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A QUALITATIVE COMPARATIVE ANALYSIS OF THE FACTORS AFFECTING SUCCESS IN RENDERING WATER SERVICES SUSTAINABLE BASED ON ICT REPORTING

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WaterAid itad IRC

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Front cover: Wateraid Uganda

Acronyms	
CD	Compact Disc
FLOW	Field Level Operation System
GSM	Global System for Mobile
HSW	Human Sensor Web
ICT	Information and Communication Technologies
INGO	International Non-Governmental Organisation
M4W	Mobile Phones for Improved Access to Safe Water (Initiative in Uganda)
NGO	Non-Governmental Organisation
QCA	Qualitative Comparative Analysis
SIBS	Water and Sanitation Information System (Initiative in Timor Leste)
USB	Universal Serial Bus
USSD	Unstructured Supplementary Services Data
WASH	Water, Sanitation and Hygiene
WPM	Water Point Mapping

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EXECUTIVE SUMMARY

The potential of Information and Communication Technology (ICT) services in improving service delivery is well recognised. In the water sector, there has been a growing interest in supporting the sustainability of services in recent years. The sector has also witnessed an increase in ICT initiatives, including those that aim to improve and sustain water services. While there are a number of reviews that document different water sector ICT initiatives, the existing literature does not systematically consider the individual initiatives' success or failure. The objective of this research is therefore to better understand the factors that facilitate and inhibit the success of ICT-based reporting to improve rural water supply sustainability.

In this study, ICTs are defined as consisting of the hardware, software, networks, and media for the collection, storage, processing, transmission and presentation of information (voice, data, text, images). Most ICT initiatives examined in this study involved the reporting of water service levels using mobile phone technology.

The research design employed in this study is Qualitative Comparative Analysis (QCA). QCA helps to identify a variety of causal patterns (based on the contribution of different conditions) that lead to a specific outcome when comparing a small to medium number of cases.

Through a literature review and online survey, the research team identified a range of ICT initiatives used to monitor and report on water supply sustainability. From these, the team selected eight ICT initiatives to be the focus of the research study:

- Mobile Phones for Water (M4W), Uganda
- Maji Voice, Kenya
- Maji Matone, Tanzania
- Next Drop, India
- Water and Sanitation Information System (SIBS), Timor Leste
- Re-imagining Reporting, Bolivia
- Human Sensor Web, Zanzibar
- Smart Handpumps, Kenya

The focus of the study is on improving water supply sustainability in rural areas. However, ICT initiatives covering urban areas were also included in order to enrich the diversity of mechanisms employed for ICT-based reporting, report processing and related service improvements.

The team defined success in three outcomes: 1) successful ICT-based reporting; 2) successful processing of ICT reports by government or service provider, and 3) successful water service improvements. Based on existing literature and documented lessons from existing ICT initiatives in the sector, the team developed a theory of change, from which it derived conditions assumed to be influential for the success of each of these sub-processes.

The following findings emerged based on the QCA analysis:

Smart Handpumps, Maji Voice and Next Drop were successful in all three outcomes. The other five initiatives were unsuccessful in achieving one or more outcomes.

- In the case of Maji Matone, successful reporting using ICTs did not take place and reports were not processed successfully by the government or service provider. Nevertheless, service improvements were made in 66 per cent of the reported breakdowns.
- For M4W, ICT reports were successfully received and processed, but this did not result in significant water supply service improvements. Only 24 per cent of the reported failures were addressed.
- In the case of SIBS in Timor Leste, successful reporting using ICTs took place and reports were processed successfully by the national government. However, these reports were not used consistently to plan and budget service improvements.
- Re-imagining Reporting in Bolivia had successful reporting and processing using ICTs and there was improvement in planning and budgeting as a result of these reports. However, Re-imagining Reporting was judged to be unsuccessful for outcome two because, whilst reports were processed successfully, local government or service providers were not involved in this.
- Human Sensor Web was not successful in any of the three outcomes. Successful reporting did not take place using ICTs (very few text messages were sent), successful processing of the reports did not take place and service improvements were not made based on the reports.

Analysis of the eight initiatives suggests that ICT initiatives for reporting on water supply functionality are more likely to be successful if the reports are government- or service provider-led rather than reliant on crowdsourcing, and when the ICT mechanism is the preferred method of reporting. Other key factors that facilitate successful reporting include mobile phone reception, availability of mobile phone charging facilities and affordability of reporting by water users.

The processing of ICT reports is more likely to be successful if the related operational costs are met by a government body or service provider and not by a third agency such as an INGO. Other key success factors include internet connectivity, human resources and knowledge for processing, as well as the availability of back-up support to solve any problems with ICTs.

Repairs are more likely to take place if four factors exist: (1) there are sufficient funds, (2) there are sufficient spare parts, (3) a local mechanic is available and (4) when the responsibilities for operation and maintenance are clear to all parties. The three initiatives where maintenance was carried out by the same party that received and processed reports, were successful in all three outcomes. To increase the likelihood of service improvements, it may be necessary to internalise these four factors into the ICT initiative itself.

The main contribution of the study is the confirmation of existing factors already highlighted in the literature through a systematic and methodologically rigorous analysis. The next stage of the project is to examine the specific governance dynamics affecting the reporting and rural water service sustainability. This will be done through in-depth case studies from among the eight mapped initiatives.

1 INTRODUCTION

Access to water supply around the world is increasing.[1] While efforts are still focused on providing infrastructure, the sector's attention appears to be shifting to the reliability and sustainability of water services. Poor sustainability of water supply is a key barrier to access to safe drinking water. Data shows that nearly a third of all rural water supply schemes across sub-Saharan Africa are considered non-functional at any given time (Foster 2013; Rural Water Supply Network 2009).

In recent years, there has been a growing interest in improving water service sustainability, and in obtaining related data. Some development partners are introducing sustainability clauses into funding agreements[2], development partners and NGOs are increasingly monitoring the sustainability of their interventions, and some governments in the South have introduced ambitious functionality targets[3].

The water and sanitation sector has seen a growing number of ICT initiatives over the past few years that aim to improve different aspects of water and sanitation services. These initiatives have a variety of purposes and designs with some focusing on water quality monitoring, others on pay and some aiming to improve equity in water supply distribution. This report focuses on ICT initiatives that aim to improve water supply functionality.

The objective of this research is to better understand the factors that facilitate and inhibit the success of ICT-based reporting mechanisms that aim to improve the sustainability of rural water supply services.

The research team used Qualitative Comparative Analysis (QCA), a method designed to identify patterns that lead to a specific outcome of interest. QCA helps to understand why some initiatives were successful and which conditions, in which contexts were important for this.

While this study focuses on rural water supply sustainability, the research and QCA analysis also includes some urban-based ICT initiatives. The urban cases were included because they enrich the analysis by providing an additional point of comparison in identifying patterns for success.

The report is structured as follows: Section 2 gives a brief overview of the potential and challenges related to the introduction of ICT initiatives in improving water services, based on a literature review. Section 3 provides an overview of the eight chosen case studies, followed by a more in-depth description of each initiative. In Section 4, the research methodology is explained. QCA is introduced as the overall research design, followed by a more detailed explanation on how this method was applied by the team. In Section 5, the research results are discussed and Section 6 concludes with a summary of the findings, reflections on the use of QCA and suggestions for the next steps in this research project.

[1] Between 1990 and 2012, access to an improved drinking water source increased from 76 to 89 per cent across the world (WHO/UNICEF 2014).
[2] E.g. a recent decision by the Dutch government to introduce a sustainability clause in future funding agreements for delivering rural water supply services. This clause will require implementing organisations to monitor the sustainability of water supply services for 10 years after project completion (Smits 2013).
[3] In the East Africa region, for example, Ethiopia has a national target to reduce water supply non-functionality to below 10 per cent and in Uganda, the sector target is to decrease non-functionality to below 20 per cent, and towards 10 per cent (Welle & Williams 2014).

2 LITERATURE REVIEW ON THE USE OF ICT REPORTING FOR RURAL WATER SUPPLY SUSTAINABILITY

This brief review aims to summarise existing literature on the use of ICT innovations for improving sustainability of rural water supply. It focuses on the potential of such innovations to improve monitoring practices and the challenges that can be faced in their successful use in rural settings.

What is an ICT?

The World Bank ICT glossary defines Information and Communication Technologies (ICT) as consisting of the hardware, software, networks, and media for the collection, storage, processing, transmission and presentation of information (voice, data, text, images), as well as related services (World Bank 2013).

For this research, the team considered an 'ICT initiative' to be the ICT itself and the project that was designed to introduce the technology into a rural or urban setting.

Potential of ICTs

ICTs are believed to hold great potential to improve the collection and dissemination of data on water supply and provide new opportunities for monitoring and influencing policy making. For instance, Clement Dzidonu (2010) states that ICTs have the potential to improve service delivery by reducing operational inefficiencies in government administration and by facilitating new communication channels between government and citizens (Pearce, Welle & Dickinson 2013) .

Mobile phones can be used to read meters, pay bills and report faults. This is of interest to service providers, in addition to regulators, governments, donors and NGOs as it helps them to better understand and react to what is happening on the ground. David Schaub-Jones (2012) sets out the following ways that ICTs can bring about improvements in the water, and other, sectors:

- strengthening revenue collection
- managing assets more productively
- building better relationships with customers/users
- measuring and reporting technical performance, thus allowing for improved or more effective financing for the sector.

ICT tools mean that, instead of relying on field staff from water service providers to collect data, it can be collected from the public directly (crowdsourcing). NGOs and community-based organisations can collect data in real time and with a much higher quantity and quality. Schaub-Jones (2012) deduced that there are three main drivers for

stakeholders to adopt ICTs: (1) improving access to information, (2) bringing immediate and long-term financial benefits, and (3) confidence building between stakeholders. He concludes that ICTs can improve responsiveness, accountability and trust.

Water Point Mapping (WPM) is an ICT tool for monitoring the distribution and functionality status of rural water points. It can help to visualise different aspects related to access to water supply and, by presenting complex information on a particular geographic locality in an accessible way, WPM has the potential to inform Water, Sanitation and Hygiene (WASH) service related decisions (Welle 2007). Donors could use the information as a basis for investment decisions while civil society organisations could use it to hold governments and development partners to account.

Challenges in the introduction of ICT initiatives

Schaub-Jones (2012) acknowledges a wide range of factors that can impact on the success of ICT initiatives and emphasises that an ICT system that works in one context cannot just be transplanted successfully into another. The enabling environment affects the successful implementation of an initiative. The perspectives of, incentives for, and barriers to stakeholders entering information into the system, ensuring that this information is reliable and then using this information for decision making are different in each context.

A desk review of ICT use in the water and sanitation sector by CoWater International Inc and University of Cape Town iComms (2014) examines the challenges of ICT initiatives in the water and sanitation sector, focusing specifically on Africa. Challenges identified include:

- limited access to long term funding with many initiatives only being funded for the pilot stage
- ICT applications being developed as part of competitions such as ‘hackathons’ but then not being scaled up due to a lack of a long term strategy or lack of market for the application
- lack of capacity for using ICTs and low literacy levels in rural areas
- poor network connectivity and lack of electricity
- insufficient research and evaluation to analyse whether projects were useful and successful.

Integrating ICT initiatives into existing government systems

Both CoWater (2014) and Schaub-Jones (2012) note a significant risk of fragmentation with a variety of organisations piloting different ICTs without ensuring that the technologies and systems can be used and absorbed by government, replicated and scaled up if effective. When ICT interventions are developed and implemented outside of existing institutional systems, including local governments and community themselves, they are more likely to fail. Political and community buy-in is crucial, and hence it is important that a variety of stakeholders collaborate in such projects in order to feel ownership and to understand that the ICT will solve a genuine need.

Similarly to CoWater (2014) and Schaub-Jones (2012), one of the key challenges identified in introduction of WPM was in institutionalising WPM within routine local and national government planning and monitoring processes. One of the issues identified here is the degree to which governments are prepared to make information freely available. Each government who participates in this initiative will have to decide how much information to release and how often to update it (Welle 2010).

Other challenges identified in the introduction of WPM at the district government level include operational challenges due to weak reporting structures below the district government level, and technological challenges due to expensive software that requires advanced skills in the use of geographic information systems. Pearce, Dickinson and Welle (2015) identify lack of availability of human resources and skill sets, and weaknesses of existing government structures as challenges in introducing ICTs and translating them into lasting WASH improvements. Data collection can be time consuming and expensive and, depending on the software used and the skill base available, data entry and processing can often be beyond the capacity of local government staff.

However, software is continuously improving, and becoming easier to use and more affordable. Increased availability of open source software enables anyone to use and distribute the software for any purpose. Therefore, problems with affordability of software and insufficient local government capacity may be reduced as software continues to evolve.

The use of the initiatives by citizens themselves

McGee and Carlitz (2013) consider the need to better understand how citizens make use of the possibilities of ICTs, and what encourages them to use them to hold governments or private sector actors to account. They caution that citizen-led social accountability may wrongly imply the will and ability of citizens to act in certain ways, for example in the reporting of water point breakdowns through crowdsourcing initiatives such as the Mobile Phones for Water (M4W) initiative in Uganda. Both McGee and Carlitz (2013) and Hellström (2010) question the assumption that East African citizens want to directly engage with government via ICTs rather than solving issues through other means or having them solved by a third party.

When engaging citizens, differentiations between the various public stakeholders need to be considered at the design stage and include gender (with access to mobile phones for marginalised girls likely to be lower), rural/urban location, language and degree of socioeconomic marginality. Marginalised citizens are often those most in need of government accountability and responsiveness, yet are often those with the lowest satisfactory government response to their demands and hence often have low incentives for engaging with transparency and accountability initiatives. Special measures are needed to make sure those citizens' voices meet with responsiveness (McGee and Carlitz 2013).

Collection of useful data

ICT initiatives can often lead to a dramatic increase in the amount of data, but this data still needs to be processed, interpreted and used to make decisions and deliver action. The difference between data collected and useful information must be recognised (Schaub-Jones 2012). An example of this is the Field Level Operations Watch, an open mapping software developed by Water for People to track the condition of water points, in which one of the key challenges identified was data management. An excessive amount of data is currently being collected by the software and it is difficult to identify which of this data is actually actionable (CoWater International and University of Cape Town iComms 2014). Ultimately stakeholders should only be collecting data that has meaningful value, that they are capable of analysing, and intend to use.

Outstanding questions that this research study aims to answer

The literature on the use of ICT reporting for rural water supply sustainability is extremely limited, and none of it is available in peer-reviewed journals so far. While

the existing literature considers the potential of ICT initiatives to improve monitoring and the challenges that are often faced in the introduction of such initiatives, it does not examine in detail the extent of the challenges, and how they actually impact on the success or failure of the different initiatives. The literature does not set out criteria for judging success, nor identify which initiatives were deemed to be successful, and which were less so. In this research study, the aim is therefore to better understand the factors facilitating and inhibiting the success of ICT-based reporting mechanisms that aim to improve rural water service sustainability. The objective is to ascertain which factors, in the design of the initiative or in the context, have an impact on whether an initiative is successful or not.

3 AN INTRODUCTION TO THE CHOSEN CASE STUDIES

Through a literature review and survey, the research team identified a range of ICT initiatives for monitoring and reporting on water supply sustainability. The team used five key criteria to select ICT initiatives: (1) the initiative's aim was to improve the sustainability of water service provision and went beyond reporting on interventions of a specific NGO or donor; (2) information about water services would be reported using ICT; (3) data would be analysed; (4) ICT-based data would be used for decision-making; (5) ICT-based reporting would be updated or continue to be reported via crowdsourcing for at least six months. The team selected eight ICT initiatives to be the focus of the research study:

- Mobile Phones Improved Access to Safe Water (M4W), Uganda
- Maji Voice, Kenya
- Maji Matone, Tanzania
- Next Drop, India
- Water and Sanitation Information System (SIBS), Timor Leste
- Re-imagining Reporting, Bolivia
- Human Sensor Web, Zanzibar
- Smart Handpumps, Kenya

Each of the selected initiatives is summarised in Annex 1.

3.1 TYPES OF INITIATIVES

A number of key differences were identified between the types of ICT initiatives included in the study:

Scale, type of water supply technology and setting: The ICT initiatives operate at very different scales. The smallest initiative includes only 40 water kiosks in Zanzibar town, while the largest scale initiative, Water and Sanitation Information System (SIBS), is operational at national scale in Timor Leste. Most initiatives are implemented in a number of districts, sub-districts and parts of piped water supply networks in towns. The type of technology varies with the setting: rural ICT initiatives report hand pump related data while urban ICT initiatives report data on piped household connections or water kiosks.

Who collects the data? Some of the ICT initiatives collect data through crowdsourcing, which means that a group of people or a community are collecting the data rather than it being collected by an employee or contractor. For example, Mobile Phones for Improved Access to Safe Water (M4W) is a citizen monitoring initiative through which water users report on functionality by sending text messages with a mobile phone. Such initiatives rely on citizens taking action and using the technologies to make reports. Hence sensitisation of communities about the initiatives is crucial to success. In contrast, in other ICT initiatives members of government or service provider staff collect data, including SIBS. For the SIBS initiative, local government staff called WASH facilitators, collect data and send it to a central database to be processed.

When is the data collected? Some initiatives aim to collect information shortly after a breakdown of a water point occurs and use this information to respond to and repair the breakdown as quickly as possible. For example, the Maji Voice initiative in Kenya encourages citizens to report any problems with their water supply as soon as possible so that action can be taken to ensure it is repaired. In contrast, some of the ICT initiatives that the team has identified are not focused on reporting of specific breakdowns as and when they occur but are focused on regular, periodic reporting. For example, Re-imagining Reporting in Bolivia is an initiative in which data is collected once per year. This data is then used to inform national and local government planning and budgeting.

How is the data collected? Most of the ICT initiatives identified require human interaction to collect the data through sending a text message, making a phone call or uploading data on to a database, or on the internet. However, one initiative collects data automatically using the ICT, the Smart Handpumps initiative in Kenya. A smart hand pump is a pump that has a Global System for Mobile (GSM) transmitter securely fitted inside the handle of the pump. The transmitter automatically sends data on hand pump use via text message over the mobile phone network without requiring human interaction (Smith School of Enterprise and the Environment 2014). Table 1 sets out the key differences in the design of reporting mechanisms for the different initiatives.

Table 1: Comparison of characteristics and reporting mechanisms for ICT initiatives included in the study

Initiative	Rural/ urban	Crowdsourcing or government/ service provider led	Data collected periodically or related to specific incidents	Scale	Water supply technology	Human interaction required or automatic reporting?
M4W, Uganda	Rural	Crowdsourcing	Specific incidents	Eight districts	Hand pump	Human interaction
Maji Voice, Kenya	Urban	Crowdsourcing	Specific incidents	Two cities	Piped house connection	Human interaction
Maji Matone, Tanzania	Rural	Crowdsourcing	Specific incidents	Four districts	Hand pump	Human interaction
Next Drop, India	Urban	Crowdsourcing	Specific incidents	Three cities	Piped house connection	Human interaction
SIBS, Timor Leste	Rural	Government/ service provider	Periodically	National	Hand pump	Human interaction
Re-imagining Reporting, Bolivia	Rural	NGO led	Periodically	Six municipalities	Hand pumps and piped connections	Human interaction
Human Sensor Web, Zanzibar	Urban	Crowdsourcing	Specific incidents	50 water kiosks in one town	Piped water kiosk	Human interaction
Smart Handpumps, Kenya	Rural	Government/ service provider	Periodically	66 hand pumps in one district	Hand pump	Automatic

4 METHODOLOGY

The literature review on ICT initiatives to support water supply sustainability in Section 2 identified a gap in the provision of consistent, multi-case analysis, an issue also identified in a wider review of transparency and accountability initiatives by McGee and Gaventa (2010). The research team chose Qualitative Comparative Analysis (QCA) as the research method for this study in order to strengthen the existing evidence and knowledge base on factors that affect success in ICT initiatives. QCA allows a systematic comparison between different cases against a specific set of factors for success, across initiatives and contexts.

This section retraces the steps followed to arrive at the findings presented in Section 5. Limitations are highlighted and reflections offered on the challenges in applying QCA in a small research project.

What is QCA?

QCA is a family of research approaches that was originally developed by Charles Ragin in 1987. QCA helps to understand causal patterns when comparing a number of different cases. Rather than examining the factors causing a specific outcome in depth in a single case, QCA focuses on identifying a variety of patterns that lead to a specific outcome when comparing a small to medium number of cases (Befani 2013). QCA is in line with (but not inherently linked to) realist approaches that see outcomes as dependent on context-specific mechanisms (Befani, Ledermann, and Sager 2007).

In applying QCA, researchers start by developing a theory of change related to the outcome they investigate. The theory of change subsequently guides the researchers in identifying a number of conditions that are assumed to be key influencing factors for achieving the particular outcome. The researchers collect data on all conditions for each case study and determine whether the conditions were fulfilled or not. When the QCA analysis is applied, it brings to light different, parallel causal patterns that lead to the same outcome, and causal patterns that fail to achieve this outcome.[4]

Applying QCA requires an iterative approach to working with the data. The researcher continues to refine the outcomes and hypothesised conditions that lead to these outcomes during a process of data collection and analysis.

4.1 HOW QCA WAS APPLIED IN THIS PROJECT

Step one: Defining outcomes

Originally, the team defined two outcomes to encompass success in ICT reporting for improving water supply sustainability. Outcome one refers to successful ICT reporting whilst outcome two describes successful follow up ICT reports and service improvements as a result. After the first round of data collection, it emerged at that

[4] An introduction to QCA can be found in Rihoux and Ragin (2009) and Schneider and Wagemann (2012).

point that outcome two was not sufficiently defined: in some cases the responsible government body or service provider processed ICT reports, but this did not always lead to the repair of a scheme or general service improvement. The team therefore decided to split the second outcome into two separate outcomes. Each outcome represents the successful completion of a sub-process: (1) successful reporting, (2) successful report processing, and (3) successful service improvement. There is an in-built hypothesis that the fulfilment of outcomes one and two will lead to outcome three: a greater sustainability of water services through ICT-based reports. Table 2 presents the definition of the achievement and non-achievement of each outcome.

Table 2: Definitions of achievement or non-achievement for each outcome

Achievement of outcome 1	Non-achievement of outcome 1
Successful ICT reporting: Users or their representatives, including government staff, directly or indirectly, use ICTs in the way specified by the initiative to report water supply functionality to the local government authority or relevant stakeholder; this could be either through ad hoc crowdsourcing or through government- or service provider-led, regular updating mechanisms.	***Unsuccessful ICT reporting:*** Users, or their representatives fail to use ICTs to report water supply functionality, or bypass the ICT channel using other forms of communication with the local government authority or relevant stakeholder.
Achievement of outcome 2	**Non-achievement of outcome 2**
Successful processing of ICT reports: Local government authority (national sector government, if relevant) or service provider process ICT reports.	***Successful processing of ICT reports:*** Local government authority (national sector government, if relevant) or service provider do not process ICT reports.
Achievement of outcome 3	**Non-achievement of outcome 3**
Successful service improvement: Water points are repaired based on ICT reports and processing.	***Lack of service improvement:*** Water points are not repaired based on ICT reports and processing.

The outcomes do not specify any numeric or percentage targets related to ICT reporting, report processing and repairs carried out compared to the overall non-functionality rate in the intervention areas. This was left out because the relevant data could not be obtained across the board from the initiatives (the related limitations are discussed in Section 5.2).

Step two: Developing a theory of change

The team drew on both their literature review and existing sector knowledge to develop a theory of change of the key factors that influence the extent to which ICT reporting and monitoring initiatives can improve the sustainability of rural water supply services. The team reviewed grey literature on the experience of past ICT initiatives in the sector and related water supply sustainability. The initiatives discussed in the literature were also some of the initiatives that the research team chose for a more in-depth study in this research. A summary of this literature can be found in the literature review in Section 2. The literature led the team to identify a number of key factors or conditions that were expected to influence the success or failure of ICT initiatives for improving sustainability of water supply services. Below is a summary of the review organised along the three revised outcomes: successful ICT reporting, successful ICT report processing and successful service improvements.

Success factors related to outcome one: successful ICT-based reporting

Certain technical parameters need to be fulfilled to enable ICT-based reporting: The GSM reception in the area must be sufficiently reliable, and people must be able to charge phones on a regular basis. As expansion and development of ICT infrastructure in the majority of developing countries is still underway, network connectivity and lack of electricity are major potential barriers to ICT implementation and adoption (CoWater International and University of Cape Town iComms, 2014). Specifically in the rural settings where some ICT initiatives were set up, the network might not be sufficiently reliable (IRC, SNV, WaterAid, and Ministry of Water and Environment Uganda 2012). In addition, in order to send an ICT report, users must have access to a mobile phone, either by owning it or through a member of a water user committee or a community member. In the case of the Maji Matone and the Human Sensor Web (HSW) initiatives, it was recognised in the final review that, since it is women and children who largely fulfil the role of 'water-fetchers', it is these users who are more likely to take responsibility for reporting a breakdown yet women and children are those with least access to mobile phones (Daraja Development Ltd 2013).

The literature review also identified certain accountability conditions that need to be conducive to motivate water users to make use of ICT reporting. In order to increase accountability via ICT reporting, the local government or service provider need to be open to feedback and the users must also feel that their feedback is taken seriously. Whilst users might initially find it empowering to voice their concerns and priorities, this sense of empowerment will not continue, (and they will become apathetic and not continue to voice their concerns), if their voices secure no action by decision-makers (McGee and Carlitz 2013). The Human Sensor Web initiative's findings highlighted that if users do not trust the service provider's responsiveness in the first place, they may not be prepared to report breakdowns (McCall, Martinez, and Verplanke, 2013).

Furthermore, users need to be well informed about the initiative, and to understand how to send a failure report. Problems found with the M4W initiative in Uganda include that stickers on water points showing the water point identification number do not last. This results in users not having all of the required knowledge to report the breakdown (IRC *et al*. 2012). Reported lessons from the first ICT initiatives in the sector identified the chosen input method, text messaging, as an obstacle to reporting, because users were not able to read or input the correct messages, and because they preferred other mechanisms of reporting such as calling or reporting incidents in person. For example in the Human Sensor Web in Zanzibar, users added greetings to their failure reports, which led to the system not being able to process the message (Verplanke *et al.* 2010). In addition, users must be prepared to meet the economic costs of reporting a breakdown in case fees apply. Users not being able to meet text messaging costs was seen as a problem in the M4W initiative in Uganda (IRC et al. 2012).

Success factors related to outcome two: successful processing of ICT-based reports

Similar to user reporting, the team expected that several technical parameters would need to be fulfilled in order to enable the relevant government body or service provider to receive and process the ICT reports successfully. These include sufficient GSM reception or internet connection in the office environment, and the availability of sufficiently reliable hardware and software to process data and to prioritise interventions.

For successful processing of ICT reports, there needs to be sufficient human resource and infrastructure capacity for the system to function i.e. skills and knowledge to manage the system on a day-to-day basis, analyse data and interpret results. In the absence of access to such skills internally, sufficient back-up support needs to be

available to help solve software related problems. WPM research found that, even though the water point mapper was based on excel and no internet connection was necessary to process reports, local water officers encountered problems in processing reports (Welle 2011). WPM outputs were produced using ArcGIS software which is expensive and, more importantly, requires advanced technical skills, which cannot easily be transferred via short trainings, causing significant challenges for district staff in processing of data (Welle 2011). The M4W initiative also reports one of the problems with their pilot being that stakeholders struggled to use the system. The hand pump mechanics, community development officers and district water officers had all indicated that they needed additional training and did not yet feel confident in using the system. Delays occurred in implementation of the project because the district water officers were not yet sufficiently capable to operate the system (IRC et al. 2012).

The team also identified a key potential influencing factor as whether the ICT reporting initiative was designed in line with existing sector responsibilities and was sufficiently embedded in the local government or service providers' ways of working for data processing and follow up. The literature reviewed identified a significant risk of fragmentation if organisations introduced ICTs for monitoring and reporting without ensuring that the technologies and systems could be used and absorbed by government, and scaled up if they were effective (Schaub-Jones 2012). In addition, research findings related to WPM indicate that data analysis and action was often highly dependent on continued engagement from non-governmental actors and had generally failed to become an integral part of sector government monitoring procedures (Welle 2007). Political and community buy-in for the initiatives is therefore crucial, and hence it is important that a variety of stakeholders collaborate in such projects in order to feel ownership and for the initiative to become sustainable in the long-term. McGee (2014) refers to the need for individuals that are willing to act as 'champions' within government for citizen-driven efforts. The reports from the M4W initiative in Uganda show recommendations made by district water officers in the pilot districts that their budgets should have an allocation to facilitate activities needed to use the system (IRC et al. 2012). By including M4W in the operational budget of the district water office, they have effectively been championing the initiative and hence it has become better institutionalised and there is a budget for training of staff to fulfil their responsibilities and for holding team meetings about the initiative.

Success factors related to outcome three: successful service improvements

Apart from the quality of the technical design and construction of the facility and user satisfaction with the service provided, the user committee's ability to raise funds, access to repair skills and spare parts are key to effectively maintaining rural water supply schemes (Sugden 2003; Welle and Williams 2014). In addition, user committees need to be supported by clear sector guidelines and support structures by the local government or equivalent. Whilst the user committees' ability to raise funds and their access to repair skills and spare parts is seen as an enabling condition, it may also directly affect the ICT initiative in that users might be less likely to report a breakdown if they assume that they will not be able to provide the sufficient funds or receive adequate support to actually carry out the needed maintenance.

When it comes to the operationalisation of the ICT initiative, its design needs to support existing sector responsibilities for management of water supply systems. If the initiative sets up new parameters that contradict the existing distribution of roles between the users, their representatives and the service provider or local government structure, repairs might not be carried out despite the reporting and processing of ICT-based breakdown reports.

Step three: Identifying conditions against each outcome

Based on their theory of change, the team identified a number of conditions deemed influential for achieving each outcome. The conditions were grouped into factors related to the wider enabling environment and factors directly related to the ICT initiative. The conditions are presented in Table 3. Please note that this is the revised and reorganised version used by the team for the final analysis. The original 17 conditions including a detailed description of each condition supported by literature is documented in the team's inception report (2014).

Table 3: Conditions affecting successful ICT-based reporting, processing and improvements in water service sustainability

Description of condition	Definition of achievement	Definition of non-achievement
Outcome 1: Successful ICT-based reporting		
1.1 Enabling environment is conducive to reporting		
1.1.1 GSM reception	The network is reliable (e.g. in urban areas) or the data can be sent when the facilitator has reception e.g. back in the office	The network is not reliable
1.1.2 ICT devices can be charged.	Charging phones does not provide a serious obstacle to reporting breakdowns.	There are significant problems with keeping phones charged, and this inhibits reporting.
1.1.3 Users or their representatives have access to the ICT device used by the initiative.	The person responsible for reporting has access to a mobile phone.	There is a challenge with access e.g. the person responsible for reporting does not have access to a mobile phone.
1.2 Characteristics of the reporting process		
1.2.1 Is the data reported periodically or related to specific incidences?[5]	The data is reported when there is a specific incidence.	The data is reported periodically.
1.2.2 Does the report require human interaction or is it automatic?[6]	It requires human interaction.	It is automatic.
1.2.3 Who reports? Crowdsourcing or government/ service provider-led?[7]	Reporting is based on crowd sourcing.	Reporting is government/service provider led.
1.2.4 People reporting the problem prefer the ICT mechanism over alternatives.	People prefer the mechanism, there are different options from which people can choose, or preference is not important because it is part of peoples' job descriptions (e.g. government staff).	There is resistance against the proposed communication method of reporting.
1.2.5 The costs of reporting are not a problem for the person who reports.	Cost is not an issue, or users are prepared to pay a higher cost to alternatives.	Cost is an issue, including when government staff use the allocated credit for other purposes.
1.2.6 People who want to report the problem have sufficient information and knowledge to do so.	People who want to report the problem have sufficient information and knowledge e.g. access to the number.	People who want to report the problem encounter problems in using the ICT reporting mechanism.

[5–7] This condition specifies a difference in reporting, it does not judge its achievement.

Description of condition	Definition of achievement	Definition of non-achievement
Outcome 2: Successful processing of ICT reports		
2.1 Enabling environment is conducive to processing of ICT reports		
2.1.1 Internet/GSM reception at local government/service provider office environment.	GSM/internet reception problems do not inhibit effective data processing.	There are challenges related to receiving ICT-based reports.
2.1.2 Computers and electricity are available to receive and store reports.	Yes.	No.
2.1.3 There is access to the necessary software to store and process data.	Yes.	No.
2.1.4 There is access to back-up support for solving ICT-related problems.	Yes.	No.
2.2. Characteristics of processing ICT reports		
2.2.1 The responsible agency has sufficient human resources and knowledge to process ICT reports.	Yes.	No.
2.2.2 There is clarity in procedures for following up on the ICT report.	Procedures for following up are clear.	Procedures are not sufficiently clear or the system does not require follow up.
2.2.3 The operational costs are largely met by the local/national government or service provider.	The local/national government or service provider is covering the operational costs.	The local/national government or service provider is not paying for the operational costs.
Outcome 3: Water points are repaired based on ICT reports and processing		
3.1 Enabling environment is conducive for carrying out repairs.		
3.1.1. There are sufficient funds for carrying out the repair.	In the majority of cases, water user committees or the responsible agency has sufficient funds for carrying out repairs.	In the majority of cases, water user committees struggle to collect sufficient funds for carrying out repairs.
3.1.2 Operation and maintenance responsibilities are clear to all parties.	In the majority of cases, responsibilities are clear.	In the majority of cases, responsibilities are not clear.
3.1.3 Spare parts are available for the repair.	In the majority of cases, spare parts are available.	In the majority of cases, spare parts are not available.
3.1.4 A mechanic is available to carry out repairs.	In the majority of cases, a mechanic is available.	In the majority of cases, a mechanic is not available.
3.2 Characteristics of the operation and maintenance model/sector planning procedures		
3.2.1 The local government/ service provider has accountability mechanisms in place to ensure that ICT reports are acted on (repairs are carried out).	There is an established way of following up on processed ICT reports, and is put into effect.	Who follows up on processed ICT reports is unclear or not put into effect.
3.2.2 The ICT initiative supports existing sector responsibilities for operation and maintenance.	The mechanisms put in place by the initiative are in line with sector responsibilities.	The mechanisms put in place by the initiative contradict existing sector responsibilities.

Step four: Scoping out of ICT initiatives

Based on the literature review the research team was interested to learn about initiatives which met with several key criteria:

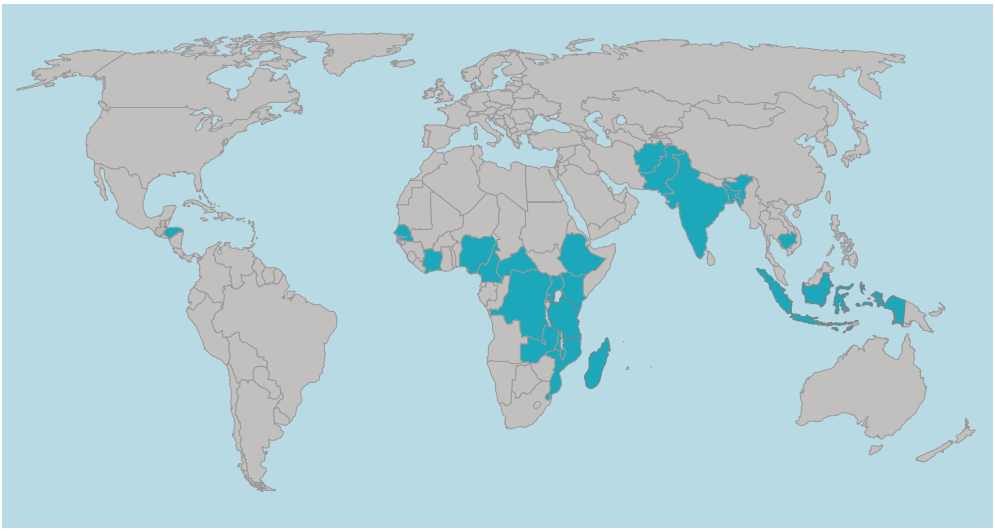
- the initiative's aim is to improve the sustainability of water service provision and it goes beyond reporting on interventions of a specific NGO or donor
- information about water services is reported using ICT
- data is analysed
- ICT-based data is intended to be used for decision-making
- ICT-based reporting continued for at least six months.

To capture information about previous and ongoing initiatives which meet the key criteria of successful monitoring initiatives, the team developed a short survey designed and published using **SurveyMonkey.com** to capture details of as many initiatives as possible.[8] The Rural Water Supply Network's (RWSN) Mapping and Monitoring online platform was used to launch and promote the survey.[9]

Survey responses were followed up by the research team with specific questions relating to the information submitted. This included telephone and Skype discussions but mostly involved email communication. In addition, emails were sent to RWSN members in specific countries to identify respondents beyond the ones forthcoming in the survey. In total, the team identified 46 ICT related initiatives in 24 countries (see Figure 1 for the geographic distribution of identified initiatives).

Relevant supporting documentation for each initiative was collected and reviewed to take a decision on the case study's eligibility. Discussions with respondents in several countries was necessary to determine the status of respective cases. Only 13 initiatives from 11 countries qualified in meeting the five, key criteria above. Among these, only the eight initiatives presented in Chapter 4 responded to the team's requests for interviews.

Figure 1: Countries which responded to survey with relevant information



Source: Authors

[8] The survey included the following questions: name of the country where the initiative is implemented; who leads the initiative?; at what scale is the initiative?; is there an ongoing process for updating the data?; is there further information on the initiative?; details of respondent.

[9] With over 900 members from across government, NGO, private sector and academia in 75 countries this is the most established and wide-reaching network of WASH sector professionals and practitioners working with monitoring and mapping issues.

Step five: Data collection and revision of conditions

Most ICT initiatives were not well documented, and when they were, the documentation did not provide sufficient information to decide whether the condition was achieved or not.

Therefore, for each of these eight ICT initiatives, two interviews were carried out with NGO, donor or university staff that were involved in their design and implementation.[10] Detailed information about each initiative was collected, in addition to specific information about each of the identified conditions. Interviewees were asked to give reasons why they thought a particular condition (see Table 3) was achieved or not, and their answers were checked against each other.

After a first round of interviews, the research team mapped the data obtained against the originally identified conditions in an excel sheet. This provided a first opportunity for an iteration between the data and conditions. Several issues emerged. In some cases, it was difficult to obtain reliable data on a condition through interviews (e.g. on the trust relationship between users and service providers or government bodies). Some conditions overlapped and needed consolidating, and other conditions needed splitting or reformulating to give interviewees a better idea of the information required. A discussion of the findings obtained from the first round of interviews also helped to bring out additional differences between cases with a potential impact on their success. These were logged in additional conditions.

The final step before running the data through the QCA software was the scoring of the conditions and of the outcomes. The team came together and discussed each scoring in turn. In some cases, it was difficult to identify the 'correct' scoring. In these cases, the team settled on a 'predominant' score. For example, the Smart Handpump initiative in Kenya used both an automatic, regular report via a mobile phone chip built into hand pump handles but also gave users a mobile number to call the service provider in case of a suspected breakdown (crowdsourcing). The team decided to focus on the 'predominant' reporting mode, the automatic transmission of data via the in-built mobile devices in the hand pump handles.

Step six: QCA analysis and interpretation

The QCA analysis was co-conducted with Barbara Befani who advised the team throughout the research process on questions related to applying QCA. The team decided to apply crisp-set rather than fuzzy-set QCA. Crisp-set QCA requires the researcher to score the fulfilment of a condition as either 0 or 1 whereas fuzzy-set QCA allows for a more nuanced analysis on a sliding scale between 0 and 1. The research team decided that crisp-set analysis was adequate because the definitions of some conditions and the data available to judge their fulfilment did not lend themselves for applying a sliding scale. Furthermore, a fuzzy-set analysis would have required additional time and resources that were not available under this research project. Three different types of software were used to conduct different types of analysis: R, fsQCA and 'Tosmana'.[11] The findings are not meant to be generalised beyond the set of cases analysed. The cases were not extracted randomly so they cannot be considered representative of a broader population.

[10] With the exception of the Smart Handpump initiative, where the research team only interviewed one stakeholder.

11 See also the forthcoming guide which will discuss the type of software platforms that are appropriate for different types of analysis http://eba.se/en/evaluating-development-interventions-with-qca-potential-and-pitfalls/

4.2 CHALLENGES IN APPLYING QCA AND RELATED STUDY LIMITATIONS

A number of challenges emerged during the application of QCA, which resulted in limitations that affect the research findings presented in Chapter 5.

The identification of ICT initiatives and subsequent data collection process was more onerous and drawn out than envisaged. The team was unable to establish contact with some initiatives and had to drop them from the case study list.

Furthermore, most ICT initiatives that the team considered were not well documented, and when they were, the documentation did not provide sufficient information to decide whether the condition was achieved or not. The team therefore relied extensively on Skype interviews to collect data. The interviewees were often individuals who either designed or were managing the initiative, hence hindering objectivity. In most cases, the team interviewed at least two stakeholders per initiative in order to limit the subjectivity introduced by the interviewees in judging the achievement of each condition. Although interviewees were asked to give reasons why they thought a particular condition was achieved or not, and their answers were checked against each other, one could argue that people external to the project should also have been interviewed to reduce subjectivity. However, this aspect was beyond the scope of the research.

The limited number of ICT initiatives that aim to support the sustainability of rural water supply services also resulted in comparing cases of very different scales (ranging from covering 50 water points to covering a whole country), and the inclusion of three urban water supply cases (Human Sensor Web, Maji Voice and Next Drop). The limitation of the total number of cases also meant that the team included initiatives whose aim was more indirectly related to improving water supply sustainability, namely by enabling local sector governments to improve budgeting and planning for rural water supply (Re-imagining Reporting and SIBS). These last two initiatives were excluded from the QCA analysis of outcome three. While it is important to compare initiatives that have similar objectives, the diversity in data collection, processing and service improvement models is positive as it enriches the QCA analysis.

The formulation of tight conditions was at times difficult. An example is condition 3.2.1: ‘The local government/service provider has accountability mechanisms in place to ensure that ICT reports are acted on’. Often the problem is that the mechanisms are in place but do not get used to ensure that necessary service improvements are made. This may be because enforcement mechanisms exist but only on paper and are not put into effect, or because enforceability measures do not exist at all (i.e. no credible threat of sanctions. While it is important to clearly distinguish formalities from actualities here, the team did not have sufficient data in order to explore whether accountability mechanisms were actually followed. As a result, the explanatory power of this condition remains limited.

Defining and judging outcome achievement proved difficult because of the lack of comparable data available across the initiatives. Originally, the team intended to define a minimum percentage of breakdown reports, follow up actions and repairs, compared to the overall water point non-functionality in the intervention area, for an initiative to be considered successful. However, during data collection it became clear that these figures were not available for most cases. Hard numbers were therefore omitted from the definition of outcome achievement. This is a potential limitation in the

research design as the judgement of success or failure in relation to outcome three is rendered more subjective.

Finally, the team had difficulties in assigning specific 0 or 1 scores against the achievement of individual conditions in some cases. This was particularly the case for conditions 3.1.1 – 3.1.4 (funds are sufficient for carrying out the repair; operation and maintenance responsibilities are clear to all parties; spare parts and a mechanic are available) It was difficult to assign scores against achievement of these conditions for initiatives where the actual implementation of repairs relied on the existing predominant sector model of community-based operation and maintenance. This difficulty is highlighted in the discussion of the research findings and discussed in the conclusions.

5 QCA FINDINGS

This chapter presents the QCA findings and the team's interpretation of them. In Section 5.1, the achievement of outcome one (successful ICT-based reporting), outcome two (successful processing of ICT-based reports), and outcome three (successful water supply service improvements) is presented for all the cases. In Section 5.2, the different causal patterns are explained for each outcome in turn, and tested against the team's theory of change. The detailed analytical steps taken and related raw data are contained in various annexes that are referenced in this chapter.

5.1 PATTERNS OF SUCCESS IN ICT REPORTING, PROCESSING AND RELATED WATER SUPPLY SERVICE IMPROVEMENTS AMONG THE EIGHT CASE STUDIES

The team scored the eight cases against the three outcomes, with a score of '1' indicating outcome achievement and a score of '0' indicating that the outcome was not achieved. The scoring results are presented in Table 4 and the team's basis for deciding on the scorings are summarised in Table 5.

Table 4: Scoring of outcome achievements

	Smart Handpumps	M4W	Maji Matone	Maji Voice	SIBS	Re-imagining Reporting	Next Drop	Human Sensor Web
Outcome 1: Successful ICT-reporting	1	1	0	1	1	1	1	0
Outcome 2: Successful ICT report processing	1	1	0	1	1	0	1	0
Outcome 3: Successful service improvements	1	0	1	1	0	1	1	0

Outcome one – successful ICT reporting: Six out of eight cases were scored successful, while two cases, Maji Matone and the Human Sensor Web, were scored unsuccessful. In both those cases, the total number of ICT reports received (text messages based on crowdsourcing) were very low. In the case of Maji Matone, a total of 53 messages were received during a six month pilot, and even fewer messages were received under the Human Sensor Web initiative during a similar time window.

Outcome two – successful ICT-report processing: Five out of the eight cases scored as successes. Again, both Maji Matone and the Human Sensor Web were judged unsuccessful. This was because neither a relevant government body nor a

responsible local service provider were involved in the processing of text messages in these cases. In addition, Re-imagining Reporting also scored '0' because of the lack of local government involvement in the processing of the collected data (the processing was done by Water for People staff). It is important to note that even for all cases judged unsuccessful the reported data was actually processed.

Outcome three – successful service improvements: This outcome was scored successful in five of the eight cases. The three unsuccessful cases were M4W, SIBS and Human Sensor Web. In the case of M4W, only 24 per cent of the breakdown reports received via SMS led to successful repairs. In the case of SIBS, most local governments were not using the ICT reported data for sector planning and follow up on non-functional water points. In the case of Human Sensor Web, the initiative had not established a follow up mechanism based on failure reports from users and water kiosk owners with the local service provider, the Zanzibar Water Authority.

Testing against the theory of change

When setting up the three sequential outcomes of successful ICT reporting, ICT report processing and service improvements, the team assumed that outcomes two and three would depend on the achievement of the previous outcomes. However, the results paint a slightly different picture for some of the initiatives.

The Re-imagining Reporting initiative scored a succession of 1-0-1. This is because, although the local government was not involved in processing ICT reports, the data was still fed back and used by local government as a basis for sector planning and budgeting in Bolivia. Maji Matone received a scoring sequence of 0-0-1 due to the fact that only very few (53) text messages were received during the pilot period, and the processing of the reports did not involve local sector staff (the reports were processed by the NGO, Daraja). However, the processed failure reports were forwarded to district water engineers and the local media, and the initiative found in subsequent studies that in 66 per cent of the cases, the problem had been fixed. The team judged the high rate of repairs in the few reported cases as a successful outcome achievement. M4W received a scoring of 1-1-0 because only 24 per cent of the failure reports were addressed, and SIBS had the same scoring sequence of 1-1-0 because the data received on CDs was not consistently used by local sector staff for planning and specific follow up actions on non-functionality of water points.

When analysing the success of the initiatives, the question of scale and the specific aim of the initiative is important. SIBS operated at a national scale, and was first and foremost aimed at improving sector reporting. In that, the initiative succeeded. However, the initiative was not explicitly designed to translate the improved reporting into addressing rural water point functionality. According to the interviewees, this issue is now being pursued, and may thus well be addressed in the future. Similarly, Re-imagining Reporting was geared to support sector budgeting and planning processes in addition to providing data to the NGO, Water for People, for internal purposes. Because SIBS and Re-imagining Reporting aimed to improve water supply services indirectly, via improved budgeting and planning, rather than directly through repairs, these two cases were excluded from the outcome three QCA.

Maji Matone, Smart Handpumps and M4W were explicitly designed to improve rural water point functionality albeit using different reporting, processing and follow-up mechanisms. These types of differences, and how they led to different results, will be explored in detail in the next section.

Table 5: **Information used for judging the outcome achievements for each ICT initiative**

	Smart Handpumps	M4W	Maji Matone	Maji Voice	SIBS	Re–imagining Reporting	Next Drop	Human Sensor Web
Outcome One: successful ICT reporting	1 – ICT devices in hand pumps send data in regular intervals to maintenance service provider	1 – 1,561 SMS received between 2011 and 2014	0 – 53 SMS were received compared to 3,000 targeted	1 – 4,000 complaints received per month, a 10 fold increase compared to before Maji Voice was introduced	1 – WASH facilitators report; at its peak over 96% of the data was accurate and up to date; declined to 60% more recently	1 – Data is successfully collected and updated by RiR staff, students and community	1 – complaints have reduced from 30–10% because users are more informed about their supply	0 – only 5–10 SMS received in the initial period, followed by 2 SMS per week when targeting kiosk owners
Outcome Two: successful ICT report processing	1 – the maintenance service provider processes the data received from hand pumps	1 – the SMS go into the local government system – the district water officer closes the tickets	0 – Maji Matone processes the data received. District water engineers receive a text message from Maji Matone	1 – The service provider is processing 50,000 complaints per year.	1 – SMS reports are processed by the sector government at national level and sent via CD to the local government level	0 – the data is processed by RiR internally, and subsequently shared with the local government	1 – the utility has outsourced the processing of data to Next Drop, but monitors the progress of a complaint through the complaint management system; Next Drop follows up with engineers on their behalf	0 – data processing and reporting was automated and real time through a website. The service provider was not directly involved in the process
Outcome Three: successful water supply service improvements	1 – tenfold reduction in downtime, and 98% of hand pumps functioning	0 – 24% of water points were repaired based on messages received	1 – 66% of reported problems were solved	1 – ticket closure rates increased from less than 50% in first six months to over 90% in second six months	0 – local governments do not use the data on the CD for planning/ repairing	1 – used for annual planning process at district level in Bolivia	1 – the problem resolution rate increased from 30% to 80%	0 – undertaking repairs was not part of the original design. When added later, it failed

5.2 CAUSAL PATTERNS EXPLAINING ACHIEVEMENT OF INDIVIDUAL OUTCOMES

In this section, the different causal patterns leading to success, and to failure, are identified and interpreted. Annex 2 outlines the basic steps taken to arrive at the below analysis. The team had identified the conditions assumed to be important for ICT-based reporting, ICT report processing and successful water supply service improvements in Table 3, Chapter 4. The scoring against each condition provides the basis for identifying the different causal patterns across the eight case studies. Below, the analysis is presented for each outcome in turn.

5.2.1 OUTCOME ONE: SUCCESSFUL ICT-REPORTING

Using Boolean minimisation analysis (see more detailed explanation of the steps taken in Annex 3), the following five conditions lead to four different causal patterns presented in Table 6:

1.1.1: GSM reception
1.1.2: Mobile devices can be charged
1.2.3: Who reports? Crowdsourcing or government/service provider led
1.2.4: User preference for using the ICT mechanism
1.2.5: Costs of reporting are not a problem

Table 6: Causal patterns under outcome one – successful ICT-based reporting

1.1.1 GSM reception	1.1.2 mobile devices can be charged	1.2.3 who reports? Crowd-sourcing or government / service provider led	1.2.4 user preference for using ICT mechanism	1.2.5 costs of reporting are not a problem
Pattern 1 leading to outcome achievement applies to three cases: Smart Handpumps, SIBS, and Re-imagining Reporting				
✓	✓	✓	✓	✓
Pattern 2 leading to outcome achievement applies to two cases: Maji Voice and Next Drop				
✓	✓	✗	✓	✓
Pattern 3 leading to outcome achievement applies to one case: M4W				
✗	✓	✗	✗	✗
Pattern 4 failing to achieve outcome applies to one case: Maji Matone				
✗	✗	✗	✗	✓
Pattern 5 failing to achieve outcome applies to one case: Human Sensor Web				
✓	✓	✗	✗	✓

Three patterns are related to success and two patterns related to failure.

The most popular pattern applies to three of the six successful cases: Smart Handpumps, SIBS, and Re-imagining Reporting. In these three cases, reporting of breakdown is successful when all five conditions are fulfilled. Condition 1.2.3 explains a difference in reporting between initiatives rather than the achievement of a condition. In the present three cases, reporting is service provider-led: in the case of Smart Handpumps, the dominant reporting mechanism is the automatic transfer of hand

pump data via a GSM transmitter built into the hand pump handle; in SIBS, data is collected by WASH facilitators on a regular basis; and under Re-Imagining Reporting, Water for People initiates and organises the data collection process on a regular basis.

Pattern two, which applies to two cases, Maji Voice and Next Drop, is only different in that reports are mainly initiated via crowdsourcing: water users contact the service provider in case of service interruptions. Note that, for Next Drop, the service provider also sends updates to subscribed water users when water becomes available at their particular valve.

The last successful pattern applies to one case, M4W. Only one condition is positive in this case: the mobile phones can be charged (and the fact that reporting takes place through crowdsourcing is not seen as related to non-achievement). ICT-based reporting is successful despite the non-fulfilment of several conditions. Further details about the initiative help to make sense of this outlier result: M4W had persistent problems with GSM reception, particularly in the more remote districts, but this mainly led to the delay of ICT reports rather than failure to receive them. One interview highlighted that, at village level, mainly business people had access to phones, also leading to delays in sending reports, but not necessarily to a failure to send them. People also prefer making a missed call to a known person rather than sending a text to an unknown number, and one interview highlighted that the cost of sending a text message acted as a barrier. A possible explanation for how these issues were overcome in the case of M4W might be the strong back-up support provided by the Triple-S team during the initiative and the length of the pilot (the initiative was active for three years). Strong back-up support by the initiative's supporting organisation may thus present an additional condition that is not currently represented in the present model. A better understanding of the dynamics between users, user committees, hand pump mechanics and district water officers in reporting and follow up actions on the breakdowns provides an interesting topic for a further, in-depth case study in the next phase of this research.

Maji Matone, one of the unsuccessful reporting cases, is similar to M4W in that it relies on crowdsourcing to report faults of rural water supply services. If anything, reporting conditions appear to be more positive than in the M4W case, as costs for reporting are not seen as posing a problem. In addition, the interviews suggested that users had good knowledge of the reporting mechanisms based on extensive advertisement via radio, posters and flyers. In the case of M4W, the removal of stickers with the relevant reporting codes from the water points was considered a major problem. A reason for the seemingly perplexing results could, again, be the continued programme level support provided by M4W and the longer time span of the initiative overall. The pilot of Maji Matone ran for six months whilst the M4W initiative ran for three years.

The Human Sensor Web, the urban reporting initiative in Zanzibar, is the other unsuccessful reporting case. In the case of the Human Sensor Web, neither GSM reception nor charging phones or reporting-related costs were a problem. The initiative was based on crowdsourcing and reports were prompted by specific incidents. Additional factors leading to unsuccessful reporting were related to the design of the pilot programme at the time: the initiative was conceptualised to bring about changes by revealing shortcomings in water provision indirectly through political pressure rather than failure reports directly triggering repairs. This was also the case for Maji Matone, and may provide an additional explanation why Maji Matone was unsuccessful in reporting compared to M4W, where reports directly reached hand pump mechanics.

Another important negative factor in Zanzibar town was that water users were accustomed to experiencing frequent service interruptions and did not expect that their reports would help to remedy the situation. Water users did not trust the Zanzibari water service provider ZAWA. Furthermore, people knew that many interruptions at the particular time of the initiative were linked to electricity shortages, an issue that could not be addressed by ZAWA, and hence did not see the point of making a report. This highlights the importance of contextual factors for successful reporting of water problems.

Comparison of causal patterns with original theory of change

Due to a lack of data across the different cases, the team was unable to explore factors related to the local government or service providers' openness to user feedback and the users' expectation that their feedback would be taken seriously. The reports about the lack of trust in the Zanzibari water service provider ZAWA under the Human Sensor Web is an indication that the trust relationship between users and service providers may be a very important factor in some of the initiatives. However, because of a lack of data across the eight cases, they could not be explored via QCA and therefore remain 'hidden' from this particular analysis.

The review of existing ICT initiatives in the sector highlighted problems regarding users' knowledge about the reporting mechanism and their ability to send a report as important obstacles to success. The literature also emphasised the need to tailor the reporting method to the users' preferences i.e. using voice calls rather than texting as the method for failure reporting. Contrary to the suggestions in the existing literature, condition 1.2.6 (users have sufficient information and knowledge for reporting a breakdown) did not strongly influence the success of reporting water supply functionality across the eight cases. Condition 1.2.4 (users prefer using the ICT mechanism for reporting) was always present when the initiative was successful (a sufficient condition), and is therefore confirmed as an important factor for the initiative's success.

The findings point to a pattern that the team did not identify as crucial in their original theory of change: the dominant successful reporting pattern is linked to regular, government or service provider-led reporting mechanisms rather than initiatives based on crowdsourcing. This points to the continued problems with initiatives aimed at strengthening the voice of water fetchers by directly reporting failures, a point that was highlighted in the literature review (i.e. Hellstroem 2010; McGee and Carlitz 2013), but not specifically picked up by the research team in the identification of conditions. It can be argued that service provider or government-led reporting mechanisms also aim to strengthen user feedback. In the cases where a service provider or government body makes efforts in obtaining information on user satisfaction or service breakdowns can also be interpreted as a move towards increased responsiveness to water users.

5.2.2 OUTCOME 2: SUCCESSFUL ICT REPORT PROCESSING

Using Boolean minimisation analysis (see more detailed explanations on the steps taken in Annex 4), the following four conditions lead to five different causal patterns presented in Table 7:

2.1.1: GSM reception in the local government/service provider office

2.2.1: The government body/service provider has the human resources and knowledge to process ICT related reports

2.2.2: Clarity of procedures for following up on ICT reports

2.2.3 Operational costs are largely met by local/national government or service provider

Table 7: Causal patterns under outcome two – successful processing of ICT reports

2.1.1 GSM reception	2.2.1 human resources to process ICT-reports	2.2.2 clarity of procedures for following up on ICT-reports	2.2.3 operational costs largely met by a local / national government or service provider
Pattern 1 leading to outcome achievement in three cases: Smart Handpumps, Maji Voice, and Next Drop			
✓	✓	✓	✓
Pattern 2 leading to outcome achievement in one case: SIBS			
✗	✓	✓	✓
Pattern 3 leading to outcome achievement in one case: M4W			
✗	✗	✓	✗
Pattern 4 failing to achieve outcome in two cases: Maji Matone and Re-Imagining Reporting			
✓	✓	✓	✗
Pattern 5 failing to achieve outcome in one case: Human Sensor Web			
✓	✓	✗	✗

Three patterns are related to success and two patterns to failure in the processing of ICT-based reports.

For three of the five successful cases, Smart Handpumps, Maji Voice and Next Drop, all four conditions are positive: there is sufficient internet connection/mobile phone reception; the responsible agency has the human resources to process ICT reports; there is clarity of procedures for following up on ICT reports; and the operational costs are largely met by the government body or the service provider rather than a third agency.

The three unsuccessful cases, Maji Matone, Human Sensor Web, and Re-imagining Reporting (pattern four and five) differ from the three successful cases in one particular condition: the operational costs are not met by the government or service provider. A possible reason for the importance of meeting operational costs internally through the government or service provider is that this indirectly expresses the agency's ownership of the initiative, and therefore a commitment to processing ICT reports. The involvement of a relevant government agency or service provider was a key element for scoring this outcome as successful. For the Human Sensor Web (pattern five), the reports were processed automatically with no direct involvement from the service provider ZAWA.[12]

In the case of the other two successful causal patterns (pattern two and three), M4W (pattern three) is again an outlier among the cases scoring success: ICT reports are successfully processed even though only one of the four conditions is positive; and there is clarity of procedures for following up on ICT reports. The availability of support from Triple-S to process the messages helped to mitigate the lack of ICT competencies in processing ICT reports at the local government level. At the same time, the strong reliance on Triple-S for ICT support for funding of operational costs during the pilot phase indicates that this reporting mechanism may struggle to function effectively once

[12] A public website provided real-time information (a map with pictograms) about the amount of complaints received from a public water point.

Triple-S support is withdrawn. This is another reason why following up on M4W with an in-depth case study in phase three of this research will be very interesting.

Finally, the government-led monitoring system SIBS also successfully processes ICT reports (pattern two). In the case of SIBS, human resources, knowledge and back-up ICT support at local government level is not vital for the successful processing of the reported ICT data because the analysis is carried out at the central government level, which is sufficiently resourced to do so. The problem of a working internet connection at the local government level was overcome in this specific case by sending results back on CD and USB. The fact that the operational costs of SIBS are largely met internally is the only positive condition in this specific pattern and hence further confirms the importance of this condition. However, lack of ownership at the local government level may be a significant problem for achieving service improvements based on the mobile phone reports, and hence an issue with the overall design of the initiative. This will be confirmed when analysing outcome three.

Comparison of causal patterns with original theory of change

All eight cases fulfilled the technical conditions of having access to the necessary hardware and software for ICT report processing. As a result, the QCA analysis does not offer any additional explanations with regard to these two conditions. Having adequate equipment to process data is important in all cases, and initiatives may have simply made sure to take the ICT initiative forward in settings where these minimum conditions are fulfilled. Lack of GSM reception or necessary software and hardware to process ICT reports may still pose a problem in the scaling up of initiatives.

GSM reception and back-up support to solve ICT related problems - the two other conditions related to the enabling environment - feature among the four conditions with the highest explanatory power, but only in conjunction with other conditions. The two other conditions important here are the availability of human resources to process reports, and that related operational costs are largely met internally. The conjunction of these conditions confirms the findings in the literature that the initiative needs to be properly anchored within the local government or service provider to achieve successful local processing of reports.

The assumption that ICT initiatives need to be well embedded in government reporting mechanisms is, to some extent, also represented in condition 2.2.3 (operational costs are largely met by the service provider/government body). This condition is very important in explaining the success or failure of processing ICT reports in six of the eight cases, and therefore confirmed as an important factor for the success of ICT processing, in comparison to all other factors under this outcome.

5.2.3 OUTCOME THREE: RURAL WATER POINTS ARE REPAIRED BASED ON ICT REPORTS AND PROCESSING.

The team excluded Re-imagining Reporting and SIBS from the outcome three QCA because the initiatives aimed at improving service delivery indirectly via improved budgeting and planning. The remaining six initiatives aimed to improve the service at the specific schemes for which shortcomings were identified via ICT reports. Using Boolean minimisation analysis (see explanation on the steps taken in Annex 5), the following five conditions lead to four different causal patterns among the six case studies:

3.1.1: There are sufficient funds for repairs
3.1.2: Operation and maintenance responsibilities are clear to all parties

3.1.3: Spare parts are available for the repair
3.1.4: A mechanic is available for carrying out the repair
3.2.1 Accountability mechanisms are in place for acting on ICT reports

The model identifies two successful and two unsuccessful causal patterns (see Table 8).

Table 8: Causal patterns under outcome three – successful water supply service improvements

3.1.1 there are sufficient funds for repairs	3.1.2 operation and maintenance responsibilities are clear to all parties	3.1.3 spare parts are available for the repair	3.1.4 a mechanic is available for carrying out the repair	3.2.1 accountability mechanisms in place for acting on ICT reports
Pattern 1 leading to outcome achievement in three cases: Smart Handpumps, Maji Voice and Next Drop				
✓	✓	✓	✓	✓
Pattern 2 leading to outcome achievement in one case: Maji Matone				
✗	✗	✓	✗	✓
Pattern 3 failing to achieve the outcome in one case: Human Sensor Web				
✗	✓	✓	✗	✗
Pattern 4 failing to achieve outcome in one case: M4W				
✗	✓	✗	✗	✗

The most popular successful pattern applies to three out of the four successful cases: Smart Handpumps, Maji Voice, and Next Drop. In these three cases, all four conditions are fulfilled. In all three cases, a fifth condition, 3.2.1 (responsibilities for acting on the report are clear), is also fulfilled. Two of the successful cases, Maji Voice and Next Drop, operate in an urban environment where the service provider who processes the reports is also responsible for handling repairs. Interestingly, this is also true for the rural Smart Handpumps initiative where the maintenance provider repairs schemes using data received via regular text messages, transmitted via the hand pump handle. This means that in all three cases the same service provider handles reporting, report processing and repairs.

A second successful pattern is represented by Maji Matone. Here, only one of four conditions is positive: spare parts are available for the repair. Problems were reported with funds, clarity of operation and maintenance roles and with finding mechanics to carry out a repair. It is important that conditions 3.1.1 - 3.1.4 are all contextual factors, and that, in the case of Maji Matone, the research team experienced challenges in scoring the outcome achievements, as the fulfilment of conditions vary across water supply schemes (see also Section 4.2). Through Maji Matone, district water engineers were made aware of non-functional schemes and followed up with the communities to remind them of their role and support them in carrying out the necessary repairs, but improving maintenance operations was not part of the initiative. The follow up from the district water office may explain why repairs were carried out despite adverse contextual conditions overall and shows that, despite the overall negative evaluation of the initiative, it was linked to a high number of repairs in the few cases where reports were sent. The success of Maji Matone also needs to be viewed in comparison with the Smart Handpumps project where an improved maintenance model was part of the

ICT initiative. Under the Smart Handpumps project, the average downtime of water points was reduced ten times (from 27 days to three days) and 98 percent of the water points were functional at the end of the pilot phase.

The M4W initiative (pattern four) was scored unsuccessful in leading to service improvements. Only 24 per cent of the schemes reported as broken down via text messages were actually repaired in total. While operation and maintenance responsibilities were clear to all parties, funds, spare parts and mechanics to carry out the necessary repairs were hard to come by according to interviews. Again, the scoring needs to be considered with some caution as the achievement or not of these conditions vary across schemes. Contrary to the Smart Handpump initiative, an improved maintenance model was not an inherent part of the initiative. This may be a decisive factor for the difference in success to improve services between Smart Handpumps and M4W.

Finally, the Human Sensor Web (pattern three) shows a similar causal pattern to M4W, leading to failure to carry out repairs based on ICT reports. In addition to clarity of operation and maintenance responsibilities, spare parts were also judged to be available, but funds were not sufficient and a mechanic not judged to be available in time to carry out repairs. In the case of the Human Sensor Web, though, the failure to repair schemes based on ICT reports is largely due to the lack of a direct accountability mechanism to follow up on ICT reports. A basic assumption in this initiative was that reports on problems with water supply would lead to a build-up of political pressure, which would then shame the responsible water service provider ZAWA into action. However, because citizens were used to the regular service interruptions, and because the interruptions were partly related to electricity problems in the town, very few reports were actually filed. Sufficient political pressure was never built up and ICT reports were not acted on. Within the service provider ZAWA, ICT reports were not perceived as a priority action to dispatch one of the available mechanics to the site in addition to general funding shortages.[13]

Comparison of causal patterns against the original theory of change

It is noticeable that all conditions under the Boolean minimisation model are related to carrying out repairs rather than any factors that relate to the follow-up of ICT reporting results.

In the most popular successful causal pattern, all conditions related to carrying out repairs are fulfilled. As discussed above, these three successful initiatives also have in common that a service or maintenance provider is responsible for carrying out repairs as part of the ICT initiative's model. In all other cases, the repair of broken down schemes was not made an inherent part of the ICT initiative. Maji Matone represents the only case where service improvements were judged successful despite it not being an inherent part of the initiative.

In light of the above, condition 3.2.1 (accountability mechanisms in place for acting on ICT reports) was maybe not formulated strongly enough. While it may be clear who is responsible for following up on the ICT report, this responsibility may not be followed in practice if conditions 3.1.1 – 3.1.4 related to carrying out repairs are not fulfilled (see also Section 4.2 on methodological challenges). This challenge highlights the need for new maintenance models in rural water supply, a well-documented topic in the sector (Lockwood and Smits 2011; Moriarty, Smits, Butterworth and Franceys 2013). The Smart Handpump initiative is a very interesting case study in this context, because it developed an innovative maintenance model. A follow up case study could explore the links between the reporting and maintenance model in more depth.

[13] A couple of years after the completion of the pilot phase, under new directorship, ZAWA did take an interest in HSW as a way to manage functionality. This indicates that leadership at the management of the service provider can be a factor for success.

6 CONCLUSIONS AND NEXT STEPS

6.1 SUMMARY OF QCA FINDINGS

The aim of this phase of the research project was to better understand the factors for success and failure in using ICTs for reporting and taking action on rural water supply service breakdowns by assessing the factors for success and failure between different ICT initiatives.

Among the eight ICT initiatives investigated in this research project, Smart Handpumps, Maji Voice and Next Drop were successful in all three outcomes. This means that, for these initiatives, successful ICT-based reporting took place, ICT reports were processed successfully by the service provider/local government and service improvements were made.

Two ICT initiatives, M4W and SIBS, were successful in the first two outcomes: ICT-based reporting and the processing of these reports. However, these processes did not lead to significant service improvements. For M4W, only 24 per cent of the reported failures were addressed and for SIBS, reports were not used consistently to make service improvements at the local government level. In both initiatives, the lack of success in sustaining water supply services is likely to be related to external factors such as lack of spare parts, availability of mechanics and sufficient funds to carry out repairs. In addition, in SIBS, addressing water supply functionality was not part of the initiative's design.

Two cases had somewhat surprising results in that they were successful in improving services despite being unsuccessful in ICT reporting and/or ICT report processing. For Re-imagining Reporting and Maji Matone, the zero score in relation to report processing is due to the fact that processing was not primarily led by the local government or relevant service provider, but by the supporting agency. In both cases, reports were processed nonetheless. For Maji Matone, reporting was judged unsuccessful because of the small number of reports received in total: 53 text messages compared to the ambitious target of 3,000 within a six month pilot phase.

Table 9 summarises the conditions, organised under external and contextual, that had the most explanatory power when examining the reasons for success or failure under the three outcomes:

Table 9: Summary of conditions that explain successful outcomes

Outcome 1: Successful ICT-based reporting
• GSM reception • Mobile phones can be charged • Reporting is government provider led/based on crowdsourcing • User preference for the reporting mechanism • Reporting costs are not a problem
Outcome 2: Successful ICT-report processing
• There is sufficient GSM reception • ICT back-up support is available • The responsible agency has the human resources and knowledge necessary to follow up ICT reports • Operational costs are also largely met by the government body or the service provider rather than a third agency
Outcome 3: Successful water supply service improvements
• Funds are sufficient for carrying out the repair • Operation and maintenance responsibilities are clear to all parties • Spare parts are available for the repair • A mechanic is available for carrying out the repair. • Accountability mechanisms are in place for acting on reports

From the analysis of the eight initiatives, the team suggests that ICT initiatives for reporting on water supply functionality are more likely to be successful if the reports are government- or service provider-led rather than reliant on crowdsourcing, and when users prefer the reporting mechanism. The fact that crowdsourcing initiatives were less successful compared to service provider-led initiatives in improving services confirms the caution in the existing literature (see Section 3) that citizens might not want or have the knowledge and capacity to pro-actively engage through ICTs to improve water supply services.

The processing of ICT reports is more likely to be successful if the related operational costs are met by a government body or service provider and not by a third agency such as an INGO.

Repairs are more likely to take place if there are sufficient funds, spare parts and a mechanic is available. The three initiatives where maintenance was carried out by the same party that received and processed reports, were successful in all three outcomes. This is an interesting finding in relation to the aim of empowering citizens via ICT initiatives.

Considering external factors that impact on success of ICT initiatives for reporting on water supply functionality, it can be concluded that key factors that need to be present include mobile phone reception, availability of mobile phone charging facilities and affordability of reporting. For processing of ICT reports, the key factors include internet connection, human resources and knowledge for processing and the availability of back-up support to solve any problems with ICTs. Finally, for service improvements to be made successfully, the key factors are that funds, spare parts and a mechanic are available for the repairs, and that the responsibilities for operation and maintenance are clear to all parties. For service improvements to be guaranteed, it may be necessary to internalise these four factors into the ICT initiative itself.

Another factor to take note of is that, of the eight initiatives considered, two were urban initiatives (Next Drop in India and Maji Voice in Kenya). Of the three initiatives that were judged to be successful on all three outcomes, two of these were the urban initiatives. These initiatives differ significantly to the rural initiatives as they involve piped water supply and paying customers, and mobile phone reception and charging facilities are much more available. The maintenance model of the successful rural initiative, Smart Handpumps, also included upfront payments and pooling of financial resources among a number of water user committees.

6.2 REFLECTIONS ON THE APPLICATION OF QCA

Phase two of this research project has given the team a thorough, systematic and methodologically rigorous grounding of factors that can impact ICT initiatives' success or failure. The contribution of this research phase is thus of a methodological nature.

As stated in Section 4, QCA aims at identifying different causal patterns that led to the achievement of an outcome, versus patterns that were not successful in achieving the same outcome. The emphasis in the comparative analysis is on explaining diversity. In the interpretation of the data, the researcher identifies diverse patterns as a basis for providing recommendations to policy makers and practitioners.

The advantage of QCA is that it encourages a systematic cross-case analysis because the researcher is required to focus his/her comparison on a limited number of conditions. The QCA analysis in this report brought to light a number of different successful and unsuccessful patterns for each outcome. At the same time, some clear messages emerged for NGOs and governments who are currently experimenting with ICTs in supporting the sustainability of water supply services, as discussed in Section 5 and 6.1.

However, whilst the QCA method has been useful in allowing comparison of eight very different initiatives, there are also a number of caveats. The method can result in some of the specific details of the initiatives not being considered during the analysis. For example, the research team perhaps did not include a condition that captured one of the key differences between the initiatives and hence that difference was not considered. Similarly, failure to collect sufficient data on a specific case or condition automatically leads to the omission of either the condition or the case from the analysis (for example on the trust relationship between users and the government/service provider). This systematic comparison across cases may become problematic when data availability on some determinant conditions is limited.

In QCA, it is important to carefully choose cases with the same definition of success. The ICT initiatives in this study had applied somewhat different criteria for measuring their success, and success had not always been rigorously assessed by the initiative itself. Two of the ICT initiatives (Re-imagining Reporting and SIBS) aimed at improving planning and budgeting for improving water services rather than leading directly to the implementation of repairs. Hence, only the remaining six cases were included in the QCA against outcome three.

Finally, it was difficult for the team to judge the fulfilment of some of the conditions for some case studies. To take an example, the M4W initiative was implemented in eight districts in Uganda. The conditions for a repair included the availability of spare parts, funding and a mechanic to carry out repairs. Among these districts, these conditions are fulfilled for some water points but not for others. In such cases the question becomes whether, overall, this condition is more likely to be achieved or not. The team took time to debate the fulfilment of each condition, and also re-evaluated the

scoring of some conditions that appeared contradictory during the interpretation of the QCA analysis results. Actively questioning the scoring of conditions was important for validating the inputs that went into the QCA analysis.

The following forthcoming resources might be useful for researchers interested in applying QCA:

- a step-by-step guide to QCA by Barbara Befani
- a Centre for Development Impact practice paper on QCA that will discuss the application of QCA in the context of impact evaluations

6.3 NEXT STEPS

The team expects that the next research phase, the in-depth case studies, will generate substantive contributions, namely new factors that the sector is not yet aware of.

The next stage of the project is to examine in more detail the specific governance dynamics affecting the reporting and addressing of rural water service sustainability through two in-depth case studies from among the eight mapped initiatives. Through field observations, semi- structured interviews and focus group discussions, the in-depth cases will provide further insights on gendered intra-household, intra-community and sector institutional dynamics that hinder or support reporting and addressing of rural water service sustainability issues. This will enable the research team to gain more insight into the technological and non-technological factors that affect success or failure of ICT initiatives for improving rural water supply functionality. The research results from the QCA study have provided some specific pointers for follow up regarding these dynamics. The team has identified one potential in-depth case study under each of the three outcomes:

Outcome one: Successful ICT reporting: It would be interesting to better understand the ICT reporting dynamics in the M4W case study where reporting was successful despite the non-achievement of several conditions. The case study aims to follow successful and unsuccessful reporting cases to better understand the intra-community reporting dynamics that enabled or inhibited successful reporting.

Outcome two: Successful ICT report processing: SIBS is the only regular sector wide monitoring initiative that has been successful in regularly updating water supply monitoring data over a number of years. Nonetheless, this case has never been documented, and how government, internal report processing works is not well understood in the sector. WaterAid Timor Leste and the sector government are currently discussing a second phase of SIBS, and an in-depth case study documenting the reporting and report processing mechanisms of SIBS. Exploring the extent to which data has been used for planning would provide a useful contribution to the Timor Leste stakeholder, and the sector more widely.

Outcome three: Closing the loop through successful repairs: A third follow-up opportunity is the Smart Handpumps initiative, particularly the relationship between the design of the ICT reporting mechanism and the related water supply maintenance model. An interesting confirmation of the literature from this research phase was that the three initiatives successful in all three outcomes had in common that reporting, report processing and follow-ups were all service provider-led. Among these, the Smart Handpumps initiative was the only rural case study. It would be interesting to further investigate the effects of the improved maintenance model, and how this is perceived by water users.

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ANNEX I SUMMARY OF THE INITIATIVES SELECTED FOR IN-DEPTH RESEARCH

I. MOBILE PHONES FOR IMPROVED ACCESS TO SAFE WATER (M4W), UGANDA:

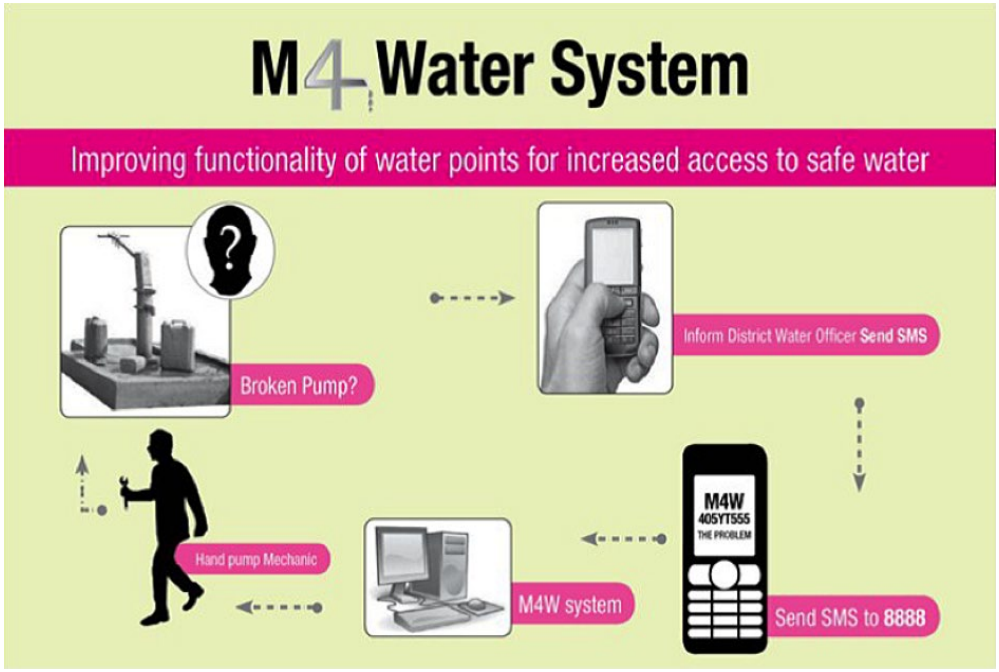
Summary of the initiative: This initiative aims to improve the functionality of rural drinking water sources by reducing downtime through use of timely, actionable information: a user with a broken pump sends a text message to the system, which sends a message to a mechanic to go to the site.

Scope and timeframe: The initiative was launched in 2011 and finished in October 2014. It is hoped that the Ministry of Water and Environment will continue this initiative. The pilot project covered eight districts, Arua, Kasese, Kyenjojo, Kabarole, Masindi, Amuria, Lira and Katakwi.

Who supports the initiative? The initiative was implemented by a consortium of partners including SNV, IRC/Triple-S, Makerere University, WaterAid and the Ministry of Water and Environment. The initiative has now finished but the Ministry of Water and Environment has already expressed interest to conduct an assessment of the M4W system in the eight districts in order to lay down the foundation for scaling up the initiative across other districts in the country (Abisa 2014).

How it works: If there is a problem with a water source, the user sends a text message to the code 8888, indicating the source identification number and the nature of the problem. Once the system receives the notification, it generates a text message which is automatically sent to the relevant hand pump mechanic's phone. Upon receiving the message, the mechanic goes to the source in question to assess the magnitude of the fault. If the fault is minor, the mechanic advises the community on the necessary action and they pay for this through their water user fees collected by the water user committee. For major faults, the district water office is informed and will often support with the repair of the breakdown. Each fault attended to by the hand pump mechanic is reported to the system and the user that sent the initial text message is also given feedback. The district water officers are responsible for keeping track of the reports made and check if repairs have been carried out, and then mark on the system that the report has been dealt with once this has been confirmed.

Figure 2: Information flow under M4W



Source: SNV World (2013)

Measurement of success: The M4W project team have not yet defined what critical mass of reports received and responded to on rural water supply functionality is required to judge the ICT initiative as a success. As an alternative to this, the M4W team have focused on judging success by assessing progress against three key objectives that were set out when the M4W project was started:

- Improve efficiency in reporting faults on water sources – quicken the process of reporting and responding to faults, with an aim of no more than two weeks (ideally two days) between a report being made and a response by a mechanic
- Reduce the time of non-functionality of water points
- Regular acquisition of data for updating of the District Water Management Information Systems at reduced costs.

According to the available M4W reports, these objectives have largely been achieved (IRC, SNV, & Ministry of Water and Environment Uganda 2013). Data collection has improved at the local level and hence there is more up to date and accurate data available at the national level for planning purposes. Almost 10,000 water sources were monitored using the M4W system across the eight districts in the country in October 2014. Within the pilot project, it was discovered that 19 per cent of the water sources in the pilot districts had not previously been captured on the Ministry of Water and Environment database. These water sources were given water source identifiers by the M4W project and were subsequently included on the Ministry database and monitored by the district water officers (Abisa 2014a). The district water officers can easily extract data on non-functional water sources by type of technology and this can be used for planning purposes. The digital system also provides instant data on reasons for non- functionality of particular water sources and number of water sources with water user committees, hence helping the district water officer to collect data that would be otherwise costly to collect using the paper system. This data collected through M4W is also accessible to the public (Abisa 2014b).

The M4W briefing note for the Joint Sector Review (IRC et al. 2013) states that a comparison between the data from the Joint Sector Review in 2012 and the data collected by M4W 2013 shows an upward trend in functionality in seven of the eight M4W implementing districts. However, a comparison of the Sector Performance Reports data for the eight implementing districts for the years 2011, 2012 and 2013 reveals some improvements in functionality in only Arua, Lira, Kabarole and Amuria districts.[14]

In addition, according to a report by Dr Peter Wakholi of Makerere University, whilst great effort has been made to collect monitoring data, little has been achieved in using this data to improve safe water access for rural communities (Wakholi 2013). There is some concern that the uptake of M4W by the communities and hand pump mechanics has been quite slow. The upward trend in functionality may therefore actually be due to other interventions, including the formation of Hand Pump Mechanics Associations and sensitization of the communities on the relevance of contributing operations and maintenance funds (Abisa 2014).

Since October 2011 the system has received at least 1,561 messages reporting faults, of which 377 (or 24 per cent) have resulted in the water points being fixed (Abisa 2014a). However, this data may not be accurate as some mechanics do not send an update once a repair has been made and often the district water offices fail to close the 'ticket' when the repair has been carried out, making repairs difficult to track.

2. MAJI VOICE, KENYA

Summary of the initiative: This project seeks to improve service standards in the urban water sector by putting in place better accountability systems. Maji Voice is a new accountability software that aims to make water providers more efficient and accountable to the public. The system allows consumers to easily report and track complaints, query bills and receive updates on their mobile phones. It provides utility staff with a task-management software to process and analyse incoming complaints, and compiles automatic statistics for the regulatory authority.

Scope and timeframe: This is an urban initiative that was introduced at the end of 2013 and is currently live in four cities: Nairobi, Nakuru, Mathira and Thika. It is important to note that the Maji Voice initiative is primarily focused on paying customers with accounts rather than on community water points.

Who supports the initiative? The project was financed and introduced by the World Bank but the formal owners are the utility operators (Nairobi Water Company in Nairobi). Maintenance of the system is carried out by the World Bank for larger problems but ICT staff at Nairobi Water Company have also been trained to carry out the more day to day running of the system.

[14] This discrepancy could be related to differences in accuracy between the two surveys, and also due to the fact that M4W does not provide data on all sub-districts within a district.

Figure 3: Illustration of text message from user under Maji Voice

Source: Majivoice.com

How it works:

There are five options available to users for making a report:

- text message
- USSD shortcode messages[15]
- through the internet site, accessed by computer or mobile phone
- at the service centre itself
- through calling the hotline.

Over the counter complaints at the service centre and hotline number are still the most popular ways of contacting the utility because customers are more familiar with these channels compared to the website. No matter how a complaint is made, the user will always receive a text message to their mobile phone after making it to give them a reference number for this complaint that they can use to follow up.

Maji Voice aims to assist Nairobi Water Company to process incoming customer feedback more efficiently. Using Maji Voice, complaints can be received, organised, assigned to relevant departments, then tracked and escalated to management for further action. These functions create a structure of accountability within the organisation and allow feedback to be processed faster and more reliably.

Measurement of success: The key success criteria identified by Maji Voice are:

1 Adoption and use of the system by the staff within the utility company: the system enables tracking of how many staff log in and actually use the system. In both Nairobi and Nakuru, around 300 staff use the system every day and over 4,000 complaints have been received.
2 More efficient water service providers: Maji Voice assists Nairobi Water Company to process incoming customer feedback more efficiently. The company manages over 250,000 accounts and now receives over 4,000 customer issues and complaints per month (a tenfold increase compared to before it was introduced). So far, almost 50,000 individual issues have been processed by Maji Voice, with steadily improving complaint closure rates. Closure rates of 'complaint tickets' 'increased from less than 50% in the first six months to over 90% in the second six months. The closure rate is' is now over 100 per cent which indicates that tickets are being closed more quickly than being received and hence the backlog is also being reduced. Each year, 40,000-50,000 complaints are received through Maji Voice representing 20 per cent of the overall number of account holders.

[15] Unstructured Supplementary Service Data (USSD) is a protocol used by GSM cellular telephones to communicate with the service provider's computers. USSD can be used for WAP browsing, prepaid call back service, mobile-money services, location-based content services and menu-based information services. Unlike Short Message Service (SMS) messages, USSD messages create a real-time connection during a USSD session. The connection remains open, allowing a two-way exchange of a sequence of data. ("Unstructured Supplementary Services Data (USSD)". TelecomSpace)

3. MAJI MATONE, TANZANIA

Summary of the initiative: Daraja is a Tanzanian not-for-profit company, based in Njombe that develops tools and encourages citizens to report water point functionality in their areas. Daraja piloted the Maji Matone initiative in 2010/11 aiming to use mobile phone technology to give citizens in rural Tanzania a new channel to report on broken down water points and to use local media to amplify these reports and put pressure on local government departments to resolve the reported problems (Daraja Development Ltd 2013).

Scope and timeframe: The pilot phase of the project launched in late 2010 in three districts, Njombe, Mbozi and Morogoro Rural, and ran for six months. However, the pilot was declared as a failure by Daraja because citizens' engagement fell far below expectations.

Who supported the initiative? The initiative was run by a small Tanzanian NGO, Daraja, in partnership with Twaweza, an independent initiative focusing on large-scale change in East Africa. Additional funds came from the UK's Department for International Development (Taylor, n.d.).

How did it work? When a breakdown occurred, a community member could send a text message to a shortcode number. They would then receive an automated response thanking them for their message and explaining what next steps will follow from this. This text would be automatically received by the Maji Matone team and it would then be forwarded to the mobile phone of the district water engineer, and to a local journalist. If this was not acted on within three weeks, further messages would be sent and, if this continued, journalists were further informed that actions were not being taken. The aim therefore was to pressure local governments to act to help the communities with breakdowns. Partnerships with local radio stations were established in the three pilot districts, under which weekly programmes on rural water supply were broadcast. Programmes included documentary slots on rural water supply policy and budgets, as well as journalists following up on water point breakdowns as reported by text messages, and on actions taken or promised by district water engineers in response (Daraja Development Ltd 2011).

Measurement of success: A total of 53 usable text messages were received, compared to a target of 3,000 messages, (which, arguably, was very ambitious). This led to Daraja to discontinue the project after the pilot phase and to declare it a failure. Though the level of engagement with the programme, as shown in the number of usable SMS messages received, was well below targets, the programme was very effective at turning information received into actions taken to fix the reported problems. By the end of the pilot period actions had already been taken by district water engineers to solve 21 of the 53 reported problems. A second follow up, six months later, found that a further 14 water points had been fixed as a result of the programme. This is equivalent to two thirds (66 per cent) of the reported problems resulting in the problem being solved (Daraja Development Ltd 2013).

4. NEXT DROP, INDIA

Summary of the initiative: Next Drop's real-time data and messaging system uses SMS to inform water users who have subscribed to the service about when they will be receiving water, when there is a delay, when pipe damage is likely to affect them, and when someone in the community has water updates to share. The ICT initiative works to connect the utility that manages the water system with the citizens who use it so that they know when they can expect water and, if they are not receiving water, the reason for this and when it is likely to return.

Timeframe and scope of the initiative: Next Drop began operations in 2010, in Hubli-Dharwad, twin cities in the southern state of Karnataka and then expanded to Bangalore and Mysore. The utilities in these cities are charged for Next Drop's services. It is focused on municipal water supply that is paid for by residents.

Who supported the initiative? Next Drop is a for-profit social enterprise. The utility is charged for the dashboard and the service for citizens – typically one rupee per month for each citizen and 400 rupees per month for each utility licence for the dashboard (every engineer that uses the dashboard requires one licence and there are approximately 800 licences in Bangalore).

How it works: In the urban areas in which Next Drop works, users rely greatly on the one to two hours of supply that they receive from the water board (utilities) each day. The utilities contract Next Drop to provide the service and then provide regular information to Next Drop through the water board's valvemen. This information includes the times that valves will be turned on and off, and any maintenance works planned which may affect supply. There are set schedules for water supply but there are often changes and delays and the valvemen are the most up to date on the changes that will occur. The valvemen give the information to Next Drop by calling a toll free number (once they connect, they choose option one to say that they are opening the valve now, option two if they are giving information about the schedule ahead of time and option three if the scheduled service is cancelled.) Valvemen use a particular identification number to identify the valve, and every water user who is subscribed to that valve identification number receives the information about the supply in an automatic text message. Recently a smartphone application has been introduced and the valvemen have started to use this to share information about water supply with Next Drop rather than the toll free number. The smartphone is attached to the valve by the valvemen and the application automatically records when the valve is being opened or closed, plus any issues with the valve, enabling a text message to automatically be sent to the users in that valve area.

Subscribers contact Next Drop if they are receiving the wrong information or if they are experiencing any problems with their supply. They usually report problems using missed call numbers set up by Next Drop. Problems include lack of supply, contamination and leakages. When the Next Drop team receive a missed call, a representative calls them back to collect the relevant information. This is then shared with the water board and followed up on by engineers and valvemen if appropriate (both of these are employed by the water board/utility). The Next Drop team will then call the user again with any further updates.

Measurement of success: Next Drop measures success by carrying out surveys to see if customers and the utility value the service. Next Drop's water alert system has already shown that the water related complaints have reduced from 30 per cent to 10 per cent since Next Drop was introduced. This is because more users are informed

about what time they are likely to receive supply and about any problems with their service, and so they have less reason to complain. In Bangalore, where Next Drop are also managing the complaint management system, complaints are being resolved much more quickly than they were previously with the resolution percentage increasing from 30 per cent to 80 per cent. Next Drop have been able to ensure that engineers are informed more promptly about problems. In the other cities in which Next Drop works, they are only responsible for the valve monitoring and reporting system whilst other private companies are contracted to manage the complaints management systems. There is no data available about the complaint resolution percentages for Mysore and Hubli-Dharwad.

5. WATER AND SANITATION INFORMATION SYSTEM (SIBS), TIMOR LESTE

Summary of the initiative: SIBS is a water supply monitoring system led by the national government of Timor Leste in which data on water point coverage and functionality is collected by district government staff every three months. The aim of the SIBS national monitoring tool is to:

- Manage and monitor water services in rural areas at the sub-district, district and national level.
- Monitor sanitation and hygiene coverage in rural areas.
- Provide evidence for government planning and investment in service delivery.
- Measure progress towards the national targets for water and sanitation.
- Measure functionality down to the village level.
- Allow analysis of key aspects of sustainable service delivery.

Scope and timeframe: SIBS was developed in 2010 and transitioned to full use of mobile phone technology in 2012. It now covers all rural villages in Timor Leste.

Who supports the initiative? The Australian Department for Foreign Affairs and Trade (DFAT) funded the set-up of the initial system. Many of the costs are now being covered by the Government including replacement phones and Compact Discs (CDs)/Universal Serial Bus (USBs) to send the data to the local government offices. In addition, the staff that collect the data are government staff and the central government pays for their salaries, fuel costs and motorcycle repairs. DFAT provides an expatriate Information Management Systems Adviser who works with the Timor Leste government to keep strengthening the system. In addition, DFAT still cover some running costs including the airtime top ups for the mobile phones.

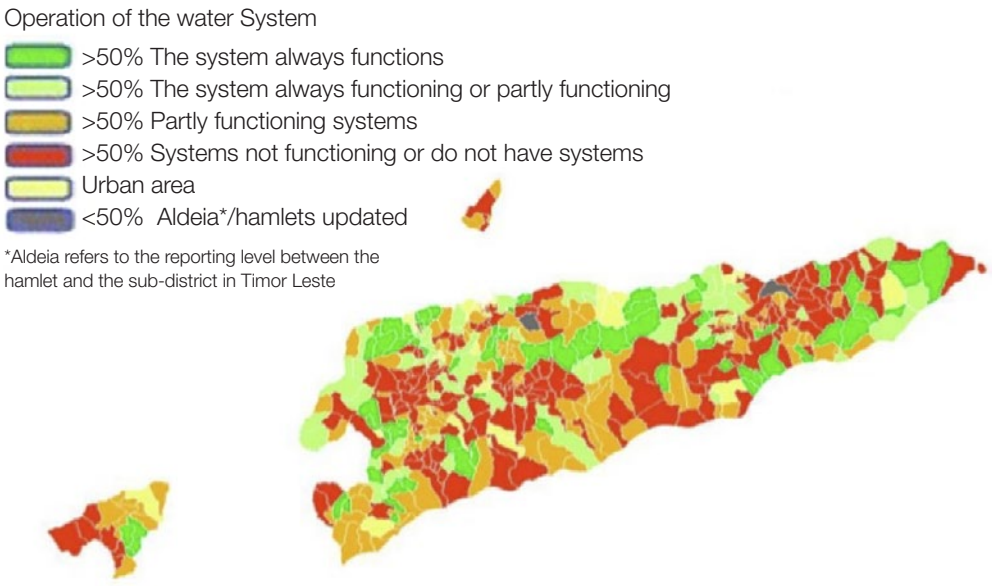
How it works: The data is collected every three months and sent using text messages via mobile phones to a central database at the national level. The government staff responsible for the data collection are called 'Water, Sanitation and Hygiene (WASH) facilitators' and they also responsible for visiting communities and supporting them to manage their water system. Therefore, the data collection is part of their day to day work. The WASH facilitators collect data on a number of indicators:

- Number of households (served and unserved)
- Time taken to collect water
- Adequate water supply
- Water system functioning status
- Water quality and level of water source protection
- System management including whether there is a Water User Committee/Group and

if funds are being collected and repairs being undertaken.
- Number of women in roles of responsibility in the water user groups
- Access to improved latrine
- Access to unimproved latrine
- Access to shared latrine
- Access to handwashing (with soap) facility
- Open Defecation Free status.

The data collection system includes data on functionality, which is collected periodically by WASH facilitators. It does not provide a system for communities to report if a breakdown occurs. It does, however, enable the sub-district, district and national government staff to monitor coverage and functionality of water services in rural areas, and to track this as it improves or worsens. The aim is that the data collected is used by sub-district, district and national government staff for monitoring and planning purposes. The data is sent via text message to the national database, where it is processed by a member of government staff with support from the DFAT advisor and is made available on the internet. Many local government offices do not have internet and hence cannot access the data online so the data is sent to local government staff on CD/USB. However, this data is displayed in visual format through mapping software and is confusing to many members of government staff hence causing difficulties in them using it for planning.

Figure 4: Water point functionality rates based on mobile phone reports across Timor Leste in 2012



Source: Willets (2013)

Measurement of success: The success or failure of this system is measured by the timeliness and accuracy of the data being collected through the water supply monitoring system. 5 per cent of the data is periodically checked for accuracy by the national government. At its peak, checks showed that 96 per cent of the data held in the SIBS system was accurate and up to date, showing that the district and sub-district government staff (WASH facilitators) were collecting the data every three months as required. However, more recently, checks have shown that the data held is only 60 per cent accurate, showing a decline in data collection by local government staff since this data is not being regularly updated. It is thought that this reduction in data collection is due to management challenges at all levels of government.

6. RE-IMAGINING REPORTING, BOLIVIA

Summary of the initiative: Re-imagining Reporting is a platform to which monitoring data is uploaded. It aims to visually show where the INGO Water for People works, what programmatic results they are seeing, how their finances are allocated, and what is happening in the field. It was developed and is being implemented by Water for People. It aims to provide an interactive, visually compelling way for donors, stakeholders and the public to understand Water for People's progress and outcomes while also allowing for analysis and review of initiatives for programmatic improvements. The term 'Re-imagining reporting' also covers the annual reflection meeting which includes all Water for People partners, including government, NGOs and CBOs, and is an opportunity to reflect on the monitoring data and encourage partners to use it to plan for the year ahead. AKVO Field Level Operation System (FLOW) is the ICT tool that is used for the data collection and monitoring.

Timeframe and scope: The initiative is currently being implemented in nine countries but, for this research, the focus was on the implementation of Re-imagining Reporting in Bolivia. Water for people are currently working in six rural municipalities in Bolivia, each of which includes around 160 communities. The focus is on reaching everyone ("Everyone Forever") in those municipalities first, before scaling up. Water for People held its first reflection meeting in Bolivia in July 2013 using data that had been collected in the municipalities it works in.

Who supports the initiative? In Bolivia, the costs of the introduction of the initiative were met by Water for People. Currently, Water for People still cover much of the costs including for the AKVO FLOW software. However, the municipal governments have started to see the value of the data collection taking place and have started to be trained in data analysis. In some municipalities, the government is now funding 50 per cent of the data collection costs.

How it works: The data is collected using android phones and the AKVO FLOW software. Data collectors have, over the past three years, included community members, university students and, more recently, a private company. There is a Water for People staff member who supports each team of data collectors and brings the data back to the office to be uploaded. Municipal government staff are also being trained in the data collection. Once the data has been collected, the local Water for People offices do the first round of data cleaning before it is passed up to the Water for People headquarters. If the municipal governments take over the data collection in future, Water for People would continue to lead on the data analysis or build the capacity of government to analyse the data in-house.

Measurement of success: The data is being collected successfully but only in areas in which Water for People works. However, the aim in Bolivia is to further engage the municipal governments in the initiative and to increase their interest in and knowledge of collecting and analysing data. Government monitoring staff are already in place in each municipality and are being trained by Water for People in data collection and analysis. However, staff change quite regularly which causes problems.

7. HUMAN SENSOR WEB, ZANZIBAR

Summary of the initiative: The Human Sensor Web (HSW) initiative aimed to collect data on water supply functionality and quality in Zanzibar Town. The reporting was based on crowdsourcing with users encouraged to send a text message to the water authority if they experienced water shortages. The data is meant to be used by

communities to forewarn against lack of water at kiosks and poor water quality as well as to advocate for better water services (Hutchings et al. 2012).

Scope and timeframe: The initiative covered 50 public water kiosks in Zanzibar Town. The technical trial lasted around 18 months from 2009 to 2011. People could feedback via text messages for around a year but data actually came in for three to six months in total.

Who supported the initiative? The Human Sensor Web was developed by University of Twente, Faculty of Geo-Information Science and Earth Observation, Twente Institute for Wireless and Mobile Communications, and the 52°North initiative. It was implemented in Zanzibar with the support of the Zanzibar Water Authority with two local partners: Zantel, the mobile telephone company partly owned by the Government of Zanzibar and Inet, a local Internet Service Provider. The initiative was also supported by United Nations Habitat and Google.org through the H2.0 Monitoring Services to Inform and Empower Program.

How it works: At each of the 50 public water kiosks, there was a signboard with information about the project and how to report a problem with the water supply by text message using a specific phone number. The messages were required to contain a specific code indicated on the signboard. The original aim was that the service provider, the Zanzibar Water Authority would take action upon reception of a report. A technician would investigate the problem, and if possible, provide a solution. Using a specific code, the technician would report back to the system on the status of the problem and would send a final text message once the problem was resolved. The Human Sensor Web website would be updated accordingly, and the system would send a text message about service restoration to the subscribers and the service provider (Verplanke et al. 2010). A coordinator was employed by the project to publicise and coordinate the initiative locally. However, in practice, follow up from Zanzibar Water Authority did not get embedded in the initiative, so the project remained a technical trial of the reporting mechanism.

Measurement of success: The higher end project goal was to contribute to empower citizens and to make service providers more responsive and to better inform decision makers. In Zanzibar, the project aimed to establish and test the technical reporting mechanism based on the Human Sensor Web approach (Verplanke et al. 2010).

During the initial period, only five to ten messages were received. After that, the local coordinator provided credit to local water kiosk owners who could then send messages using prepaid credit. Even then, only a couple of messages per week were received. It was found that there was little trust among people in the capacity of the local water authority to solve the water problems. Despite a long-running programme, the water authority was still facing image problems, probably tainted by years of bad service provision. People did not see the point of sending a message from which they did not expect to receive any responses. Socio-cultural factors also prevented users of Human Sensor Web from participating in an effective manner, where men typically keep possession of the family mobile phone, which prevented women from being able to report water issues immediately after experiencing service disruptions. Another socio-cultural problem was that local leaders (Sheha) who are traditionally approached for problems with service provision, were not properly included in the design of the reporting procedure. Finally, people reported problems with elaborations in their messages rather than just texting a specified code. This led to error messages, which could not be properly processed by the system (Sung 2010, Yusra 2011 in: McCall et al. 2013).

8. SMART HANDPUMPS, KENYA

Summary of the initiative: Smart Handpumps, an initiative by the Department of Geography and Environment at the University of Oxford, is based on real time monitoring of hand pump downtime. A 'smart hand pump' has a GSM transmitter securely fitted inside the handle of the pump. The transmitter automatically sends data on hand pump use via text message over the mobile phone network.

Scope and timeframe: In 2013, a one year pilot study was implemented in 60 villages in Kyuso district, Kenya, serving 66 hand pumps.

Who supports the initiative: The initiative was implemented by the Smith School of Environment and Enterprise at the University of Oxford in collaboration with Rural Focus in Kenya.

How it works: A smart hand pump has a GSM transmitter securely fitted inside the handle of the pump. The transmitter is small and robust with no moving parts with a specially designed antenna that fits discreetly to the handle. The transmitter monitors how much the handle moves, giving a rough estimation of the volume of water that is being pumped from the well. The device, which is powered by a long-life battery, sends periodic text messages (four batches of data per day) to relay this information to research teams in Nairobi and Oxford. If a pump stops being used, that will show up quickly on the computer interface. A specific maintenance service was introduced to carry out repairs. A member of this maintenance service team can then call someone in the village to ask about the state of the pump. If the pump needs to be fixed, then someone can be dispatched immediately to repair it. In addition, a sticker with a telephone number was attached to each hand pump so that water users could also directly report any breakdown or problem to the maintenance provider (Smith School of Enterprise and the Environment 2014).

Measurement of success: The 12-month trial aimed to design and test a new maintenance model based on timely hand pump functionality data, reduce hand pump down-times and test the 'Smart Handpump' hardware, and to measure the costs of delivering the maintenance service based on the data delivered by Smart Handpumps and evaluate community acceptance of this service.

According to Smith School's Water Programme study (Smith School of Enterprise and the Environment 2014), the 12-month 'Smart Handpump' trial in Kyuso in rural Kenya in 2013 resulted in:

- A ten-fold reduction in hand pump downtime (down from 27 to three days not working)
- A shift to 98 per cent of hand pumps functioning[16]
- A fairer and more flexible payment model contingent on service delivery
- New and objective metrics to guide water service regulatory reform
- A revised financial architecture shaped by an output-based payment model.

The Smith School Water Programme study compared the response rate of smart hand pumps with the response rate of crowdsourced reporting in the same project area, and found that the reports from smart hand pumps were more reliable than the latter, and that hand pumps fitted with a smart device were 50 per cent more likely to be repaired within two days than crowdsourced hand pumps.

16 A baseline survey was conducted in 2012 on 21 water pumps. Of the 21 water pumps, 18 had experienced a failure. No direct comparative figure to the 98% functionality rate is given based on the survey (Smith School of Enterprise and the Environment 2014).

ANNEX 2 ADDITIONAL INFORMATION ON DATA ANALYSIS STEPS FOLLOWED

Step one: Trivial conditions are identified. A trivial condition is one that can be either always present or absent. These conditions may be important for the outcome to occur, but since they are also present in unsuccessful cases, they do not help to explain the differences between successful and unsuccessful cases.

Step two: Necessary conditions are identified. A condition is 'necessary' when it is always present in successful cases but not always present in unsuccessful cases. According to Legewie (2013) "Condition A is necessary for outcome Y if the occurrence of Y is not possible without the presence of A, but A alone is not enough to produce Y". Necessary conditions represent requirements for success.

Step three: Sufficient conditions are identified. According to Legewie (ibid) "condition A is sufficient for outcome Y if Y will always occur if A is present, but other conditions besides A may also produce Y". Sufficient conditions can, by themselves, produce an outcome, but the outcome can also be produced by other conditions.

Consistency and Coverage: According to Ragin (2006) in Legewie (2013), "consistency measures the degree to which a relation of necessity or sufficiency between a causal condition (or combination of conditions) and an outcome is met within a given data set". Consistency values range from '0' to '1'; '0' represents no consistency and '1' represents total consistency.

Coverage measures how empirically relevant a set of necessary and sufficient conditions or combination of conditions are within the dataset.

Step four: Boolean minimisation. The Boolean minimisation process aims to simplify the dataset by reducing the number of combinations of conditions that lead to a specific outcome. Less relevant conditions are taken out (for example trivial conditions) leaving those conditions, mainly sufficient conditions in the model that help to highlight different patterns leading to success. In so doing, so called "causal recipes" (Legewie 2013) are identified, namely combinations of conditions that highlight more general patterns in the dataset, thus minimising complexity.

Step five: Interpretation. Each causal pattern is explained and interpreted in the light of the contextual knowledge about the initiatives.

ANNEX 3 ADDITIONAL INFORMATION ON DATA ANALYSIS FOR OUTCOME 1: SUCCESSFUL ICT REPORTING

Table 10: Scoring of conditions

Outcome 1: Users or their representatives, including government staff, directly or indirectly, use ICTs in the way specified by the initiative to report rural water supply functionality to the local government authority or relevant stakeholder; this could be either through ad hoc crowdsourcing or through government-led, regular updating mechanisms.

	1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5	1.2.6	
	GSM Reception is reliable	ICT devices can be charged	Access to the ICT device	Data collected periodically/ related to specific incidents	Reporting requires human interaction/ is automatic	Reports crowd-sourcing or government/ service provider-led	Preference for using ICT mechanism	Reporting costs are not a problem	sufficient infromation and knowledge for reporting	Outcome
Smart Handpumps Kenya	1	1	1	0	1	1	1	1	1	1
M4W Uganda	0	1	0	1	0	0	0	0	0	1
Maji Voice Kenya	1	1	1	1	0	0	0	1	1	0
Maji Voice Kenya	1	1	1	1	0	0	1	1	1	1
SIBS Timor Leste	1	1	0	0	0	1	1	1	1	1
Re-imagining Reporting Bolivia	1	1	1	0	0	1	1	1	1	1
Next Drop Bangalore, India	1	1	1	1	0	0	1	1	0	1
Human Sensor Web Zanzibar	1	1	0	1	0	0	0	1	0	0

One condition is **necessary** (i.e. always present when success occurs) – 1.1.2: the ICT device can be charged.

A number of conditions are **sufficient**, which means that their presence is invariably linked with success:

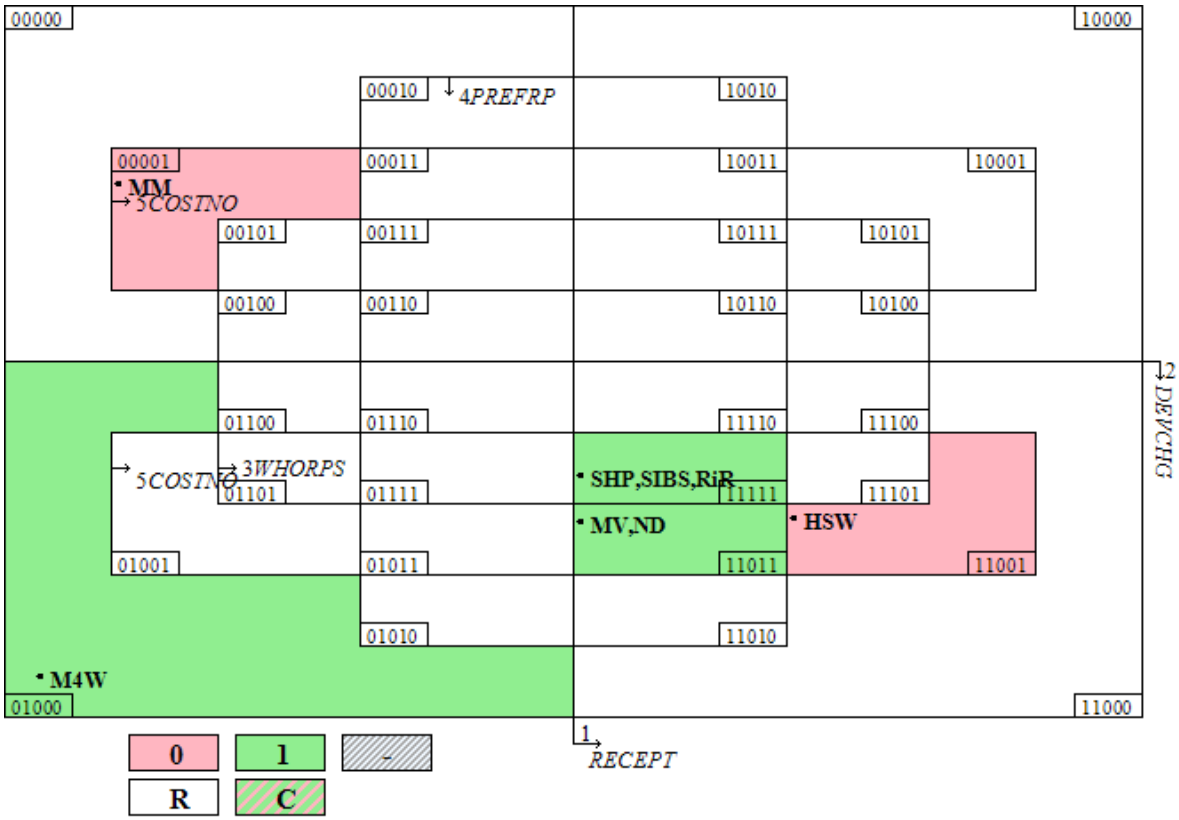
- Condition 1.1.3 (users or their representatives have access to the ICT device), present in four of the eight cases
- Condition 1.2.1 (data is collected periodically or related to specific incidents), present in three out of eight cases
- Condition 1.2.3 (reporting is crowdsourcing or government/service-provider led), present in three out of eight cases)
- Condition 1.2.4 (people reporting the problem prefer using the ICT mechanism), present in five out of the eight cases

Boolean minimisation based on a five condition model including the following conditions:

1.1.1: GSM reception
1.1.2: Ability to charge ICT device
1.2.3: Crowdsourcing or government/service provider led reporting
1.2.4: Preference for using the ICT mechanism
1.2.5: Costs of reporting are not a problem

Solution coverage: 1.000000; solution consistency: 1.000000

Figure 5: Venn diagram for outcome one – five condition Boolean minimisation model



Key

ICT initiatives

HSW	Human Sensor Web
M4W	Mobiles for Water
MM	Maji Matone
MV	Maji Voice
ND	Next Drop
SIBS	SIBS Timor
RiR	Re-imagining Reporting
SHP	Smart Handpumps

Outcome 1 conditions used in the Venn diagram:

1 RECEPT	GSM reception is reliable
2 DEVCHG	ICT devices can be charged
3 WHORPS	Who reports? Crowd-sourcing or government/service provider-led
4 PREFRP	People reporting the problem prefer the ICT mechanism over alternatives
5 COSTNO	Reporting costs are not a problem for the person who reports

ANNEX 4 ADDITIONAL INFORMATION ON DATA ANALYSIS FOR OUTCOME TWO: SUCCESSFUL ICT-REPORT PROCESSING

Table 11: Scoring of conditions

Outcome 2: Local government authority (national sector government, if relevant) or service provider process and follow up on ICT-based reports								
	2.1.1	2.1.2	2.1.3	2.1.4	2.2.1	2.2.2	2.2.3	
	GSM Reception	Availability of computers and electricity	Access to necessary software to store and process data	Access to ICT-back up support	HR and knowledge to process ICT reports	Clarity of procedures for follow-up on ICT reports	Operational costs largely be met by government/ service provider	Outcome
Smart Handpumps Kenya (Oxford University)	1	1	1	1	1	1	1	1
M4W Uganda	0	1	1	1	0	1	0	1
Maji Matone Tanzania	1	1	1	1	1	1	0	0
Maji Voice Kenya	1	1	1	1	1	1	1	1
SIBS Timor Leste	0	1	1	1	1	1	1	1
Re-imagining Reporting Bolivia	1	1	1	1	1	1	0	0
Next Drop Bangalore, India	1	1	1	1	1	1	1	1
Human Sensor Web Zanzibar	1	1	1	1	1	0	0	0

One condition is **necessary** (always present in successful, but not always present in unsuccessful cases).

- Condition 2.2.2 (clarity in procedures for follow up on the ICT reports). It is present in all successful cases but also present in Maji Matone and Re-imagining Reporting even though these cases had unsuccessful outcomes.

Several conditions are **sufficient** as single conditions (whenever they are observed, the case is successful).

- Condition 2.2.3 (the operational costs of reporting are largely met by the government / service provider), present in four out of the eight cases.

Boolean minimisation model based on the following four conditions:

2.1.1: Internet/GSM reception in the local government/service provider office

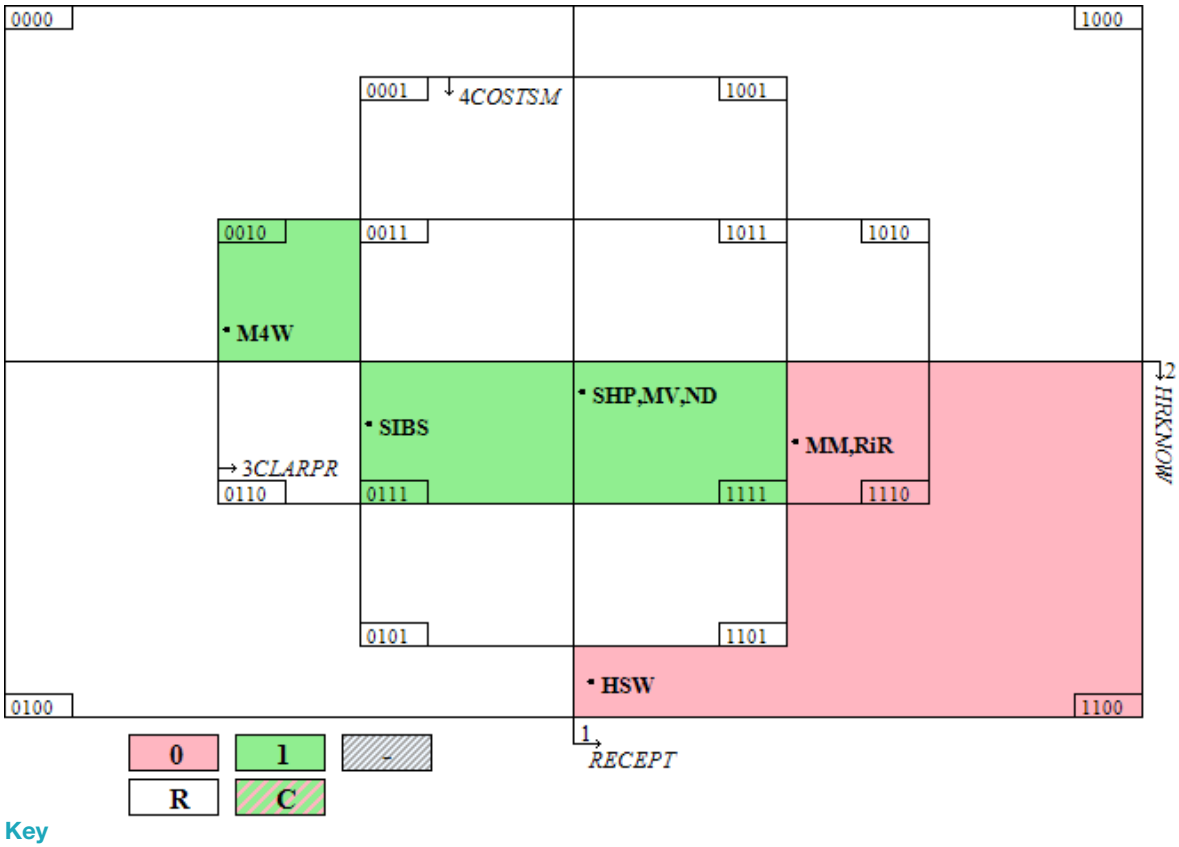
2.2.1: The local government authority/service provider has the human resources and knowledge to process ICT-related reports

2.2.2 Clarity of procedures for follow-up on ICT-reports

2.2.3: The operational costs are largely met by the local government authority/service provider

Solution coverage: 1.000000; solution consistency: 1.000000

Figure 6: Venn diagram for outcome two – four condition Boolean minimisation model



Key

ICT initiatives

HSW	Human Sensor Web
M4W	Mobiles for Water
MM	Maji Matone
MV	Maji Voice
ND	Next Drop
SIBS	SIBS Timor
RiR	Re-imagining Reporting
SHP	Smart Handpumps

Outcome 2 conditions used in the Venn diagram:

1 RECEPT	GSM reception at local government/service provider office environment
2 HRKNOW	The responsible agency has sufficient human resources and knowledge to process ICT reports
3 CLARPR	There is clarity in procedures for following up on ICT reports
4 COSTSM	The operational costs are largely met by the local government/ service provider

ANNEX 5 ADDITIONAL INFORMATION ON DATA ANALYSIS FOR OUTCOME THREE: SUCCESSFUL WATER SUPPLY SERVICE IMPROVEMENTS

Table 12: Scoring of conditions:

Outcome 3: Water points are repaired based on ICT reports and processing							
	3.1.1	3.1.2	3.1.3	3.1.4	3.2.1	3.2.2	
	GSM Reception is reliable	ICT devices can be charged	Access to the ICT device	Data collected periodically/ related to specific incidents	Reporting requires human interaction/ is automatic	Reports crowd-sourcing or government/ service provider-led	Outcome
Smart Handpumps Kenya	1	1	1	1	1	1	1
M4W Uganda	0	1	0	0	0	1	0
Maji Matone Tanzania	0	0	1	0	1	1	1
Maji Voice Nairobi	1	1	1	1	0	0	1
SIBS Timor Leste	0	0	0	0	0	1	0
Re-imagining Reporting Bolivia	1	1	1	1	0	1	1
Next Drop Bangalore, India	1	1	1	1	1	1	1
Human Sensor Web Zanzibar	0	1	1	0	0	1	0

Two initiatives are omitted from the QCA: SIBS and Re-imagining Reporting.

There is one **trivial** condition: 3.2.2 (the ICT initiative supports existing sector responsibilities for operation and maintenance). While this condition is important for a successful follow up, it is fulfilled in all cases and does therefore not add value to the comparative analysis between the different levels of success.

Two conditions are **necessary**:

3.1.3 (spare parts are available for the repair)

3.2.1 (accountability mechanisms are in place to ensure that ICT reports are acted on)
Three individual conditions are identified as sufficient (when they are observed, the case is always successful).

3.1.1 (funds are sufficient for the repair), present in four out of six cases

3.1.4 (a mechanic is available to carry out the repair), present in three cases

3.2.1 (the local government/service provider has accountability mechanisms in place to make sure the reports are acted on), present in four out of six cases.

The **Boolean minimisation** model is based on five conditions:

3.1.1: Funds are sufficient for carrying out the repair

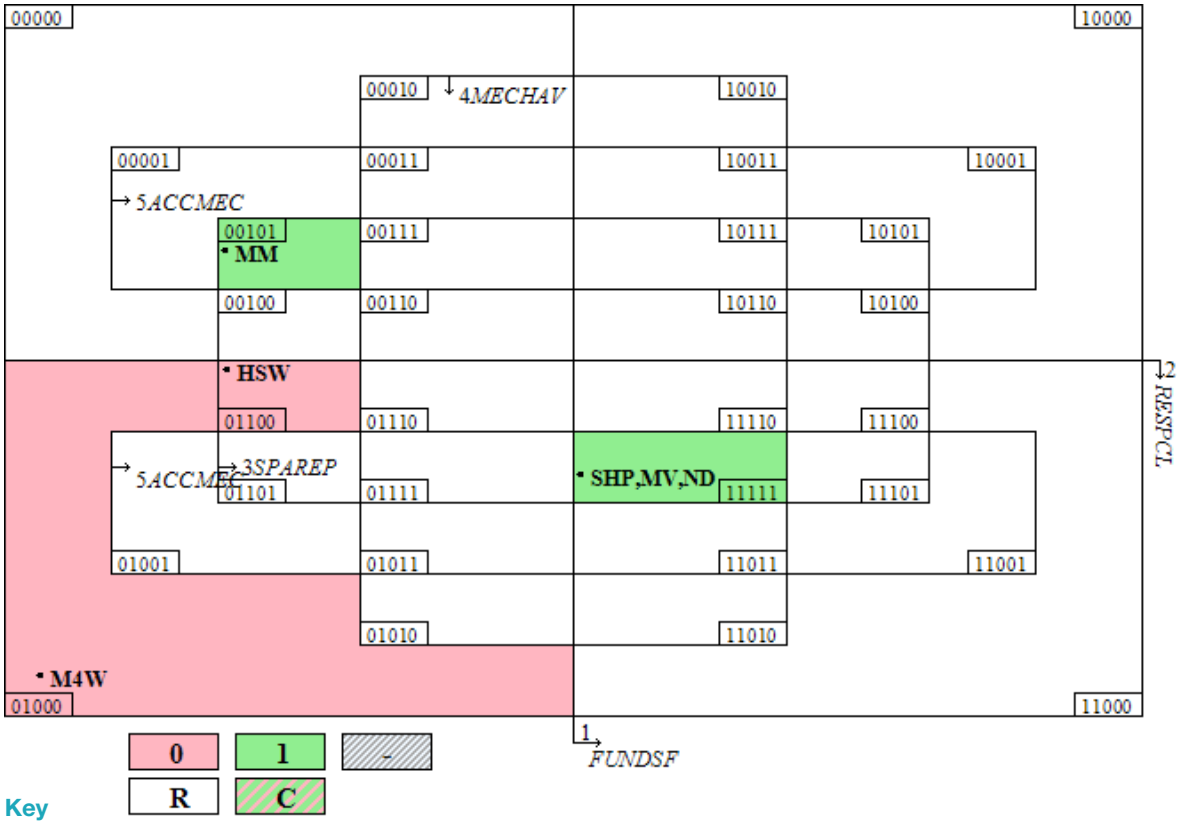
3.1.2: O&M responsibilities are clear to all parties

3.1.3: Spare parts are available for the repair

3.1.4: A mechanic is available for carrying out the repair

3.2.1: Accountability mechanisms are in place to ensure that ICT reports are acted on
Solution coverage: 1.000000; solution consistency: 1.000000

Figure 8: Venn diagram for outcome three – five condition Boolean minimisation model



Key

ICT initiatives

HSW	Human Sensor Web
M4W	Mobiles for Water
MM	Maji Matone
MV	Maji Voice
ND	Next Drop
SIBS	SIBS Timor
RiR	Re-imagining Reporting
SHP	Smart Handpumps

Outcome 3 conditions used in the Venn diagram:

1 FUNDSF	There are sufficient funds for carrying out the repair
2 RESPCL	Operation and Maintenance responsibilities are clear to all parties
4 MECHAV	A mechanic is available to carry out repairs
5 ACCMEC	The local government/service provider has accountability mechanisms in place to make sure reports are acted on

MAKING ALL VOICES COUNT

A GRAND CHALLENGE FOR DEVELOPMENT

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ABOUT MAKING ALL VOICES COUNT

Making All Voices Count is a programme working towards a world in which open, effective and participatory governance is the norm and not the exception. This Grand Challenge focuses global attention on creative and cutting-edge solutions to transform the relationship between citizens and their governments. We encourage locally driven and context specific change, as we believe a global vision can only be achieved if it is pursued from the bottom up, rather than the top down. The field of technology for Open Government is relatively young and the consortium partners, Hivos, Institute of Development Studies (IDS) and Ushahidi, are a part of this rapidly developing domain. These institutions have extensive and complementary skills and experience in the field of citizen engagement, government accountability, private sector entrepreneurs, (technical) innovation and research. Making All Voices Count is supported by the U.K Department for International Development (DFID), U.S. Agency for International Development (USAID), Swedish International Development Cooperation Agency, and Omidyar Network (ON), and is implemented by a consortium consisting of Hivos (lead organisation), the Institute of Development Studies (IDS) and Ushahidi.

RESEARCH, EVIDENCE AND LEARNING COMPONENT

The Research, Evidence and Learning component's purpose is to contribute to improving performance and practice and build an evidence base in the field of citizen voice, government responsiveness, transparency and accountability (T&A) and Technology for T&A (Tech4T&A). It is managed by the Institute of Development Studies, UK, a leading global organisation for research, teaching and communication with over thirty years' experience of developing knowledge on governance and citizen participation.

ABOUT WATERAID

WaterAid is an international organisation whose mission is to transform the lives of the poorest and most marginalised people by improving access to safe water, sanitation and hygiene. WaterAid was responsible for the overall implementation of the research study for this report. The research was carried out in collaboration with IRC and Itad.

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