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Community-based management of handpumps in rural Ghana

A quantitative analysis of what needs to change

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Supporting water sanitation and hygiene services for life

Acknowledgment

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Abbreviations

CBM	Community-based management
CWSA	Community Water and Sanitation Agency
DA	District Assemblies
DiMES	District Monitoring and Evaluation System
GoG	Government of Ghana
GWCL	Ghana Water Company Ltd.
JMP	Joint Monitoring Programme
Lpcd	Litre per capita per day
NCWSS	National Community Water and Sanitation Strategy
OR	Odds Ratio
PURC	Public Utilities Regulatory Commission
SDG	Sustainable Development Goal
Triple-S	Sustainable Services at Scale
WASH	Water, Sanitation and Hygiene
WRC	Water Resources Commission
WSDB	Water and Sanitation Development Board
WSMT	Water and Sanitation Management Team
WATSAN	Water and Sanitation Committee

Summary

The image of broken-down, unused handpumps littering landscapes in Sub-Saharan Africa is a familiar and disappointing sight for many in the water sector. Many factors contribute to the lack of sustainability of these water points and they must be addressed in order to reach Sustainable Development Goal 6.1 for access to safe and affordable drinking water for all by 2030. In investigating potential contributing factors to sustainability, we must adopt a systems thinking approach and examine the sector as a whole. This paper, focusing on Ghana as a case study, investigates some of the factors that contribute to the sustainability of water systems by examining the relationship between community-based management characteristics and handpump functionality in rural Ghana.

Around a quarter of the population in Ghana have access to safely managed water, the 'gold standard' service. However, only 7% of the rural population receive water at this service level. Thirteen percent of rural Ghanaians still rely on surface water as their main source of water. Community-based management (CBM) is the main system of water provision in rural Ghana. This structure relies on the District Assembly as the service authority, charged with ensuring the operation of water and sanitation services in the District (GoG, 2016). At the community level, the Water and Sanitation Management Teams (WSMTs) are in charge of the daily delivery of water to the community. WSMT members volunteer their time and efforts and are trained by the service authority.

The CBM system of water delivery management has been called into question as an effective management model (Agbemor et al., 2017; Whittington et al., 2009). Although intended to address the issues with the breakdown of water systems soon after installation, we still see that around a third of handpumps breakdown within a year of installation (IRC, 2018). By investigating the relationship between management characteristics and handpump functionality and reliability, this paper seeks to determine which aspects of CBM are functioning well in rural Ghana and which may need to be restructured.

By conducting descriptive analysis and logistic regression on the characteristics of service authorities and providers and the functionality and reliability of handpumps, we found that the sustainability of handpumps are improved when they are managed by WSMTs with caretakers, access to spare parts supply within three days, breakdown repair within three days, positive revenue and expenditure balances, and no need to rely on the service authority for repair support.

These results highlight the need to rethink the CBM system in Ghana. While some aspects of the system are working well, there are other aspects that appear to be hindering progress. While this may not point to the need for a complete reboot of the management system in rural Ghana, it may be necessary to restructure the system to include elements of other management systems. For instance, professionalisation of area mechanics and treasurers may improve breakdown repair and funding mechanisms which would improve the sustainability of handpumps. Currently, it appears that the service authority does not have the resources necessary to support the providers, and a rethinking of the system may be the best option to build the capacity of providers and bring Ghana closer to achieving SDG 6.1.

Introduction

Around 30% of handpumps in Sub-Saharan Africa break down within a year of installation, and of those that do not, many are left unused or non-functional for a large part of the year (Alexander

et al., 2015; Foster, 2013; IRC, 2018). With the lack of sustainability so well known, why are the same methods for service provision continually implemented? This issue points to a disconnect between knowledge and action when it comes to the effort to achieve the Sustainable Development Goal (SDG) for safe water. If we continue to invest in building infrastructure but do not focus on the sustainability of the systems we construct, we will never achieve access to water and sanitation for all.

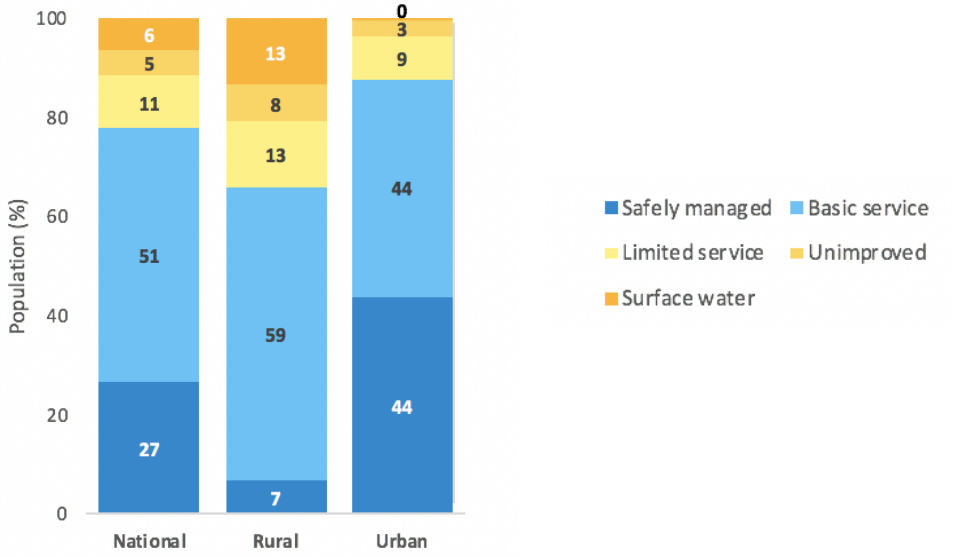
Ensuring that water facilities are sustainable requires focusing on many aspects of the service provision system. Key among them are funding—not only for capital costs, but also for operations and maintenance, direct support and indirect support—as well as good governance and management of water systems (Alexander et al., 2015; Foster 2013; Schouten & Smits 2015; Whittington et al., 2009). The current preferred service provision structure for rural water delivery in Sub-Saharan Africa is community-based management (CBM) (Whittington et al., 2009). Recognising the current challenges with handpump sustainability under this management model, does it make sense for the water sector to continue emphasising the use of CBM for service provision?

This working paper seeks to contribute to a larger analysis on whether community-based management is still a feasible option for service delivery in rural Ghana, or if it may be time to think about adapting the current system to better fit the needs of the water sector. In order to address this question, we first examine which management characteristics render community-based management teams most effective in the provision of water services. We then look at the role and effectiveness of service authorities in regulating and supporting service providers. By investigating the relationships between the characteristics of service providers and authorities and handpump functionality, we can gain insight in whether it is worthwhile to continue investing resources into the CBM model as it stands or whether the rural water service delivery model might benefit from restructuring.

SDG progress in Ghana

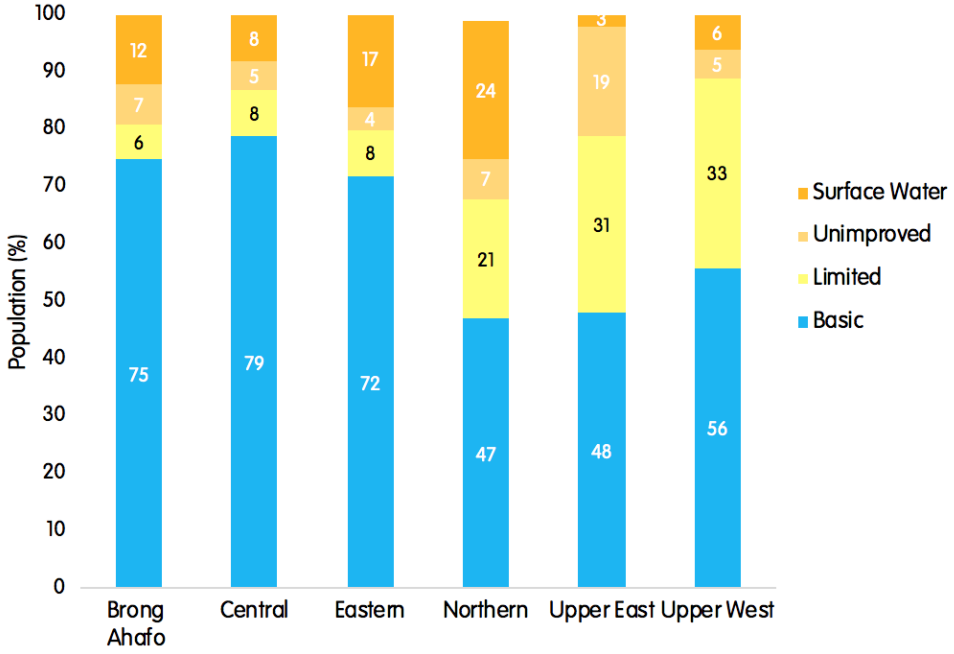
According to data from the Joint Monitoring Programme, an initiative by the World Health Organization and UNICEF to monitor achievement toward the SDGs, access to safe water in Ghana has been improving since 2000 (JMP, 2018). Currently, an estimated 27% of the population have access to safely managed water, the ‘gold standard’ service, and only 6% continue to rely on surface water (Figure 1). While coverage of top-grade water services has been increasing over this period, there exists a large inequality in the distribution of services among Ghanaians. These inequalities exist across and within regions (Figure 2), as well as between urban and rural populations (Figure 1). Differences in wealth also play a role in the disparity, with the portion of the population in the lowest wealth quintiles falling on the lower rungs of the ladder (GSS, 2014).

Figure 1 Water service level ladders in Ghana



Source: WHO/UNICEF-JMP[1]

Figure 2 Water service level ladders per region



Source: WHO/UNICEF-JMP[2]

Within the JMP figures, there also lies some misrepresentation of the actual percentage of the population covered with water services due to the relatively high rates of infrastructure non-functionality. According to data collected between 2014-2016 through the joint CWSA and IRC SMARTerWASH monitoring initiative, 26% of handpumps in Ghana were non-functional (Adank et al., 2016). Additionally, many of those that were functional were performing at a sub-optimal level (Adank et al., 2016). In looking at water quality, quantity, reliability, non-crowding and

[1] Ghana Country File - https://washdata.org/data#!/gha (accessed 31/07/2018).
[2] Lockwood, H., Nkum, K., Baste, T., Duti, B., & Ayi-Bonte, V., 2017. Community Water and Sanitation Agency Organisational Assessment: Final Report. Ghana: CWSA IRC Aguaconsult.

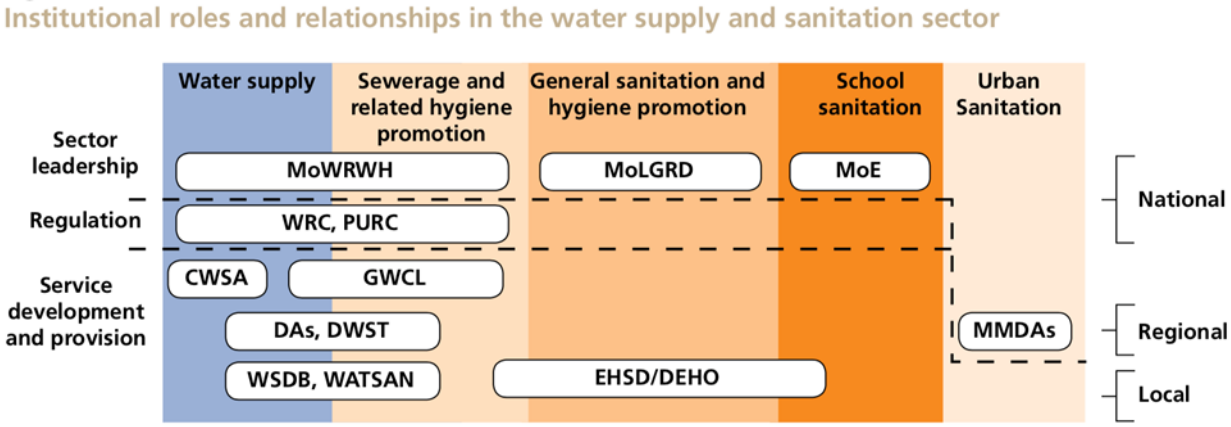
distance, the lowest scoring indicator across handpumps was the distance from each water point to the population accessing it (Adank et al., 2016).

Because the distance indicator highlights the need for more handpumps to be built, it is necessary to understand why the existing handpumps have such high non-functionality rates. Without this analysis, investing in new infrastructure would be risky given the high probability of breakdown.

WASH policy and structure

In analysing potential reasons for the non-functionality of handpumps in Ghana, an important place to start is the WASH policy and management structure to understand who is responsible and how maintenance of handpumps is meant to take place. The basic governing and provision structures are decentralised to the local level (Figure 3).

Figure 3 Institutional roles in the Ghana WASH sector



Source: AMCOW[3]

The Ministry of Water Resources, Works and Housing holds a sector leadership role at the national level (Lockwood et al., 2017)[4]. Within the national government, the Water Resources Commission (WRC) and the Public Utilities Regulatory Commission (PURC) have regulation authority for rural and small-town water and urban water respectively. At the regional level, the CWSA is in charge of rural water service development and provision and provides direct support to the District Assemblies (DA). These Assemblies regulate and provide support to the small-town and small-community water and sanitation management teams—WSDBs and WATSANs (CWSA, 2014).

Managed as a professional water service, the Ghana Water Company Ltd (GWCL) provides water to urban areas. The provision of rural water, on the other hand, follows a community-based management system. Although the CBM structures are regulated and supported by the District Assemblies, a local team manages day-to-day operations and maintenance (Foster, 2013). Ideally, these CBM teams collect revenues in order to cover all operation and maintenance costs, as well as some of the capital costs. These teams in Ghana (WSMTs) are given the power to set tariffs,

[3] Water and Sanitation Program 2011. Water Supply and Sanitation in Ghana: Turning Finance into Services for 2015 and Beyond AMCOW Country Reports Accra, Ghana: AMCOW.

[4] A new Ministry for Sanitation and Water Resources in Ghana was created in 2017, and now holds ministerial responsibility for WASH. See https://www.ircwash.org/press/irc-hails-ministry-sanitation-and-water-resources-and-urges-funding-prioritisation.

which are approved by the District Assembly. The National Community Water and Sanitation Strategy (NCWSS) lays out the role that each of these groups plays in water service provision, and the guidelines for effectively managing water systems are relatively straight-forward (CWSA, 2014). Unfortunately, translating these guidelines into practice has proven to be a challenge (Adank et al., 2013).

Community-based management

The community-based management system has often been called into question as an effective means of service provision (Agbemor et al., 2017; Whittington et al., 2009). While this service delivery model was first developed to address the issues with the breakdown of water systems soon after installation, we still see that around a third of handpumps breakdown within a year of installation (IRC, 2018). This demand driven CBM model is meant to "foster a sense of community ownership" and lead to improved service delivery through a community "commitment to use and maintain the facilities" (Whittington et al., 2009). However, after years of relying on CBM for rural water provision and countless efforts to build the capacity of WSMTs, there are still challenges with the lack of professionalisation and systematic operation of services, financing deficits and limited monitoring capabilities. This begs the question of whether CBM can still be recovered as an effective management of rural water provision, or whether it is time for the water sector in Ghana and elsewhere to rethink the system entirely.

In discussing a shift from community-based management, it must be acknowledged that there is a spectrum in management structures between CBM and full professionalisation. It may not be necessary for an entirely new management structure to be implemented when CBM is not functioning properly, but a shift towards professionalisation may benefit the water sector in providing safe water in Ghana. Because CBM structures in Ghana are so prevalent, we must consider the steps that are involved in the shift towards professionalisation—does the sector require an entire reboot or can the existing structure be reformulated?

Monitoring handpump functionality and management

Triple-S

Between the years of 2012 and 2014, as part of the Triple-S project, IRC and CWSA developed and tested a water service monitoring initiative. This initiative aimed to collect and analyse data on all improved water facilities in three districts (Kumasi et al., 2014). In order to monitor these water facilities and the teams managing them, a national monitoring framework was developed. The framework included indicators on handpump and piped scheme water services (quantity, quality, reliability, distance to source, and coverage), service providers and service authorities (CWSA, 2014).

A 2014 report on the Triple-S initiative found that both service providers and service authorities at the local and district levels were often not complying with the guidelines laid out in the NCWSS (Adank et al., 2013). Around a third of handpumps were not functioning and many of the indicator benchmarks for providers were not met. Financial management indicators were the lowest scoring indicators across the board for service providers. Service authorities, on the other hand, often did not have the resources available to provide necessary support to the providers (Adank et al., 2013). Thus, when water service authorities and providers were not able to follow the policies provided by the government, service provision suffered, and many people were left without water.

In addition, economic growth in Ghana over the past decade has resulted in changes in the type and quantity of development support available to WASH and other sectors. Because the country has been considered a lower-middle income economy since 2011, foreign aid is on the decline despite the significant infrastructure gap still remaining (Lockwood et al., 2017). This poses a significant threat to the construction of new water points.

Because of the need for new infrastructure, as well as the need to focus on the sustainability of existing infrastructure in Ghana, the current management system must be evaluated. Water service authorities and providers need to ensure that the proper management structures are in place to build and maintain water delivery systems once much of the foreign aid has been halted. It must assess the availability for investment finance rather than aid for infrastructure and evaluate the mechanisms and limitations of using tax revenues and tariff systems to carry out operation and maintenance. Therefore, it is necessary to understand which management factors contribute most to sustainability of systems. By identifying these management characteristics, authorities can better understand which factors are successful and which may require rethinking. This will allow for a knowledge base with which to make decisions on reprioritising or restructuring the water delivery system.

SMARTerWASH

Using the national monitoring framework developed by the Community Water and Sanitation Agency, CWSA once again partnered with IRC to implement monitoring on a larger scale than under the Triple-S initiative. The SMARTerWASH project involved the aggregation of data on water facilities collected through the national District Monitoring and Evaluation System (DiMES), SkyFox infrastructure monitoring and Akvo Flow mobile phone data collection throughout six of the ten regions in Ghana (Adank, 2016). Handpumps and piped schemes were given service level scores based on the CWSA framework indicators. Management characteristics of the service providers and authorities were also scored based on the indicators and sub-indicators from the framework. These data were collected into separate databases for water source monitoring and management monitoring.

This analysis further explores the monitoring data on service provider and service authority management characteristics and handpump functionality. By analysing which management characteristics are related to the functionality of handpumps, and which service authority characteristics are related to service provider performance, it is possible to draw some conclusions on the necessary focus areas for improving water access in rural Ghana. The next section of the paper will focus on the methods for data analysis. The paper will then turn to discuss results of the analysis and possible conclusions. Lastly, the paper will address the overarching question of how the management factors that are contributing to successful service delivery can be leveraged to improve the management of rural water provision in Ghana.

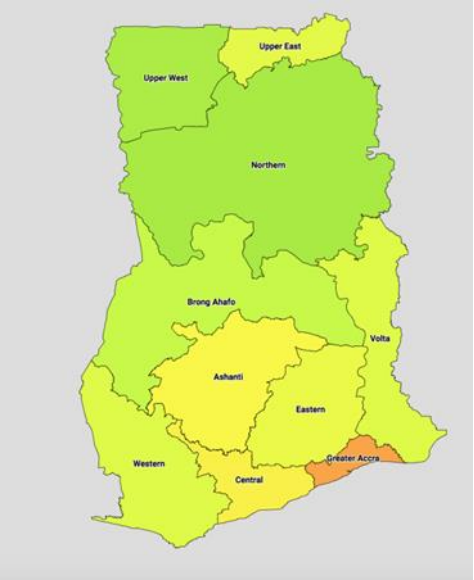
Methods

Under the SMARTerWASH initiative distinct datasets have been established for management characteristics of service providers and authorities, as well as for piped scheme characteristics and handpump characteristics. For this analysis, two datasets were used—one describing the characteristics of handpump service providers and authorities and one describing the characteristics of the handpumps themselves. In order to cross-analyse the two databases, a merged dataset was created by matching the management data to each of the handpumps respectively.

This dataset included data on handpumps managed by WSMTs, private persons, institutions and "other" management structures, as well as those without a management structure. Descriptive analysis was conducted on this total population of handpumps (14,694) to analyse non-functionality by management type and handpump type. After this analysis, all management types that were not CBM were removed from analysis to allow for exploration of data on the CBM structures specifically. This completed dataset only including handpumps managed by WSMTs allowed for the analysis of 11,597 handpumps across the Northern, Central, Brong Ahafo, Upper East, Upper West and Western regions.

Figure 4 Map of the regions of Ghana

The regions included in analysis were Brong Ahafo, Western, Eastern, Northern, Upper West and Upper East.



Source: City Population (2018)[5]

The indicators that were developed by CWSA and used to monitor handpumps and piped schemes by service level are seen in Table 1. Management factors were also analysed based on indicators and sub-indicators for service providers and service authorities (Appendix I).

Table 1 Service level indicators for CWSA monitoring framework

Monitoring indicators	
Service level indicators	**Standard**
Quantity	Handpump and standpipe: 20 lpcd: Household connection: 60 lpcd
Quality	Meets all Ghana Standards Authority standards for water quality of drinking water
Crowding	Hand dug well: max 150 people per facility; Borehole or standpipe: max 300 people per facility
Distance facility and users	Up to 500 meters
Reliability	The facility is providing water for at least 95% of the year.

[5] City Population (2018). Ghana. Retrieved from https://www.citypopulation.de/php/ghana-admin.php.

Handpump service level	Description of handpump service level
III	The handpump provides water services meeting the standard on all the service level indicators
II	The handpump fails to meet the standard on one or more of the service level indicators
I	The handpump is not functioning or not used
Piped scheme service level	**Description of piped scheme service level**
IV	The piped scheme provides service as per design standards for population category and meets all the sub-indicators
III	The piped scheme does not meet one of the sub-indicators
II	The piped scheme provides service not in line design standards
I	The piped scheme is not functioning

Source: CWSA (2014)[6]

Table 2 Service provide performance for CWSA monitoring framework

Service Provider Performance	
Indicator Group	**Indicator – benchmark**
Governance	**WSMT composition** – in line with guidelines and members have been trained
	Operational team – at least half filled by qualified staff
	Financial and operational records – kept up to date
	Political interference – no political interference in composition of WSMT
Operations	**Spare parts** – available within 3 days
	Area mechanic (HP) / technical services – available within 3 days
	Routine maintenance – done at least annually / according to maintenance schedule
	Water quality testing – done by certified institute on regular basis
Financial management	**Revenue / expenditure** – positive balance
	Bank account – available and accounts up to date / 3 bank accounts up to date
	Tariff – tariff set
	Facility management - Facility management plan in place

Source: CWSA (2014)[7]

With this merged dataset, descriptive and logistic regression analyses were conducted using STATA 15.1 (Appendix I, Appendix II, Appendix III, and Appendix IV).

Descriptive analysis

The descriptive analysis describes the functionality of handpumps across districts. Using the explanatory variables included in the analysis, handpumps were divided based on those that met

[6] CWSA. 2014. Framework for Assessing and Monitoring Rural and Small Town Water Supply Services in Ghana. In: Ministry of Water Resources, W. A. H. (ed.). Accra, Ghana.
[7] Ibid.

the benchmark for each indicator and those that did not. The percentage of the total handpumps that each group represents was calculated. Lastly, the non-functionality rate was calculated for each group of handpumps.

The first analysis describes non-functionality rates of handpumps by management type and handpump type for all 14,694 handpumps (Appendix I). The second analysis describes the non-functionality rate of the 11,597 handpumps that were managed by WSMTs (Appendix II).

Logistic regression

Following the descriptive analysis, a logistic regression analysis was conducted on management factors as explanatory predictors for basic functionality as the dichotomous variable. Logistic regression is a statistical method to analyse a data set with multiple independent variables and a binary outcome. This regression analysis is predictive and is used to explain the relationship between the outcome and the independent predictor variables.

Functionality analysis

For the logistic regression analysis on management factors and handpump functionality, handpumps classified as sub-optimally functional were considered to be functional. While this one-time measure of functionality does not consider all of the factors involved in the sustainability of systems, it is commonly chosen as a proxy for logistic regression analysis on water point data. This is because the analysis can measure associations between independent dichotomous and categorical predictors and a non-continuous outcome (Alexander et al., 2015; Cronk & Bartram, 2017; Foster, 2013; Whittington et al., 2009).

The logistic regression included all 14 main indicators from the CWSA[8] framework as well as six of the 21 sub-indicators. Of the sub-indicators previously found to be significant predictors in other analyses, the six chosen for this analysis were those that had enough data collected to be representative of the total handpumps (Alexander et al., 2015; Cronk & Bartram, 2017; Foster, 2013; Whittington et al., 2009). Age and handpump type were also included in this analysis to account for some of the factors outside of management that could be affecting the functionality of handpumps.

The results of the logistic regression on non-functionality can be found in Appendix III and include both the unadjusted and multilevel analyses. The unadjusted analysis gives an odds ratio for the relationship between the outcome and the indicated independent variable. The multilevel analysis gives the odds ratio for the relationship between the indicated independent variable and the outcome adjusted for the other independent variables in the data set. Modelled for non-functionality, the odds ratios (OR) calculated from the regression indicate the odds of a handpump being non-functional for each predictor. Based on prior research on modelling of this type of data from the literature, I chose not to conduct a stepwise selection (Mundry & Nunn, 2009; Whittingham et al., 2006). Therefore, the model accounts for predictors not significantly associated with the outcome. Those predictors that are significantly associated are indicated as such in Appendix III.

Reliability analysis

[8] CWSA Indicators for Service Providers and Authorities: Record Keeping and Accountability, Freedom from Political Interference, Spare Parts Supply, Area Mechanic Services, Breakdown Repairs, Routine Maintenance, Water Quality Testing, Revenue and Expenditure Balance, Financial Management and Auditing, Tariff Setting, Facility Management Plans, O&M Monitoring Support, and Support in Case of Major Breakdown. CWSA. 2014. Framework for Assessing and Monitoring Rural and Small Town Water Supply Services in Ghana. In: Ministry of Water Resources, W. A. H. (ed.). Accra, Ghana.

Because functionality does not truly address the question of sustainability of handpumps, an analysis was also conducted on those management characteristics that are associated with handpump reliability. Handpumps that meet the benchmark for reliability are those that are functioning at least 95% of the time. This indicator is also a proxy for sustainability and cannot address all of the aspects that contribute to the sustainability of water systems. However, the reliability indicator gives a better overall picture of the functionality of handpumps given that it is not a one-time measure of functionality.

This logistic regression analysis included the same indicators that were used in the functionality analysis. The results of this analysis are given in Appendix IV. Similarly to the functionality analysis, the odds ratios for this regression were modelled for non-reliability. Therefore, each odds ratio gives the odds of non-reliability for each predictor.

Results

Box 1 Key findings

Key Findings:

What works:	**What doesn't work:**
Handpumps were more likely to be functional and reliable when they were managed by WSMTs with: • Younger handpumps • Spare parts available within three days • Breakdown repair within three days • Positive revenue and expenditure balances and • No need for repair support from the service authority	Handpumps with no management structure show the highest rates of non-functionality. Handpumps were less likely to be functional and reliable when they were managed by WSMTs with: • handpumps that were not Afridev, • older handpumps • no support from service authority when needed

What was surprising:

Some factors expected to decrease non-functionality based on former analyses that were not found in this study were:

a. Tariff collection
b. Area mechanic services
c. Training of WSMTs and
d. Service authority management of providers*

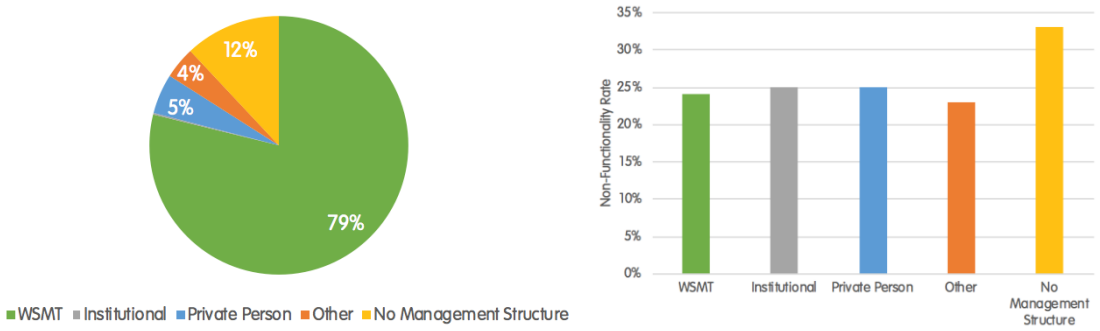
*So few of the WSMTs received support from the District Authority that it was difficult to statistically assess the relationship between different support types and functionality.

Descriptive analysis

According to the descriptive analysis, 61% of handpumps were fully functional on the scale of non-functional, partially functional and fully functional; however, only 6% were providing water services at a level in accordance with national norms–performing at a service level III. Around

half of handpumps were the Afridev type, which showed the highest functionality of all models. Handpumps classified as "other" were the lowest functioning models. WSMTs manage a majority of the handpumps and show an average non-functionality rate of 24% (Figure 5). The other management types have similar rates of non-functionality; however, they only represent 9% of handpumps collectively. Those without a management structure have the highest non-functionality rate (33%) and represent 12% of the total handpumps.

Figure 5 Descriptive analysis of handpump functionality



Logistic regression analysis

Functionality

As shown in Appendix III, the adjusted odds ratios for non-functionality, i.e. the likelihood of non-functionality, were significantly higher for WSMTs with:

- handpumps that were not Afridev
- older handpumps
- treasurers
- record keeping and accountability
- a facility management plan.

The odds of non-functionality increased for each increasing age category, with those handpumps that had been installed less than five years ago showing the lowest odds of non-functionality. The likelihood of a handpump being non-functional were almost nine times higher for handpumps classified as "other" (OR = 8.84, $p < .0001$). The findings on an increased likelihood of non-functionality for WSMTs with a treasurer, record keeping and accountability, and facility management plans were surprising.

These results have not been reported in past studies and are difficult to explain without further research into the context. It is possible that investing time and resources into a treasurer, record keeping and accountability, and facility management plans while relying on volunteers that are not trained or incentivised actually has a negative effect on the provision of services. If these factors were properly implemented, perhaps they would offer a benefit for the WSMT that allows for improved functionality of handpumps. This discrepancy between the theory behind community-based management and the actual results from this analysis highlight a potential area for improvement through a restructuring of the management models used in Ghana.

The adjusted odds ratios for non-functionality, i.e. the likelihood of non-functionality, were significantly lower for WSMTs with:

- caretakers
- younger handpumps
- spare parts supply available within three days
- breakdown repair within three days
- positive revenue and expenditure balance
- no need for repair support.

Management teams that have spare parts available within three days were 19% less likely to be non-functional compared to those that do not have spare parts available within three days (OR = 0.81, $p < .0001$). Teams that complete breakdown repair within three days were 25% less likely to be non-functional compared to those that do not complete repairs within three days (OR = 0.75, $p < .0001$). Having a positive revenue and expenditure balance decreases the likelihood of non-functionality by 32% compared to having a negative balance (OR = 0.68, $p < .0001$). For WSMTs that report having needed repair support from the service authority, there is no significant difference in the odds of non-functionality between teams that receive support versus those that do not. However, for WSMTs that have not had to request repair support, the likelihood of being non-functional are much lower than for teams that required support (OR = 0.52, $p < .0001$).

While this statistic may not seem especially useful considering handpumps that have not required major repair would be expected to have a higher functionality than those that have, it is also telling to look back at the descriptive analysis. Of those WSMTs that did require repair support, only 16% report having received support. This discrepancy may not have resulted in a statistically significant difference in the odds of functionality; however, it points to the disconnect between service providers and authorities when it comes to providing repair support.

Reliability

As shown in Appendix IV, the adjusted odds ratios for non-reliability, i.e. the likelihood of non-reliability, were significantly higher for WSMTs with:

- handpumps that were not Afridev
- older handpumps
- not receiving support from service authority when needed
- a facility management plan.

The odds of non-reliability also increased for each increasing age category. In this case, however, the odds of a handpump being non-reliable were only 2.5 times higher for those classified as “other” (OR = 2.54, $p < .0001$). Those WSMTs that did not receive support from the service authority when needed were 24% more likely to be non-reliable as compared to those teams that needed support and received it (OR= 1.24, $p = 0.012$). Once again, the increased likelihood of non-reliability for those WSMTs with facility management plans was a surprising finding and may be explained by the same reasoning as for the non-functionality.

The adjusted odds ratios for non-reliability, i.e. the likelihood of non-reliability, were significantly lower for WSMTs with:

- younger handpumps
- spare parts supply available within three days
- breakdown repair within three days
- positive revenue and expenditure balance
- no need for repair support.

WSMTs with spare parts available within three days were 21% less likely to be non-reliable compared to those without spare parts available (OR = 0.69, p < .0001). Those with breakdown repair within three days were 22% less likely to be non-reliable (OR = 0.68, p <.0001) and those with a positive revenue and expenditure balance were 14% less likely to be non-reliable (OR = 0.86, p = 0.30) as compared to those WSMTs without breakdown repair or a positive balance. Those WSMTs that did not require repair support from the service authority were 42% less likely to be non-reliable than those that did require support and received it (OR = 0.58, p < .0001).

Comparison with past analyses

This analysis examined some of the same management and handpump characteristics that have been investigated in prior research in Ghana, Nigeria, Tanzania and Ethiopia on the connection between the management of water systems and their functionality, as well as some unique variables that have not yet been investigated such as freedom from political interference in the development of WSMTs and having a facility management plan in place. The next section will first address the findings that echoed those of past analyses conducted by Foster (2013), Alexander et al. (2015), Fisher et al. (2015) and Cronk & Bartram (2017). The comparison will then turn to findings that differed from those of past analyses or from what would be expected based on the objectives behind CBM.

Validating previous findings

Handpump and management type

In past analyses, handpumps classified as “other”, or not one of the most commonly used types/brands, showed a much higher rate of non-functionality than those used more commonly (Fisher et al., 2015; Foster, 2013). The current analysis echoed this finding, and also found that Afridev pumps had a significantly lower non-functionality rate than other types of pumps. The findings from this analysis also agreed with Foster’s finding that the odds of non-functionality increased as the age of the handpump increased (Foster, 2013). In looking at the average age of the different types of handpumps included in this analysis, those handpumps classified as “other” had actually been constructed more recently than the more common types of handpumps, further highlighting the risk of installing uncommon handpumps. The other handpump models in this analysis did not have significantly different ages. Therefore, Afridev pumps were not performing better because they were the newest, but because of other factors unrelated to age.

In his analysis on handpumps in Sierra Leone, Liberia and Uganda, Foster (2013) found no difference in the odds of functionality between Afridev pumps and India Mark pumps. Fisher and colleagues (2015) found no difference between any of the pumps in their study on the Greater Afram Plains region of Ghana. Foster does point out in his discussion that differences in non-functionality may be observed between Afridev and India Mark pumps because the Afridev type are less technologically challenging (Foster, 2013). He also points out that managerial factors may be even more influential on functionality than the technological difficulty of maintaining pumps (Foster, 2013). Therefore, the difference in functionality rates between the two pumps may be

related to the managerial capacity to fund, operate and maintain handpumps is lacking in these communities in Ghana.

The difference in functionality between pump types could also be related to the relative commonality of Afridev pumps and the presence of more spare parts and knowledge about these pumps locally. Another possible factor is that the type of project that constructs the water points may be linked to the choice of pump, and that projects that favour Afridev pumps are implemented in a fashion that results in longer-term sustained functionality than other types of projects.

WSMT capability

The regression analysis found that having spare parts available within three days and being able to complete breakdown repair within three days are significant predictors of handpump functionality and reliability. This agrees with past studies, echoing the importance of WSMTs having the ability to conduct minor repairs themselves rather than relying on external technical support or funding from service authorities or from NGOs and other development partners (Alexander et al., 2015; Fisher et al., 2015, Foster, 2013).

In Alexander et al.'s (2015) study on community water schemes in Ethiopia, the research team found that there was a positive association between having a caretaker and handpump functionality. This analysis had a similar result. While this association was not statistically significant in either study, we may still want to consider caretakers to be an important investment in maintaining the functionality of handpumps.

Differing findings

Tariff collection

Some of the findings from this analysis were unexpected based on prior analyses and assessments of CBM. The most surprising finding was the lack of a positive association between tariff collection and functionality of handpumps. In all of the past studies reviewed, researchers found tariff collection to be an important predictor of handpump functionality (Alexander et al., 2015; Cronk & Bartram, 2017; Fisher et al., 2015; Foster, 2013). Considering the need for revenue and financing to conduct repairs at the daily operation level, this could suggest that tariff collection does not necessarily lead to an availability of funds when needed by operators.

This discrepancy in funds may be due to factors interfering with the positive effect that tariff collection usually has on handpump functionality. For example, a major challenge identified in the Community Water and Sanitation Agency Organisational Assessment was that few WSMTs collect tariffs and of those that do, they do not collect a high enough tariff to impact the functionality of their water schemes (Lockwood et al., 2017). The tariff collection structures may be preventing any incoming funds from having a substantial impact on the functionality of handpumps. This result may point to the need for increased tariff charges or for a restructuring of funding from the national government to subsidise communities unable to pay high enough tariffs to maintain their water facilities.

Area mechanic services

The descriptive analysis found that handpumps with area mechanics available within three days had a higher average non-functionality rate, while results from the logistic regression found no effect of area mechanics on functionality or reliability. This is surprising according to both common sense, and to the findings from Foster's analysis that found that having an area mechanic decreases the non-functionality rates of handpumps (Foster, 2013). It is true that

simply having an area mechanic may not automatically lead to improved functionality. Perhaps local area mechanics are available but lack training or resources. If this is the case, it cannot be assumed that handpump functionality will improve simply with the presence of area mechanics.

Training of WSMT
The current analysis found that there was no association between initial training of WSMT members and improved functionality, which supports the findings from Foster's analysis (2013). In proposing potential reasons for this result, Foster discusses the fact that training is often only given once, and that the context of the training may be inadequate to truly make a difference. The same phenomenon may be occurring in rural Ghana. According to a study conducted by Marks, Komives and Davis (2014), training of WSMT members occurred during the project planning phase for many handpumps, but was not necessarily conducted at any late point. While this training may be offered for the majority to management teams, initial training may not be sufficient, and therefore may not play a role in the functionality of handpumps.

Service authority management
It would generally be assumed that those service providers that are monitored and technically supported by the service authority would perform better than those that are not. This analysis found that those WSMTs that did not have to rely on the service authority for repair support showed decreased odds of non-functionality as compared to those that required support. Those WSMTs that required support from the service authority but did not receive it, also showed a higher likelihood of being non-reliable as compared to those that required support and received it. Of those WSMTs that reported having needed repair support, only 16% received it. WSMTs also report a low level of monitoring support, with 84% reporting not having received monitoring support.

This analysis found no significant difference in the level of non-functionality or non-reliability between the WSMTs that received monitoring support and those that did not. In looking at those WSMTs that report receiving monitoring support, the majority do struggle with functionality of their handpumps. Perhaps service authority support is given to the lowest preforming WSMTs, and therefore appears to have a negative effect on functionality. However, because so many WSMTs report not receiving monitoring support and not receiving repair support when it is needed, there appears to be a larger issue in the District Assembly fulfilling its role in the management of WSMTs.

Improving functionality through effective management

According to past analyses, a major challenge in improving handpump functionality lies in the funding and technical capacity of community-based management teams (Fisher, 2013; Alexander et al., 2015; Cronk & Bartram, 2017). This analysis sought to determine which management characteristics of service providers and authorities in rural Ghana were predictors of handpump functionality and reliability. The logistic regressions conducted on non-functionality and non-reliability of handpumps found that handpumps provided better service when they were managed by WSMTs with:

- caretakers
- access to spare parts supply within three days
- breakdown repair within three days
- positive revenue and expenditure balances

- no need to rely on the service authority for repair support.

These findings point to the fact that those WSMTs that are better able to follow the prescribed national guidelines for community-based management performed better than those that lacked the capacity to uphold these guidelines.

This analysis also examined the role that service authorities play in service provider performance. Based on the results of the logistic regression analyses, those WSMTs that did not require technical repair support from the service authority performed better than those that did. Monitoring support was not found to be a significant predictor of functionality or reliability of handpumps. In looking at the descriptive analysis, 84% of WSMTs reported not receiving monitoring or repair support from the service authority. It is clear from this analysis that the service authority is not upholding its prescribed role as a regulator and technical supporter to the local management teams, and without the District Assembly as reliable support, this arrangement may be negatively impacting the performance of service providers.

Moving forward in the rural water sector

Given that community-based management has often been criticised as a method of service provision meanwhile the structure is so embedded in the rural water sector in Ghana, it is important to think about possible approaches for improving the capacity of WSMTs to maintain and operate facilities.

Service authorities

Beginning at the service authority level, this analysis shows that the majority of District Assemblies are not functioning in accordance with the role laid out for them in the Local Governance Act 936. This Act mandates that the District Assemblies ensure the operation of water and sanitation services in the District (GoG, 2016). In practice, this refers to the planning, implementation, coordination and monitoring of water systems. The findings of this analysis echo those of a recent study conducted by CWSA and IRC in Ghana on the District Assembly role in water provision. This study showed a significant lack in the DA's ability to "fully exercise their mandates as development authorities" (Agbemor et al., 2017).

Surprisingly, the study found that those water projects implemented through development partners actually followed national guidelines better than those implemented by the central government. Confusion around roles and responsibilities has often been noted as an issue with service provision at the local level and may be a potential contributing factor in the poor performance of service authorities seen here (Lockwood et al., 2017). The differences in modes of implementation between development partners and the Government of Ghana also lead to challenges in effective management of systems. Oftentimes, the District Assemblies are not involved in the implementation process, which causes problems when they are expected to manage the water facilities in their jurisdiction (Agbemor et al., 2017). The funding mechanisms also differ between implementers, and the management of funds at the local level becomes a challenge (Agbemor et al., 2017).

With these factors in mind, it seems that better coordination between stakeholders in rural water may lead to improved management by service authorities. Beyond improved coordination, it is possible that District Assemblies may require an organisational transformation in order to better manage budgets and plan for future breakdowns, as well as successfully monitor and evaluate service providers. Building this capacity of District Assemblies would allow them to

support the WSMTs in managing and maintaining their water systems on a regular basis, rather than only supporting those WSMTs who struggle to maintain functioning handpumps.

Service providers

At the service provider level, this analysis echoes the reality of low service levels in rural areas showing that there are certainly challenges in the management of water systems at the community level. Those WSMTs that are better able to uphold the national guidelines for community-based management are performing better than those that are struggling to meet these benchmarks. In the logistic regression analysis, not all of the indicators that were monitored were determined to be statistically significant predictors for functionality or reliability. Perhaps this indicates that there needs to be a focus on improving the specific factors associated with higher performance by targeting these elements among WSMTs that are performing poorly. Further analysis on the interactions between these indicators, as well as interactions between other factors that contribute to the sustainability of handpumps, would be helpful in determining which components of the community-based management teams need to be addressed. Given the results of the current analysis, some factors that we may begin with are:

- training and knowledge of area mechanics
- WSMT member capacity to maintain records and finances and develop facility management plans
- District Assembly capacity to support service providers.

Another possible solution to the low service levels is to investigate other methods of service provision. Perhaps the current community-based management system in Ghana would benefit from a restructuring at the service authority and provider levels, or even at the CWSA level. Rather than focusing on capacity building at the WSMT and DA level, the entire framework could be reassessed to determine how the critical roles of these bodies could be shared or transferred to alternative parties. This restructuring could focus on shifting responsibilities for different aspects of service provision and focus on establishing professionalisation at all levels. For instance, because having a treasurer was related to poorer handpump performance, perhaps professionalising the financial management of WSMTs beyond simply naming a volunteer treasurer would improve service provision. Another opportunity for professionalisation is in handpump repair. Because so many WSMTs were reliant upon the service authority for major repair support, and the service authority was unable to support such a large number of service providers, bringing in a professional service may improve repair capacity. The professionalisation of services within the CBM system is a current discussion within the sector, and there is growing evidence for its success (IRC, 2011).

The professionalisation of services in rural Ghana may prove to be a complicated task given that most WSMTs do not collect user fees, and therefore do not take in a lot of revenue. In order to pay for some of the services that the WSMT is expected to provide, it may be necessary to restructure budget allocations or to institute new tariff structures at the local level. This process may be made easier by clustering more handpumps together under a larger management structure, allowing for increased capacity and efficiency. While the government intentionally adopted the decentralisation strategy that led to the current roles played by the DA and the WSMTs, it may be useful to move back to a bit more of a centralised system.

Another possible method to address the funding capacity of WSMTs is to re-evaluate the role of private sector actors in service provision. In some cases in rural Ghana, Water and Sanitation Development Boards (WSDBs), which manage water systems in larger communities, create

contracts with private operators to completely operate and maintain their water systems (IRC, 2011). This currently only applies to those WSDBs that manage complex Water Supply Systems. While WSMTs that manage handpumps in rural Ghana may not require fully privatised maintenance, it may be beneficial for these teams to extend privatised services for some aspects of the O&M of their water points. Privatisation can elicit a fear of increased service costs and marginalisation of vulnerable populations, however, the inclusion of private sector actors with the knowledge and capacity to install and maintain water facilities in the rural water sector may improve the sustainability of water facilities in rural Ghana. These actors can function within the system, such that the sector management is still community-based, and these actors can be regulated by the District Assembly, the service authority.

Other possibilities include transforming rural water provision into a wholly professional service, akin to that of the urban water utility, or trying out different methods of provision such as self-supply.

Conclusion

As of 2015, only 7% of the rural population in Ghana has access to safely managed water services (JMP, 2015). With a large gap left to fill before the country can achieve Sustainable Development Goal 6.1, what changes can be made?

In looking at the community-based management structure in Ghana, there are large challenges that need to be addressed to improve the provision of water. This analysis sought to contribute evidence to the larger question of whether it is worthwhile to continue investing in CBM or whether it is time to think about new methods for management. This question is still largely on the table. The results of this analysis on handpump functionality and service provider and service authority management in rural Ghana provide evidence that the management of handpumps must be improved. There are certain management characteristics that predict better handpump performance and those that predict worse performance. Perhaps this evidence can be used to improve the current CBM model or to develop new models to be tested.

Community-based management has often been criticised for the same issues that were raised through this analysis. However, it remains in effect in many places around the world. Continuing this discussion on improving the current CBM model or designing new models for service provision is important in ensuring that necessary changes are made to the management of water systems to allow for increased access to safe water. Arguments for and against CBM persist, however, the critical next step is identifying clear ways forward to initiate the transition toward more robust and professional service provision. There is much to be learned about how improvements have been made in the urban context and there are lessons that may be relevant for identifying next steps in reforming the CBM system. Without testing new systems, it is hard to say whether a reinvented or highly capacitated form of CBM is still the best option for rural water supply.

In order to achieve Sustainable Development Goal 6.1, the sector needs to focus on those populations without access to safe water. Many people in rural Ghana still rely on surface water and new infrastructure will need to be built to reach these populations. The proper management structures must be in place when these systems are built, or they will not be sustainable. It is the hope this working paper can contribute to the discussion on which management models are the most effective in water service provision and to encourage the improvement and reform of

existing and future management systems that are capable meeting the needs of all segments of the population.

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Appendix

Appendix I Descriptive analysis including all handpumps

Explanatory Variable	n (%)	NFR
Handpump Type		
Afridev	8082 (55%)	20%
India Mark II	3478 (24%)	29%
Nira AF-85	2078 (14%)	35%
Vergnet	790 (5%)	27%
Other	267 (2%)	62%
Management Type		
WSMT	11,604 (79%)	24%
Institutional	28 (0.2%)	25%
Private Person	679 (5%)	25%
Other	626 (4%)	23%
No Management Structure	1757 (12%)	33%

Appendix II **Prevalence of handpump and management characteristics and non-functionality rates**

Explanatory Variable	n (%)	NFR
Age		
0-5 years	499 (4%)	24%
6-10 years	2,505 (22%)	18%
11-15 years	2,920 (25%)	25%
16-20 years	1,755 (15%)	25%
21-40 years	3,275 (28%)	31%
+40 years	650 (6%)	15%
Proportion of Women in WSMT		
Benchmark Met	8,659 (75%)	24%
Benchmark Not Met	2,546 (22%)	26%
No Data Available	295 (3%)	27%
Treasurer		
Present	8,958 (77%)	24%
Not Present	2,646 (23%)	24%
Caretaker		
Present	9,587 (83%)	24%
Not Present	2,017 (23%)	31%
Training		
Completed	8,632 (74%)	24%
Not Completed	2,972 (26%)	24%
Up-to-date financial and operational records		
Present	1,400 (12%)	24%
Not Present	10,197 (88%)	24%

Area Mechanic available within 3 days		
Yes	7,816 (67%)	22%
No	3,781 (33%)	28%
Spare Parts available within 3 days		
Yes	5,935 (51%)	20%
No	5,662 (49%)	29%
Breakdown Repair within 3 days		
Yes	6,333 (55%)	21%
No	5,264 (45%)	29%
Routine Maintenance at least annually		
Yes	5,604 (48%)	24%
No	5,993 (52%)	24%
Water Quality Testing Conducted		
Yes	1,021 (8%)	26%
No	10,576 (91%)	24%
Bank Records Kept		
Yes	1,523 (13%)	24%
No	10,074 (87%)	24%
Positive Revenue/Expenditure Balance		
Yes	1,968 (17%)	20%
No	9,629 (83%)	25%
Tariffs in place		
Yes	2,912 (25%)	24%
No	8,685 (77%)	24%
Facility Management Plan		
Yes	3,182 (27%)	28%
No	8,422 (73%)	23%
Monitoring Support from Authority		
Yes	1,908 (16%)	27%
No	9,689 (84%)	24%
Repair Support from Authority		
Yes	757 (7%)	31%
No	3,955 (34%)	33%
No Need	6,885 (59%)	19%
Total	**11,597 (100%)**	**24%**

Appendix III Unadjusted and multivariable logistic regression models for non-functionality

Explanatory variables	Unadjusted OR (95% CI)*	p-value	Multivariable Adjusted OR (95% CI)*	p-value
Handpump Type				
Afridev	1		1	
Ghana modified India Mark II	**1.55 (1.40, 1.72)**	<.0001	**1.31 (1.17, 1.46)**	<.0001
Nira AF-85	**1.93 (1.71, 2.19)**	<.0001	**1.85 (1.62, 2.12)**	<.0001
Vergnet	**1.37 (1.14, 1.65)**	<.0001	**1.23 (1.01, 1.51)**	0.037
Other	**8.24 (5.69, 11.92)**	<.0001	**8.84 (5.91, 13.23)**	<.0001
Age				
0-5 years	1		1	
6-10 years	**1.34 (1.02, 1.76)**	0.034	**1.32 (0.99, 1.75)**	0.055
11-15 years	**2.01 (1.54, 2.62)**	<.0001	**1.88 (1.42, 2.38)**	<.0001
16-20 years	**2.00 (1.52, 2.63)**	<.0001	**1.79 (1.34, 2.38)**	<.0001
21-40 years	**2.73 (2.10, 1.47)**	<.0001	**2.35 (1.79, 3.10)**	<.0001
+40 years	1.06 (0.76, 1.47)	0.741	0.86 (0.61, 1.23)	0.418
30% Women Benchmark	**0.88 (0.79, 0.97)**	0.011	0.98 (0.88, 1.09)	0.680
Treasurer	1.03 (0.93, 1.14)	0.598	**1.14 (1.01, 1.29)**	0.035
Caretaker	**0.86 (0.77, 0.96)**	0.008	**0.84 (0.74, 0.95)**	0.007
Initial Training	1.02 (0.92, 1.12)	0.758	1.05 (0.94, 1.17)	0.394
Record Keeping and Accountability	1.01 (0.89, 1.14)	0.913	**1.34 (1.11, 1.62)**	0.002
Spare parts supply	**0.60 (0.55, 0.65)**	<.0001	**0.81 (0.73, 0.91)**	<.0001
Area Mechanic Services	**0.74 (0.68, 0.81)**	<.0001	1.00 (0.89, 1.13)	0.935
Breakdown Repairs	**0.64 (0.59, 0.69)**	<.0001	**0.75 (0.67, 0.83)**	<.0001
Routine Maintenance	1.02 (0.93, 1.11)	0.691	0.97 (0.87, 1.05)	0.366
Water Quality Testing	1.10 (0.95, 1.28)	0.183	0.97 (0.83, 1.14)	0.747
Revenue and Expenditure Balance	**0.74 (0.66, 0.84)**	<.0001	**0.68 (0.59, 0.80)**	<.0001
Up-to-date financial and operational records	0.95 (0.92, 1.09)	0.486	0.85 (0.70, 1.03)	0.098
Tariff Setting	0.99 (0.90, 1.09)	0.799	0.96 (0.85, 1.08)	0.458
Facility Management Plan	**1.31 (1.19, 1.43)**	<.0001	**1.33 (1.20, 1.49)**	<.0001
Monitoring Support	**1.19 (1.06, 1.33)**	0.002	1.10 (0.96, 1.24)	0.196
Repair Support				
Yes	1		1	
No	0.93 (0.79, 1.10)	0.424	0.88 (0.74, 1.05)	0.157
No Need	**0.49 (0.43, 0.51)**	<.0001	**0.52 (0.47, 0.58)**	<.0001

*Bolded ORs are significant at the 0.05 alpha level.

Appendix IV Unadjusted and multivariable logistic regression models for non-reliability

Explanatory variables	Unadjusted OR (95% CI)*	p-value	Multivariable Adjusted OR (95% CI)*	p-value
Handpump Type				
Afridev	1		1	
Ghana modified India Mark II	1.61 (1.46, 1.76)	<.0001	**1.37 (1.23, 1.52)**	<.0001
Nira AF-85	1.80 (1.60, 2.03)	<.0001	**1.71 (1.51, 1.94)**	<.0001
Vergnet	1.35 (1.14, 1.60)	<.0001	**1.22 (1.02, 1.47)**	0.033
Other	3.10 (2.19, 4.34)	<.0001	**2.54 (1.73, 3.73)**	<.0001
Age				
0-5 years	1		1	
6-10 years	**2.01 (1.54, 2.62)**	<.0001	**1.89 (1.43, 2.50)**	<.0001
11-15 years	**2.80 (2.15, 3.64)**	<.0001	**2.54 (1.93, 3.33)**	<.0001
16-20 years	**2.13 (2.39, 4.10)**	<.0001	**2.78 (2.10, 3.68)**	<.0001
21-40 years	**4.38 (3.38, 5.68)**	<.0001	**3.58 (2.73, 4.69)**	<.0001
+40 years	**2.07 (1.52, 2.81)**	<.0001	**1.66 (1.20, 2.93)**	0.002
30% Women Benchmark	**0.82 (0.74, 0.90)**	<.0001	0.96 (0.87, 1.06)	0.409
Treasurer	1.00 (0.92, 1.10)	0.934	1.08 (0.97, 1.21)	0.178
Caretaker	0.91 (0.82, 1.00)	0.072	0.92 (0.82, 1.04)	0.198
Initial Training	**0.83 (0.76, 0.91)**	<.0001	0.86 (0.78, 0.95)	0.003
Record Keeping and Accountability	0.98 (0.87, 1.10)	0.699	1.07 (0.90, 1.27)	0.432
Spare parts supply	**0.48 (0.45, 0.52)**	<.0001	**0.69 (0.62, 0.76)**	<.0001
Area Mechanic Services	**0.60 (0.55, 0.65)**	<.0001	0.94 (0.84, 1.05)	0.264
Breakdown Repairs	**0.54 (0.50, 0.58)**	<.0001	**0.68 (0.62, 0.75)**	<.0001
Routine Maintenance	0.93 (0.86, 1.01)	0.089	0.93 (0.85, 1.02)	0.105
Water Quality Testing	0.98 (0.86, 1.13)	0.803	0.95 (0.82, 1.10)	0.463
Revenue and Expenditure Balance	**0.88 (0.79, 0.98)**	0.020	**0.86 (0.75, 0.98)**	0.030
Up-to-date financial and operational records	1.03 (0.91, 1.16)	0.654	0.96 (0.80, 1.14)	0.625
Tariff Setting	1.14 (1.04, 1.24)	0.005	1.11 (0.99, 1.24)	0.058
Facility Management Plan	**1.19 (1.09, 1.30)**	<.0001	**1.18 (1.07, 1.31)**	0.001
Monitoring Support	**1.24 (1.12, 1.38)**	<.0001	1.10 (0.98, 1.25)	0.118
Repair Support				
Yes	1		1	
No	1.25 (1.07, 1.46)	0.006	**1.24 (1.05, 1.46)**	0.012
No Need	**0.49 (0.45, 0.53)**	<.0001	**0.58 (0.53, 0.46)**	<.0001

*Bolded ORs are significant at the 0.05 alpha level.

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