



The challenges of implementing modular, adaptive, and decentralised water technologies – The perspective of a rural service provider in Kenya

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ABSTRACT

FundiFix is a social enterprise that offers rural water systems maintenance service in rural Kenya. In recent years FundiFix has been operating these three types of water system that fall under the MAD (modular, adaptive, and decentralised) water systems paradigm: Solar powered groundwater kiosks, water ATMs, and reverse osmosis filtrations systems. This article outlines some of the challenges of operating these in a rural context. We identify four key challenges that must be considered if these technologies are to provide sustainable benefits to rural communities: managing higher capital and maintenance costs; the requirement for more skilled staff to manage and maintain them; the risk of the most marginalised communities being left behind; the importance of considering maintenance from the start.

1. Introduction

FundiFix is a social enterprise that offers rural water systems maintenance service in rural Kenya, currently serving around 70,000 people. FundiFix has been an innovator in the professional maintenance and management of small-scale water supply systems, aiming to bridge the gap between Community Based Management and larger scale public utilities that manage municipal piped water systems. This supra-community, professional model was uncommon in Kenya prior to the decentralisation prescribed by Kenya's new constitution in 2010 and the subsequent Water Act (2016) that in Article 94 allowed for "community associations, public benefits organizations or private persons" to provide water services in "rural areas not commercially viable" for large water service providers.

FundiFix evolved out of research into rural water provision, originally servicing only handpumps, and was established as an independent entity in 2014. It has now expanded its operations to include small piped systems mainly comprising motorised or solar-powered boreholes, all of which are decentralised and use modular components. FundiFix now has a number of years of experience with these MAD (modular, adaptive, and decentralised) water systems, and we will discuss the challenges of operating three types of MAD systems in the rural areas where FundiFix

is based:

Solar powered groundwater kiosks can lower the cost of operations by reducing maintenance and fuel costs, while reducing the carbon emissions of supplying water;

Water ATMs help improve revenue collection efficiency, provide 24/7 access to water and allow the service and pricing model to be adapted to the specific needs of the site and season;

Modular RO (reverse osmosis) systems can be deployed to bring low-quality water to potable standard for lower volume systems in more remote areas.

The potential benefits of these systems are significant, giving higher level of service to communities who have to-date often enjoyed basic water service¹ provision through handpumps and unreliable piped systems. However, operating and maintaining these technologically superior systems comes with challenges.

2. Requirement for skilled staff

These technologies require more specialised staff to keep them working, both logistically and technically. Solar systems (see Figure 1) need skilled engineers to maintain them, someone who understand control systems, power loss dynamics and efficiencies, not just

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¹ The UNICEF/WHO Joint Monitoring Programme defines a "Basic" water service as: "Drinking water from an improved source, provided collection time is not more than 30 min for a roundtrip including queuing".



Figure 1. A solar powered water kiosk in Kwale that has replaced a handpump.

technicians who can do basic electrical wiring or repair handpumps. RO systems require a strict maintenance in the various sections of the plant including regular replacement of consumable e.g., filters, pH solution, chlorine solution, activated carbon, etc., and continuous monitoring to ensure optimal operation of the water treatment system to deliver the right quality of water. This knowledge is not inherently more advanced than that required to maintain the diesel-powered generator that solar systems are replacing, but it is harder to find someone with this knowledge and expertise in rural areas.

Similarly water ATMs use proprietary dashboards for their operation. These enable adaptability, for example remote top-up of user credit and flexible pricing, and high levels of information about system use, but at the cost of complexity. When it comes to debugging and repairs, just a minor software issue requires someone to connect the ATM to a laptop, and sometime liaise with the manufacturer's technical support staff abroad. This requires a different skill set to that of a handpump or generator mechanic.

To resolve issues within a day or two in order to fulfil our promises on water service availability, these skilled people must be on staff, not

brought in as consultants or as part of a service contract with manufacturers or distributors. Recruiting and training staff with the right skills and capacity is difficult. It is also expensive to retain them, when there are other opportunities in urban areas which may be more attractive to live in due to better social amenities than remote villages. Requiring skilled personnel on permanent staff is also a challenge as the volume of work is very seasonal, peaking in the dry season, when demand on water systems is greatest, and being very low at other times.

3. Higher capital and inventory costs

While these technologies may perform better than a handpump or diesel powered system, in addition to the higher costs associated with staff support, their capital cost is higher. Even in the case where we can cover the operating costs with user fees, in the rural context where we work there are household welfare and affordability issues, so there is a limit to the maximum tariffs you can pass on to users. The cost of servicing a commercial loan to pay for the capital investment cannot be passed on to users, or absorbed by FundiFix, leaving a funding gap for

constructing new systems without external support.

These more advanced technologies can also have higher costs associated with the spare parts needed in order to be able to fix them on time. In the rural context travelling hundreds of kms to the supplier or distributor in the city for parts mean delayed repairs, so we must maintain a significant stock of spares to resolve most issues within a day or two. Some parts, such as electronic controller boards for water ATMs or RO filter sets, cannot be repaired and must be swapped out, so we have to maintain stocks ourselves. This is expensive as we have to replicate every technology that we are maintaining as there isn't compatibility between parts, and they may only be available directly from an overseas supplier or original manufacturer. This also creates a risk that we do not face with standard plumbing or handpump spare parts: that of obsolescence and spare parts becoming unavailable.

To be able to honour the service guarantees that we do, an operator like FundiFix has to order spare parts further in advance and hold more cost in inventory at any given time, increasing operating costs. Compared to the cost of servicing debt for the initial capital investment, the monetary cost of high inventory levels may be small, but it adds further complexity to planning and management. The stock management of such parts is very different from that of low-cost and easily available plumbing or handpump parts, requiring more management time from more skilled staff.

4. Risk of people being left behind

If you look at these technologies from the angle of transitioning from basic technology like a handpump, as we are, there is a risk that the moment you shift technologies you abandon the old system, and you've shifted from a mature—albeit low-tech—technology that probably breaks twice in a year to one that need some sort of attention once in a month. The costs of keeping the technology working might be low in the initial two or three years, but as the system ages you start to see increased cost of maintenance.

Under the community-based management model (CBM) whoever funded the capital cost usually assumes that users are going to pay for operation and maintenance. Calculated O&M costs may have included an allocation for water user committees or limited external support but did not include the value of communities' time maintaining these systems. The implication is that the true costs of O&M was higher, and is even more so for higher technology MAD systems as it includes salaries for professional staff.

The more you invest in better service delivery, for instance, inclusion of complex water treatment solutions, the greater the cost of operation and maintenance. Operators thus face a choice between maintaining the status quo of basic water service to keep costs low, or shifting to a safe water service and having to pass along costs to users. Regulatory water quality requirements and need for compliance eventually places enterprises such as FundiFix in a tight position, from both a regulatory and financial point of view. Increased costs and funding gap means operational subsidies are required to sustain service delivery, making rural water maintenance unattractive to 'for profit' enterprises. All operators in our context face some version of this dilemma until the required technologies become cheaper.

There is a substantial long-term risk associated with tying communities into more advanced systems that are not suitable for CBM. Simpler systems, such as handpump or basic kiosks, can switch to CBM and continue to function albeit with more and longer breakdowns, if the service provider cannot continue to operate. Technologies, such as water ATMs or RO treatment must be managed by professional service providers, and so will most likely—possibly very rapidly—cease to function completely if the service provider exits.

In this scenario, the very poor will end up suffering the most because they end up paying a high price (e.g. for vended water), or go without good water as they cannot pay, and have to switch to more expensive or less safe sources. For example, in rural Kitui it is common to find untreated water being charged at KES 5 per jerrican, equivalent to 230 (USD 1.64) per cubic meter, which is two or three times the cost of treated safe water in the city. In the dry season this can double or triple depending on distance from source.

5. Conclusion

The decentralisation of responsibility for rural water provision in Kenya, from central government to County level, has created an opportunity for social enterprises like FundiFix to provide services to rural populations, operating in the gap between community management of single handpumps and formal water service providers managing piped municipal water systems. Newer, modular technologies provide a means to deliver a higher level of services to these communities.

But in the same way that professional service provision, which can reduce downtimes by an order of magnitude compared to CBM is not cheaper than CBM, it must be acknowledged that the higher level of service that these systems can provide comes at a greater cost. The operations and maintenance required by these systems is more involved than that of the technologies they hope to replace. This must be considered as part of the project design phase, so responsibilities for operating and maintenance are agreed in advance, formalised, and budgeted for with the capital cost. They will need a maintenance service provider, and that provider should be involved in the design phase to select suitable technologies that are cost effective, and have reliable spares supply chains. This will guarantee timely maintenance with minimal downtime ensuring continuous flow of water to rural populations.

New technologies are never a silver bullet as they come with new complexities that must be understood and tested and require staff to have new skill sets to maintain them. Age old problems do not disappear, but manifest themselves slightly differently (e.g. any equipment, no matter how well-designed and well-built, must be maintained). These issues must be considered from the outset, with management adapting accordingly. If MAD technologies are to *sustainably* contribute to improving the water security of rural communities, the management and institutional models within which they operate must be appropriate. We must move away from the CBM approach still prevalent in rural water provision and toward professionalization, which is taken for granted in urban water provisions, to truly empower rural communities by giving them reliable and affordable water services that do not require their active management.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Jacob Katuva and Cliff Nyaga are directors to FundiFix Limited, and all three Authors are trustees to the FundiFix Water Services Trust. Given role as Guest Editor, Patrick Thomson had no involvement in the peer-review of this article and has no access to information regarding its peer-review. Full responsibility for the editorial process for this article was delegated to Justin Stoler.

Data availability

No data was used for the research described in the article.