Photo Credit: Patrick Naase

Research Brief

Sustainable WASH Systems Learning Partnership

Emerging Lessons on Sustaining Rural Water Services in Uganda: A Case Study of Whave's Preventive Maintenance Model

December 2019
University of Colorado Boulder, Whave

Abstract

To address the complex challenges of sustainable rural water service delivery, Whave has been testing a model for the provision of preventive maintenance services. Whave's approach focuses on results-based payment for avoiding breakdowns, rather than payment for repairs. By incentivizing performance, their goal is to establish a system that reduces water source downtime and therefore improves the reliability of water supply systems. Whave is currently operating in more than 400 communities across Uganda. This case study focuses on results in three districts where Whave has operated for more than 4 years, achieving high rates of hand pump functionality — consistently above 97 percent, following the government's functionality metric — with a short duration for breakdowns (less than 3 days of downtime on average). Sustaining this level of service quality will require a greater share of operations and maintenance (O&M) costs financed by water user tariffs, less from development partner organizations, and increased investment by local and national government to build a professionalized O&M framework. Whave has been successful in designing and implementing a maintenance service model that addresses many key barriers. However, government ownership and leadership in mobilizing public sector resources, combined with community tariff payments, is necessary to sustain the functionality assurance demonstrated.

Introduction

There are significant challenges to sustaining reliable water services throughout rural Uganda. Although Uganda receives investment in infrastructure from local and international sponsors, water supply in rural areas is characterized by frequent breakdowns, prolonged repair delays, and premature abandonment of infrastructure. Field studies indicate that rural water supply is nonfunctioning for 30 to 40 percent of the year on average, with worse performance in some areas. Reasons for prolonged downtimes and frequent breakdowns are complex and the subject of much research, but at the heart of the challenge is the absence of a self-sustaining and properly functioning system for maintaining water services.

USAID FROM THE AMERICAN PEOPLE

SUSTAINABLE WASH SYSTEMS
A LEARNING PARTNERSHIP

Whave, a Ugandan-registered company, is testing an approach to maintenance service provision that seeks to address the barriers to sustainable rural water service delivery. Operating as a Ugandan regional service provider in three pilot districts, Whave has signed over 400 preventive maintenance and continuous rehabilitation agreements (PMCRAs) with communities, requiring community leaders to charge maintenance tariffs from water users, manage the collected funds in supervised bank accounts, and pay Whave an annual service fee on behalf of the community. An important component of this model is incentivizing local technicians to prevent breakdowns by paying them based on the number of days a water source is functional, instead of paying them to make repairs. Whave is also working with the local government to build an effective institutional structure to establish preventive maintenance services and enforce regulations. The objective is to align incentives and recover costs locally so that water schemes function reliably.

The United States Agency for International Development (USAID)-funded Sustainable WASH Systems Learning Partnership (SWS) is investigating systems approaches to improve the sustainability of water, sanitation, and hygiene (WASH) service delivery. A core learning area of SWS is evaluating maintenance approaches for rural water systems. SWS is supporting the scale up of Whave's preventive maintenance model to study and learn from their implementation approach. This research brief presents a summary of findings from a comprehensive assessment of Whave's preventive maintenance service and business model.

Eating Before You Faint: A Brief Introduction to Preventive Maintenance

In 1984, the World Health Organization (WHO) defined preventive maintenance as a "…systematized and periodic maintenance procedure applied to the components of a system in order to minimize breakdowns, ensure their efficient working, and prolong their respective lives."[1] Contrasted with reactive maintenance (i.e., maintenance that is carried out only following and in reaction to a breakdown), the key distinguishing factor to preventive maintenance is that it is carried out prior to faults in the system, with the intent of minimizing the number and magnitude of breakdowns before they happen.

The model employed by Whave is not exclusively preventive; part of their service agreement with communities is to carry out immediate reactive maintenance to repair hand pumps post-breakdown. However, the overall focus of Whave's service model is preventing issues before they arise to maximize continuity of water services.

> *"The idea of preventive maintenance is very clear: we do not wait until we faint to decide to eat, we eat before we faint."*
>
> –Assistant Commissioner, Rural Water, Ministry of Water and Environment (MWE) Uganda

To some degree, preventive maintenance is a more complex service delivery model than reactive maintenance. It requires changing behaviors around pre-payment for maintenance of water services, marketing new concepts (e.g., insurance, prevention) to end users and water committees, and dealing with the complexities inherent in managing several communities under a preventive maintenance model. Additionally, the concept of pre-payment for a service requires an established trust, between people and within entities, that can be challenging to develop in nascent markets such as the one for rural water system maintenance services. There is also an elevated complexity around monitoring several communities and forecasting their anticipated maintenance needs, leading to higher administrative and upfront expenses that may have hindered the piloting of preventive maintenance approaches in the past.

It is only relatively recently that the WASH sector has come to better understand the delivery and sustainability of rural water services in the context of an overall system.[2] This understanding has led to a greater degree of experimentation with more complex maintenance models, which can be best described, understood, and improved through a systemic, or systems-based, paradigm. The primary intention behind a systemic approach to WASH generally, and preventive maintenance specifically, is to enable and improve the system such that it has the intrinsic resilience necessary in the long-term to sustain itself in the absence of system-external resources such as donor or aid funding.

[1] WHO. "Preventive Maintenance of Rural Water Supplies." 1984.

[2] In this context, an overall system is comprised of actors (consumers, public institutions, private sector, civil society, etc.) and factors (financial, institutional, social, and regulatory factors, asset management, service delivery models, etc.) and the dynamic interrelationships among them, all of which influence rural water service delivery.

Whave's Method

Whave's activities related to preventive maintenance are best differentiated as: (1) efforts to facilitate and support the growth of the overall preventive maintenance system; and (2) efforts to model the business and service delivery element within the preventive maintenance system. Both areas contribute to Whave's overall theory of change: by strengthening the overall preventive maintenance system and optimizing the preventive maintenance service business model so that it is not reliant on donor funds, the delivery of reliable preventive maintenance services can be sustainably provided by local stakeholders and actors in the long run, with service quality and continuity improved through fewer breakdowns and reduced downtimes.

As such, Whave is both a systems enabler and a business modeler or, both a market facilitator and a district-level utility providing a public service. Overall, Whave's intention in one area is to lay the groundwork (i.e., develop the system) for the overall sustainability of their work in the other area (modeling the delivery of preventive maintenance services from within the system). Some of the specific activities Whave is carrying out under these two different roles are outlined below.

Whave as a System Enabler

- **Coordinating with local and central government:** Whave has carried out several activities since 2011 to bring local (district and sub-county level) government into the preventive maintenance model, while also providing central government with a case study that contributes to national O&M frameworks. Convening workshops and meetings with local and central government officials has led to government-level awareness of and promotion of Whave's services.
- **Marketing of preventive maintenance services to communities:** Through radio talk-shows and messaging, and public information outreach in marketplaces, Whave has familiarized rural communities with preventive maintenance services, establishing market demand.
- **Stimulating the development of relevant by-laws and resolutions:** By working closely in partnership with local government, and by demonstrating practical results, Whave has stimulated the development and passing of resolutions and potential new by-laws that support the preventive maintenance system.
- **Piloting payment modalities to reduce transaction costs:** Traditionally, payments for rural water services have been primarily cash-based with much time and resources dedicated to payment collection. Whave is developing cashless mobile money payment systems, together with water committee bank transactions, to make payment management cost-efficient.
- **Optimizing monitoring processes and key performance indicators (KPIs) for preventive maintenance services:** Whave has placed significant emphasis on monitoring, with the long-term objective of streamlining and optimizing monitoring processes so they can be most efficiently and effectively taken up by local government and/or other actors best placed to assess and track preventive maintenance system performance. KPIs currently being monitored include hand pump functionality, number of breakdowns and extent of downtimes, customer satisfaction, water quality, technician performance, and tariff payment compliance.
- **Significant coordination with the aid and development sector:** Whave's preventive maintenance work is currently very dependent on and integrated with the Ugandan aid and development sector for activities designated toward initially setting up a viable public-private partnership and preventive maintenance system framework. These activities include building the system's contractual framework, training service providers and government actors, restoring sub-standard pump installations, and providing capital financing for upgrades to piped supply and other upgrades such as prepaid automatic dispensers and metered home supply.

Whave as a Model Preventive Maintenance Service Delivery Business

- **Demonstrating and testing the business model for preventive maintenance service provision:** Whave operates as a Ugandan service provider to show how preventive maintenance can deliver continuous water services to communities. Whave currently provides services to over 400 hand pumps serving approximately 150,000 people in six districts across Uganda.
- **Managing water service technicians (WSTs) and results-based payments:** Maintaining trusting and accountable relationships between WSTs or hand pump mechanics and communities, and aligning incentives through results-based payment, are fundamental elements to offering quality preventive maintenance services and minimizing breakdown durations.

- **Ongoing marketing of preventive maintenance services to communities**: Whave uses ongoing marketing to help familiarize communities with new products and services and continue to grow its customer base.

Realigning Incentives: A Potential Game Changer for Rural Water Point Maintenance

If one had to single out the most important systemic shift brought about within Whave's preventive maintenance service model, a strong case could be made for the incentive realignment carried out at the core of the preventive maintenance system. Under a traditional reactive maintenance model, hand pump mechanics are only paid when there is a water system breakdown. This model can create mistrust, as mechanics are sometimes suspected of less-than-ideal work in the hopes of a future payout from a subsequent breakdown. Under Whave's results-based preventive maintenance model, water service technicians are paid primarily based on their preventive maintenance service visits. They also receive bonuses (or penalties they avoid) depending on whether they succeed in preventing any breakdowns each month and, in case of water system failure, how long it takes them to resolve a breakdown. Under this structure, water service technicians are incentivized to provide a continuity of water services through preventive maintenance and timely resolution of breakdowns. The technicians have higher job satisfaction under this arrangement (given consistent and predictable income), and communities experience a more reliable service with reduced breakdown times. With customer-provider trust improved, incentives better aligned across system actors, and service quality optimized, willingness to pay has been shown to increase, promising greater financial sustainability in the long run, especially as the volume of service agreements increases, so creating social consensus and normalization.

Effectiveness of the Whave Preventive Maintenance Model

The overall objective behind continuing improvements in the resilience and effectiveness of the preventive maintenance approach is that end users have reliable water service. As such, the effectiveness of the preventive maintenance model is defined as the model's impact on community customers, and more specifically the extent to which preventive maintenance services have improved outcomes with respect to water services (i.e., functionality and continuity), as well as customer perception around the quality of services.

As part of their monitoring activities, Whave collects data pertaining to breakdowns, water service downtime, and functionality. Whave also collects information on more subjective factors, such as end user perception of service quality through customer satisfaction surveys from a representative sample of their customers. Table 1 presents results from an assessment of functionality carried out by Whave in the first quarter of 2018.

Table 1. January 2018 – June 2019 Performance Monitoring

Kamuli District						
	Q1 2018	Q2 2018	Q3 2018	Q4 2018	Q1 2019	Q2 2019
Number of Communities with PMCRAs	138	166	179	213	178	197
Customers Served	31,671	38,097	41,081	48,884	40,851	45,212
Functionality (On Day of Visit)	98%	99%	98%	99%	98%	99%
Total Breakdowns/Total Water Points	14/138	18/166	14/179	9/213	11/178	28/197
Average Down Days	1	2	1	5	1	2
Payment Compliance (Expected vs. Received)	75%	76%	82%	81%	88%	73%

Kumi District						
	Q1 2018	Q2 2018	Q3 2018	Q4 2018	Q1 2019	Q2 2019
Number of Communities with PMCRAs	50	57	68	82	85	102
Customers Served	14,100	16,074	19,176	23,124	23,970	28,764
Functionality (On Day of Visit)	100%	100%	100%	100%	99%	98%
Total Breakdowns/Total Water Points	2/50	2/57	4/68	4/82	8/85	1/102
Average Down Days	2	2	2	1	1	3
Payment Compliance (Expected vs. Received)	90%	83%	81%	78%	78%	87%

Nakaseke District						
	Q1 2018	Q2 2018	Q3 2018	Q4 2018	Q1 2019	Q2 2019
Number of Communities with PMCRAs	45	45	45	46	50	54
Customers Served	8,883	8,883	8,883	9,080	9,870	10,660
Functionality (On Day of Visit)	100%	97%	98%	98%	100%	98%
Total Breakdowns/Total Water Points	2/45	6/45	1/45	1/46	1/50	3/54
Average Down Days	2	1	2	2	1	1
Payment Compliance (Expected vs. Received)	94%	99%	91%	90%	85%	92%

The data show that from the first quarter of 2018 to the second quarter of 2019, communities served by Whave in the three districts investigated (increasing from 233 to 353 communities during that same period) experienced high rates of functionality, with an average downtime of 2 days per breakdown. During this period, Whave customers also reported a high level of satisfaction, specifically regarding Whave's water service technicians and pump functionality. A large majority of respondents would be likely to recommend Whave's services to other communities. These high levels of customer satisfaction, combined with the functionality and reliability data, indicate the high quality and effectiveness of Whave's services. Furthermore, government representatives echoed these assessments and anecdotally reported similar functionality outcomes, universally complimenting Whave for their service quality and effectiveness. The main challenge for Whave will be in sustaining this high level of service without continued donor funding.

Financing the Whave Preventive Maintenance Model

It is important to distinguish between funding that establishes the preventive maintenance system, and funding that tops up current community payments for recurring expenses (such as results-based payments to hand pump mechanics) that are part of the long-term service delivery business model. The former are one-time investment costs, and the latter are permanent, recurrent service costs. It is the service cost that Whave seeks to replace with recurrent tariff revenue to achieve sustained functionality of rural water sources. Until the model fully matures, both mechanisms of financing for Whave's model are supported by external donor funds.

Examples of initial start-up expenses include:

- Initial mobilizing and marketing to communities
- Expenses associated with preliminary (and ongoing) coordination with government, establishment of clear roles and responsibilities of system actors, and dissemination of information on the O&M framework and structure
- Government promulgation of appropriate preventive maintenance system resolutions, ordinances, and by-laws, such as tariffs, protocols, and appointments of area service providers
- Quality assurance regarding water source hardware and design

Whave's goal is to demonstrate effective service delivery, initially using donor funds to make the case for national and local government investment in the model. Ultimately, Whave would like to have government support for start-up expenditures without reliance on government or donor support for recurring service costs. Table 2 outlines the differences between the current funding streams and a hypothetical future case.

Table 2. Current and Future Cases of Key Preventive Maintenance Activities

Key Preventive Maintenance System Activities	Current Case		Future (Ideal) Case	
	Who is Doing?	Who is Paying?	Who is Doing?	Who is Paying?
Coordinate with Local Government	Whave	Donors	Whave, National Ministry of Water and Environment (MWE)	Government, MWE
Monitor Service Quality	Whave	Donors	Local government	Local government
Market Services to End Users; Community Mobilization	Whave (majority), Government	Donors, Government	Local government, other communities, Whave	Local government, Whave
Coordinate Payments	Whave	Donors	Local government, Whave	Local government, Whave
Establish Resolutions	Government	Government	MWE, local government	MWE, local government
Implement Resolutions	Government	Government	MWE, local government	MWE, local government
Provide Preventive Maintenance Services	Whave water service technicians	Donors (majority), end users	Whave water service technicians	Communities, end users, government

Table 3 summarizes Whave's forecasted vision for the most likely recurrent cost per water source in the long term, once the preventive maintenance system is mature and services are normalized. The analysis focuses on farming communities that are relatively small, usually with populations between 200 and 600 people. These communities typically manage water sources through subscription payment. The question of whether rural water preventive maintenance service providers should cover larger communities or trading centers with populations of up to 5,000 population (i.e., the government's rural-urban demarcation) is important and included in Whave's deliberations with government on proposed national O&M frameworks. In Table 3, hardware expenses refer to the replacement of parts, labor expenses constitute the preventive checks and repairs conducted by technicians, and management expenses include management and staff salaries, as well as payment for contractors hired to conduct monitoring which informs performance-based payments for technicians.

Table 3. Whave's Forecasted Annual Cost per Water Source Unit of Preventive Maintenance Service System

Unit Expense (Per Source)	Per Source Unit Cost in USD ($1 = 3,800 UGX)
Hardware Expenses (Future Estimate)	$92
Labor Expenses (i.e., WSTs, Members of the Hand Pump Mechanics Association)	$50
Management Expenses (Fixed per Source, Assuming Approximately 600 Sources)	$108
Default Costs and Contingency (20 Percent Default Plus Approximately 5 Percent Contingency)	$63
TOTAL APPROXIMATE ANNUAL PREVENTIVE MAINTENANCE SERVICE FEE (ROUNDED, PER WATER SOURCE)	**$313**
Payment to Water Service Committee (WSC) Member(s)/Caretaker	*$158*
TOTAL ANNUAL REVENUE NEEDED FOR COST RECOVERY IN THE LONG-TERM BUSINESS MODEL ENVISIONED BY WHAVE	**$471**

Table 4 demonstrates the challenges to sustainable cost recovery from community service fees alone. In Kamuli District and other areas where revenue generation through significant service fee increases could prove the most challenging, one can also look at lowering costs to potentially achieve cost recovery. Ideas for narrowing this gap around hardware expenses, some of which Whave is already considering or moving forward with, include the following:

- Reduce the amount of hardware covered under a PMCRA or request co-pays from the community based on certain larger-scale hardware expenses
- Subsidize hardware unit costs through other donor-related sources of funding, such as high-interest investments (government bonds, etc.), annuity or trust funds from investors, high-net-worth individuals, corporations, etc.
- Optimize parts replacement timelines
- Solicit government financing to fill the hardware expense gap
- Subsidize small farming communities with populations typically between 200 to 1,000, using surplus earned in larger rural communities or trading centers with populations up to 5,000, utilizing a for pay-for-volume approach in the larger communities

Table 4. Percent Increase in Annual Service Fees Needed to Meet Forecasted Cost Recovery from Community Fees

District	Kamuli	Kumi
Average community annual payment (2018-2019)	$74	$92
Percent increase in service fee needed for full cost recovery	423%	340%
Percent increase in service fee needed, including WSC payment	636%	512%

Even with some reduction in hardware expenses, the forecasted service cost recovery will still be challenging to attain through community fees alone, and some subsidization of the model will most likely be necessary. However, an interesting outcome is the implied average cost per household per month is under $1 and less than 2 percent of average rural incomes.[3] Smaller pro-poor tariffs are therefore possible with two-tier pricing structures to ensure universal access. Whave is working with local and central government to structure two-tier tariffs for maintenance services for all communities designated as rural by the government, which provides scope for universal access and cross-subsidy between large and small communities.

Bridging the gap between costs and revenue requires several strategies. A reduction in costs associated with marketing, transaction, and coordination activities may be possible through greater economies of scale. Steadily increasing tariff and service fees will increase revenue generation if conducted with the support of government at a rate that customers can manage. Another strategy is streamlining hardware replacement and repair protocols such that hardware cost-effectiveness and efficiency is optimized without compromising service quality. Perhaps most importantly, cross subsidization or leveraging more government investment or public subsidies into the preventive maintenance system will help ensure costs

[3] Ugandan average household income (2016/2017). Available at: https://www.ubos.org/explore-statistics/statistical-datasets/13323/ (accessed Nov. 20, 2019).

are covered and services are not unaffordable to poor households.

In addition to financing, the transition of roles and responsibilities from Whave to the national and local government to undertake coordination, monitoring, and other supporting duties, is a challenge that must be faced for the model to be sustained.

Key Findings

Some key conclusions about Whave's preventive maintenance approach are:

- **Functionality rates above 96 percent are achievable consistently over time, at affordable tariff levels, partly due to shifting incentives from repair payments to guaranteed-service payments.** Moving the financial incentive of water service technicians to functionality-based performance has been a breakthrough in achieving high functionality rates at low cost.
- **Government leadership is crucial to the long-term sustainability of the preventive maintenance system.** Whave's work in mobilizing local and central government over the past few years within dozens of workshops, meetings, and activities — such as regular local government reviews of the service delivery — is laudable and should serve as the start of a model for other development programs involving the delivery of public services in which government plays a significant role.
- **The largest challenge is moving toward full cost recovery of functionality assurance.** There is a significant gap between what is currently received in non-donor revenue (e.g., community service fees and government funding) and the forecasted recurrent service costs of the model. This gap is currently being filled by donor funds, and the transitional steps Whave is taking toward an O&M framework that includes pay-for-volume modalities, cross-subsidies between large and small communities, improved government financing efficiency, and growth to economic scale, are necessary for financial sustainability.

Additional research on the future involvement of the public sector, in terms of subsidy and service provision, as well the transition of service delivery to small piped systems and the impact of growing urbanization, continue to be investigated.

Acknowledgments

This brief was prepared by Pranav Chintalapati and Tim Roberts, with Karl Linden. It is based on a full report authored by David Sparkman. The authors would like to thank Whave for providing access to documentation and information, and Director Adam Harvey for his input and support. This material is partly funded by SWS, a USAID cooperative agreement led by the University of Colorado Boulder. For more information, or a copy of the full report please contact Dan Hollander (Daniel.Hollander@colorado.edu). A report by Adam Harvey further detailing rural water in Uganda and the role of Whave can be found at www.gwf-wasser.de/fileadmin/GWF/WaterSolutions/Research_Harvey_Rural_Water_in_Uganda.pdf.

About the Sustainable WASH Systems Learning Partnership:

The Sustainable WASH Systems Learning Partnership is a global United States Agency for International Development (USAID) cooperative agreement to identify locally-driven solutions to the challenge of developing robust local systems capable of sustaining water, sanitation, and hygiene (WASH) service delivery.

This report is made possible by the generous support of the American people through USAID under the terms of the Cooperative Agreement AID-OAA-A-16-00075. The contents are the responsibility of the Sustainable WASH Systems Learning Partnership and do not necessarily reflect the views of USAID or the United States Government.

For more information, visit www.globalwaters.org/SWS, or contact Dan Hollander (Daniel.Hollander@colorado.edu) or Elizabeth Jordan (EJordan@usaid.gov).

USAID FROM THE AMERICAN PEOPLE

SUSTAINABLE WASH SYSTEMS A LEARNING PARTNERSHIP

University of Colorado Boulder · Environmental Incentives · IRC Supporting water sanitation and hygiene services for life · LINC · TETRA TECH · UNIVERSITY OF OXFORD · WaterSHED · Whave a fair future