

## Research Article

# Working with the Grain: How Amenable to Digital Transformation Are the Monitoring and Repair of Rural Water Points in Tanzania?

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## Abstract

*Rural water services are still not working for poor people. The rising mobile phone penetration in Africa raised hopes in the development community that mobile phone-based ICT platforms could digitally transform rural water supply services. Our approach to platform development is “working with the grain” of the information flow between citizens and district officials, in view of emerging funding opportunities for water point repair in Tanzania (Payment-by-Results). We distinguish between discretionary tasks and transaction-intensive tasks in the information flow. An ICT platform for monitoring and repairing rural water points should start by digitally transforming tasks with high transaction intensiveness and low discretion that occur outside village and district institutions. Actors in rural water supply should collaboratively simplify formal rules and procedures that govern information flows within local institutions before considering further digitization.*

## Introduction

Sustaining functional rural water supply infrastructures has been a challenge in sub-Saharan Africa (Giné & Pérez-Foguet, 2008). Recent studies show that new hand pumps and diesel-powered piped water systems become nonfunctional within a few years of installation. In Tanzania nearly half of all rural water points are nonfunctional (United Republic, 2013b), and about 20% of newly constructed water points become nonfunctional within one year. Contributing factors include poor postconstruction services (United Republic, 2002), lack of technical and financial capacity by rural citizens to effectively operate and maintain water projects (Jiménez & Pérez-Foguet, 2011; Mayo & Nkiwane, 2013), and lack of reliable access to appropriate and affordable spare parts (Giné & Pérez-Foguet, 2008; Jiménez & Pérez-Foguet, 2011). Villagers quickly abandon defunct water systems, returning to traditional, unimproved water sources (ponds and streams) and endangering their health and wellbeing (UNICEF/WHO, 2015).

Tanzania's rural water woes are chronic. In 1971 the first rural water policy declared that by 1991 all rural

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## WORKING WITH THE GRAIN

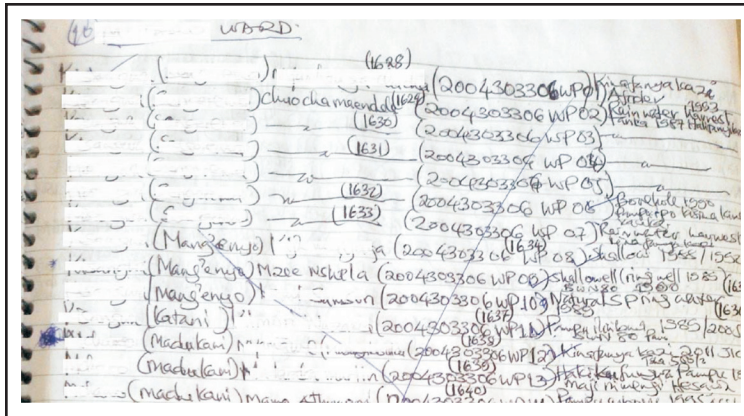


Figure 1. Extract of paper form containing water points.

households should have access to safe water within 400 meters. Donors were quick to support this ambitious goal by financing, planning, and implementing rural water supply systems across the country (Therkildsen, 1988). By the late 1980s, rural water plans were “collecting dust” (p. 51), while donor-funded water systems ceased to function soon after being handed over to users. In 2002 the government declared the National Water Policy, or NAWAPO 2002, under which grassroots “user groups are not

only responsible for operating, maintaining and sustaining the infrastructure; they are also responsible for planning and managing it for the entire water sector in Tanzania” (United Republic, 2006, p. 3). In 2006 the Water Sector Development Programme (2006–2025) was launched, funded by donors with US\$2.3 billion. Finally, from 2010 to 2013, the first-ever nationwide digital information system was implemented by the Ministry of Water and Irrigation (MoWI), funded by the World Bank.

The information system, known as the Water Point Mapping System (WPMS), aims to provide, in digital form, the status (functional, nonfunctional, needing repair) of all rural water points to inform planning and budgeting for repairs at the district council and national levels. In 2013 the WPMS became tightly coupled to the Payment-by-Results (PbR) pilot proposed by Department for International Development (DFID). PbR is a UK£78 million incentive to the government to maintain and expand access to rural water points in 50 pilot districts. PbR pays UK£1,500 to local governments “to fix broken water points instead of simply building new ones [with] payments made upon an independent verification of results, building on the existing Water Point Mapping System” (Janus & Keijzer, 2015, p. 12). DFID’s ambition is premised on the quality of WPMS data, delivered by district water departments around the country. The criteria for distributing funds to eligible district councils include “a functioning water and sanitation team, a credible water and sanitation plan, and report timely and accurate data on water points” (British High, 2017, n.p.) and were introduced on January 30, 2017 in Dodoma, Tanzania’s capital.

It quickly became clear that WPMS data quality “was far worse than the GoT [Government of Tanzania] and donors had expected. This was an unexpected challenge to both GoT improving delivery of functional water points, and GoT and DFID monitoring outcomes to make PbR payments” (DFID, 2015, p. 4). The water point data of entire wards within a district had either not been captured at all in the WPMS survey or had dubious status (Georgiadou, Verplanke, Lungo, & Mbise, 2016). While district water officials know their water points more accurately—due to numerous formal and informal interactions with villagers and village officials at the district capital or in the villages—they often record the data on idiosyncratic paper forms (an extract is shown in Figure 1) that are intelligible only to themselves. To secure PbR payments for repair, government and donors needed a digital bridge to connect the real status of water points in villages to the WPMS.

This locally nominated and prioritized need (Pritchett, Woolcock, & Andrews, 2010) empirically triggered our study (e.g., a digital bridge was crafted locally and specifically to serve a specific need) to secure PbR payments for repair. Consultations with stakeholders led us to experiment at the village level with a standard phone-based ICT platform, as simple as the popular MPesa money transfer application, given the rising mobile phone penetration in Tanzania to 63 subscribers per 100 inhabitants (World Bank, 2015).

Our approach complements existing literature on mobile phone-based ICT platforms for solving rural water problems (Georgiadou et al., 2011; Jonoski et al., 2012) empirically and analytically. Several authors have discussed and compared such platforms for water supply (Ball, Rahman, Champanis, Rivett, & Khush, 2013;

Hutchings et al., 2012; Jonoski et al., 2012). The most recent comparison by Welle, Williams, and Pearce (2016) surveyed eight platforms, all aimed at water services, on three continents, including two failed platforms in Tanzania. However, these studies either explain the failure in hindsight (an autopsy, of sorts) or the success of a platform (Welle et al., 2016), or they hide patterns of local variations in homogenized national averages of cross-national comparisons (Fox, 2015). The process, the “how-to,” is missing. No study so far has mapped the invisible work villagers and district officials do from the moment a water point breaks down through its eventual repair. Nor does any study map show how a detailed representation of this work can be used to decide which, if any, elements of the information flow could be digitized. Our research addresses this gap. It asks: To what extent can information flows related to rural water services between the village and the district council be digitally transformed? This research is inspired by the “working with the grain” approach for development interventions (e.g., Booth, 2012; Levy, 2014).

### **Abbreviations**

COWSO	Community water supply organization
DED	District executive director
DFID	Department for International Development
DT	District treasurer
DWE	District water engineer
ICT	Information and communication technologies
MoWI	Ministry of Water and Irrigation
NAWAPO	National water policy
O&M	Operation and maintenance
OC	Other charges
PbR	Payment-by-Results
VEO	Village executive officer
WEO	Ward executive officer
WPMS	Water Point Mapping System

### **Empirical Context**

This section summarizes recent developments in Tanzania and highlights community water projects in three villages. To preserve the anonymity of informants, which they explicitly requested in order to confide in us and allow us to observe their daily practices, we use fictitious names for the district (Mashujaa) and the three villages (Ufukweni, Mji Mwema, Mwembeni).

#### ***Rural Water Supply in Tanzania***

NAWAPO 2002 and the Water Supply and Sanitation Act (2009) guide rural water services. They shift responsibility for operation and maintenance (O&M) of community-based water supply projects to communities via a new village institution, the Community Water Supply Organization (COWSO). O&M involves three institutional levels: central government, district councils, and communities (a ward, village, or subvillage [known as a hamlet]). The central government coordinates, facilitates policy development and capacity building, and monitors performance, but in practice it emphasizes new systems over maintaining existing systems. For instance, the central government “allocates less than 6% of investments for rehabilitation and less than 4% for district management support and capacity building” (Jiménez & Pérez-Foguet, 2010, p. 241). In 2013 the president’s “Big Results Now!” initiative re-established the importance of maintaining existing water systems (United Republic, 2015). However, the community is now expected to contribute 100% of the O&M costs (United Republic, 2013a). The district council is responsible for investments in rural water supply infrastructure and for technical support to COWSOs, that is, access to spare parts for broken water points and execution of complex maintenance work. COWSOs are responsible for planning, constructing, financing, and managing water supply projects. They source funds from collection of water fees from users, contributions from members, donations, loans, and financial assistance from local government (United Republic, 2009).

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COWSOs must keep water funds in bank accounts. They can request financial support from the district council only if they “demonstrate ability to sustain water schemes and willingness to pay a portion of the capital costs of the water schemes either in kind or cash” (United Republic, 2009, p. 28).

### ***Mashujaa District***

Mashujaa is one of the poorest districts in Tanzania. More than half of its 300,000 residents live below the poverty line. Almost 80% of the residents are subsistence farmers and livestock keepers, while the rest are petty traders and small-scale fishers in the nearby lake. Ubiquitous Chinese motorcycles ensure transportation to remote areas. Mobile phone connectivity is fairly good in the district capital, but variable in the villages. The main water sources are shallow wells and boreholes fitted with hand pumps or with diesel- or electricity-powered motorized pumps. First introduced in the 1970s, most of the rural water infrastructure is now crumbling due to age and lack of maintenance. Some 69% of the shallow wells and 55% of the hand pumps are nonfunctional.

During the 1970s and early 1980s the government provided free water, largely through hand pumps. Between 1985 and 2000, the district received financial assistance from Scandinavian development partners to construct shallow and deep wells and introduced village bank accounts for water funds. Improvements were short-lived as many wells became nonfunctional after a short period of operation. District officials attribute the failure to extreme drought caused by climate change, lack of community ownership, and vandalism of water pumps and pipes by community members due to “poverty and ignorance” (interview with district water technician). The three village water institutions must cope with 28–40-year-old infrastructure and a variety of extraction and distribution technologies (Figure 2).

### ***Village Water Institutions***

The Ufukweni Water Committee supplies water to Ufukweni, a village at the lakeshore with a population of 2,600. It has relatively easy access to the district capital throughout the year except during the rainy season. Travel to the district capital by public bus takes two hours. Mobile phone connectivity is available. The village’s piped water system features a nearly worn-out diesel-powered water pump that was installed in the early 1980s. The system provides water only intermittently due to a lack of fuel and regular breakdowns. The village lacked piped water during our entire fieldwork<sup>1</sup> due to a breakdown in June 2013 that had still not been fixed in March 2015. Most villagers get water directly from the lake, while a few buy water (with monthly fees) from a single public standpipe run by a church. When water is available, the water committee distributes it through public standpipes and charges fees at the collection point.

The COWSO of Mji Mwema, a village of 1,500 people, is considered a success story by neighboring villages:

We have been to Mji Mwema and learnt a lot. They have a very strong COWSO that penetrates down to a very low level—every water point has a subcommittee for detailed management. [They] fence their water points to protect them. People know they must remove their shoes when collecting water to keep hygiene. (Mwembeni COWSO chairperson)

The COWSOs’ good reputation is partly due to its simple and easier-to-maintain water infrastructure—seven water points with hand pumps, all of which are functioning. It has lower O&M costs compared to diesel- or electricity-powered systems elsewhere. Nevertheless, it took COWSO leaders three months to collect enough voluntary contributions to repair a single water pump, broken prior to our fieldwork.

Daily public transport connects the village to the district capital every 30 minutes. Mobile phone connectivity is available, but not electricity, so only those few citizens who use solar-powered batteries can charge mobile phones. The villagers’ good relations with their diaspora in big cities ensure that public fund allocations are channeled to the village: “In the near future we will shift to electricity-powered water pumps, thanks to our child who works for the national electricity company in Dar es Salaam. He promised us that by next year we should have electricity” (Mji Mwema citizen).

The Mwembeni village COWSO is unique in terms of water system complexity and the extent of the

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1. Our fieldwork began in November 2013 and ended in March 2015.

	Mji Mwema	Mwembeni	Ufukweni
Served population	1,500	11,000	2,600
Water source	Bore holes	Bore holes	Lake
Water extraction technology	Hand pumps	Electric-powered pump	Diesel-powered pump
Water distribution technology	Stand-alone standpipes	Piped network to house connections and standpipes	Piped network to standpipes
Institutional setup	COWSO	COWSO	Water committee
Water fee collection	Contributions only when a breakdown occurs	Monthly flat rate for individual piped connections & fees at collection point for public standpipes	Fees at collection point
Mobile phone connectivity	Available	Available	Available
Urban/rural	Typical village	Both urban and rural characteristics	Typical village
Access to electricity	No electricity	Connected to the national electricity grid	No electricity

Figure 2. Summary of COWSO characteristics.

catchment area. The COWSO consists of 12 members, including eight men and four women (chairperson, secretary, treasurer, and nine members), and three committees (one for planning, finance, and education; one for technical matters; one for security). Two security guards and two pump attendants provided by the district council support the COWSO members. The water system was built in the 1960s and is the oldest of the three. Since then, it has been repaired and improved many times. Between 2007 and 2009, a new water tank, a pump house, and five new public water points were constructed to reach three additional villages. The system is now managed as a ward project that serves 11,000 people in four villages. An electric-powered water pump installed on a borehole pushes water to a tank 3.5km up a hill. The long distance results in massive electricity bills and the need for regular replacement of broken pumps. The pump, broken in October 2013, was fixed 18 months later with funds raised from the village diaspora. The system's complexity increases the COWSO's dependence on the district council for paying electricity bills, paying the salaries of pump attendants, and purchasing spare parts. Mwembeni displays both urban and rural characteristics. It offers typically urban facilities: police station, primary court, health center, primary and secondary schools, and stores and marketplaces. It is one of the 7% of villages with access to electricity in Tanzania (International Energy, 2011).

### Working with the Grain: Concepts and Methods

Woodworkers working with the grain attend to the orientation of wood fibers and direct their chisel or sandpaper along the fibers. Sanding the wood against its grain may scratch the wood surface and defeat the purpose of sanding in the first place. "Working with the grain" in development interventions (Booth, 2012;

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	<b>Transaction-intensive</b>	<b>Nontransaction-intensive</b>
<b>Discretionary tasks</b>	Less amenable to improvement through digitization	Not amenable to improvement through digitization
<b>Nondiscretionary tasks</b>	Highly amenable to improvement through digitization	Lasting dispositions

Figure 3. Tasks amenable to improvement through digitization.

well-known book *Seeing Like a State*, gives an example of how Japanese engineers work with the grain in water management. If they want to redesign a stream or small river,

they will live along that river for a year or two just studying the water movement and different rain patterns at different times of the year and after two years or so they will make a small intervention, a little check dam, and then they'll watch for another month or two what the water does around that check dam and in different circumstances, after heavy rainfall, in a drought. So each of their interventions is . . . reversible. (Scott, 2008, p. 10)

### Concepts

We draw on the framework of Pritchett and Woolcock (2004) and the World Bank (2014), which distinguishes between discretionary elements and transaction-intensive elements in key services<sup>2</sup> to citizens and adapts the framework to microlevel tasks of decision making. Transaction-intensive tasks require many transactions involving face-to-face contacts with district officials, village water technicians, COWSO members, and citizens (e.g., a water technician detecting a broken water point and reporting to the COWSO secretary). Discretionary tasks involve decisions based on information that “is important but inherently imperfectly specified and incomplete, and entails extensive professional or informal context-specific knowledge” (Pritchett & Woolcock, 2004, p. 194). A village assembly agreeing to contribute funds for repair or a district official approving a COWSO’s request for funds is a discretionary task.

*Transaction-intensive tasks* are easily amenable to digitization, while *discretionary tasks* are not amenable to digitization because the actor’s decisions cannot be mechanized. Nondiscretionary tasks and transaction-intensive tasks can easily be codified in computer programs (World Bank, 2016). Tasks that are neither discretionary nor transaction-intensive are *lasting dispositions*, “propensities to think, feel, and act in determinate ways, which then guide [people] in their creative responses to the constraints and solicitations of their extant milieu” (Wacquant, 2005, p. 316), but digitization does not apply to them. They include the systematic preference of villagers to meetings for distribution of food for hunger relief and to attending funerals rather than COWSO meetings, but also more general patterns of mutuality and reciprocity that pervade village social life and underpin the “economy of affection” in rural Tanzania (Hydén, 1980). Figure 3 shows the relationship between task characteristics and amenability to digitization.

### Methods

The first author lived in the Mashujaa district capital and villages for eight months, from November 2013–April 2014 and from February 2015–March 2015. He conducted in-depth interviews in Kiswahili with eight COWSO members, four water technicians, six pump attendants, three security guards, three village chairpersons, three village executive officers and six subvillage chairpersons, seven district officials (including the

Kelsall, 2011; Srivastava & Larizza, 2013) starts with the existing situation, seeking incremental ways to achieve modest gains (Levy, 2014) without harming a country’s institutional fabric by bypassing local institutions and villagers. In this study, *working with the grain* stands for incrementalism and digitization efforts that can be reversed, redesigned, and redeployed until there is a sustainable fit with the empirical setting.

The basic idea is not new. James C. Scott, in a speech on his

2. Key services are those for which some government action is necessary, desirable, and/or inevitable (e.g., improved water supply, sanitation, or health).

district water engineer [DWE], the highest-ranking water official in the district and supervisor of the district water technicians), two ward councilors (locally elected politicians), and several citizens. Participant observation in village assemblies and at the district council gave the first author a deeper understanding of the interactions between COWSOs and the district council, a better appreciation of village life, and the difficulties district officials face when performing their duties. Informal interactions in the market, in canteens, and on the street revealed lasting dispositions that interviews could not capture. He transcribed and translated interviews and field notes into English, coding and analyzing the data in terms of information flow and task classification. Coauthors regularly visited Mashujaa for meetings and participated in a formal workshop in February 2015 with ward councilors, district officials, and COWSO leaders to deliberate on the fieldwork findings.

## Information Flow in Reporting and Fixing Broken Water Points

We describe the main steps in the information flow between the villages and the district council, the sequence of tasks (mostly according to formal rules and procedures), and actors and time estimates. Figure 4 represents a composite information flow that is representative of all the villages.

### ***Step I: Detecting a Water Point Breakdown***

Detection of a water point breakdown by pump attendants or security guards or water technicians is the first step and affects the quality of subsequent steps. COWSOs with resident water technicians (more skilled than pump attendants or security guards) diagnose breakdowns more accurately and quickly. COWSOs often use security guards to curb theft of pumps and other expensive parts. In Mwembeni security guards may operate water pumps. In Mji Mwema they work as pump attendants. They collect contributions for repairs, may refuse access to noncontributors, and monitor the number of buckets per household to ensure equitable water access during the dry season. Security guards may be employed by the district council and receive a monthly salary, while pump attendants are volunteers who receive a fraction of collected fees as compensation. The pump attendant or security guard reports the problem to a COWSO or water committee secretary (in Ufukweni), either by mobile phone or in person at the village market.

### ***Step II: Reporting the Breakdown to the District***

The COWSO secretary, who is in charge of all communications, communicates the breakdown by phone or in person to a local water technician and requests a diagnosis. If a water technician is unavailable locally, the secretary writes a formal letter to the district council to report the problem and request that a district water technician travel to the village for a diagnosis.

### ***Step III: Diagnosing the Breakdown***

If the technician is a local man, diagnosis is swift (2–3 hours), depending on the severity of the breakdown. If he is unavailable due to livelihood-sustaining work (e.g., fishing) or absent (e.g., attending to district council responsibilities), diagnosis may take 1–2 days. Subsequently, he submits a hand-written report to the COWSO secretary, summarizing the inspection and recommending the type of repair and the cost. Only in Mwembeni, where a private printing service is available, can he prepare a typed letter and charge the printing cost to the COWSO. “[Often] I pay for the printing. It is always good to have a printed letter, especially if the letter is forwarded to the district council” (District water technician).

Diagnosis and letter writing may take as much as a few hours to a whole day. Some of the breakdowns in motorized boreholes may require the technician to extract the submersible water pump from the borehole (often more than 50 meters deep) for proper inspection, a process that requires mobilizing a village workforce or renting a tripod from the district capital. If the tripod is not in use by another village, it may take up to three days to deliver. Evidently, water system complexity (motorized boreholes) increases dependence on the district council for technical (water technician) and material (tripod) assistance.

The COWSO secretary must inform users about the outcome of the diagnosis. She or he issues a written public notice and posts it in popular places such as the market, village government office, important trees, schools, and health facilities. Informing water users about changes in the water supply such as breakdowns “is an official requirement, otherwise people get information through word of mouth,” said the Mwembeni

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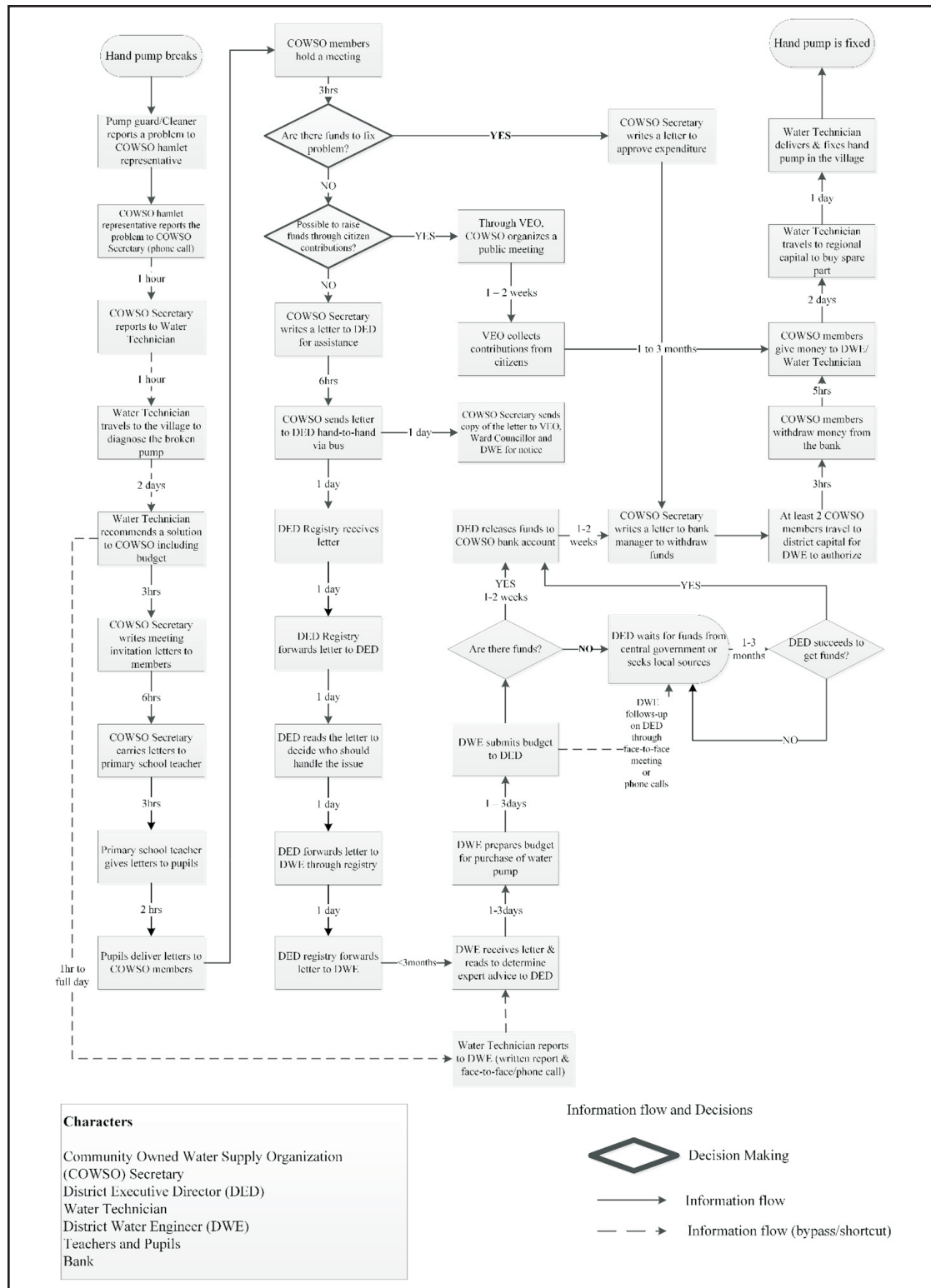


Figure 4. Typical information flow in monitoring and repairing rural water points.



COWSO secretary. In systems suffering from regular breakdowns, water users can predict not only when these will occur, they can also diagnose the cause and spread the news by word of mouth, a major source of information in villages. In Ufukweni,

the problem of fuel has become so acute that we do not have to tell people the cause of intermittent supply of water. They would just guess that lack of water means there is no fuel. They are often right. (Ufukweni water committee secretary)

Under such conditions, dishonest COWSO leaders may use chronic failures to conceal their own negligence.

#### **Step IV: Mobilizing Funds to Finance Repairs**

The water technician's diagnostic report suggests a repair of the breakdown *without* or *with* the purchase of spare parts. In the first case, the COWSO secretary asks him to proceed with the repair. In the second case, the secretary must convene a COWSO steering committee meeting so it can approve the required expenditure and identify ways to finance the repair. Without the meeting minutes to authenticate the COWSO's request, financial assistance from the district council and withdrawal of funds from the bank are impossible.

Organizing this meeting involves setting a date, inviting members to attend, and conducting it. The secretary writes invitations by hand (except in Mwembeni) and sends them to members' homes. They are delivered personally on foot or by primary school pupils or by hiring motorbikes. Delivery by students is the preferred option. It is free and effective for scattered subvillages. When letters are ready for distribution, the secretary brings them to a primary school teacher, who hands them over to pupils to deliver to COWSO members. In Mwembeni, which includes four villages, the secretary distributes letters to four primary schools. He opts for motorbikes only when the COWSO is in good financial shape and the meeting is urgent: "The ubiquity of motorbikes in our village has facilitated cheap and quick transportation of letters. However, hiring motorbikes is only possible when we have funds," said the COWSO secretary in Mwembeni.

Organizing a COWSO meeting may take two or more days. The date should not fall on weekends, public holidays, or funerals: "It is challenging to get enough members to record a quorum. We conduct our meetings on weekdays" (Mwembeni COWSO secretary). Finally, COWSO members travel to the office on hired motorbikes (usually later reimbursed by COWSO). During the meeting, the secretary presents the diagnosis and the members debate which of three options to use for mobilizing funds: (1) using funds from collected water fees, (2) using contributions from water users, or (3) obtaining financial assistance from the district council.

#### **Step IV-1: COWSOs Withdraw Funds from Bank Account**

If the COWSO has sufficient funds in its bank account, members approve the budget and authorize the withdrawal. At least two signatories of the bank account are required as well as an authorization by the DWE to make any transaction on the COWSO bank account. First, the COWSO secretary writes to the bank manager to request the withdrawal, copying the DWE for authorization. At least two signatories must travel by bus to the district capital to deliver the letter to the DWE for authorization and then carry it to the bank manager to withdraw the money. Usually this process takes one day for preparation while in the village (writing a letter, organizing for bus fare) and another day for traveling to the district capital. Given the moderate distances between the villages and the district capital, it is possible to conduct all banking business in a single day. After the withdrawal COWSO members hand over the money to the DWE or water technician, who facilitates the spare parts purchase (e.g., a water pump), a widely contested practice. District officials claim that purchasing spare parts exceeds the COWSO's skills, while COWSO members view it as an opportunity for profiteering by district officials.

If funds are unavailable, COWSO members must consider their second or third option: using contributions from water users or obtaining financial assistance from the district council. COWSOs prefer the former when water systems are low-cost (hand pumps) and fees are charged only for repair. Only the Mji Mwema COWSO claims to have collected contributions from water users to finance a repair. The other two communities always request assistance from the district council, claiming high repair costs. District water officials are skeptical about these COWSOs' choices. "Prior to [NAWAPO 2002] these two community piped-water projects were receiving grants for operation and maintenance from the district council and are now dependent" (District water technician).

### **Step IV-2: COWSOs Collect Contributions from Water Users**

If the COWSO decides to collect voluntary contributions from water users (often all village members), the secretary must ask the village government to organize a public meeting and collect funds on the COWSO's behalf. The meeting objective is to formally present the issue to the villagers, determine per-capita contributions, identify strategies to collect funds, set deadlines, and determine which villagers can be exempted. The COWSO secretary writes a letter to the village executive officer (VEO) or ward executive officer (WEO), requesting a public meeting. The VEO/WEO sets a date and invites the citizens. Calling a public meeting may take up to several weeks, depending on the season. The VEO/WEO may hire a public relations firm to spread the word (only applicable to Mwembeni and Ufukweni) or to write letters to hamlet chairpersons, who then pass the information to hamlet residents through house visits or post invitation posters at popular hamlet locations. Achieving good attendance is difficult: "We get maximum attendance when we call meetings for distribution of food for hunger relief; otherwise, people always find excuses for not attending. They will tell you that they are going to attend funerals, or go to worship" (Mwembeni WEO).

During the public meeting, the VEO/WEO presents the COWSO's case and asks the villagers to contribute. Elderly (over age 60) and disabled villagers are exempted from contributing. Hamlet chairpersons keep an updated list of exempted people; otherwise, the public meeting itself serves to update the list. The chairperson reads aloud the names of household heads, and the audience agrees or disagrees with the exemption. Then the COWSO computes and presents each household head's contribution. A deadline is set for hamlet chairpersons or COWSO hamlet representatives to collect money, a process that may take as many as several months.

This mode of funds mobilization is long and unpredictable. The willingness and ability of villagers to contribute cannot be taken for granted and depends largely on the season (farming or harvesting). The obligatory involvement of the village government in collecting contributions on the COWSO's behalf is a further challenge. It jeopardizes the COWSO's autonomy and increases the reluctance of citizens to contribute, especially when the village government has a poor reputation for funds management.

### **Step IV-3: COWSOs Seek Financial Assistance from the District Council**

If the COWSO decides to seek financial assistance from the district council, the secretary writes to the district executive director (DED) to request funds, attaching the COWSO meeting minutes and the signatures of all attendees.

#### **Sending a Letter to the District Executive Director**

The COWSO secretary travels to the district capital to deliver the letter to the DED's office in person or may ask anybody with official status (VEO/WEO, primary school teachers, water technicians, agricultural extension officers) traveling to the district capital to deliver it on his or her behalf. The DED's Registry attendant receives and routes letters to one of the several departments (finance, human resources, water, etc.) in the district council, depending on the content. An important artifact in routing is the *paper dossier* for each department. Each head of department has his or her own paper dossier that "moves" all department-related letters from the Registry to his or her department and back. The idea is to allow easy handling of letters of similar nature. In practice, significant delays occur when a dossier carries two letters that involve different decision-making routes (personal allowances of a water official vs. a COWSO's funds request).

The Registry attendant forwards the letter to the DED, who reads such letters only after 2 P.M. and decides that the right head of department is the DWE. The DED returns the letter for filing and instructs the Registry attendant to forward it to the DWE. After filing the letter in the DWE's paper dossier, she or he carries it to the DWE's office, a 300-meter stroll from the Registry. Given the short distances between the Registry, DED, and DWE, moving letters should be a straightforward matter; however, it is not. The speed depends on the DED's availability to read the letter (she or he may be out of town for business), or on whether the DWE's paper dossier is at the Registry and not "on the move" somewhere so the letter can be filed in it. Thus:

Sometimes the letter is completely lost because the registry attendant forgets to file the letter when the paper dossier returns to the Registry. Often this is not intentional. The Registry is run manually, and they have a tremendous amount of letters to deal with. (DWE)

We received a call from DWE that he couldn't find the letter that we sent earlier. We had to write another one. (Mwembeni COWSO secretary)

DWEs do not depend on formal letters only. They often receive informal breakdown reports (phone calls as well as in-person reports) from district water technicians visiting village water systems. But their hands are tied until the formal letter has moved along the prescribed channels.

### **Funds Mobilization Within the District Council**

The lengthy procedure that must be followed until the funds are released to the COWSO bank account deserves to be described in detail.

The DWE completes a request form (*dokezo* in Swahili, meaning recommendation), including a budget and the COWSO letter, and addresses it to the DED. The DWE hands the package to his or her secretary, who carries it to the district treasurer's (DT)<sup>3</sup> office and hands it over to the DT's secretary. The latter leaves the package at the treasurer's desk for approval and for issuing a payment voucher. The treasurer's approval depends on the availability of funds allocated to the water department. If funds are available, the treasurer approves the *dokezo* and orders an accountant to prepare a payment voucher. Depending on the urgency and the timing of the request, the accountant may put requests from the water department on hold while dealing with requests from others:

One accountant deals with our water budget, but he is not always available. The DT office frequently complains about slow Internet. I have to follow up constantly every fund request that we send to DT's office. I need to walk to DT's office and have a face-to-face conversation with the accountant, requesting him to prepare the payment voucher. Sometimes the DT secretary helps to remind him. (District official, DWE's office)

Constant follow-ups and long waiting periods do not always end well. Often the treasurer returns the *dokezo* to the DWE with the inscription: "Funds exhausted. See next OC" [other charges—monthly disbursement of funds from central government]. To this, the DWE remarked sarcastically, in writing, "Who exhausted?" followed by a date and his signature. The DWE tried to secure a dedicated accountant without success:

We have argued several times that [the accountant] should transfer his desk to the water office but the DT doesn't like the idea. Because sometimes the DWE suspects that [the DT] has money although he claims the opposite. The OC for December 2014 was 60 million shillings, the department only spent half of it, and the other half was allocated for repairing a broken pump in Ufukweni. When the DWE requested the remaining funds, he was told that funds were not available. The same happened for January's OC. We were told that 12 million shillings were allocated to our department but when we sent the request we were told there were no funds. Can you imagine someone telling you that you have 12 million and the next day the same person tells you that you have no funds? (District official, DWE's office)

If the district has funds, the DT directs an accountant to prepare a payment voucher. The accountant prepares and returns it to the DT for signing. The DT signs and gives the payment voucher to the secretary, who delivers it to the DED for signing. As usual, the DT secretary hands over the payment voucher to the DED's secretary, who then puts it on the DED's desk. Depending on the DED's availability, it may take up to a week for the signing process to be completed. The DED's secretary then takes it to the treasurer's office and hands it over to his or her secretary, who puts the payment voucher on the treasurer's desk. The DT assigns an accountant to write a bank check, but due to the slow Internet (a common excuse at the district council) this task causes long delays:

Usually it takes a week for the accountant to write the check. This is when I do frequent follow-ups. I have to go to DT's office every day and if the funds are urgently needed, I sometimes make multiple visits in a day. (District official, DWE's office)

To facilitate financial transactions, including preparing checks, the district council uses an electronic accounting system connected via Internet with the central government Treasury in Dar es Salaam. The district's Internet is indeed slow and unreliable. Nevertheless, water officials feel that accountants overuse slowness as an excuse:

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3. The District Treasury Department employs three trained accountants, who have responsibility for several departments besides the water department, and seven supporting staff.

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[Accountants] always claim that the Internet is slow. However, since we have no ability to verify whether they tell the truth, we cannot do anything but wait for fast Internet the same way we wait for the rain. No one knows when fast Internet will be available. But when they have to do their work [such as transactions related to personal allowances], then Internet is no longer slow. (District official, DWE's office)

When the accountant has sufficient Internet speed, she or he prepares a check and forwards it to the Treasurer and then to the DED for signing. The DT secretary delivers the check to the DED's office and hands it over to the DED's secretary. The DED's secretary records the check number in a logbook before forwarding it to the DED. When the DED has signed the check, the DED's secretary updates the logbook. The DED's secretary submits the check to the district cashier. The cashier phones the COWSO secretary, who travels to the district capital to collect the check. The DED writes to the COWSO, informing them of the disbursement of funds, with a copy to the ward councilor, WEO, or VEO. At this stage, the COWSO begins the process of money withdrawal from the bank as described in step IV-1.

After the accountant has prepared the check, she or he detaches the payment voucher from the paper dossier (carrying old funds request letters). The DT secretary can now deliver the water-related dossier to the Registry. The Registry attendant attaches the newly arrived COWSO letters to it and sends it to the DWE for the process to start again. It is worth noting that from the moment the DWE files the fund request form, his paper dossier is no longer at the Registry. Thus, no letters arriving at the Registry for water matters could be "moved" to the water department, creating a huge backlog! When the district has no funds for rural water systems, the funds mobilization becomes unpredictable. COWSOs are told to wait for the next OC, which can be several months.

### **Step V: Purchase of Spare Parts**

Upon receiving money from COWSO members, water technicians begin the purchasing process. Since the district capital is a small town, technicians insist they must travel to the region's capital or to Dar es Salaam or Nairobi to consult with pump distributors:

We took with us all technical drawings of the whole water scheme. Having experienced regular problems with other brands, we wanted to get a long-term solution and opted for brand change. We needed expert advice on the type of pump we had to buy. (Water technician, DWE's office)

Traveling long distances on the COWSO's account causes friction. Although COWSOs are responsible for such purchases, in practice the process is still dominated by district water technicians: "Currently the [COWSO] is doing all the purchases [for] small things. For large spare parts, it is the responsibility of the district council" (Water technician, DWE's office). COWSOs incur all the costs, including travel costs for officials (fare, meals, accommodations, allowances):

The district council sent the water project manager to Nairobi, and his daily travel allowances and hotel costs were borne by us. They said it was cheaper to buy the pump in Nairobi. We were not convinced. Since we are on the receiving end, we had nothing to do but wait for the pump. Our main interest is to see people get water and not politics involved in between. (COWSO treasurer)

### **Step VI: Fixing the Water Pump**

Upon return from the city and the arrival of the spare parts at the district council, the water technician travels to the village to fix the pump, a process that may take 2–3 days. The COWSO must inform citizens that the water pump is about to be fixed, although this is hardly necessary. The technician's arrival in the village spreads quickly by word of mouth. As soon as he arrives, villagers start following the progress closely and the outcome of the repair.

## Discussion

Tackling the longest delay in the information flow (Step IV-3: COWSOs Seek Financial Assistance from the District Council) matches the PbR opportunity (e.g., District Council may use PbR funds to finance repairs), but assumes that the district can deliver digital water point data that is compatible with the WPMS. Could a COWSO member, using a simple mobile phone-based ICT platform, provide this data to the district?

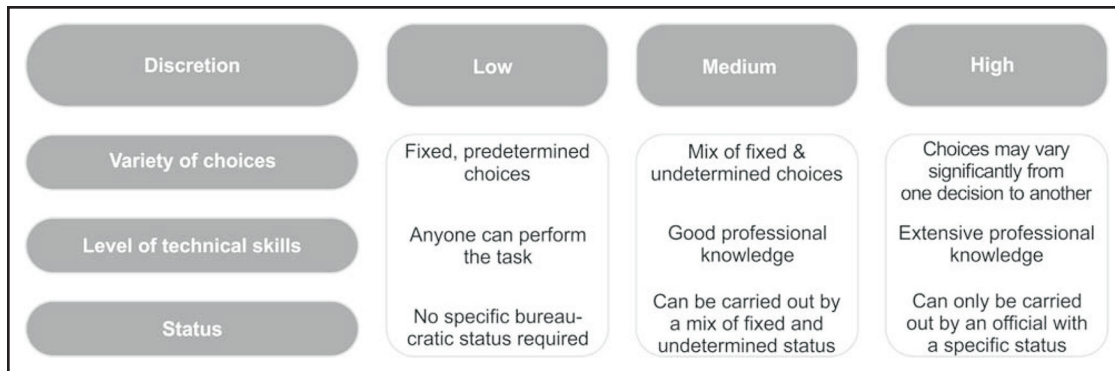


Figure 5. Levels of discretion.

**Conceptualizing Microtasks in the Information Flow**

From the district council’s point of view, the microtasks in steps I–VI (see Appendix 1) of the information flow are transaction-intensive and/or discretionary. Microtasks, which are not handled within village institutions, are transaction-intensive because district officials must deal frequently and face-to-face with many village officials in more than 100 villages in the district. Only the tasks’ level of discretion (low, medium, high) needs to be refined, for which three factors are relevant (see Figure 5).

The *variety of decision choices* determines the level of discretion. It is low when choices are fixed and predetermined, medium when choices are fixed and undetermined, and high when choices vary significantly from one decision to the next. The *level of technical skills* and experience required to conduct a task and decide which village’s needs to prioritize affect discretion. A high level of prior experience and understanding of the job at hand is required to repair a complex breakdown and to prioritize a village. Finally, discretion increases with the district officials’ bureaucratic *status* (e.g., only the DWE can approve a COWSO’s request for funds).

**Internal Functioning of Village and District Institutions and Related Tasks**

All tasks unfolding *within* local (COWSO and village government) and district institutions are infused with numerous rules and procedures, mostly formal, but also informal (mobilizing funds from the village diaspora). While some procedures may appear absurd to an outsider, they reflect a deeply embedded bureaucratic culture that is difficult and even counterproductive to dislodge by technological means. Why? It is an old saw of information system design that “the less of its user’s behavior a system encodes, the less functionality it can provide[;] . . . the more behavior is encoded[,] . . . the more technologies may come to prescribe human activities” (Suchman, 1995, p. 59). Tanzanian villagers, on the one hand, have a well-documented, uncanny ability to covertly resist directives, especially when they originate from the state (Hydén, 1980), and to effectively evade the state, a lasting disposition that arguably contributes to political stability in Tanzania (Mulqueen, 2009). The villagers’ covert resistance is unsurprising if we bear in mind that the “institutional order in Tanzania and its colonial and postcolonial legacy never really demonstrated their superiority in providing justice and prosperity” to citizens (Rottenburg, 2009, p. 141). District water officials, on the other hand, find the increasing pressure from the ministry to report rural water-related information upward in various formats excessive:

I am overburdened by the information collection roles and reporting to higher levels, which derail me from focusing on other responsibilities. . . . The Big Results Now! [initiative instituted by Tanzania’s president] introduced new reporting and information collection formats that are confusing and impossible to handle, especially when Internet services are poorly available. (District water technician)

As Pritchett et al. (2010) argue, any additional “premature load bearing” (pressure) on district water officials, based on unrealistic expectations about the improvement of district capacity with digitization, may lead to stress and a weakening or collapse of capacity. A flexible standards approach to creating a modular hierarchy of national-, district-, and village-level water point datasets to release tensions between standardization

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(required by the Ministry and donors) and localization (favored by the district) that are accompanied by intensive capacity building would be worth trying (Braa & Hedberg, 2002).

The tasks in steps IV-1, IV-2, and IV-3 include a mix of all three levels of discretion—low, medium (attendance at meetings, traveling to carry letters to the district council, withdrawing funds from the bank), and high (approval of the COWSO steering committee to request funds from the DED or the district treasurer). However, while nondiscretionary tasks might seem to be easy candidates for digitization, expediting some of them with technology before new, comprehensive rules and procedures are agreed on by all concerned is inadvisable as they might conflict with the other tasks.

### ***ICT Platform as Gateway Between Village and District Institutions***

Only three tasks in steps I and II are easily amenable to digitization (Appendix 1). In light of the PbR program, we generalized these into a single task—COWSO member regularly reports the status of water points to the district (not only when broken)—and developed a mobile phone–based ICT platform. Stakeholders see value in the platform for different reasons. Senior district officials say they could “get up-to-date and correct data across all departments in the district.” Water officials felt it would exonerate them from accusations of corruption and help them identify villages with acute problems. Ward councilors saw it as a tool to keep them informed of their voters’ concerns, while COWSOs saw it as saving time and transportation costs. Nevertheless, they disagree on who should receive the reports. Senior district officials insist that only “the planning department which is coordinating all planning activities and statistics of the district should receive reports” and are reluctant to share this information with councilors: “The way I see it, this is a working tool for the district water department. Councilors are outside this tool. This is a working tool for professionals” (senior district official). They also disagree on who should make the reports. Few Mashujaa villages have COWSOs, while most have village executive officers, who are trusted by the district as fellow bureaucrats, but not by the COWSOs and ordinary citizens, given bureaucrats’ reputation for questionable management of village funds. Additional digital tools, such as dedicated dashboards for VEO/WEOs and councilors, may resolve these tensions without compromising the transparency of water point information to all stakeholders. Ideally, the MoWI would facilitate district–village interactions and further incremental digitization in the medium term, with financial support from the donors. The MoWI would also mediate between district and village to identify appropriate reporters, beyond COWSO members, in the short term.

Finally, tasks outside village and district institutions include those in step III (diagnosis) that require the physical presence of skilled individuals in the village and can be transformed by building the COWSOs’ capacity to repair broken water points, independent of the district council. Tasks in steps V (purchase of spare parts) and VI (fixing) may be amenable to digital transformation. Transparently available and timely information about breakdowns may provide external market parties with the opportunity to stockpile spare parts efficiently and dispatch technicians to the right locations. A social enterprise could probably provide this service under a business model that would benefit a network of warehouses and technicians down to the village level. Figure 6 summarizes the amenability to digitization of steps and tasks listed in Appendix 1. Mwembeni and other communities are now experimenting with a *social enterprise*, a hybrid water governance model that combines elements of government, community, and private-sector management.

## **Conclusion**

This study’s qualitative portrait of rural water supply reveals the “invisible” work around access to rural water and draws attention to aspects of village–district interactions that go unnoticed by the MoWI and donors in Dar es Salaam. The study exposes lasting dispositions that may hold villagers captive (through their reluctance to participate in water meetings), exhibits villagers’ resourcefulness (in mobilizing their diaspora to fund repairs), re-articulates assumptions that are taken for granted regarding profiteering by district officials, and shows where opportunities are available for improvement. In this sense the study’s findings empower villagers, regarded as passive “policy endurers,” and district officials, regarded as lacking a “monitoring and reporting culture” (Therkildsen, 1988).

“Working with the grain” does not interfere with the internal functioning of village institutions and the

Steps	Low Discretion # tasks	Medium Discretion # tasks	High Discretion # tasks	Amenability to digital transformation	How?
I: Detection & reporting at village	2			High	Mobile phone-based ICT platform
II: Reporting to the district	1				
III: Problem diagnosis		4		Medium	Social enterprise
V: Purchase spare parts		2			
VI: Fixing	2	2			
IV-1: Village mobilizes funds by withdrawal	9	3	1	Low	Simplifying rules and procedures in collaboration with actors, then digitizing
IV-2: Village mobilizes funds by collecting contributions	11	2	3		
IV-3: Village mobilizes funds at district council	33	10	3		

Figure 6. Steps and tasks amenable to digitization.

district council. However, it does render visible formal rules and procedures within local and district institutions that could be simplified without disrupting the bureaucratic culture and social fabric of villages. “Rehabilitated” rules and procedures may help access new funding opportunities such as Payment-by-Results and eventually lead to rehabilitated rural water points. Positioning an ICT platform as a possible village–district gateway presumes a willingness to deploy a platform, learn how it can be used (and abused), and redesign it until it reaches a sustainable fit. A digital incrementalism of small, reversible changes, skeptical of ICTs that bypass local institutions (Fung, Gilman, & Shkabatur, 2013) may generate clumsy solutions to rural water services, but an elegant failure becomes less probable. ■

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# Appendix 1

<p><b>I. Detection and reporting at the village</b></p> <ol style="list-style-type: none"> <li>1. COWSO water technician detects a broken water point</li> <li>2. COWSO water technician reports to COWSO secretary</li> </ol>	<ol style="list-style-type: none"> <li>12. COWSO representative withdraws funds from bank</li> <li>13. COWSO representative gives funds to water technician</li> </ol> <p><b>IV-2. Mobilize funds at the village through contributions</b></p> <ol style="list-style-type: none"> <li>1. COWSO secretary sets meeting date</li> <li>2. COWSO secretary selects meeting venue</li> <li>3. COWSO secretary writes meeting invitation letter</li> <li>4. COWSO secretary carries letter to COWSO members</li> <li>5. COWSO members attend a meeting</li> <li>6. COWSO members agree to collect contributions from village members</li> <li>7. COWSO members sign meeting minutes to request funds from village government</li> <li>8. COWSO secretary carries letter to village executive officer (VEO)</li> <li>9. VEO sets a meeting date</li> <li>10. VEO selects meeting venue</li> <li>11. VEO invites citizens to village assembly</li> <li>12. Villagers attend the village assembly</li> <li>13. Village assembly agrees to contribute funds for repair (incl. amount per person, waivers, deadline, etc)</li> <li>14. VEO collects contributions from citizens</li> <li>15. VEO gives funds to COWSO secretary</li> <li>16. COWSO secretary gives funds to water technician</li> </ol>	<p><b>6. COWSO members agree to withdraw money from bank</b></p> <ol style="list-style-type: none"> <li>7. COWSO secretary writes fund request letter to DED</li> <li>8. COWSO member carries fund request letter to DED</li> <li>9. DED registry attendant receives the letter and forwards fund request letter to DED secretary</li> <li>10. DED secretary carries letter to DED</li> <li>11. DED reads letter</li> <li>12. DED assigns DWE to deal with letter</li> <li>13. DED secretary carries letter to registry</li> <li>14. DED registry attendant files the letter</li> <li>15. DED registry attendant carries letter to DWE secretary</li> <li>16. DWE secretary carries letter to DWE</li> <li>17. DWE reads COWSO letter</li> <li>18. DED approves the COWSO's request for funds</li> <li>19. DWE fills fund request form (FRF)</li> <li>20. DWE secretary carries fund request form to District Treasurer (DT) secretary</li> <li>21. DT secretary carries FRF to DT</li> <li>22. DT signs fund request letter</li> <li>23. DT assigns accountant to prepare payment voucher</li> <li>24. Accountant prepares payment voucher</li> <li>25. DT secretary carries payment voucher to DT</li> <li>26. DT signs the payment voucher</li> <li>27. DT secretary carries payment voucher to DED secretary</li> <li>28. DED secretary carries payment voucher to DED</li> <li>29. DED signs the payment voucher</li> <li>30. DED Secretary carries payment voucher to DT secretary</li> <li>31. DT secretary carries payment voucher to DT</li> <li>32. DT assigns accountant to prepare a bank check</li> <li>33. Accountant prepares bank check</li> <li>34. DT secretary carries bank check to DT</li> <li>35. DT secretary carries bank check to DED secretary</li> </ol>	<ol style="list-style-type: none"> <li>36. DED secretary carries bank check to DED</li> <li>37. DED signs check</li> <li>38. DED secretary carries check to DWE secretary</li> <li>39. DWE secretary carries check to DWE</li> <li>40. DWE carries check to bank</li> <li>41. COWSO secretary writes fund withdrawal letter (FWL) to bank manager (via DWE)</li> <li>42. COWSO members travel to send FWL letter to DWE and bank</li> <li>43. DWE signs FWL letter</li> <li>44. COWSO members carry letter to bank</li> <li>45. COWSO members withdraw funds from bank</li> <li>46. COWSO members give funds to water technician</li> </ol>
<p><b>II. Reporting the problem to the district</b></p> <ol style="list-style-type: none"> <li>1. COWSO secretary reports to district water technician</li> </ol>			
<p><b>III. Problem diagnosis</b></p> <ol style="list-style-type: none"> <li>1. District water technician travels to the village to diagnose problem</li> <li>2. District water technician diagnoses the problem</li> <li>3. District water technician recommends the type of spare parts to purchase</li> <li>4. District water technician recommends where to buy spare parts (provider &amp; city)</li> </ol>			
<p><b>IV-1. Mobilize funds at the village by withdrawing money from bank</b></p> <ol style="list-style-type: none"> <li>1. COWSO secretary sets meeting date</li> <li>2. COWSO secretary selects meeting venue</li> <li>3. COWSO secretary writes meeting invitation letter</li> <li>4. COWSO secretary carries letter to COWSO members</li> <li>5. COWSO members attend a meeting</li> <li>6. COWSO members agree to withdraw money from bank</li> <li>7. COWSO members sign meeting minutes to approve withdrawal of funds</li> <li>8. COWSO secretary writes fund withdrawal letter to bank manager (attaches signed minutes)</li> <li>9. COWSO representative travels &amp; carries letter to DWE</li> <li>10. DWE signs COWSO letter to bank</li> <li>11. COWSO representative carries letter to bank</li> </ol>			<p><b>V. Purchase of spare part</b></p> <ol style="list-style-type: none"> <li>1. District water technician travels to buy spare part</li> <li>2. District water technician buys spare part</li> </ol> <p><b>VI. Fixing</b></p> <ol style="list-style-type: none"> <li>1. District water technician travels to the village to fix a broken water point</li> <li>2. District water technician fixes a broken water point</li> <li>3. District water technician reports to DWE about the fixing</li> <li>4. COWSO secretary reports to citizens about the fixing</li> </ol>

Legend  
 Italics – low discretion  
 Normal font – medium discretion  
**Bold** – high discretion