at higher level and then presenting the solution to communities. Kaputia (Turkana) is a good example of this – what Oxfam considered was good for the community, was not acceptable or compatible with social structures - engagement must start at the bottom.
- Considering that the Nairobi ATMs were implemented by other organisations, in absolute numbers, the majority of ATMs installed by Oxfam in Kenya are not functioning. Whilst it should be acknowledged that Oxfam Kenya has been a pioneer and there has been a lot of learning from ATM projects, this should serve as an important warning for other Countries to set expectations.
- It is questionable however whether Kenya is learning lessons as the most recent ATM installations are not performing noticeably better than the early trials. Equally in arid and semi arid regions where water is scarce and rationed, it is questionable whether investment in ATMs is the best use of limited resources.

3.0 BANGLADESH

Soon after the first Kenya ATMs, in 2016 Oxfam Bangladesh piloted two coin-operated water dispensers in Dhaka slums – reportedly in the region of $5,500 per unit. Each system contained an integrated RO treatment unit, required due to the nature of the raw water. An evaluation conducted soon after installation found that actual water sales fell well short of projections and contrary to the expected return on investment of 2 years, based on the CBOs financial records, the actual return on investment would be 27 years. The overall conclusion was that the project has the potential to be economically viable but not with the existing CBO that lacked the entrepreneurial skills required. Followed up with the Bangladesh team in 2021, confirmed that the whole slum had been destroyed in a fire in 2016 or 2017 and with it these systems. This limits the learning and its unclear whether they were still functioning at the time of the fire but based on available information it is unlikely they were never going to be viable in the long term.

Figure 8 – A coin operated water ATM with integrated treatment, Dhaka

4.0 UGANDA

The Government of Uganda has a progressive policy towards refugees encouraging assimilation with host communities and allowing the right to work. Oxfam Uganda has been supporting efforts of UNHCR and the Government to develop an operating model that transfers responsibility for water service provision to local utility companies as part of a transition strategy. As part of efforts to strengthen institutional capacity to sustainable O&M and management of the water services and explore innovative technologies/approaches to increase the efficiency of the water supply services, WIF funding facilitated an ATM trial in Kyaka II and Ramwanji refugee camps in SW Uganda. Within the project justification, it was noted that management structures lack strong governance systems, are inefficient, lack transparency and accountability which contributes to a reluctance from users to pay for water.

This was the first time ATMs had been trailed in a refugee camp context where water had previously been supplied freely. Given one of the key justifications of ATMs is to improve revenue collection, from its inception there were questions regarding whether water ATMs were appropriate and cost effective for a camp context. However, host communities share the same schemes and reportedly do pay for water. Furthermore, as livelihood opportunities for refugees grow and they become assimilated into the local community there is an expectation that a greater percentage of the operating costs need to be covered locally and refugees will start to pay for water. It was envisaged that there would be a lifeline tariff to ensure no-one was excluded from accessing water, with incrementally higher tariffs as usage increases (so those who consume more water and are able to pay would effectively subsidise those who can't.

An internal end of project report submitted to WASH Innovation fund stated that the ATMs had served their purpose and led to enhanced user fee collection and reduced non-revenue water. Reported challenges were competition from surrounding (conventional) tapstands where water is free, software glitches affecting two kiosks and general unreliability and rationing of the whole water network, making ATMs unreliable. Despite this, the report recommended they should be scaled up.

Kyaka II refugee settlement was visited as part of this review where 10 Susteq ATMs have been installed within a large network alongside conventional tapstands which account for over 90% of all water delivered. Susteq was chosen over Lorentz because each Susteq dispenser can accommodate upto 3 outlets, which makes the cost per tap outlet cheaper. During the review visit, several of the ATMs were not operating because of the scheduling (rationing) of water across the camps. Feedback from users at an ATM that was operating was very positive. However with only 10 ATMs out of a total of 100+ tapstands only a very small proportion of the camp population was actually accessing water from the ATMs. The limited coverage was compounded by a shortage of tokens so some residents in close proximity to an ATM were not guaranteed access and it was unclear how many more would use the ATM if they could get a token. It was expected that other agencies present in Kyaka camp would also invest in ATMs, which hadn't happened. This inadvertently has created a two class system.

The full benefits of ATMs in a camp will only be realised with universal coverage across the whole camp with all households registered and accessing water through their unique tag. This would then enable water managers to analyse who is receiving water, whether it is equitable

and what the losses are (between production and user collection). Establishing such a system requires a coordinated effort from all agencies under the leadership of the Government and/or UNHCR, which within the short timeframe since ATMs were introduced has not happened. Uganda team didn't do an analysis to determine what the cost of upgrading the whole camp to automated taps would be but in the current context of funding shortfalls and without the possibility of the capital investment being repaid through water charges, it is difficult to justify as a cost effective use of limited resources.

An underlying problem in Kyaka II is that there is insufficient water for the number of people in the camp so it has to be rationed. In contexts where Oxfam is struggling to meet basic minimum standards of supply and there are times when there is no water available at the ATMs, it is difficult to justify their added value.

Figure 9 – A Susteq ATM in Kyaka II refugee settlement

The above photographs show the front and back end and internal workings of a Susteq ATM. Uganda team experienced considerable reliability problems specifically the electronic valves (blue and black on far right photo). But for the skill and ingenuity of Oxfam's electromechanic – the ATMs would have experienced much greater downtime, cost and reliability issues. Meeting minutes between Oxfam and the ATM provider note some issues with faulty tokens, a faulty card reader, poor quality cabling, display board coming loose, and lack of remote oversight from the system. Overall, there was a surprisingly large number of technical issues with the ATMs which required the attention of Oxfam. The small charge for ATM water was able to contribute to maintenance costs but not to fully cover the running costs.

The findings of the review contrast with the very positive feedback initially reported by the Uganda team. The limited nature of the pilot restricted the possible impact however from the observations and interview conducted, there is no evidence to suggest that ATMs have improved transparency, governance or accountability. It has increased revenue collection (as refugees were previously not paying) but because the revenue generated is not sufficient to service the ATMs this still represents a net loss. The conclusion of this review is that this pilot does not demonstrate there is any strong case for scaling up ATMs in a camp setting.

5.0 SOUTH SUDAN

Figure 10

South Sudan team has installed over 50 ATMs in multiple locations. The first ten were installed in Juba in a neighbourhood where Oxfam has invested in a multiyear programme to improve water supply. Starting as a cholera response intervention (emergency surface water treatment), a more durable water supply system was developed to treat and supplying water from the River Nile. This was accompanied by an intensive capacity development effort to establish professional management with a viable business plan. ATMs where the final part of this plan. which were presented as part of an online GHT learning event on ATMs in 2020.

Gumbo Village and its surrounding neighbourhood in Juba has a population 20,000 people. The water system has a capacity of treating 300,000 litres of water per day. It comprises a water intake on the bank of the Nile river, a 300m3 sedimentation tank, a 75m3 elevated storage tank, solar pumping system, water tanker filling station and two kisoks. In 2020 at a project cost of $53,954, the system was upgraded with installation of 10 ATMs at the kiosks plus a diesel generator as back up for the solar powered system. It was envisaged that each ATM would serve 500 users, improve revenue collection by the water management committee, improve accountability to users and reduce wastage.

The same kiosk and ATMs are pictured below, 12-18 months later, by which time none of the ATMs were functional. According to South Sudan team due to a land dispute and pending court case, the ATMs had to be removed and were lying idle in a storeroom managed by the community.

Figure 11 – Gumbo water kiosk after removal of ATMs

There are ATMs in other locations of South Sudan (including Wau (9), Yei (29), Torit (10) and Yambio (5)) so the Juba example may not be representative of the overall situation. These are more recent installation so not visited as part of this review as it is too soon to evaluate their performance and impact. It would be of value to conduct an independent review of these sites in in the next 1-2 years.

Figure 4 – A water kiosk in Kakuma

Figure 12 - two newly installed Lorentz ATMs in Wau (November 2022) supported with WASH

6.0 ZIMBABWE

In recent years municipal reticulation systems in Zimbabwe have been increasingly unreliable, compelling communities to rely on shallow wells and handpumps. Growth in informal settlement and contaminated groundwater due to a dilapidated sewer system and unregulated septic tanks and pits have been drivers of a re-emergence of cholera. This was the rationale for Oxfam in Zimbabwe to implement a new water scheme which incorporated the first ATMs in Country in 2019:

A new borehole was drilled which is 56m deep, yielding 11.5 cubic metres/hour. A 3 HP Lorentz solar pumping system with a discharge of 5m3/hr was installed to pump water from the borehole to 2 x 10000 litre elevated tanks. Water is treated at the water kiosk by means of 3-stage cartridge filtration, ultra-violet treatment, and inline chlorination with slow dissolving tablets. The water kiosk has 4 Lorentz smart tap dispensers (ATMs). The smart tap application is an android-based smartphone application used by the water seller to register customers and crediting of tags. The smart tap application also performs other functions like deducting credits if there is an error during crediting, requesting credits from the operator, viewing the customer list, showing statistics of water sold to customers as well as transaction logs.

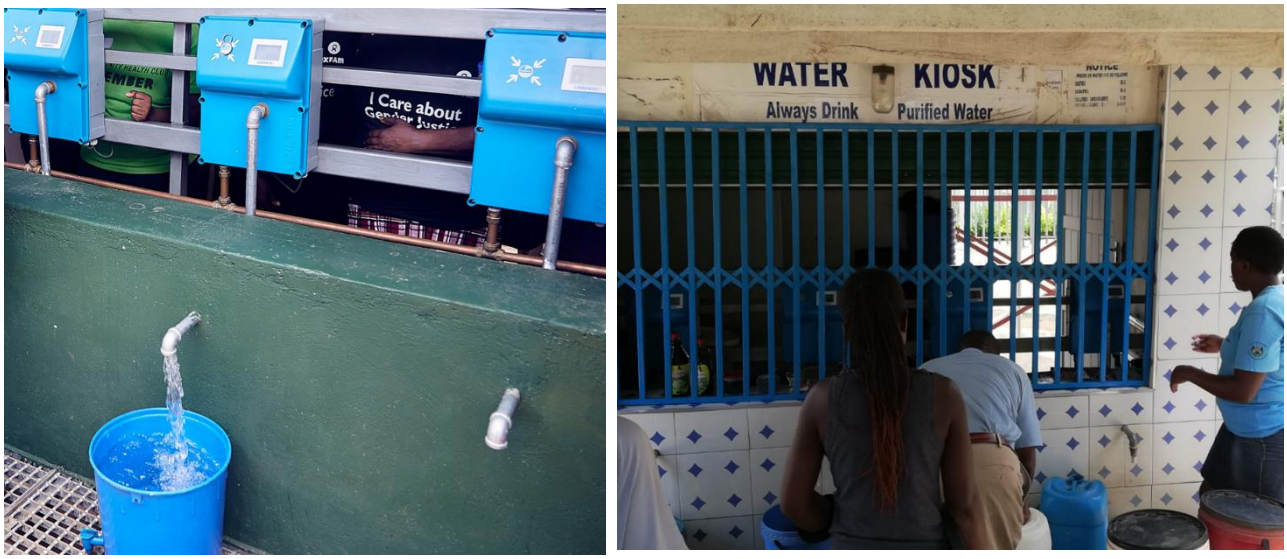


Figure 13 - Water kiosk in Harare

The water kiosk was completed in February 2020 so had been successfully operating for 3 years and 8 month at the time of the review, without any technical problems. The total cost of establishing the water kiosk was around $45,000. It is open between 8:00 and 17:00 although on days when demand is high (when the municipal reticulation system is not working) it stays open longer. The kiosk supports 1,500 households and has a daily average production of 30,000 litres. This generates an average monthly net profit of $340 (based on recorded revenue of $800 and operating costs of $460) indicating a highly successful scheme. According to the local administrator 25% of the profit is given to the local authority which has been used to repair other waterpoints, fund solid waste management and new water schemes.

A profit of $5,000/yr is sufficient to repay capital investment costs and according to Oxfam Zimbabwe team, the success of this scheme has resulted in other Municipalities across Zimbabwe replicating it. Key enablers have been:

- Community involvement since project inception led to buy-in in turn enhanced ownership of the project.
- Heavy stakeholder involvement including local authority and community lead led to the development of an operational model which is practical to the context.
- A well trained and committed water point committee ensuring proper operations and maintenance.
- As a result, the kiosk is meeting its operation and maintenance costs through revenue generated as compared to other water supply systems which are failing.
- The water kiosk is supplying high quality water compared to other sources and this is valued by users.
- Enhanced accountability as a direct consequence of the ATMs was highlighted as being a key enabler for the overall success of the scheme.
- The local authority is supportive and fully engaged. This was evident during the review field visit. It provides a supervisory role in running the water kiosk, provided land for its construction, assisted in the mobilisation of communities during consultation stages, has helped assist in conflict management and review of the financial reports from the water kiosk committee.

The following challenges have been noted:

- Some users still have to walk long distances or struggle to access water due to working hours coinciding with opening hours of the kiosk which is shut in the evening due to security concerns.
- Cash payment to water sellers is still used in parallel to mobile money so risk of theft or fraud remains.
- 2 out of 3 water kiosks installed in Harare are operating well but a third (not visited) is struggled as a result of political interference hindering communities from accessing water freely.

7.0 LEARNING FROM ELSEWHERE

The findings and experience from Oxfam projects are consistent with conclusions of external studies. It is worth noting that a literature review was only undertaken after Oxfam findings were documented to avoid the risk of influencing results and finds.

A research paper prepaid water meters in Tanzania [ref 4] summarised the rationale for ATMs and findings on their performance as follows:

> Poor sustainability of rural water schemes is a major problem in service delivery in sub-Saharan Africa. About half of the schemes fail one year after commissioning, mostly due to poor operation and maintenance. Many communities fail to collect and manage water revenue. Prepaid technologies are argued to remedy the poor water revenue management. However, it is not clear to what extent prepaid systems can contribute to the sustainability of rural water schemes. ..... Although the technologies used can simplify water revenue collection, they are not a panacea to deliver sustainable and equitable water services. The capital cost of the prepaid system is often paid for by donors, which is not being recovered, hence the notion of cost recovery is biased here. Also, a strong institutional capacity and knowledge is required alongside the technology. Therefore, the technology which is being promoted as better for improving cost recovery is, instead, causing a burden on water users.

The same report notes that although user satisfaction of ATMs is high, from an organisation perspective, it is an expensive investment estimates at 7-9% of project capital investment (with additional hidden costs such as hardware, software upgrade, training, transaction, maintenance and installation) on non water costs with a lifespan less than the water infrastructure. At one site 12 out of 23 dispensers were not functional whilst at another 3 out of 10 were out of service. Contrary to one of the main selling points of ATMs, at no sites was any financial and information flow generated by pre-paid dispensers being used to improve transparency or flow of financial information. Proper financial reconciliation is still needed which requires capacity, commitment and resources and there is a lack of evidence to show improved revenue collection is being translated into better planning for scheme operations.

A World Bank report[1] on prepaid water dispensers across 6 Countries concluded "prepaid water systems are not a technical magical wand to fix underlying management issues in the delivery of urban water supply. A service provider that falls short on effective management, governance, and sound customer relations is likely to take on far more than it can deal with by resorting to prepaid systems." The same report documented inconsistent technical performance compromising reliability and that the financial basis for adopting pre-paid systems is very tenuous, noting that "it is difficult to justify spending a substantial amount to achieve a relatively small percentage in revenue when a significant reason that utilities struggle financially is because their tariffs do not adequately reflect their costs". Financial modelling within this study suggests pre-paid dispensers will be a net loss for a typical service provider.
It goes on to document the impact that water pressure, grit and air can have on valves and accuracy of dispensers and concludes that "reliable 24-7 water should be a minimum requirement before ATMs should be considered," something that is rarely achieved in Oxfam contexts.

[1] The limits and possibilities of prepaid water in Urban Africa: Lessons from the field

8.0 OTHER SMART TECHNOLOGY

8.1 DROUGHT PREPAREDNESS AND EARLY WARNING SYSTEM

In 2010 Oxfam Kenya and Ethiopia, under the leadership of the Regional Advisor (Tom Wildman) tried to develop a web platform hosting and displaying real time data that could be used as an early warning indicator for water stress. It was envisaged that this could be a "one stop shop" capable of displaying different data types including production data from Lorentz solar pumps, water level borehole dataloggers at strategic sites, SMS data from operators on production or generator operating hours. A market assessment at that time confirmed that whilst there were available software options for mapping water points and displaying static data, e.g. Akvoflow, MWater, there was no platform that could handle complex real time data. With funding from Nokia, Oxfam contracted Element Blue, an IBM approved software consultancy to develop the platform. Ultimately the system never reached a stage where it was able to handle the range of data types envisaged or be sufficiently user friendly to convince other organisations of its worth. The project was put on hold once it became clear that additional funding was needed with no guarantee of success.

To have been successful the initiative required the support and buy in from other stakeholders in the WASH sector. Although attempts were made to achieve this – UNICEF Ethiopia decided to invest in Akvo, which curtailed the interest of Oxfam Ethiopia, and agencies in Kenya couldn't agree a common way forward. Oxfam underestimated the complexity and cost of developing a single platform and the recurrent costs of maintaining it. Although nice to be able to see multiple data sources on the same screen, the complexity of importing data from Lorentz solar pumps or Troll dataloggers into the Element Blue platform proved difficult and not cost effective when considering that these different providers already had their own software tools that were available to Oxfam at little or no cost.

8.2 PUMP CONTROL UNITS

Leading pump brands capture and display pump performance information within their control units that can provide valuable analytical data to understand and improve performance, sometimes at no additional cost. Since 2012, Oxfam has been able to monitor remotely and in real time, pump output and performance of Lorentz pumps with installation of a PS communicator. Even without this, Lorentz pump control units keep a record of performance data allowing current and historical data to be viewed or uploaded on site to mobile phone (pump scanner app) using Bluetooth. This is a powerful tool that, if used more, could provide valuable data on performance, and alongside other datasets, contribute to improved transparency and accountability (to address issues of non revenue water), enable remote stakeholders to track performance and troubleshoot problems, or even allow international donors to verify that their investments are having an impact.

On several occasions Oxfam has communicated with Lorentz to explore the feasibility of having all our solar pumps accessible using a single log-in to give a visual overview of the impact of our work from anywhere in the world, at any point in time. This has proved complicated because of the large number of different suppliers of equipment, the ownership of those schemes which

are typically handed over to other partners or operators and the fact that data transfer requires telecommunications credit, which relies on people topped up SIM on these devices.

Whilst this potential exists, often at little or no cost or effort, in reality the examples of where this data is actually being used by Oxfam and partner staff to monitor and improve performance are few. See figure xx Kutapalong, Bangladesh.

8.3 WATER TRUCKING MONITORING DEVICE

Oxfam Global Humanitarian Team collaborated with Vodafone to develop a portable device with pressure sensor which fits within the reservoir of a water truck, provides a GPS trail and record of volume of water delivered at specific waypoints. The system (hardware and licensing) which Oxfam intended to trial in Kenya, ultimately proved to be too expensive to be practical for scale up as part of a larger water trucking operation.

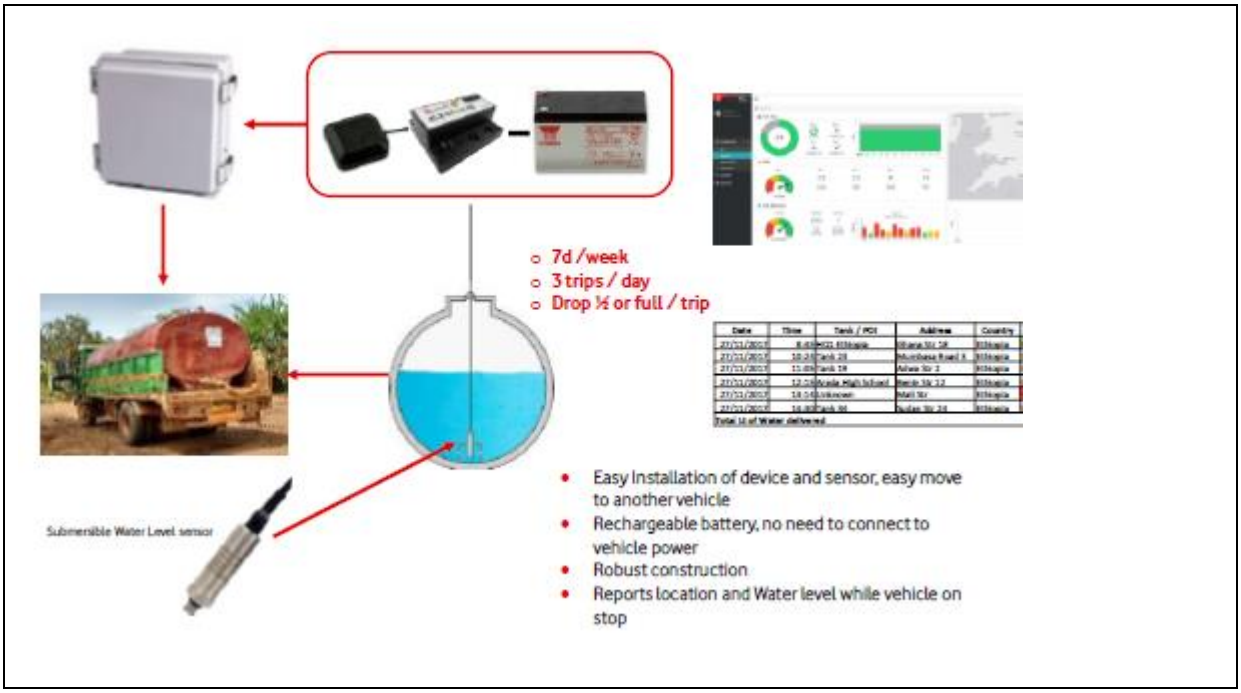
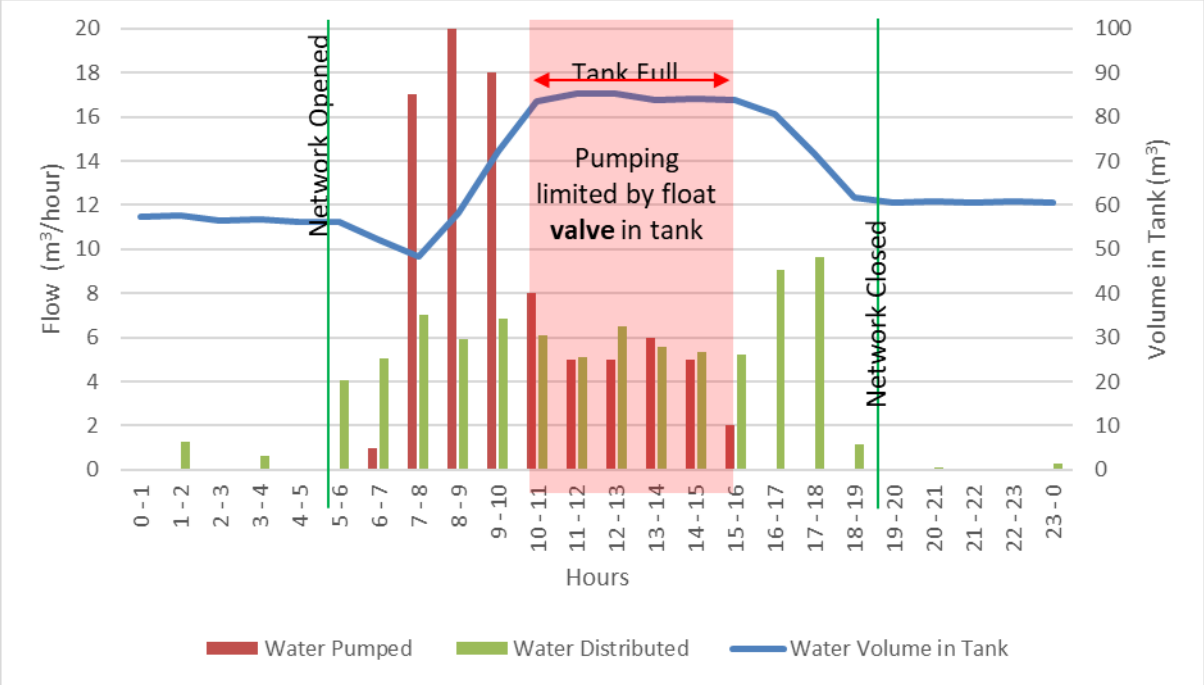
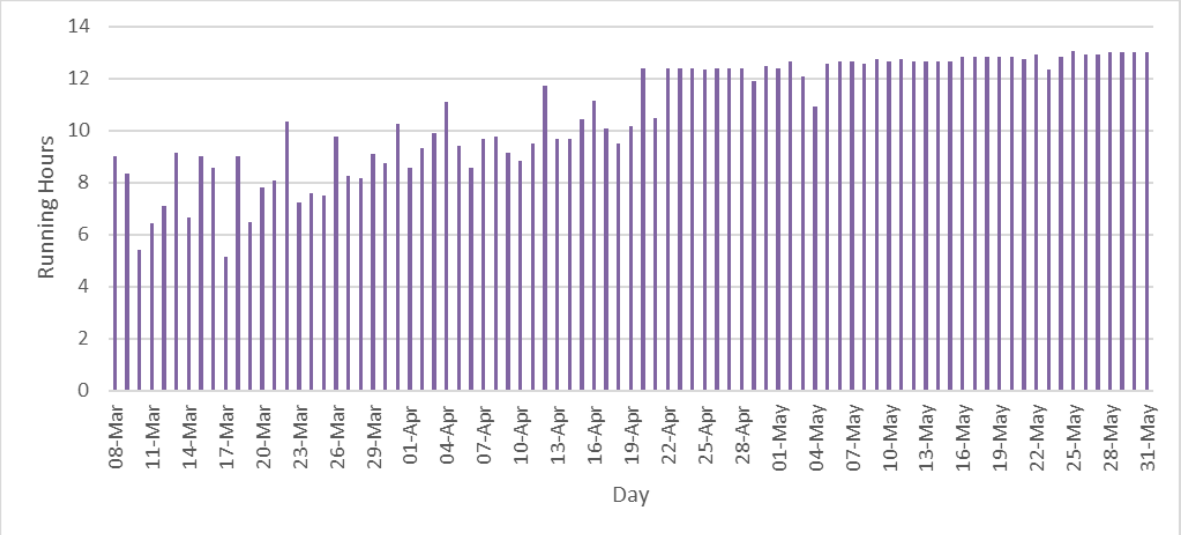


Figure 14 - Vodafone water tracking device

Figure 15 - Cox's Bazaar – using data to improve understanding of water supply



By placing a data logger in the water reservoir and comparing change in storage against production, it was possible to calculate water demand at tapstands at different points during the day. This analysis also demonstrated that the solar pumps were being under-utilsed and at some sites restricting opening hours were out of sync with user demand and where having an unintended knock on effect of reducing production.



At the above site, analysis of pump output data from the Pumpscanner app which provided more precise and comprehensive data than the operator manual records, and demonstrated that actions taken (in good faith) by the operator were unnecessarily reducing production. From 19th April, the operator was instructed to leave the pump in "auto" mode and production significantly increased thereafter.

8.4 UNHCR IOT INITIATIVE

During the peak of the South Sudanese refugee influx into Uganda in 2017, UNHCR was paying for 600 water trucks to supply water to 500,000 people. This was resulting in invoices exceeding $2M per month and they realised that its monitoring systems were inadequate to ensure accountability. This was the trigger for UNHCR to start exploring the potential of "internet of things" devices within its programmes in Iraq and Uganda. These included static and mobile water monitoring devices communicating through Long Range Wide Area Network (LoRaWAN) technology to transmit data.

Figure 16 - Smart water devices

In 2020 UNHCR secured €1M from EU to expand real time WASH monitoring in its refugee operations and document learning. The vision of UNHCR was to establish a complete smart network similar to the description in Table 1. Monitoring of water levels in reservoirs can detect system losses, bulk water meters can give a measure of equity and water security in all parts of the system, groundwater monitoring for depletion of aquifer levels etc. These are all parameters that can and should be measured as good practice using conventional collection of results by staff taking manual readings. UNHCR has not yet published its results and attempts to get an update from the project went unanswered. So the overarching question is whether the expense of introducing this technology in camps is justified by the benefits, still remains unanswered.

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