Considerations for the successful design & implementation of ICT systems in the WASH sector

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Abstract
The use of new ICT (Information Communications Technology) tools to support WASH provision is expanding rapidly. Yet too often the focus appears to be on the tools themselves and on the ability to collect data in a different way – and not sufficiently on what the data gets used for, how the provision of data can actually change the dynamics of the situation or how reliable the data is and who will continue to provide it once the initial novelty value has worn off.

SeeSaw – a social venture working at the crossroads of ICT and WASH services – is very interested not just in the technology, but how and why it gets used. This paper discusses findings from our advisory and other work in Southern Africa, including our own learning from countries where we provide WASH-specific ICT systems. It also draws heavily on the findings of a two day workshop, co-hosted by SeeSaw and the University of Cape Town, that explored ICT-related trends and challenges in both the WASH and health sectors.

Current trends in ICT usage in the water sector
In urban areas in developing countries, a significant number of water service providers are trapped in a vicious circle of poor operational performance and low cost recovery, unable to provide adequate services to a rapidly growing population. Even those that are doing relatively better could still make significant gains in performance, particular in respect to leakage and non-payment of bills. A lack of information on customers and connections, insufficient monitoring of technical performance, under-collection of water bills and poor financial records are some of the factors that undermine the ability of water providers to improve their services.

Meanwhile, despite apparent progress towards attaining the Millennium Development Goals, much rural water provision is reportedly in a sorry state. Great efforts have been put into developing rural systems and, in particular, into drilling boreholes and

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installing handpumps. Yet many of these schemes are not-operational – or poorly used – rendering the investment in them wasted.

In contrast by mid-2013 more Africans will have a mobile phone subscription than access to an improved water source (Foster *et al.*, 2012a). A growing number of sector professionals are starting to ask whether the rapid growth in information and communication technologies (ICT) offers new opportunities to water providers to address some of their enduring challenges. Pioneers in this field have suggested that, if harnessed effectively, technologies such as mobile phones, online data bases or digital mapping of water and sanitation points, can significantly boost the performance of both urban and rural water providers.

As part of the background research that informs our training and advice, SeeSaw has looked at how ICTs are being used in the water sector. In urban areas it appears that there are three main ways in which ICT is being applied. Urban water providers are using ICT tools to better link with their customers, using SMS and other means. They are also looking to make bill payment easier and more efficient, for instance by using mobile-money. Lastly water providers are turning to ICT to assist them with managing their own performance, using remote sensors in some instances or equipping their staff with cellphones and customised reporting applications.

In rural areas the picture is slightly different. To date much of the emphasis has been on mapping the functionality of rural water supply and understanding the true level of service that rural citizens are receiving. Beyond mapping, there have been some inroads into using cellphones to communicate with rural citizens – both by 'pushing' information to them (for instance during crises) or by encouraging them to report on the issues they face. On the other hand there appears to have been less innovation - a few isolated examples aside - on strengthening the finances of rural provision or on improving supply chains, although these are two more areas where ICTs could arguably play a role.

A 2012 paper by SeeSaw (Sattler & Schaub-Jones, 2012) looked at what the main drivers for stakeholders to adopt ICT in their operations are. It suggested that these drivers fall into three broad groups:

- It improves access to information (which can improve decision-making);
- It can bring immediate and long-term financial benefits; and
- It allows confidence-building between stakeholders, which contributes to greater responsiveness, mutual accountability and trust.

Figure 1: Three main drivers for adopting ICT innovations in the WASH sector.

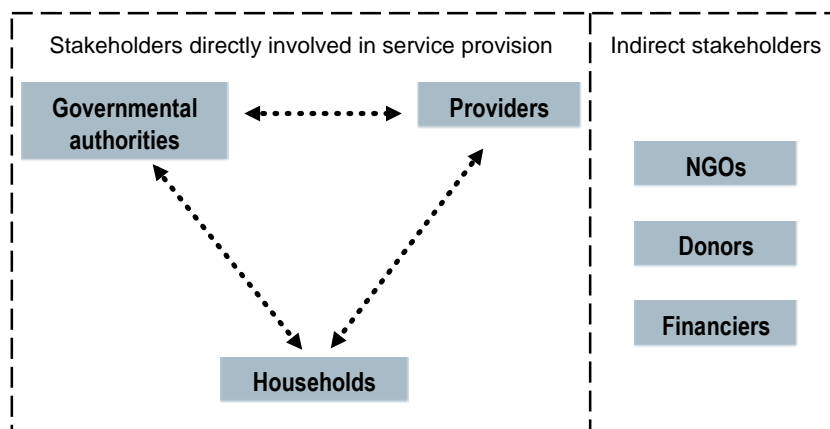

Source: Sattler & Schaub-Jones, 2012.

This paper focuses largely on the first of these, the gathering of information to improve water and sanitation delivery.

Improving data collection and the use of information

In the provision of water services there are three direct stakeholder groups – the providers themselves, the authorities that oversee them and households that use the water. In developing countries, a range of other stakeholders support these, including financiers, donors and NGOs. Each of these actors could potentially benefit from ICT systems being developed and rolled out in the water sector – all of them have an interest in greater access to reliable information.

Water sector stakeholders with a potential interest in ICT

Figure 2: Key stakeholders in the water services sector.

Source: Sattler & Schaub-Jones, 2012.

In urban areas *water providers* often struggle with limited information on their assets, the status of infrastructure, where breakdowns happen and how serious they are. Many are even unsure of the true number of households connected to their network. For them a lack of information is a major obstacle to improving service delivery, causing delays in repairs, reduced revenues, the overcharging of customers and difficulties

extending services. In *rural areas* providers lack information, amongst other things, on where to source spare parts, on maintenance needs and on how to manage the systems for which they've been given responsibility.

Regulators and *policy-makers* are particularly interested in the digitisation of information, as it helps them to receive field-reports more rapidly and to request more information. As a result their ability to measure the performance of water providers – both urban and rural – can increase dramatically, provided they have the capacity to manage the information being received and are assured of its quality.[2]

In urban contexts particularly, regulators are showing great interest in the potential of connecting directly with customers – as it would allow them to cross-reference information from the water provider with reports direct from customers – as well as help them to be seen to be responsive to the needs of citizens. In rural areas better information helps inform decisions around investment, the choice of management models, how to organise supply chains, etcetera.

One way that *urban customers* receive information is via their water bill, which tells them how much water they have used and how much they owe. A common problem is that bills are hard-to-understand and only come once a month – too late and infrequent sometimes to impact or affect behaviour. For those customers that are faced with varying water quality, irregular supply or fluctuating prices, information on when the water needs to be boiled, when the water can be expected and what the price is, is all crucial to how they behave.

In *rural areas* the nature of supply is usually different – and the level of engagement between citizens and authorities is generally lower. Yet rural citizens can also benefit from greater access to information, particularly where responsibility for supply has been partly handed over to them. This can be as simple as knowing who to contact when there is a problem, or it can go beyond this, for instance by using ICT systems to provide CBOs with advice on the technical and financial management of small schemes (based on information they themselves send through).

The potential impact of monitoring

The advent of digital monitoring has in some countries brought about a great leap in understanding the true level of performance. This is particularly true where monitoring has been able to capture information on the ongoing provision of services, rather than just snapshots of connections made or the functionality of infrastructure.

In Zambia, Tanzania and Kenya, as a consequence of installing digital monitoring systems for water regulation authorities, GIZ has reported that coverage rates in urban

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[2] The centralised aggregation of data from many schemes better enables benchmarking approaches, where the relative performance of different service providers is compared. This helps state authorities to promote competition, accountability and transparency in the water sector. Centralised databases also help track coverage rates – both facilitating reporting on the water and sanitation MDG targets and helping to plan for the funding of system expansion and maintenance.
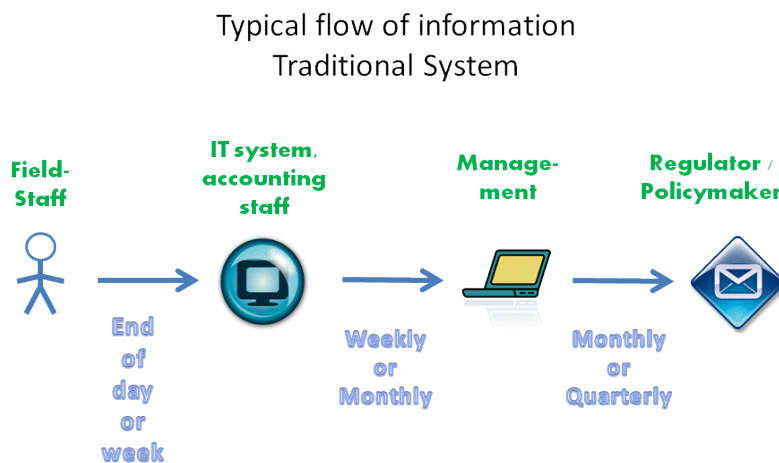
areas were significantly revised. Before the systems were in place, urban coverage rates were being reported at around 90% (across these three countries). After the systems were introduced, these coverage rates were reported at solely 47% (GIZ 2009).

This has led to a renewed focus on the level of service being received, particularly in marginalised communities.

ICT has opened up a new world of opportunity

One way to consider how new ICT tools can change things is by comparison of the 'old' versus the 'new'. Here we look at the flows of information that typically hold sway and to compare these with the flows of information that new technology (such as cellphones) makes possible. It is quickly apparent that whilst the typical systems existing in the water sector (the 'traditional systems') have a very linear and closed flow of information, the new ICT tools allow radical changes (the 'new systems').

Figure 3: 'Traditional' information flows.

Typical flow of information
Traditional System

Field-Staff — End of day or week — IT system, accounting staff — Weekly or Monthly — Management — Monthly or Quarterly — Regulator / Policymaker

Source: SeeSaw, 2012.

As in the diagram above, traditional systems rely principally on field-staff of the water provider for their information. In urban settings, staff generally submit this information – at the end of the day or week – to the IT system (often via a paper-based system that is then 'typed up'). From there information wends its way via the accounting and engineering departments to management (often with significant delays). Water providers then submit 'prepared briefs' to the regulator or to policymakers – perhaps monthly, or more often quarterly or less often.

Figure 4: 'New' flows of information.
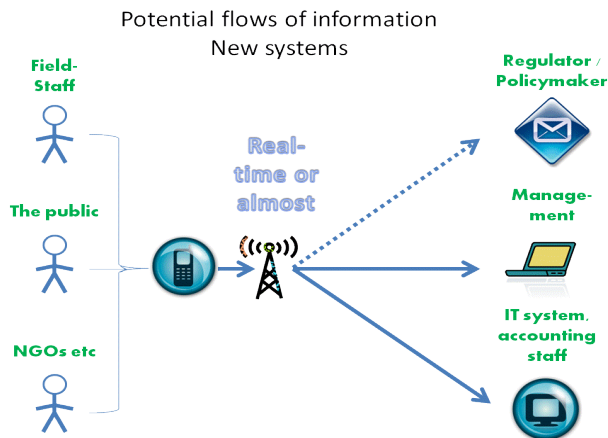
New technology has allowed 'new systems' to radically depart from this practice. New avenues for collecting information and falling transmission costs have led to an explosion in the amount of information that can be practicably collected. This can also be done now in almost real time, and it is now possible to rapidly collect a whole range of data - both of higher quantity and quality.

In addition, the source of the data is no longer restricted to the field-staff of the water provider – information can be collected from the public directly (either customers or concerned 'members of society') as well as other organisations, such as NGOs or community-based organisations (CBOs).

New challenges thus arise. The question of what information to collect, from whom and how often comes up. The issue can become one of too much information, or a lack of relevant information, rather than 'no data available'.

Whilst the two diagrams above refer primarily to urban water provision, a similar dynamic can be seen in rural water supply. Here, policymakers and others can also now rely on a range of sources for their data (something that has, in several countries, led to a dramatic reassessment of how much progress is being made).

One may ask what sorts of information from customers are of interest to the managers or urban water providers. Well, via simple SMS or other means, these providers can now gather real-time reports of:

- Infrastructure faults.
- Service disruptions or lack of pressure.
- Poor water quality.
- Excessive pricing (from the resale of water via vendors).
- Illegal water connections.

The new ICT tools also permit rapid two-way communication, permitting providers to engage better with customers – for instance sending SMS messages to warn of upcoming maintenance, to send apologies for poor service or to send public interest notices (for instance, "boil your water this week"). It also allows providers to send payment reminders and other billing related news.

Examples of systems collecting information from the field

There are a range of systems trying to use mobile phone to collect information from people 'in the field' about the performance of water systems. Some of these look to specific agents or employees (e.g. meter readers), other rely on the broader public to submit information (a dynamic often referred to as 'crowdsourcing'). Others try to automate the collection of information.

Agent-based systems include the Senegalese meter-reading system developed by Manobi[3] as well as many of the systems that we at SeeSaw are commissioned to deploy.

Crowd-sourced systems included those looking at water point functionality (e.g. H2.0, Daraja), those concerned with supply availability and disruptions (NextDrop), and others still that focus on the price charged for water and quality delivered at water points (M-Maji, SMS Water).

Meanwhile, the audience for these initiatives can be quite diverse, ranging from the general public in M-Maji's case, to local authorities in Tanzania's Daraja and H2.0 fault-reporting, to national regulators or even commercial banks with Manobi's service in

Senegal and Mali

Though many of these efforts are still in their infancy some common themes are emerging:

Crowdsourcing approaches seem to have struggled to mobilize citizens to take action and report faulty water points or supply disruptions. Implementers have been refreshingly candid with blog entries highlighting the key obstacles (see http://blog.nextdrop.org/ and http://blog.daraja.org/2012/02/so-what-have-we-learnt-summarising.html).

Some challenges are linked to the people being asked to send in the information – not all are literate, fewer phone users that you might think are familiar with SMS. Some of them are technical – for instance the ability of systems to handle SMS that are not 'in the correct format'. Arguably larger challenges lie in the system of water delivery to begin with – it seem too easy for projects to wilfully ignore entrenched political or institutional interests that benefit from the status quo or otherwise resist change (and which fatally undermine those self-same projects).

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[3] See references and further reading for links to all these initiatives

Trusting in the system has been a particular hurdle. Understandably users, many faced with long experience of 'non-responsive' providers, wonder why exactly they should go to the effort of sending a text message or making a phone call when they have little expectation that the relevant authority or service provider will take effective action. As an example, Daraja was forced to pull its Tanzanian Maji Matone system after a 6 month trial period received only 53 messages. *

Some systems are even choosing to skip 'people' all together and go for automated monitoring via mobile networks. Whether this proves to be any more effective remains to be seen, but diverse providers such as Grundfos, Sarvajal, WaterHealth International and Rural Focus (in conjunction with Oxford University) are all attempting it.*

Getting it right, before you begin

However, starting with what system to use is the wrong way of looking at the issue. A growing body of evidence from the field (only some of which is referred to above) confirms that "which system?" is arguably the last question that should be asked. Before that come a range of other questions that people making decisions about using ICT need to ask. These include:

Firstly, will your ICT system actually change the dynamics of the overall system of water provision? Or merely overlay existing patterns? Are you looking to change the way the wider system works at all? What change are you looking to make?

Secondly, ask what are the incentives that those receiving any 'new information' have to act? Are these incentives strong enough to encourage them to change from "business as usual"?
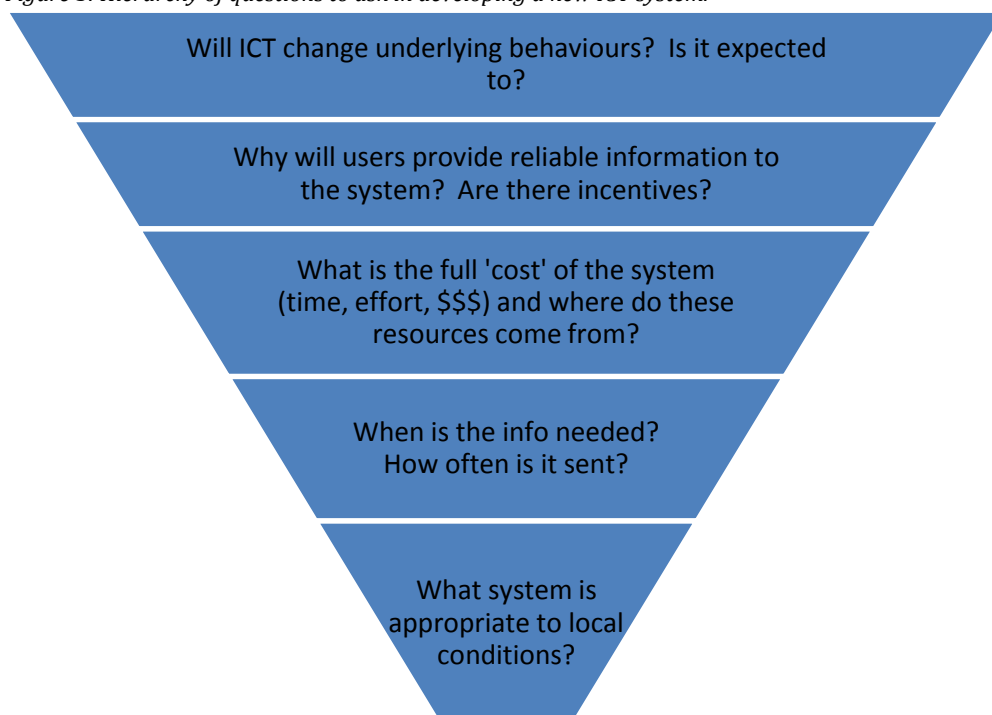
Thirdly, any information system (whether oral, paper-based or electronic) is only as good as the information being fed into it. So a key question for any initiative looking to harness ICT is *why* those being asked to input information into the system are likely to do so? What are the incentives of the various stakeholders to give information, to use the system and to provide reliable information?[4]

Fourthly, what is the cost of the system? Here we're not really referring to the direct monetary cost ($$$s) but the cost in terms of effort of the user and effort of those being asked to process information. Is this cost – which can quickly become non-negligible - viewed as an additional burden or is this somehow part and parcel of "doing business"? If it is a burden, then what incentives do the parties on all side have to make the effort being asked of them?

Only then should questions around "when to ask for information?" and "what system is most suitable?" be asked and answered.

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[4] Equally, too many IT systems either pose an additional burden on those being asked to report, collect the wrong sort of data or struggle to deal with incomplete or incorrect submission. The same issues of *why* people are going to adopt, ignore or challenge new systems need to be raised continually.

Figure 5: Hierarchy of questions to ask in developing a new ICT system.

Source: SeeSaw, 2013.

A checklist of considerations

Will this change underlying behaviour?	A first step is to look carefully at what the data will be used for. It is important to not ask for information that can't be used, nor collect information that is never analysed appropriately or actually acted upon. (SeeSaw, 2011)
Why will information be provided?	For any organisation planning to promote, develop or install a new ICT system, it is important to realise that in the end success of such initiatives relies on field workers and/or customers who have to provide and enter data of sufficient quantity and quality. Systems relying on customers' feedback must particularly be careful about being simple and giving clear incentives for participation. People will only invest time and money (that charged by mobile network operators for sending messages or making voice calls) if they can trust service providers to act upon the given information. If improvements in service delivery fail to appear, users will quickly lose interest in sharing information. A lot on this issue can be learned from a water supply scheme in Tanzania, where the NGO Daraja struggled to motivate citizens to adopt the established ICT scheme and provide the NGO with information on the water supply infrastructure (see http://blog.daraja.org/2012/02/so-what-have-

	we-learnt-summarising.html)
What is the 'full' cost of the system?	For field workers and other staff involved in data collection and reporting, feedback mechanisms must not impose an additional and heavy burden, otherwise they are likely to resist using it, collect the wrong sort of data or provide incomplete information. Anyone who has been required to fill in timesheets or prepare expense reports will understand the burden that such 'data-collection' systems can impose!

Findings from both health and water practitioners

In June 2012 two organisations focussed on using ICT in the water and sanitation sector joined forces in Cape Town. *SeeSaw* (www.greenseesaw.com) - a social enterprise that customises ICT to support sanitation and water providers - and *iComms* (www.icomms.org) - a University of Cape Town research unit - co-hosted a two day event to look at how ICT tools are changing the way that public services function in developing countries. The event brought together 30+ practitioners - with water sector professionals from across Southern Africa joined by their colleagues from the health sector (a sector that has been quick to innovate, try different approaches and learn lessons).[5] Key lessons that emerged from the discussions included:

1. Putting in place an effective ICT system can make a visible impact on the ground. It can pay for itself quite quickly in terms of efficiency gains and even costs saved. Yet a fair amount of thought must go into designing to the system to fit the local context – just transplanting a system from one context to a new environment is generally troublesome.
2. 2) A significant spin-off of looking at how to use ICT is that the effort taken to design a responsive system forces stakeholders to reflect more closely on the existing structures, process and current information flows. This can have significant benefits even if no system is later built.
3. A recommendation is to spend due time and effort in understanding the system, asking direct stakeholders what information they currently get, what information they need and then seeing how and whether ICT systems can be used to gather data that can generate additional, better or faster information and get it to where it is needed (in a way that suits the working patterns of those individuals).
4. For impact at any significant scale it is crucial that ICT systems, whether in healthcare or water and sanitation, integrate with existing government systems. There is a great risk of fragmentation - too many organisations piloting new ICT systems put in place technologies or processes that cannot easily be absorbed into existing government systems (or worse still, undermine these).

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[5] A full write-up of the event can be found here (http://greenseesaw.files.wordpress.com/2012/10/seesaw-june-2012.pdf) and in the Water Information Network of South Africa's October Newsletter (see www.win-sa.org).

5. A lot of initiatives, particularly in the healthcare system, have tried to harness ICT to get people to do what is good for them. And only that. For instance, cellphones used to gather field information can be restricted to 'work only, and airtime and data bundles used for transmitting information reserved to contribute solely to 'the project'. The disadvantage is that this turns the device into something used only for work, something alien and otherwise 'not useful' (and even costly, if the user must pay for recharging the battery). Yet alternatives exist – with some organisations finding that it is helpful to permit communities or frontline workers to use – on a limited basis if needs be – new cellphones for their own purposes (browsing the internet, accessing facebook, receiving SMS). Users were then more likely to engage with the project and to look after the equipment.

6. ICT tools can be incredibly powerful at improving the flow of data and, from there, the flow of information. But what if the flow of information is not the real problem? There are many issues that undermine water provision (as well as healthcare, or sanitation). A lot of these have very little to do with information. Cultural conflicts, different worldviews, individual rivalries, dysfunctional facilities - all of these can be the 'sand in the gearbox'. One must not assume that a new ICT system is going to solve all problems - after all, these are tools, not a panacea to what are typically complex and entrenched challenges.

Conclusions

A key point made by many present at the June 2012 event (see box above) was that the technology itself is rarely the issue. Mobile phones, software applications (apps) and open-source databases are widely available or can easily be developed. To make ICT in the water sector successful though, it is crucial to make technology demand-oriented and fit-for-purpose. This means making data entry by citizens, customers or the provider's field-staff as simple as possible. It means not overburdening the participants in any system. And above all it means paying close attention to the incentives of key stakeholders – those that need to adopt the system, those whose inaction can block it and those who will resist change altogether.[6]

Creating ownership and standardisation of systems are further issues to be addressed to make ICT approaches in the water sector efficient and sustainable. The scale of eventual impact will thus greatly depend upon the institutional and regulatory responses to ICT initiatives. Governmental water authorities must have control over the establishment of such systems, but will often require assistance from others.

Donors and NGOs can assist with capacity development, but in this ICT is no different from any other innovation – ownership needs to be vested locally and local champions found. This is essential in getting water providers and customers to adopt new systems.

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[6] SeeSaw and iComms are beginning a research project in early 2013 into how to improve information flows and how incentives shape the behaviour of different stakeholders within any ICT system designed for the water and sanitation sector.

The case of Daraja in Tanzania highlights the fact that much work needs to be done to address the behavioural constraints, which despite the potential benefits of improved services, can hinder adoption of new technologies by not just customers, but also by technical staff. Following the premise that incentives are what shape behaviour, it is crucial to understand the motivation for citizens and other stakeholders to use - or not use - a given technology. Only if this is understood systems can be adapted to the demands and incentives be created that may boost the adoption rates.

As suggested, with ICT in the water sector still relatively unexplored, it is important to embrace the lessons already learned by other sectors. In return, stakeholders involved in ICT initiatives in the water sector should make their experience public, even if project outcomes did not meet the expectations. Being transparent about both positive and negative experience will help the whole sector to move forward much quicker, ultimately benefitting the citizens that currently suffer from inadequate service provision.

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For links to some of the existing experience in ICT in the WASH sector see:

WaterHealth International - http://www.waterhealth.com/

SMS Water - http://indonesia.usaid.gov/en/USAID/Activity/294/Water_SMS_Improving_Water_Services_in_Indonesia_through_Crowd_Sourced_Map_Data

Smart handpupmps - http://oxwater.co.uk/#/smart-handpumps/4559322273

SeeSaw's SeeSawSend platform – http://www.greenseesaw.com/ourservices/software-as-a-service

Sarvajal - http://sarvajal.com/
NextDrop – http://nextdrop.org/
M-Maji - http://mmaji.wordpress.com/
Manobi - http://mwater.manobi.com/
H2.0 - http://geonetwork.itc.nl/zanzibar
Grundfos - http://www.grundfoslifelink.com/
Daraja - http://www.daraja.org/our-work/rtwp
Akvo FLOW – www.akvo.org/web/introducing-akvo-flow

Annex A : Making it work at scale: a salutary tale from Uganda

In Uganda in recent years a huge number of software applications have been developed by different organisations to assist field-based health workers to doing their job. Projects are looking to monitoring drug stocks from even the most remote rural dispensaries, provide better data on cases of illness, and so on.

As the adjacent figure shows, however, there was hardly any coordination amongst different organisations, most used different devices (such as different mobile phones or smart phones, different android or other applications, their own databases, etc.).

In 2012, the Ugandan Ministry of Health reacted by pushing for coordination. First of all, old databases are being migrated over to DHIS2, a free, open source database for medical recording used already by several countries. In addition, a moratorium has been published and addressed to all stakeholders, putting an immediate halt to all electronic health initiatives.

Different ICT systems (red circles) in the Ugandan health sector.
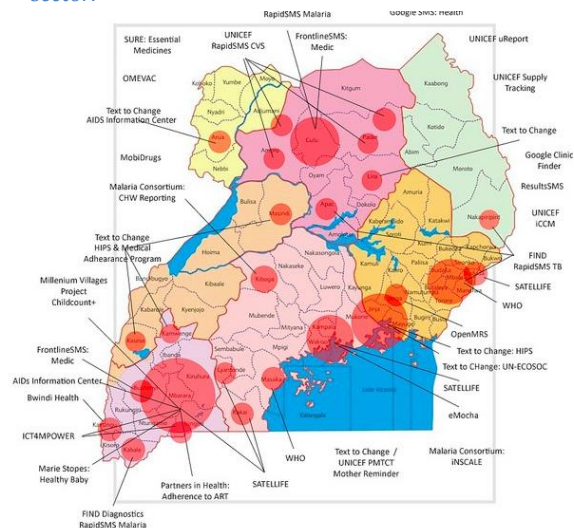
This hiatus will be maintained until sustainability mechanisms and ownership are clear, interoperability with DHIS2 is achieved, institutional structures are utilized, and the Ministry of Health approves utilization of a system (McCann, 2012)

Harmonisation

Uganda's health sector experience highlights the need for governmental authorities to include guidelines on ICT into existing water policies. Setting clear rules at an early stage can prevent fragmentation of systems and help to avoid a lot of trouble and unnecessary work later on, as well as the need to close down productive initiatives because they cannot be integrated into national systems. Early harmonization can also prevent many organisations from wasting a lot of money in re-inventing the wheel (by developing applications and software platforms that already exist elsewhere).

It is also the role of donors, aid agencies and NGOs to advocate for the development of a policy at an early stage. Rather than making the government's work even more difficult by leaving them with a multitude of different systems that authorities cannot neither oversee nor work with, they should enable the government to take ownership for its own development.

Annex B : Maji Matone – a cautionary tale from Tanzania

In 2010, Daraja, a Tanzania-based NGO, launched a water monitoring and civic participation pilot project, called Maji Matone. Citizens in the included rural areas were enabled to report outages in their water system via SMS from their mobile phones to Daraja employees, who forwarded the given information to the district water engineer. If repairs were still delayed, local media partners were informed in order to publicize the lack of action.

After 6 months, however, Maji Matone simply did not get the level of citizens' engagement aimed for, with only 53 messages received instead of targeted 3,000. This left Daraja with the question why citizens hardly made use of the system. According to Daraja, the technology itself was easy to develop and not the issue. Due to considerable promotional work, lack of information by citizens about Maji Matone also did not explain the failure. In addition, the information provided by citizens usually led to quick action by the District Water Engineers, so in theory the system did actually work.

In trying to find answers, Daraja came up with three major challenges:

Matching technology to context

In the rural areas where the project was piloted, many small challenges might have had an effect on the project's success. Low literacy and education levels, poor access to information, problems with phone networks and limited sources of electricity for charging phones are all hurdles to be overcome when asking people to send messages. One possible conclusion thus is that at the moment the rural context is simply too difficult for this kind of crowd-sourcing.

The world of water supply

The Tanzania Water Policy generally leaves communities with the responsibility for operation and maintenance of rural water infrastructure, with some support from the District Water Engineers. Knowing about their responsibility, citizens maybe were reluctant to send messages because they did not expect District Water Engineers to take action. Maybe the general confusion about institutional responsibilities also discouraged people from engagement.

In general, however, the understanding of rural citizens on the water policy is low, and the perception that government is responsible for water services still very widespread. Thus, it does not seem too likely that this reason was a major cause for citizens' low interest in the initiative.

Citizens' engagement, risk and apathy

In addition to service improvements, the program's goal was also about changing attitudes from acceptance of bad infrastructure to taking a proactive approach, thus transforming the relationship between citizens and their government by use of new communication technologies.

A widespread apathy and a low sense of entitlement are, however, amongst the main possible reasons for failure. After a long history of unfulfilled promises from government, NGOs and others, people maybe felt that there was no point in engaging and nothing would change anyway. In addition, although providers of information were kept anonymous, a project review found that people were still worried to earn a reputation for being a troublemaker.

Thus, maybe the programme was too ambitious in trying to create a culture of citizens' agency in rural areas, whereas cultural changes tend to be driven by urban society. (Source: Daraja, 2011).

Although it is difficult to draw definite conclusions of this example on what went wrong and could have been done to improve citizens' engagement, it highlights the need to give individuals involved clear incentives to use the technology provided. It also gives future planners an idea of the many factors that have to be taken into account, particularly in rural areas. Finally, it also shows that many things actually have worked.

The technology itself was no problem, most citizens were well informed about the programme, and by including the local media pressure was built upon the water engineers, who undertook repairs more quickly if only information was provided.

It is this aspect, making sure that involved individuals not only theoretically can benefit from ICT but truly see and understand the benefits for them, that carefully needs to be looked at in future. For the successful establishment of ICT systems in the water sector, it is thus crucial that information on new experiences, including both success and failure, is made transparent and shared amongst stakeholders.