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Determinants of service sustainability: small piped water schemes in rural Rwanda

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A study into the sustainability of rural, small piped water systems in Rwanda found that: a) the energy source for conveying water through the system was an important cost driver and directly affected the price of the water tariff; b) consumer demand for water may be price elastic and higher prices may increase use of cheaper, non-safe alternatives; and c) local government support may be necessary to cover large maintenance and repair costs and assist with planning. The study further considered the efficacy of different service provider models; however, results were not conclusive on which service provider model is most likely to sustain a service over time.

Introduction

The International Federation of Red Cross and Red Crescent Societies have funded the construction of 19 rural water supply systems in Rwanda since the country emerged from conflict. Given the scale of this investment, the Norwegian Red Cross Society was interested in reviewing the sustainability of rural water supply systems in Rwanda to help guide and inform future investments in the country.

A study of seven rural water supply services was undertaken in Rwanda in 2014. The study was split into three phases: a literature review of current thinking on sustainability and the parameters of assessing service quality; an ex-post evaluation of two systems built by the Norwegian Red Cross Society in Gisigara and Nyanza; and a shorter review of five additional systems, with no preference for who funded the system's construction.

The information gathered by the study will inform the drafting of a good practice guideline on sustainable rural water supply service provision in Rwanda. This briefing summarises the findings of the ex-post evaluation and the system reviews.

Rural water supply in Rwanda

Rwanda is a densely populated country, with a population estimated at 11.8 million people living within a 24,670 km square land area (UNDP, 2013). Roughly 80% of the population lives in rural areas (Ansoms and Rostagno, 2012), and approximately one third of rural Rwandans do not have access to an improved water source (WHO and UNICEF, 2014).

Rural water supply systems in Rwanda are typically small piped water schemes due to the hilly topography, which limits the use of boreholes.¹ The Government supports a range of public service provision models for supply, including community management committees and private operators, with the government limiting itself to directly managing only those services that cross district boundaries (Gisigara District Information Officer, Pers. Comm., 21 November 2014). Small piped water schemes under delegated management are therefore common in rural communities.

Since 2010 the Rwandan Government has placed an emphasis on the use of private operators in response to the low functionality of piped rural water systems. This emphasis is reflected in the Government's Economic and Poverty Reduction Strategy, which aimed for 50% of water systems to be managed through Public Private Partnerships (PPPs) by 2012 (Water and Sanitation Program, 2011). Consequently, PPPs have

become a growth area. As of 2010, 235 rural water supply systems were privately managed through PPPs in Rwanda, constituting 28% of the country's water supply systems (Prevost et al, 2010).

Study aims and hypotheses

The study was commissioned by the Norwegian Red Cross to prepare guidelines on designing sustainable rural water supply services in Rwanda. The study sought to understand the key determinants of the sustainability of such services in Rwanda so as to provide an evidence base for the guidelines. The study design focused on small piped water systems, as they are the most common improved source for providing water to rural communities, after protected springs (EWSA, 2010).

The study was exploratory in nature. An initial literature review identified eight parameters that academics and development practitioners consider to be of significance for sustainability, including user participation throughout the project cycle (de Albuquerque, 2014; WaterAid, 2011; Narayan, 1995), planning and budgeting for the life cycle costs of a service (Harvey, 2007; Fonseca et al, 2011; Lockwood and Smits, 2011; McIntyre et al, 2014), establishing cost-sharing arrangements between government and service providers (Harvey, 2007; WaterAid, 2011; Water Services that Last, 2011) and a supportive enabling environment (de Albuquerque, 2014; UN Water, 2014). The lessons learned by the sector were however very generalised, presenting a challenge for a study that was specifically interested in the water sector (as opposed to water and/or sanitation and/or hygiene) and rural service provision using small piped water schemes.

Given the specificity of the study, an ex-post evaluation was undertaken to help tease out some of the key determinants of sustainability for the context of rural, small piped water schemes in Rwanda. The findings of the literature review were used to formulate a range of evaluation questions which aimed to assess both a service's quality and likely sustainability.

The evaluation found a distinct difference in the performance of the two systems; any interruptions to the water supply for the Gisigara District system rarely lasted for more than one day, whereas stakeholders reported that the Nyanza District system broke down for more than seven days during the two weeks prior to the evaluation.² It was found that the differences in performance were chiefly attributable to the operational costs associated with the energy source for powering the water pumps (refer Table 1 below). The Nyanza District system is running a diesel generator to power the pump, whereas the Gisigara District system has a pump connected to the electricity grid. The cost of diesel and its transportation was reportedly so high that the service provider in Nyanza often did not have the required supplies. The evaluation also found that the private provider in Gisigara had arranged a cost sharing agreement with the local government, whereby maintenance and repair costs exceeding 200,000 Rwandan Francs (RWF) (equivalent to 290 United States Dollars (USD)) would be covered by the district. No such arrangement was in place with the Nyanza system, which was managed by a community committee.

The findings of the evaluation indicated that three variables may have a significant influence over service sustainability, as follows:

1. The source of energy for conveying water

The ex-post evaluation found that the source of energy for conveying water through a system was the main cost driver for water tariffs. In the case of the community managed service in Nyanza District, the system relied on a diesel generator to power the water pump, with a tariff of RWF30 (roughly US 0.40 cents) per 20 litre jerry can at public water points. By contrast, the privately managed service in Gisigara District relied on electricity from the main grid to power a water pump, with a tariff of RWF15 (roughly US 0.20 cents) per 20 litre jerry can at public water points. Both service providers explained that the source of energy for conveying water was the deciding factor for the price of the water tariff, with diesel costing more than electricity over time.

The high cost of diesel, which is imported into Rwanda, was cited as the reason the community management committee in Nyanza could not cover the cost of providing a reliable supply of water. The committee could increase the water tariff to better cover the costs; however, focus group participants assigned the current price of the water tariff an average rating of 2.2 out of 5, indicating that consumers considered RWF30 per jerry can to be expensive (1 meant "It is expensive", 5 meant "It is cheap"). The findings from the ex-post evaluation warranted further investigation and raised several questions for step three of the study: do different energy sources lead to higher operating costs and consequently, higher tariffs? Furthermore, do higher tariffs reduce demand for the service?

2. Importance of support from local government

The literature suggests that technical support (WaterAid, 2011) and financial subsidies (Harvey, 2007; AfDB, 2010) can help ensure that service providers are able to manage complex repairs and fund expensive costs over a system's lifecycle. The ex-post evaluation indicated that this was important – a community managed service operating without any government support was having difficulty covering the basic costs of operating the system. It is likely that the committee would have difficulty covering the costs of a major breakdown. By contrast, a private operator had an agreement in place with the local government, whereby costs in excess of 200,000 RWF (approximately US\$ 280) would be covered by the district. The question of whether support from local government could be a major factor that explains the differences in sustainability between systems was added to the study.

3. The model of service provision

The third variable of interest concerned the different types of service provision models that are supported in Rwanda. As previously mentioned, the two common service provision models for managing services within district boundaries are community management committees and private operators. The challenges for the former are well known; however, the evidence base for the latter is still developing. There are indications that the private sector can be a more effective management option; reviews of private operator performance indicate better performance in terms of responding to breakdowns and ongoing system functionality (Kleemeier and Narkevic, 2010).

The two systems covered by the ex-post evaluation indicated that there might be cause to compare systems with different service provider models. The Nyanza System was failing to provide a reliable supply of water, in part because of the cost of diesel, but potentially due to planning issues and limited sources of revenue (the committee could only raise revenue from one system). Conversely, the company managing the Gisigara system was responsible for seven water systems and the water supply for the Gisigara system was reliable. Conversations with the Egipres Company indicated that managing multiple systems provided surplus funding to cover the losses on other systems in their portfolio in a given year. Although the energy source was a factor in the reliability of supply, it was decided that the study should also explore whether private operators would generally prove to be more efficient than community management committees.

Review of additional systems

The third step of the study sought to gather more data by reviewing another six rural, small piped water schemes in Rwanda. This step was more limited in scope than the ex-post evaluation. A modified framework was therefore developed, composed of five components: Functionality, System, Service Quality, Service Provider and Local Enabling Environment. The assumption was that the status of a system's functionality (whether fully functional or not) could be explained by the information gathered on the system's characteristics, the service quality, the characteristics of the service provider model and the extent to which the local enabling environment could be considered supportive. A list of two to ten indicators was prepared for each component. Each indicator was chosen according to whether it was directly relevant to sustainability, based on the literature review of issues underlying the sustainability of rural water supply services, and whether the indicator was easy to assess in terms of measurability and the time taken to collect data.

In light of the questions raised by the ex-post evaluation, the sample method aimed to select a mix of systems across different districts, with different sources of energy and different service provision models. The study aimed to review six systems in addition to the two ex-post evaluation systems, however due to time constraints only five systems were reviewed. In summary, the sample consisted of two systems that were gravity-fed, one using a diesel generator and four that were connected to an electricity grid. Three systems were managed by community committees and four systems were managed by private operators, across four local government districts.

Quantitative and qualitative data was gathered through water point surveys, focus group discussions (four groups per system, eight participants per group with gender balance) and interviews with service providers and district infrastructure officers. The data for each review was compiled and presented in a tabular format to allow for ease of comparison.

Findings

The source of energy for conveying water

The study found that the energy source for conveying water is the main cost driver for water tariffs. All service providers interviewed were charging different tariffs based on whether the system was gravity-fed, pumped using electricity or reliant on a diesel generator (refer Table 1 below). Service providers reported that gravity-fed systems have the lowest operational costs, followed by pumps connected to the electricity grid.

| Table 1. Market prices for water tariffs by energy source in Rwanda and associated ratings of acceptability | | |
|--|---|--------------------------------------|
| Source of energy | Cost per 20 ltr. Jerry Can (RWF) | Average consumer price rating |
| Gravity-fed system | 8 – 10 | 4.1 |
| Electricity from national grid powering a pump | 15 – 20 | 3.6 |
| Diesel generator powering a pump | 30 | 2.3 |

Table 1 compares the different water tariffs with focus group participant ratings of the price of the water tariff, on a scale of 1 to 5 (1 meant “It is expensive”, 5 meant “It is cheap”). The table indicates that demand for water may be price elastic; consumer willingness to pay decreases as the price of the water tariff increases. However, there is insufficient data to prove the strength of the relationship between a change in price and a change in demand. Focus group participants reported that the time spent queuing was a motivation to seek cheaper substitutes and it is possible that the distance to visit a cheaper alternative may also be a factor affecting willingness to pay. Note that in all cases the cheaper alternative was a protected spring or surface water.

The model of service provision

Table 2 provides a comparison of system functionality. The proportion of functional public water points in the system is a snapshot on the day of the water point survey and does not provide an accurate picture of functionality. The duration of the last breakdown was a pass/fail criterion – a breakdown lasting less than or equal to two days was considered a pass.³ The two measures combined provide reliable information on the functionality of a system.

Table 2 shows that all four privately managed systems prevented breakdowns from lasting more than two days, whereas two of the three community managed systems failed on this criterion. All systems maintained a reasonably high level of functional water points, with the exception of Munini, which had completely broken down – funding for operations and maintenance was collected on an ad hoc basis; no tariff was charged, resulting in insufficient revenues and a gradual breakdown in system functionality. The Mututu system did maintain the water points, however, it failed the breakdown test due to insufficient diesel supplies to power the pump. Note that the average age of the functional systems is 10 years.

| Table 2. System age, functionality and service provider model | | | | |
|--|---------------------|--|---|-------------------------------|
| System | Age in years | % of Functional public water points | Duration of last breakdown in days | Service provider model |
| Kibilizi-Kansi | 7 | 89% | 1 – 2 | Private |
| Kabirira | 9 | 85% | 1 – 2 | Private |
| Mangeregere | 8 | 75% | ≤ 1 | Community |
| Rwazana | 10 | 75% | ≤ 1 | Private |
| Nyamirama | 16 | 71% | ≤ 1 | Private |

| | | | | |
|--------|---|-----|--------|-----------|
| Mututu | 2 | 87% | 3 – 7+ | Community |
| Munini | 4 | 0% | > 7 | Community |

The findings presented in Table 2 indicate that private operators may be a more reliable model of service provision than community management committees. However, there is insufficient evidence to provide a conclusive comment on whether private operators are better able to sustain a water supply service; a larger sample is required.

The importance of support from local government

All four private operators have a cost sharing arrangement in place with district-level government. These arrangements subsidise large maintenance and repair costs, acting as a form of insurance and allowing service providers to keep water tariffs low while still making a profit over time. This suggests that financial support from local government is important for sustainability.

Only one community management committee had an arrangement with the district government. This committee was the only community provider managing a system that could be assessed as functional (Mangeregere in Table 2, above). The community management committee had established a close relationship with local government; by agreement the local district office held all revenues collected by the committee and the technician had to submit a bill of quantities to the district in order to receive funding for repairs. The committee had built a reserve of RWF6 million (roughly US\$ 8,500) and was able to draw on financial support on a case by case basis.

These findings suggest that local government support can contribute to sustainability by covering large maintenance and repair costs and assisting with planning.

Conclusion

The study findings indicate that the source of energy for conveying water, the price of the water tariff and the degree of support from local government are important factors that can determine the sustainability of a rural, small piped water service. Program designs for new systems should assess the operational costs of different energy sources for conveying water, as well as consumer views on the acceptability of different tariff price points so as to ensure that there will be sufficient demand for the service and sufficient revenue generated to cover operations and maintenance. Program managers should also consider whether the likely water tariff for the system will be sufficient to cover all post-construction costs, or whether a cost-sharing arrangement for major repairs, and possibly asset replacement, will be necessary. In the case of Rwanda, such an arrangement is demonstrably possible with local government and should be given due consideration.

Limitations of the study

Due to time and cost constraints this study was limited to seven systems in Rwanda. A larger study of small piped water systems in Rwanda, with a representative sample size, would provide reliable data to further test the findings. Such a study may also provide sufficient data to indicate whether private operators are, in general, better able to maintain a service at appropriate standards (i.e. functionality and water quality) over time.

Areas for further enquiry

The role of local government in providing financial support is worthy of further exploration. The findings from this study suggest that local government can act as an insurance provider for when major breakdowns occur. However, at least in the Rwandan context, there is no formal policy on this and it remains unclear whether local or national government will fund major breakdowns and long-term asset replacement. Such costs do need to be planned for, however the literature does not yet provide consensus on who should cover those costs. The study findings concerning operational costs and price elasticity suggest that relying solely on water tariffs to cover life cycle costs may not be possible for all system designs.

Issues concerning economies of scale and the price elasticity of demand for water suggests that local government and service providers would benefit from the use of a business modelling tool that can predict likely profit margins at different tariff price points for a system when the operations and maintenance costs (driven by pipeline length, the system energy sources, the number of water points, labour costs and related factors) are known or can be reliably predicted. Such a tool would need to forecast potential profit margins over at least a five year period in order to accommodate possible breakdowns over time.

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Notes

¹ Only 2% of water supply sources are hand pumps in Rwanda. The majority (46%) are protected springs, followed by unprotected sources (32%) and piped water (20%) (Ministry of Infrastructure, 2010). Note that this data is from 2010 and should be considered out of date. It is likely that the number of piped water systems has increased.

² Leaking taps and broken meters led to a ‘Partially Operating’ assessment and water points that failed to supply water were listed as ‘Non-Operational’.

³ We adopted the proposed Joint Monitoring Program standard on reliability for the Sustainable Development Goals, which is that the most recent system breakdown should not have lasted for more than two days. A breakdown that lasted longer than two days was considered to fail this standard (WHO and UNICEF, 2014).

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