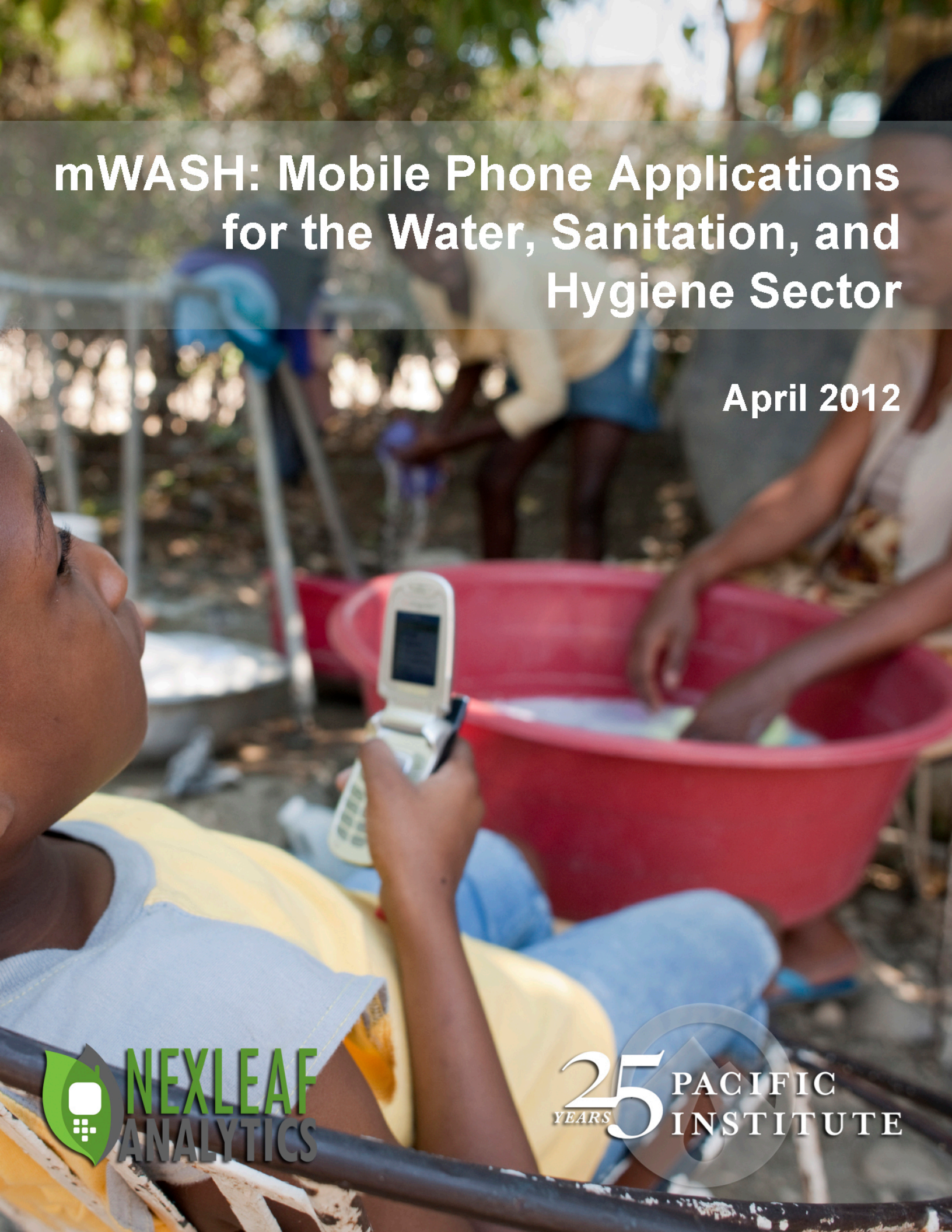

# mWASH: Mobile Phone Applications for the Water, Sanitation, and Hygiene Sector

April 2012

NEXLEAF ANALYTICS

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## About the Pacific Institute

The Pacific Institute is one of the world's leading independent nonprofits conducting research and education to create a healthier planet and sustainable communities. Based in Oakland, California, we conduct interdisciplinary research and partner with stakeholders to produce solutions that advance environmental protection, economic development, and social equity — in California, nationally, and internationally. We work to change policy and find real-world solutions to problems like water shortages and habitat destruction. Since our founding in 1987, the Pacific Institute has become a locus for independent, innovative thinking that cuts across traditional areas of study, helping us make connections and bring opposing groups together. The result is effective, actionable solutions addressing issues in the fields of freshwater resources, climate change, environmental justice, and globalization.

## About Nexleaf Analytics

Nexleaf Analytics is a nonprofit organization that aims to make mobile phone sensing technologies available to communities and organizations around the world. By combining the ubiquity of mobile networks with sophisticated server-side analytics, we are transforming regular mobile phones into leading-edge data-collection instruments. Nexleaf Analytics takes a revolutionary approach to collecting data on environment, climate change, and public health. Our platform includes mobile phone software, web portals for data analysis and visualization, and mechanisms to ensure system health and data integrity. More information on Nexleaf Analytics staff, directors, funders, and programs can be found at www.nexleaf.org.

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# Glossary of Acronyms and Terms

| | |
|---|---|
| API | application programming interface |
| application programming interface | a program designed to communicate information from one system of computing devices or programs to another system; Abbreviation: API |
| basic phone | a mobile phone that can make and receive voice calls to other phones and send SMS messages |
| feature phone | a basic phone with an additional feature such as a camera, but may include many features including mobile Internet access; smartphones are feature phones by definition, but feature phone is generally used to describe phones which are cheaper in price than smartphones, and sometimes with limited capabilities when compared to smartphones |
| general packet radio service | a telecommunications system providing fast internet connections for mobile phones; Abbreviation: GPRS |
| geocoding | the process of converting addresses into geographic coordinates which can be used to mark positions on digital maps |
| geographic information system | a system designed to capture, store, manipulate, analyze, manage, and present digitally all types of geographical data; Abbreviation: GIS |
| geotagging | the process of adding geographical identification data to various digital media such as SMS messages, photographs, video, websites, etc. |
| GIS | geographic information system |
| global positioning system | a global system of U.S. navigational satellites developed to provide precise location and time information for any location on or near the Earth; Abbreviation: GPS |
| GPRS | general packet radio service |
| GPS | global positioning system |
| ICT | information and communication technology |

| | |
|---|---|
| ICT 4D | information and communication technology for development |
| information and communication technology | any technology used to communicate, create, access, disseminate, store, manage, and manipulate information; indicates unified communications through computers, middleware, phones, mobile phones, and other devices, utilizing telecommunications (telephone lines and wireless signals) and necessary software; Abbreviation: ICT |
| information and communication technology for development | refers to an information and communication technology used for socioeconomic development; Abbreviation: ICT4D |
| interactive voice response | a telecommunications system that allows a computer to interact with humans through the use of a prerecorded database of voice messages to present options to a human user, and responses from either a user's voice or keypad touch tones (also known as DTMF or dual-tone multi-frequency) ; Abbreviation: IVR |
| IVR | interactive voice response |
| Java-enabled | can run applications based on the Java programming language |
| JavaROSA | an open-source platform for data collection on mobile devices that support Java-based programs |
| M4D | mobile phone for development; also mobile/mobile phone application/ mobile technology for development |
| mGovernance | mobile governance |
| mHealth | mobile health |
| mobile phone for development | also mobile, mobile phone application, or mobile technology for development; refers to using technologies related to mobile phones for socioeconomic development, is considered one type of ICT4D; Abbreviation: M4D |
| mobile governance | the practice of government functions through mobile devices, such as mobile phones and PDAs, for government-related services, data collection, communication, and information dissemination |
| mobile health | the practice of medical and public health through mobile devices, such as PDAs and mobile phones, for health services, data collection, treatment support, information dissemination, and so forth |

| | |
|---|---|
| mobile telemedicine | delivery of health related services and medical information via mobile communication technologies, see also mobile health |
| near field communication | a set of standards for smartphones and similar devices to establish radio communication with other smartphones, devices, tags, or microchips by touching them or bringing them very close together; Abbreviation: NFC |
| NFC | near field communication |
| PDA | personal digital assistant |
| peri-urban | describes a formerly rural area located on city outskirts that has urbanized with diverse multiple uses (residential, commercial, industrial, agricultural), or areas subject to urban sprawl; the term is used both in a qualitative sense (e.g. diffusion of urban lifestyle) and in a quantitative sense (e.g. new commercial and residential zones) |
| personal digital assistant | a handheld computer; Abbreviation: PDA |
| radio-frequency identification | a technology that uses electronic tags placed on objects, people, or animals to relay identifying information to an electronic reader by means of radio waves ; Abbreviation: RFID |
| RFID | radio-frequency identification |
| short message service | a form of communication on mobile phones that allows the exchange of short text messages between fixed line or mobile phone devices; Abbreviation: SMS |
| SIM | subscriber identity module |
| smartphone | a device that combines a mobile phone with a hand-held computer, and utilizes an operating system that can run applications for data storage, internet browsing, GPS, media players, etc. and communicate with other operating systems using APIs |
| SMS | short message service |
| subscriber identity module | a type of data storage for mobile devices, such as a SIM card for mobile phones and USB modems; Abbreviation: SIM |
| Voice over IP | a technology or set of standards for delivery of telephone calls and other voice communications over the Internet, involving conversion of analog voice signals to digital form; Abbreviation: ‘voIP’ or ‘VoIP’ |

# Executive Summary

A large number of the billions of people who lack basic access to safe water and sanitation can count a mobile phone as one of their few possessions. Year after year, global and national institutions struggle to provide growing populations with basic water and sanitation needs, while mobile phones have become ubiquitous in the developing world. The spread of mobile phones has greatly reduced the time and cost of communication between multiple, often remote areas. Mobile phones are increasingly being used as cost-effective tools for collecting data and disseminating information. In the past decade, water and sanitation practitioners have begun deploying mobile phones as tools to improve water, sanitation, and hygiene (WASH) services. In studying the deployments of mobile phone for WASH, or mWASH, applications, this paper seeks to identify best practices and help inform future mWASH implementation for current and potential implementers of mobile phone solutions in the WASH sector.

## WASH Sector Challenges and ICT Opportunities

The challenges in the WASH sector involve several complex and diverse problems. First, billions of the world's poor still lack access to basic water and sanitation services, as well as education about safe hygiene behaviors. Second, in regions where water and sanitation services are being extended, projects have a high failure rate. Third, even where formal water supply and sanitation services exist, the service is often unreliable and of poor quality. Fourth, water systems everywhere face long-term sustainability threats from over-extraction, climate change, urbanization, and pollution. Many experts have argued that overcoming these varied challenges in the WASH sector requires a focus on governance, since good governance requires a wide range of institutions and non-state actors involved in different or overlapping aspects of water, sanitation, and hygiene to manage resources and demand better services and accountability (Allison 2002; Plummer and Slaymaker 2007; UNDP Water Governance Facility 2009).

Each of these challenges could be addressed through more information, as well as better use of information by stakeholders. Information could be used to demonstrate need, monitor progress, and compel better governance and planning (WaterAid 2011). For instance, the urban and rural poor often have no way to advocate for their basic needs for water and sanitation because their problems are invisible to higher levels of planning and policymaking. Funders and WASH NGOs often do not have the resources to track continued functioning of their projects once they are built and handed over to communities. Water utilities and governments often lack information on the specific needs of the populations they serve, and are not held accountable for planning and budgeting decisions. All of these actors lack information on the state of water resources—both in terms of water quantity and quality. In the absence of a "single water manager," there is no one place for information to be collected or shared in ways that can promote better management of water supply and over-extraction results.

Collecting, aggregating, and analyzing data from remote regions and making the data available in a transparent way can help identify where investments are most urgently needed and can improve the long-term project monitoring. It can also contribute to better water resources planning. Information and communications technologies (ICTs) have the potential to address these information gaps in the WASH sector by transforming the way data is generated,

communicated, and shared. Mobile phones are already being used as tools for data collection and dissemination across multiple sectors, such as health, socio-economic development, agriculture, natural resource management, and disaster relief (Hellstrom 2010; UNICEF 2010).

## Mobile Phone System Design

Effective mobile phone solutions must be customized to address the different information needs of different change agents—NGOs, residents, utilities, research institutions, local governments—in a useful format in order to assist in addressing specific governance problems.

In developing mobile phone for WASH (mWASH) applications, three aspects can be considered in solution design: the way the application will function given social context and information needs (social design); the appropriateness of the technology platform to meet information needs (technical design); and the aspects that ensure an effective support structure for longevity and sustainability of the application (program design).

Social design involves two types of considerations: first, deciding how to recruit and engage users to ensure the system is scalable and sustainable in the long-term, and second, ensuring that the collected data is accessed and used by the audiences for which it was intended. This could be achieved by considering aspects such as partnerships with the government, via direct peer-to-peer interactions between users, or crowdsourcing data to create public information that could be used by media outlets, NGOs, or service providers.

There is a range of technical design options for data collection and dissemination. Data collection or input options include: simple SMS (short message service) data entry, interactive SMS, native forms on basic phones, smartphone applications, interactive voice response (IVR), and geolocation features. Each method involves particular opportunities and challenges for different social contexts. The options for data dissemination or output include: web-based dashboards, web-based mapping, broadcasting or bulk SMS, interactive communication, simple SMS, and other reports and data formats like interactive graphics, photos, or videos.

Finally, there is a need for effective design of the supporting program that ensures the system can be sustained and updated in response to the changing needs of its users and as technology evolves and improves.

## Review of Mobile Phone Solutions

In order to learn more about existing efforts to use mobile phones for public services, we reviewed the options for social, technical, and program design and examined cases for how some of these options might impact how mobile phone applications will perform as information interventions in various contexts. We conducted a global survey and identified over forty mobile phone projects worldwide. From this list we selected ten organizations and their projects for further study, including AppLab Indonesia; e-Pasar Ikan (Fish Marketing Information System); FLOW; Human Sensor Web; Jana (formerly txteagle); Maji Matone; NextDrop; SHM Foundation; Water Quality Reporter; and Yayasan AirPutih. We interviewed each organization to understand key decision points on social, technical, and program design and develop key principles for the success of mobile phone applications relevant to WASH.

## Designing Successful Mobile Phone Efforts in WASH

We aimed to capture a snapshot of mobile phone applications in development in general—and in wash, sanitation, and hygiene in particular. Mobile phone applications are powerful mechanisms for achieving or supporting the achievement of development goals. Through this study, we identified key elements that were critical to the success of the mobile phone case study projects.

Our review suggested that several elements were critical in the design of mobile phone solutions:

| **Considerations for User Participation and Experience** | |
|---|---|
| *Understand the Socio-Cultural Context* | While it is not always easy to anticipate challenges based in a specific socio-cultural context, documented successes and challenges of others can help future projects to prepare for issues such as: differences in mobile phone access and usage individually and as part of a household; rigid attitudes and expectations about government action; preferred mode of communication; and prohibitive fears and concerns. |
| *Build the User Base Through Well-Planned Outreach To Achieve Uptake* | Outreach is important for user uptake of the system, both during project development and implementation. |
| *Ensure the System is Easy to Use* | The success of a system and level of user participation depended heavily on technical accessibility in the data collection step (which was the user's first, and sometimes only, interface with the system), and relevant output formats in data dissemination and analytics. |
| *Fulfill a Key Need--Monetary Incentives are Not Necessary* | Compensation was not needed when the user received a direct benefit from submitting data, such as improvements to service provision. |
| **Use of the Data** | |
| *Implement and Promote User Access to Data* | A key opportunity is missed when users do not have access to the same data as the agencies they are trying to hold accountable for making improvements. |
| *Ensure Government Agency or Service Provider Responds to Reports* | Low expectations of government services based on prior unresponsiveness created a lack of motivation for users to report issues at all. Service providers and government agencies can gain the trust of their customers and constituents through timely acknowledgement and response to reports, even when a solution is not immediately possible. |
| *Use Verification Options to Create High-Quality Data* | Mobile phone applications have the potential to improve the quality and quantity of data that is collected in the long term. They can help to make manual data transfer more efficient, reduce manual data errors, and increase the frequency of monitoring due to relative cost effectiveness. Multiple manual and automated options exist to verify data. |

| Plans for Success and Sustainability | |
|---|---|
| *Identify and Measure Indicators of Short and Long-Term Success; Use This Information to Refine System Design* | Interestingly, most of the case study projects—information interventions to empower through the collection or dissemination of data—did not develop and track a variety of metrics of effectiveness that would help them to understand how different social, technical and program design factors might have impacted their success in the short and long term. Project performance and evaluation data has the potential to help understand and overcome short-term issues, but also to serve as factual proof of the need for and relevance of the system—powerful components when seeking funding. |
| *Secure a Future for the System through a Plan for Long-Term Sustainability* | Implementers risk failing their beneficiaries when they can't keep a system running due to lack of funding. Some cases showed that mobile phone solutions can be sustained with strategies such as ensuring key user-stakeholders invest in maintaining the project (e.g., local governments) or leveraging technical partners to relieve some of the burden of developing, acquiring, and maintaining software or hardware. |

## Looking Forward

While the key lessons from this study are meant to help guide careful consideration of factors and options that can impact the success of a mobile phone solution, such projects focused on achieving improvements in water, sanitation, and hygiene should take particular caution in focusing on the short term.

We have identified four broad categories of problems in water, sanitation, and hygiene, with the majority of the mWASH projects in the broad survey dealing with issues of access, failure, or breakdown and service unreliability. The untapped potential remains in use of these systems for long-term monitoring and planning. To make improvements in governance, substantial information is needed and must be put to effective use. Mobile phone solutions hold the greatest potential for amassing data quickly and thoroughly directly from the underserved populations who are most in need.

Globally, mobile phone solutions are proliferating rapidly in many regions, fueled by desires to bring effective change quickly. Sustained success in these emerging projects will be dependent on effective program management, attention to the financial and technical sustainability of the system, and monitoring and adaptively managing for system effectiveness in the short and long term.


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# Mobile Phone Applications for the Water, Sanitation, and Hygiene (WASH) Sector

## Section I. Introduction

One of the recent markers of human development has been the rate at which access to mobile phones is outpacing access to basic human needs. The spread of mobile phones in the developing world has transformed the opportunity costs of communication by greatly reducing the time and cost of acquiring and disseminating information from multiple, often remote areas. In the last decade, leading water and sanitation practitioners have begun to leverage the ubiquity of mobile phones to improve water and sanitation services.

Despite tremendous advances in human development, nearly one billion people on the planet lack access to safe drinking water, and over two billion lack access to sanitation facilities (UNICEF and WHO 2012). The devastating health impacts of poor water supply, sanitation, and hygiene are well-documented: worldwide, waterborne diseases continue to be among the leading causes of death in children under five years old; more people die from unsafe water annually than from all forms of violence, including war (Corcoran et al. 2010). Lack of access to improved sanitation is significantly associated with higher infant and child mortality (Fink et al. 2011), and corresponds to increases in maternal mortality rates (Cheng et al. 2012). Additionally, severe and repeated cases of diarrhea contribute extensively to debilitating malnutrition among children, who bear the greatest health burden in the absence of adequate sanitation (Rheingans et al. 2012). Recognizing the connections between water, sanitation, hygiene, and disease, the international development community has placed a major emphasis on addressing these related problems, led in significant part by the Millennium Development Goals.

Even as billions of people lack access to secure water and sanitation services, the developing world is experiencing a boom in new information and communication technologies (ICTs)—technologies that facilitate the capturing, storage, processing, transmission, and display of information by electronic means (ESCWA 2009). ICTs have the potential to connect people previously isolated by location or socio-economic situation. As a result, there is increasing realization that ICTs can assist in the achievement of development goals and poverty reduction by making markets work for the poor, reducing access barriers to basic services by making state institutions work better, and improving security by assisting in risk management (Cecchini and Scott 2003).

Mobile phones, a subset of ICTs, are particularly well-placed to serve the development needs of the poorest, most vulnerable populations, because they represent a widespread and relatively low-cost communication option for rapid information transfer and service facilitation, eliminating prevalent issues of distance or time. In the developing world, the development of fixed-line communications infrastructure has been bypassed in favor of wireless or mobile

telecommunications infrastructure due to relatively low investment requirements (Rashid and Elder 2009). Further, mobile phones are more affordable and therefore more accessible to users across socio-economic levels than computers.

This report reviews the potential of mobile phones to improve governance in the development sector—a field termed "mobile phone for development" or M4D—with a special emphasis on the water, sanitation, and hygiene or WASH sector. In particular, we focus on "information interventions": mobile phone usage for real-time, broad-based data collection and dissemination among and by multiple agents of change. Such information interventions are used not only to resolve immediate, short-term issues, but to facilitate the flow of information necessary for long-term planning, monitoring, policy-making, and governance. We review the aspects of mobile phone solution design that impact the effectiveness of an information intervention. We review ten selected organizations and their mobile phone projects in depth to determine whether there are broad-based lessons to be drawn from their experiences of system development and implementation. Finally, we summarize lessons that can be used by implementers of general M4D projects, as well as mWASH projects.

## Report Organization

We have introduced the purpose of the study in Section 1.

In Section II, we discuss the information needs of change agents for improving governance and how information and communication technologies (ICTs), particularly mobile phones, can be used to meet information needs in the WASH sector.

In Section III, we describe the design considerations of mobile phone solutions in terms of social, technical, and program design.

In Section IV, we look more closely at existing mobile phone solutions in the WASH sector and a set of mobile phone applications from a variety of sectors selected for case study, then draw lessons from the selected cases.

In Section V, we conclude with considerations for further study.

# Section II. Global WASH Challenges and ICT Pathways to Change

In this section we highlight ways in which the water, sanitation, and hygiene (WASH) sector suffers from governance problems, which can be addressed in part by better, more transparent information. ICTs in general and mobile phones in particular are well-placed to address this information gap, but achieving lasting change would require matching the local WASH challenge to the change agents and their specific information needs.

## Global Water, Sanitation, and Hygiene Challenges

The water, sanitation, and hygiene sector globally has some considerable challenges— both short term and long term. First, billions of the world's poor people still lack access to basic water and sanitation services, as well as education about safe hygiene practices (UNICEF and WHO 2012). Second, in regions where water and sanitation services are being extended, many projects have a high failure rate, but the extent is unknown due to lack of transparency by implementing organizations (Bliss and Bowe 2010). Third, even where formal water supply and sanitation services exist, the service is often unreliable and of poor quality for the most vulnerable populations (WaterAid 2011; Rheingans et al. 2012). Fourth, water systems (and therefore sanitation) everywhere face long-term sustainability threats from over-extraction, climate change, urbanization, and pollution.

The challenges in the WASH sector are complex and diverse; there is no silver bullet or one technological solution that can fully address WASH problems. Instead, it is increasingly recognized that efforts to improve water supply, sanitation, and hygiene in the long term depend on addressing the underlying issue of inadequate governance in the WASH sector. Broadly, water governance is "the range of political, social, economic, and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society" (Rogers and Hall 2003). In other words, roles, responsibilities, regulation, and accountability rest with a wide range of institutions and actors involved in different or overlapping aspects of water, sanitation, and hygiene (UNDP Water Governance Facility 2009). Thus, improving governance in water and sanitation services is not just about improving government systems and capacities; it is also dependent on the ability of non-state agents to interact with and demand better services and accountability from the government (Allison 2002; Plummer and Slaymaker 2007). Each of the WASH challenges outlined above has specific governance failures that need to be addressed.

*The access problem:* Billions of people lack access to affordable and functional water and sanitation services and education about safe hygiene practices. The poor suffer disproportionate impacts of inadequate access to safe water and sanitation, whether in urban or rural locations (WaterAid 2011; Rheingans et al. 2012; UNICEF 2011; UNICEF and WHO 2012). This is most significant in the distribution of access to sanitation, where the richest households have benefited disproportionately over time (UNICEF and WHO 2012). Although financial investment is needed, it has been cautioned that this alone will unlikely translate into improved access unless wider governance issues are also addressed (Camdessus 2003). Many of these problems develop from a lack of knowledge and awareness of rights and responsibilities by non-state actors like

nongovernmental organizations (NGOs) and civil society organizations (CSOs) (Plummer and Slaymaker 2007), which renders them unable to effectively advocate for basic water and sanitation services.

*The post-construction failure problem:* While progress is being made in improving access to improved water and sanitation and hygiene knowledge, new research is pointing to disturbingly high failure rates of water and sanitation systems around the world. Many systems are breaking down due to lack of maintenance or spare parts; there are more and more communities in the developing world that are "no longer served" (Fogelberg 2010). For instance, approximately 50,000 rural water points in sub-Saharan Africa are broken (Skinner 2009) and the average rate of non-functionality in 21 sub-Saharan African countries surveyed by one study was 36 percent (IRC 2009).

These high failure rates have been attributed to poor programming and implementation. In recent years, many WASH experts have highlighted the need for post-construction monitoring of functionality and use of systems (Cairncross and Feacham 1993; DFID 1998; Carter et al. 1999; Lockwood 2002; Bliss and Bowe 2010). Such a monitoring program would require collecting, aggregating, and analyzing data from remote regions and making the data available in a useful and transparent manner.

*The service unreliability problem:* In many parts of the world, populations that have nominally improved service suffer problems of poor water quality and unreliability in water and sanitation services. In many cities with rapidly growing peri-urban and informal settlement areas, if municipal water supply exists it may be supplied intermittently and unreliably for only a few hours each day or a few days each week. Sanitation services may only exist in areas of new formal development. Wealthier residents have the financial resources to cope with these issues, such as by installing storage tanks, while the urban poor pay with their time, health, and limited money to access inadequate options to fulfill their basic needs (WHO et al. 2010).

However, these challenges arise from issues in governance rather than the actual service provision itself. The issues communities experience with water and sanitation are numerous: continuity of supply, quality of water, coverage, completeness of service provision, and responsiveness of service providers to problems. From the service provider's perspective, these customer issues arise because the service provider often lacks the information, autonomy, financial and human resources, and incentives to improve and extend services, particularly to the urban poor (WSP 2009). Corruption presents another challenge to service providers, especially where accountability is not institutionalized (Davis 2004). Proper governance would ensure service providers are both supported and held accountable in providing basic services to everyone.

*The long-term sustainability problem:* There is also a significant lack of information on the state of water resources—both in terms of water quantity and quality. In many urban areas, wealthier residents and businesses directly access the water source through private wells, which impacts the water supply availability for all other users.

The governance challenge here is the absence of a single water manager. There is no single place for information to be collected or shared in ways that can promote better management of water supply. In rural areas, a similar lack of information collecting and sharing results in use of low quality or polluted water. The lack of information and indicators in both rural and urban contexts hinders effective resource allocation and management (WaterAid 2011). Poor information on

water resources and the needs of the poor impact the ability of governments and other non-state actors to reform policy and governance for appropriate regulation and investments as well as to plan in the face of shrinking water supplies as a result of climate change, urbanization, and water pollution.

Information is powerful, yet scarce—when it does not have to be. Governance in the WASH sector can be improved with the right information on gaps and inequities in access to water and sanitation services and hygiene education, on the extent and nature of current infrastructure failures, on the realities of service unreliability, and on how best to manage future risk with available resources.

## The ICT Information Opportunity

Information and communication technologies (ICTs) have the potential to address information gaps in the WASH sector by transforming the way data is generated, communicated, and shared.

Early on, disparities in access to ICTs between the rich and poor were recognized and referred to as the "digital divide," the connectivity gap, and the "information haves and have-nots" (Kirkman 1999). But this situation is changing rapidly with each new technology invention. Mobile phones have already overtaken personal computers as the most common Web access device worldwide. Even though fixed-broadband consumer prices have dropped around the world and most dramatically in developing countries (52.2% between 2008 and 2010), there are twice as many mobile-broadband (i.e., mobile internet) subscribers as there are traditional fixed-broadband subscribers (ITU 2011). As a result, mobile broadband is often the only access method available to the poor in developing countries.

Mobile phone subscriptions reached almost 6 billion in 2011, with 79% penetration in the developing world (ITU 2011), so it is no surprise mobile phones are already being used as tools for data collection and dissemination across multiple sectors, such as health, socio-economic development, agriculture, natural resource management, disaster relief, and their relevant sub-sectors in international development (Hellstrom 2010; UNICEF 2010). In health, or mHealth, mobile phones are employed for: disseminating information on public health to residents and health workers; collecting real-time data; assisting in and monitoring medication compliance; tracking disease outbreaks; managing inventories of drugs in remote locations; and through non-consumer applications diagnosing illnesses. In agriculture, or mAgriculture, mobile phones connect farmers to government services, cooperatives, and networks, as well as facilitate the flow of timely information about markets and crop prices. Mobile banking, or mBanking, has made financial services more attractive and readily accessible to poor populations and those living in remote locations. Mobile phones hold particular value in these fields because they can act as point-of-use devices, function in remote locations, and are readily carried and used at any time (Freifeld et al. 2010).

Of relevance to the WASH sector are mobile phone for governance, or mGovernance. applications. This is described as "the delivery of governance-related services via mobile communication devices, i.e., a tool and method that facilitates citizen to citizen, citizen to government and government to citizen interactions that can be leveraged to strengthen democracy and good governance" (Hellstrom 2010). In the WASH sector this can go several steps further to include additional interactions among the numerous possible change agents

required for ensuring effective service provision, governance, and policy, including multiple levels of government, international donors, NGOs, and community-based advocacy groups. mGovernance applications can deliver services and exchange information related to government news and information updates, safety and law enforcement, elections, crisis management, education and awareness, data collection, monitoring, mobilization, employment, and health (Hellstrom 2010). Interaction among all actors on the range of issues and services is a practical challenge without tools that bridge space, time, and socio-economic barriers to access.

While the benefits and uses to change agents in governance can be numerous, there are sector-specific challenges for mobile phone applications in governance as well (Hellstrom 2010). The mobile phone industry itself is very profit-driven, which can be at odds with the nature of a nonprofit, public good such as good governance; there are few examples of models that strike a balance between the two. Practical challenges include accounting for illiteracy, limiting formats for data on basic mobile phones, issues of privacy and anonymity in households that share one mobile phone, and differences in the prevalence of certain communication formats in different contexts (e.g., rural versus urban preferences).

**Data Generation**

The traditional view of the government — as the only authorized collector and aggregator of data — is no longer true. A number of trends are helping to shape the context in which ICTs are transforming how information is used in development. We distinguish these trends in terms of data generation, dissemination, and communication.

Technology is innovating the ways in which data is generated and may help in overcoming some of the challenges in ensuring the usability of data. Mobile phone technology, for example, is allowing for direct and real-time data generation and collection from larger numbers of people, often at little cost. The Internet has provided the possibility for ordinary people to gather and post information themselves, rather than only professionals or practitioners. There is even a trend in which institutions and organizations are involving the public in gathering data. CNN iReport, for example, posts “citizen journalism” reports on its website, both to capture news stories reporters otherwise might not get, and also to promote a sense of inclusiveness of the viewers in their programming. Data generation by non-traditional sources may also increase a user’s perception of the relevance or trustworthiness of the data.

The data used by change agents come from many different sources:
- *Raw data is made available by government:* In many countries governments are required to make information publicly available.
- *Community-initiated data gathering:* Local community members or community-based organizations may gather data to advocate for an issue to local government, or to address information gaps on issues that are important to the community.
- *Data intermediaries process raw data:* There has been a recent emergence of “data intermediaries,” often research institutions or NGOs that process their own data or raw government data in ways that are useful for advocacy and other purposes, making it available to the public or other institutions.
- *Individual data gathering:* Data can be generated directly by individuals. Ordinary people send or post information that feeds directly into a database. Whereas previously data was often collected only through government agencies, it is now being collected by everyday residents, often in innovative ways. User-generated data holds the potential for a more accurate picture of

what is going on because it can be more up-to-date and incorporates different first-hand perspectives.

**Data Dissemination and Communication**
Technology is also innovating the ways in which data is disseminated and communicated.

- *Technology is making it easier for people to access information.* The rise of the Internet and ICTs has meant that more and more people and organizations are accessing data. Not only is more data more readily available by virtue of ICTs, but it is more accessible to organizations and people with limited resources.

- *Technology is spurring demand for information access and transparency.* "Democratization of information" is becoming the expected practice for constituents who want to know what is or is not happening in their communities. Governments and policies increasingly dictate that data must be available to constituents for transparency and accountability.

- *Technology is enabling communities to coalesce around issues of concern.* The Internet has made it easier for communities of interest to coalesce around and draw attention to critical issues. If used appropriately, information dissemination can also serve as a means of outreach and communication between parties and help to raise awareness on key issues and build constituencies through a critical mass of support.

- *Technology is making communication between stakeholders more immediate.* The Internet and ICTs also provide more immediate means for communication. New mechanisms of feedback and reporting mean that residents can communicate with service providers and the government, and organizations can disseminate information to residents. These same mechanisms can also create the expectation among residents for immediate response, as well.

## ICT Pathways – Change Agents and Their Information Needs

To leverage the ICT opportunity to bring about change in the WASH sector, key change agents will need to be empowered with the information they need to address the specific challenges they face.

In the past the sole agent of change was the government or the local service provider. Today change is also being brought about directly by less traditional change agents: NGOs, research institutions, community organizations, and in many cases, ordinary residents. This trend in part responds to the realization that addressing social issues requires more than what traditional institutions are able to offer, but also to a rising sense of agency that residents possess in the governance process to improve conditions in their own communities. Change agents have different goals and needs, therefore information interventions must have characteristics that are suitable for a particular change agent. In the absence of timely action by the government, residents, community groups, and NGOs must become their own agents of change. The hypothesis is that with credible, localized information, underserved populations, including the poor, can effectively advocate for improved water and sanitation services (Simpson-Hébert and Wood 1998; WaterAid 2007; UN Water 2008).

**Types of Change Agents**

Change agents now fit many profiles and have the opportunity and means to develop and disseminate useful information in the areas where it is most lacking and which can provide the greatest benefits in the short and long term. In this section, we describe the types of change agents, the activities for which they use information, the different formats that support their work, and some of the challenges that they face.

*Local governments/ service providers:* Local governments both collect data from and disseminate data to the communities they serve. Most governments use data they collect themselves to address development needs, such as for budget preparation and planning activities. Local governments also use data to communicate to constituents. Many city government employees work with residents and within neighborhoods in implementing projects, and they regularly send out messages on service outages and new projects. They also routinely receive and respond to complaints from consumers.

One problem is that local governments often lack creative ways to communicate to their constituents. Often information flow from government is uni-directional, leaving constituents under- or uninformed. This can, in part, lead to a lack of trust among constituents. There is a missed opportunity for local governments to exchange information with the communities they serve, through multi-directional communications with residents, participatory methods, and more intensive and sensitive outreach.

*NGOs:* WASH sector NGOs work on a range of issues, which they tend to address through: (a) advocacy: this requires information that can help them inform local governments about policy advice and pressure them for change; (b) raising awareness: they use information to identify issues and explain them to people; (c) monitoring and evaluation: NGOs need information to monitor and track progress on projects they have implemented. These three types of activities are particularly dependent on access to reliable information.

NGOs may have limited funds and capacity to analyze and process large amounts of information, so a format that is easy to understand and can help indicate action is preferred. NGOs may also face challenges in communicating their message to reach their target audience, gathering sufficient information to inform their activities and analysis due to limited resources, and effectively using data they collect through a variety of channels.

*Research institutions/universities/data intermediaries*: Institutions that work on research require information to understand issues and design policies. Such institutions require a lot of often complex data.

The problem is that research institutions are often perceived as not having much exposure or understanding of the day-to-day experiences of the communities they study. This could affect their ability to communicate meaningfully. They may lack credibility within the community, and they may fail to identify or reach the change agents who could use the results of the research.

*Media:* The media, or press, use up-to-date information to inform the public about emerging situations and crises. For example, real-time information was used in Haiti following the 2010 earthquake to show the world the emerging situation on the ground. This kind of information can then help raise awareness about issues, or increase pressure for government or disaster aid response. News organizations are increasingly emphasizing citizen journalism, where regular people can generate timely, first-hand content which might otherwise go unreported.

The problem is that media outlets often lack access to reliable and objective information and data. They may not get the data in time or it may be in a form that is too hard to interpret and communicate to broad audiences.

*Residents:* Increasingly people are interested in accessing information about their communities in order to learn about the status and availability of public services. Residents are often most interested in local issues of immediate concern to them, and so information that shows how issues relate to them and to their communities is most relevant. Street-level maps are a good way to relate things at a very local scale. Residents who actively seek information are likely to be interested in more extensive information in order to self-educate efficiently.

Preliminary evidence suggests that there is latent demand for better information among even poor residents. In a survey conducted by the Pacific Institute in Indore, India, households expressed strong interest in gaining additional information about water (ISET and Pacific Institute 2011). The type of information needed by each of the economic groups varied based on their own perceptions of how to better manage their water at the household and community level. In general, respondents expressed the need for information to improve government responsiveness to requests for improved municipal supply, community-level water source management, household-level water source management, and household-level water conservation techniques.

The challenge is that residents may or may not be very sophisticated in their understanding of complex data. They also may not have the same access to information that institutions have (e.g., many poor people do not have access to computers). Information should thus be presented in ways that are appropriate to their level of access.

**Some Considerations in Using ICTs**

ICTs have the potential to fill critical information gaps that could improve governance in the WASH sector. However, resource constraints, biases, and prejudices can impact the integrity of data and raise important issues about the usability of data generated through ICTs. We highlight a few of these considerations here:

*Temporal considerations:* The periodicity of government data is usually regular, though it may be too infrequent to be of use, whereas data from data intermediaries can be one-off. Some information needs require real-time information; for example, the availability of water on a certain date is only relevant for that day. Other data may be useful for many years for analysis and policy making.

*Sample size:* Governments often use models to predict trends, so they may take a reduced sample size and project an expected figure. This may not accurately reflect fine-grain differences between neighborhoods, for example, or there may be a degree of error that should be understood.

*Credibility of sources:* The people in a given city or community may have their own opinion about whether or not a source of data is reliable. If a project is working with a specific target group, that group should be consulted to find out whether they think the government-provided data is accurate or not. While this perspective may be limited, it may also inform the choice of the best source of data to use.

It is important not only to understand who a user is, but what resources they have (for example do they ever use the internet or maps?); what their interest is (do they care about local or global issues?); what their level of understanding is (can they understand statistical information or should it be simplified in a diagram?); and most importantly, for what purpose they want to use the information. Understanding these variables can help to guide the types of design and formatting decisions that can make data be more effectively utilized.

## Study Methodology

The opportunity for mobile phone solutions to achieve critical improvements in the water, sanitation, and hygiene sector exists, but the methods and benefits of doing so are not yet clear for WASH sector change agents. In order to learn more about existing efforts to use mobile phones as information interventions that benefit underserved people, particularly in terms of water, sanitation, and hygiene needs, this study was developed to identify the components of mobile phone application design, then to examine the impact of chosen design options in existing cases. The study is intended to provide a broad overview of information for current and potential implementers of mWASH solutions.

We conducted a global survey and identified forty mobile phone projects worldwide (see list in Appendix A), targeting projects which were specific to the WASH sector. Criteria for identifying projects were as follows:

- The system has been developed and is in (or has completed) the implementation phase.
- The project is deployed in a developing country.
- There was an aspect of public/resident response, or input from the "field."

From this list we selected ten organizations implementing fourteen mobile phone projects for further case study. If multiple projects fit these criteria and were built with similar goals and system structure, we looked at further indicators for project success and lessons to be shared such as outreach and choices supporting long-term sustainability.

The mobile phone projects identified through this process include five in water, sanitation, and hygiene (FLOW, Human Sensor Web, Maji Matone, NextDrop, and Water Quality Reporter), as well as others in employment (AppLab's Kerjalokal); fisheries management (e-Pasar Ikan (Fish Marketing Information System)); health (SHM Foundation's Project Zumbido and Project Kopano); market research (AppLab's Mobile Survey and Jana (formerly txteagle)); disaster management (Yayasan AirPutih's Media Center); and civic engagement (Yayasan AirPutih's Klik Jkt and Klik Papua).

For the case studies, we generated a list of research areas focusing on such topics as technical development of the system, evaluation metrics, and community involvement and collaboration (see full question list in Appendix B), which were used as a guide to interview the selected organizations. The resulting case studies (see Appendix C) are used in the following section (section three) to highlight implementation examples of various design options, as well as in section four to closely review the systems for lessons that can be applied to mobile phone solutions in development general, as well as in the water, sanitation, and hygiene (WASH) sector.

## Section Summary

In this section we reviewed the WASH governance challenge. We highlighted key information gaps that ICTs can fill. We described the different change agents and their information needs, and finally concluded with some considerations that might influence solution design in using ICTs to improve WASH governance.

# Section III. Review of Mobile Phone Solution Design

In order to learn from existing efforts to use mobile phones as information interventions, in this section we will review the general options and considerations for social, technical, and program design.

In developing mobile phone for development (M4D) applications as information interventions for change agents, there are three useful aspects to consider in solution design: 1) the way the application will function given social context and information needs (social design); 2) the appropriateness of the technology platform (technical design); and 3) the aspects that ensure an effective support structure for longevity and sustainability of the application (program design).

The systems for mobile phone information interventions consist of two processes. Figure 3 below shows a diagram of information flow in a typical mobile phone solution. First, a user interacts with a server, either by sending unsolicited data or through an interactive exchange with a central server. This process is the *data collection* step of the solution. Second, the data is analyzed and communicated to appropriate audiences. We call this process *data dissemination and analytics*.

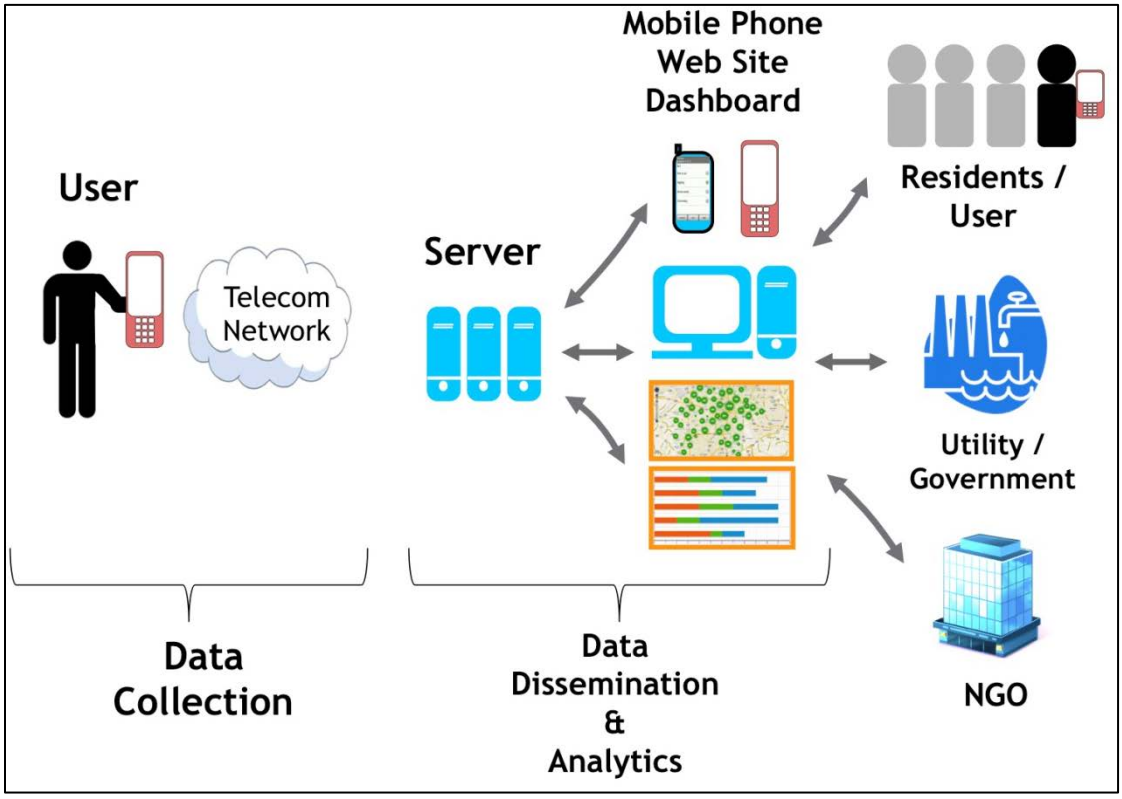


Figure 1. Diagram of information flow in a mobile phone solution

There are a variety of issues to address when designing a mobile phone solution: what information is needed, who will use the information, in what format should the information be

provided, what specific change will this achieve, and in what context. Identifying key aspects of what will make a mobile phone solution effective can follow a pathway of inquiry (Figure 2). Ideally, mobile system solutions identify numerous users of information who can all use the data to achieve a variety of different changes if it is provided in appropriate formats.

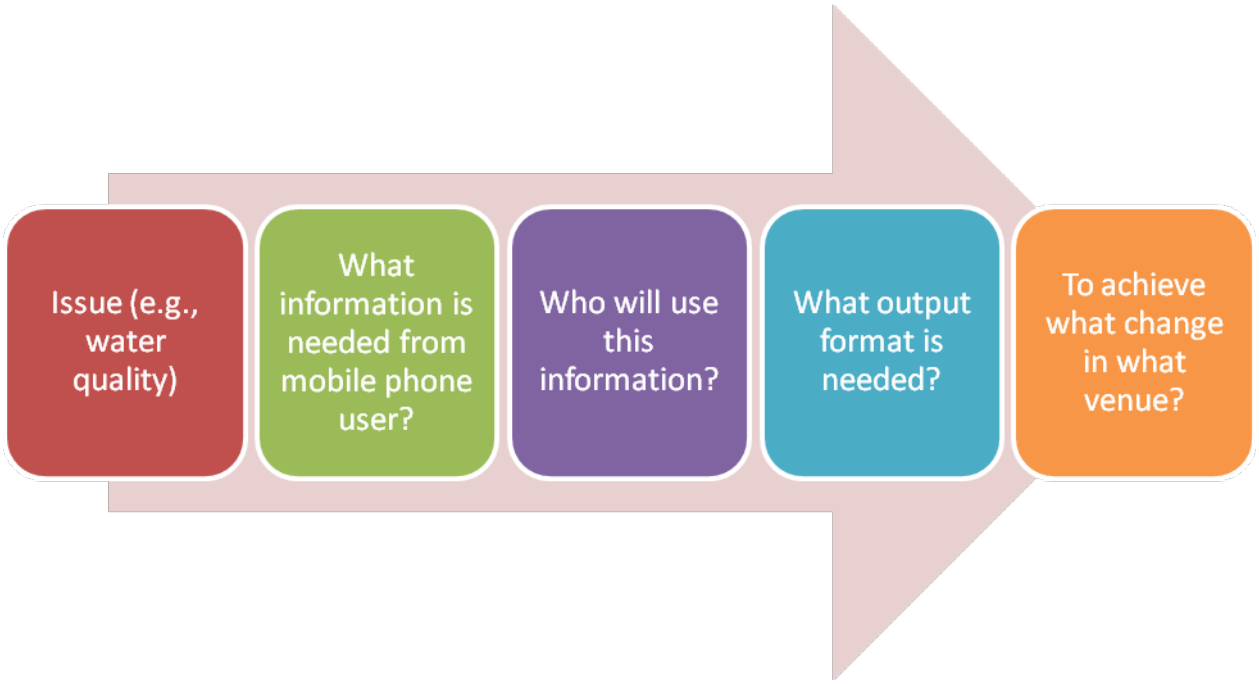


**Figure 2. Pathway of inquiry to achieving an effective mobile phone solution**

The ecosystem for success in the implementation of mobile phone information interventions involves considering several social, technical, and program design elements (Figure 3). Selection of options in data collection and data dissemination and analytics can be based on whether they are appropriate for achieving certain goals given the social considerations of the project, as well as the functional characteristics of technical options. For program design, there are other detailed resources on how to manage programs and develop business plans, but some management components prove especially relevant in this fast emerging and evolving area of development. In the following sections we summarize the social, technical, and program design considerations.

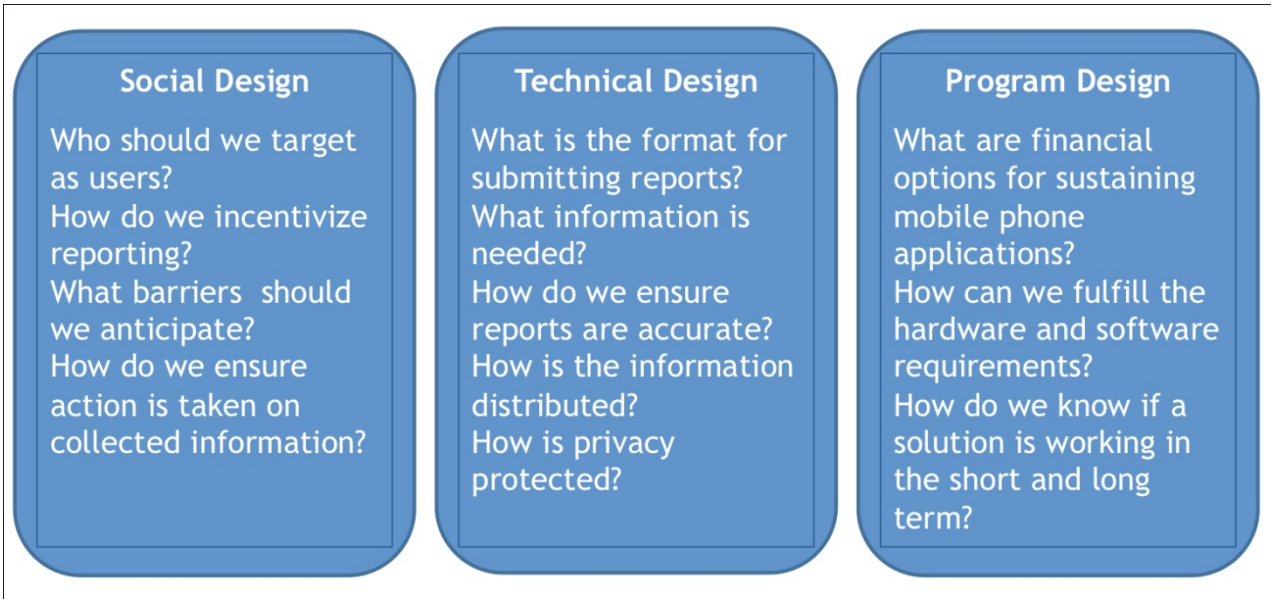


**Figure 3. Success factors in mobile phone solution design**

## Social Design

**Data Collection Considerations**

The social design aspects of data collection are as important as the technical design components. There are several considerations: 1) user perceptions—aspects of social context which influence user experience; 2) community participation—incentives and barriers for users to participate in the system; 3) privacy—the importance of protecting users' personal information; and 4) verification—credibility and usefulness of collection information.

*User Perceptions*

The method of data collection, the purpose the collected information will serve, or how it will be used is not always perceived at face value. Users may have perceptions from direct or indirect experience, personal beliefs, and other factors that influence whether they submit data or utilize a system. For example, direct negative experience in communicating particular information through one communication medium, such as mailing in an issue and not receiving a response, might lead a user to perceive that the experience will again be negative regardless of the communication medium. Indirect factors also impact the perception of data, such as the compatibility of the system with the user's way of communicating. In a study on public adoption of SMS programs, Susanto and Goodwin (2010) outlined 15 user-held beliefs which may dictate acceptance of an SMS government service, including reliability of phones and networks, ease of use, efficiency, responsiveness and usefulness, and relevance of information. Research found that when a person perceived that an SMS-based system was compatible with the way they communicated, this informed the user's perception of whether the service as a whole was easy to use regardless of the complexity of the system. While it is challenging to measure user perception, it should be considered as an influential aspect of social context in any information intervention that facilitates interaction among multiple users, especially when participation is voluntary.

*Overcoming Barriers to Community Participation*

Mobile phone for development (M4D) projects generally involve methods of engaging and motivating users to participate and utilize an application. The approach to incentivizing participants varies widely and is usually dependent on who is submitting information. Incentives can be financial (money or goods like free airtime); informational; or due to a desire to improve or change circumstances—whether reinstituting a critical service or assisting in disaster recovery. Ensuring community participation may also involve outreach to inform users about the system and ensure them that their reporting will be used in ways to benefit them, as well as remove negative barriers that prevent participation.

*Monetary Incentives:* If users do not receive a direct benefit from utilizing a mobile phone application or are otherwise unmotivated to participate, monetary incentives can be used. Some systems, such as the crowd-based reporting as pioneered by the Ushahidi platform, are generally not based on monetary incentive, but rather on the benefit that comes from creating critical mass or collective voice around individuals' issues.

*Establishing Trust:* The initial decision to utilize or participate in a system, called uptake, can be highly dependent on user trust. Users can distrust the technology, one or more of the involved stakeholders, or the project implementers. For example, user trust can be challenging to achieve when the project is not run by a local agency or organization, or is named in a non-native or foreign language. While projects may have on-the-ground, local partners, there is currently a push to leverage the technical capacity in emerging technologies and software creation within developing countries, and to localize its public aspects to encourage uptake and ensure local relevancy. The Dimagi/DataDyne Coded in Country Initiative encourages funding and operations to set aside programming costs for local

### *OUTREACH TO OVERCOME LOW EXPECTATIONS OF GOVERNMENT*

#### CASE HIGHLIGHT: MAJI MATONE

Sustainability of constructed water points is a major issue in Tanzania, with many water points eventually drying up or breaking down. Maji Matone was designed to increase access to clean and safe water in rural Tanzania by encouraging residents to monitor water infrastructure and submit reports about non-functioning water points. The system accepts and manually processes unstructured SMS messages, sending them as short code SMS messages to district water engineers and local media (radio and newspapers) which publicize the reports to highlight and put pressure on the government for a solution. The resident-generated reports are maintained in a database by Daraja, the project implementers.

When they designed the Maji Matone program, Daraja knew that although calls for government action were the typical response to any problem, the residents had low expectations of what government would actually do. Daraja made great effort to promote the new mobile phone service through posters, flyers, and radio. Through newspaper and a weekly radio program they encouraged people to engage with water management and share issues about water supply, provided water education segments, and provided a platform for local government and district water engineers on how to manage water schemes. They also worked directly with district water engineers to help them understand and make productive use of the information to help break the low expectation of government response.

developers, while the OpenROSA consortium has developers worldwide to ensure the local dissemination of open-source tools (Curioso and Mechael 2010).

*System Responsiveness:* In many mobile phone solutions for development, when a report is submitted, a confirmation message is sent automatically by the system or manually by an operator. For residents or customers using SMS messages to report issues about a public service, their incentive for participation is driven by a need to have a complaint registered and resolved as quickly as possible. However, the first (and an important) step for many users is knowing that their report was received and recorded. Without a direct response from a human, assurance needs to be given that system error will not be an additional setback in service provision.

*Improving Network Coverage:* In many parts of the world, the costs of owning and using a mobile phone are still relatively high, while usage is often limited by poor network coverage and services. This is especially true in more rural areas, or in countries where political instability may limit telecommunications networks. Unreliable electrical power is also a major issue, one that might be addressed by identifying or building alternative sources of electricity (CGHED and Earth Institute, Columbia University 2010). Other communication methods for information dissemination could be used as backup, such as conveying news over the radio when there is low broadband penetration (Meier and Leaning 2009). Proposed solutions to maintain reliable and consistent technical components include improving infrastructure for increased network coverage and providing appropriate mobile devices and chargers to program participants.

*Responsiveness of Government Authority or Service Provider:* User motivation to report a problem and expectations of whether a mobile-phone-based system will be able to "fix" the problem are often influenced by a prior view of the accountability of government services and organizations. A study was conducted on the adoption and long-term use of mHealth programs geared at HIV/AIDS care in developing countries, using a Technology Adoption Model (TAM) to study the perception and expectations surrounding technology use at a public clinic in Pretoria, South Africa (Hwabamungu and Williams 2010). The authors found multiple factors that influenced program sustainability and scalability, including user cost and programmatic support, as well as contextual factors such as pre-existing negative attitudes toward government or sponsor services.

Another study identified the significance of collaboration with existing agencies in reducing barriers to use of mobile phone technologies in low- and middle-income countries. Collaboration was one of the key factors in sustainability, facilitating support at the institutional level and ensuring that a project was addressing an existing need (Mechael et al. 2010). While many projects do not currently involve the end-user in system design or implementation, this is a possible method of ensuring that the program is useful to the local community and that development goals have a foundation of local capacity-building (Dearden et al. 2010). On-the-ground support can also aid in system sustainability to ensure necessary oversight and manual input to keep a project functional. Finally, the usefulness of the system and whether changes result from the information gathered were an essential component in sustained user participation.

### *VERIFICATION FOR QUALITY DATA*

#### CASE HIGHLIGHT: FIELD LEVEL OPERATIONS WATCH (FLOW)

Monitoring and evaluation is seen as a key step to ensuring sustainability of a development project by building a base of data to understand when and why a project is working or failing. This was the impetus for the Field Level Operations Watch (FLOW) system, developed by Water for People. FLOW is mapping software originally created for data collection for monitoring. It uses mobile phones on Android (smartphone) platforms, which allows users to take GPS coordinates, take pictures and videos, and fill out questionnaires. This information is then uploaded through the application and translated to Google Earth data in online maps.

Water for People wanted to more easily collect information to track the functionality of water access points they had installed. Yet, they understood that making the data collection more efficient was not good enough – the data had to be credible in order for them to be able to gain maximum benefit. They employed people to verify reports by making unannounced audits in the field, including cross checks with non-reporting community members. They also created incentives for report accuracy to discourage submission of reports that might falsely reflect a well-functioning water point.

*Socio-Cultural Factors*: In many cultures social factors, such as gender and class, can impact participation in projects, especially those aimed to benefit underserved groups. Different social or cultural norms may not allow for responses from those whose answers are needed. For example, women are frequently responsible for the provision of water within households. If a survey on household water usage targets the head of the household, it might not gather accurate information if the person involved in water provision is a woman. In many places, social norms may not recognize a woman as head of the household, or someone allowed to respond to outside inquiries about a family's activities.

*Data Privacy and Protection*

Freifeld et al. (2010) cite several areas of concern in protecting the privacy of people submitting reports. Many submissions contain not only a description of the event, but also the user's GPS (Global Positioning System) coordinates or a photograph of the person involved. This information can be used by anyone with access to the report to physically locate a person. Therefore, in addition to classifying and assessing validity, anonymization of report submissions is necessary: removing identifying features such as names, converting the coordinates to a town-level geographic feature name, and finally, placing a black bar over pictures to obscure any identifying features. Only the anonymized record is posted to the public site.

*Data Verification and Quality Control*

A significant concern with many mobile phone-based information systems—particularly those involving citizen reporting—is the question of how to verify submitted information. Government officials may have reservations about the quality of the data and their obligation to respond to individual reports, which could represent an added burden to their responsibilities (Freifeld et al. 2010).

Some preliminary methods of verifying a collection of data from individuals have been piloted through cross-validation with other sources and also making use of crowds for evaluating the quality of information. Collecting contact information from the person reporting enables system owners to contact the submitter to request additional details if a report merits follow-up. Many systems require messages to be reviewed by a moderator, or the reports may be marked to enable users to provide feedback and even corroboration of submissions, as has proven successful with wiki web sites, such as Wikipedia. While this tends to be a human process, there is a technical option in Ushahidi's Swift River platform, which uses automated algorithms to score and filter information based on the credibility of sources. With an effective review and filtering process to verify a report, the quality of the overall information can be improved.

**Data Dissemination and Analytics Considerations**

The second consideration in a mobile phone solution's social design is ensuring that the data collected is accessed and used by the audiences for which it was intended. A repeated theme in ensuring long-term sustainability of a system is whether the data collected was actually used to effect change. Different systems use different approaches to this.

*Partnerships with Government Agencies*

When a system is designed to serve residents in relation to a specific public service, or to facilitate communication from government agencies to or with constituents, then the system is best served by a close relationship with the related agency. Residents want to know that the data they submit will be put to effective use, particularly in receiving a response to an issue, and government agencies need data that is useful to their operations. Such systems should be developed in partnership with the government agency to ensure that the information fits into existing agency operations and uses of data.

### *ENSURING DATA IS USED BY UTILITIES*

#### CASE HIGHLIGHT: NEXTDROP

For approximately 1 million residents in the city of Hubli, India, water comes in once every five days for a five-hour block. As a result, households lose time waiting for water, are stressed by uncertainty of water availability, and may have to resort to other water sources (e.g., tanker trucks or bore wells). The NextDrop system was developed to generate high quality water timing information using inputs from utility employees in the field and local residents to alleviate the social costs of intermittent water. The system collects information through an interactive voice response (IVR) program and helps the utility to better manage water distribution, and also enables the community to advocate directly for more equitable distribution.

NextDrop knew that getting residents to submit reports (front-end users) was not enough. They also needed to ensure that the data could and would be used by the target recipients at the utility (end users). Most importantly, the participation of valve men and water utility engineers is required by the utility company which ensures that all issues receive a response. While NextDrop manages the data including verification, it gives ownership of the data to the utility to provide them and the data itself with local credibility.

### *PROVIDING ANONYMITY AND SUPPORT*

#### CASE HIGHLIGHT: PROJECT ZUMBIDO AND PROJECT KOPANO

Support groups exist for people to share experiences, learn, and get much needed moral support for handling all sorts of challenges and moving forward in their lives. But they can't work if people don't attend the meetings. Project Zumbido and Project Kopano were pilot systems developed by the SHM Foundation to connect people with HIV who lived in remote locations, were faced by stigma associated with HIV, or were faced with practical constraints such as child care or transport costs.

The group SMS technology used by Project Zumbido and Project Kopano allowed small groups of people with HIV, a medical professional, and a mentor to send messages that were distributed at once to all other group members, mimicking a group meeting experience. The technology uses one single number for messages that are relayed through an online facility to everyone within a restricted membership group, and allows for online invitations and moderation of messages. The system helped provide a protected and supportive virtual environment. The participants were able to discuss and share information about access to services, medication, and emotional support. After the pilots ended, some of the members continued to support each other with in-person peer-to-peer support, which the members said would not have happened without having started a

*External Pressure from Media*
The participation of a water or sanitation utility or other service provider in responding to and resolving complaints cannot be taken as a given. Often the utility is a monopoly with no incentive to provide adequate services to consumers. To address this, some systems are built in close partnerships with media outlets, which are utilized to build pressure on the service provider to resolve ongoing issues, as well as to highlight significant improvements in service.

*Partnerships with NGOs, Aid Organizations, and Community-Based Organizations*
NGOs, aid organizations, and community-based organizations are already motivated to make use of data collected directly from the individuals and groups they are helping. The information collected through mobile phone solutions can help the organizations target their activities to serve areas or people most in need, as well as to assist communities in their own advocacy activities.

*Peer-to-Peer Exchange*
Information is sometimes needed from and best communicated among peers rather than, for example, between constituents and authority figures. Mobile phone applications can improve the exchange of information among members of a specific group or network, or those who wish to connect around common issues, especially those who are not otherwise able to connect in space or time. Peer-to-peer exchanges by mobile phone applications may also serve as mobile bulletin boards to promote real-time knowledge sharing among participants around a common issue.

*Crowdsourcing*
Crowdsourcing is a term and methodology increasingly being used to describe the development of collective data, or data that is sourced from a crowd, group, or set of individuals. It describes when a community or group of people gathers information individually, and the information is compiled to benefit or be used by the individuals

(an excellent review of crowdsourcing and crowdfeeding can be found at the Crisis Mappers Network, by Iacucci 2010). Crowdsourcing is indicated as data dissemination rather than collection in this context because it is not until the data is analyzed or disseminated that the "collective voice" becomes meaningful. The data is collected or received as individual, disparate reports, then is later aggregated. This is useful in situations when it needs to be determined if an issue becomes amplified, or if the integrity of data can be increased by multiple rather than singular instances. For example, multiple reports can help differentiate between a normal level of disease instances and an epidemic.

## Technical Design

This section provides a general overview of the technical options available for data collection and dissemination. Technical terms are used in this section to facilitate further research by non-experts who are exploring mobile phone solution options to fulfill their information needs; however, effort is made to describe the meaning of uncommon technical terms either here or in the glossary.

### Data Collection Options

The technical options for data collection in mobile phone solutions are constantly evolving. As different project implementers explore how mobile phone solutions can meet their information needs, they customize, enhance, and evolve features and platforms to meet their specific needs, which results in constant development and innovation. Table 1 summarizes the most common technical design options currently being used for data collection.

**Table 1. Technical design options for data collection**

| Category | Technical Design Features |
|---|---|
| Simple SMS Data Entry (data based, any mobile phone) | Simple SMS involves a one-way transmission of data via an SMS message by the user to a server/person. These SMS messages can have a structured format (difficult to remember and use the structure, leads to lots of mistakes); unstructured format (can be difficult to interpret); involve multiple choice questions (can require a lot of messages, and thus increase cost of participation); or a hybrid of all of the above. |
| Interactive SMS (data based, any mobile phone) | These involve sending SMS messages back and forth to carry out a conversation. The user needs a simple phone capable of sending SMS messages. At the other end, this conversation can be handled by an automated engine (which automatically parses responses and sends follow-up questions/clarification) or even a real person. |
| Native Forms on Basic Phones (data based, basic mobile phone) | Forms use built-in applications to structure the text. These can usually be displayed on many phones, even basic phones. The advantage is that the interface is a little easier to use, can structure the responses without requiring much user training, can do some store-and-forward upload in the case that the phone is not connected, and can do some simple quality checks to ensure data entered is in the correct format. |
| Smartphone Applications (data based, Smartphone based) | These are applications that run on a smartphone, which can auto-geotag and collect data while providing aesthetically pleasing, user-friendly interfaces. The usefulness of smartphone applications depends entirely on the penetration of smartphones among the target population. Smartphones are expensive to purchase and maintain, and vulnerable to theft. They have lower levels of penetration in the developing world. |
| Interactive Voice Response (voice based system, user can use any phone, even land line) | Involves a regular voice phone call by a user to a server which houses an “interactive voice response” (IVR) system. The IVR system is located at the server end. It guides the user through a menu of options. |
| Geolocation Features | Smartphones automatically geo-tag. Basic phones using forms can solicit this information explicitly in one of the entries (e.g., asking for an address or colloquial location name such as “mayor’s office”). SMS messages can either be manually placed using geographic coordinate information (e.g., Ushahidi software) or automatically parsed for location hints in the text of the message (e.g., search for address, street, zip code, or any other location information). |

*Simple SMS Entry*

Among the many functions of mobile phones, short message service (SMS) or text messaging is one of the most widely utilized. SMS-based systems, especially when compared with manual data entry into a computer (the most common form of data collection in developing countries), are extremely powerful as they facilitate regular data collection and have the potential to significantly improve the quality of information by reducing keying error (Mukherjee et al. 2011). SMS-based systems can arguably also improve data collection even when compared to smartphone applications or other more sophisticated forms of data collection technology given the relative penetration and affordability of this mode of communication.

The SMS-based systems described in this section have been applied to a number of sectors of M4D. One of the most developed sectors is the incorporation of mobile and wireless technologies into healthcare (mHealth). Common uses include utilizing mobile phone forms to substitute for paper data collection, improving patient medication regimens through SMS-based communication, mobile telemedicine, and real-time disease tracking. These initiatives have been collected and reviewed in several previous studies (Mechael 2009; Vital Wave Consulting 2009; WHO 2011; Freifeld et al. 2010).

Methods of SMS entry for mobile phone users vary widely where the purpose of the system and the format of the message both inform the amount of information obtained and type of processing needed to parse and organize the resulting data (summarized by Loudon 2009). The majority of projects use either the standard built-in SMS service, or phone-based applications. Citizen reporting almost exclusively utilizes SMS messages, since it does not require specialized training, hardware, or downloading of a program.

SMS messages can be entered in a structured or unstructured format, but they vary in terms of how the burden is distributed between the user and the server.

*Structured* messages contain pre-determined and ordered symbols, codes, or words within the message. The symbol, codes, or words act as delimiters which help the server parse the message into specified categories of data, such as phone number, location, problem, and so forth. In order for the system to be able to process structured messages, the symbols, codes, or words are required to be used. Structured messages can sometimes be challenging for the user and require training or guidance, but are very easy for the server to process.

*Unstructured* messages have the advantage of requiring little or no training for users, and hence often solicit more frequent reporting. However, the lack of structure in the message leads to increased complexity in the system and server (i.e. data analytics). Unstructured messages usually need to be processed manually in order for information in the received messages to be accurately categorized. Since unstructured messages cannot normally be validated automatically by the system, they also may require follow up if necessary data is missing.

Finally, structured and unstructured message formats can occasionally exist together. A system can allow for a structured report submission to be followed by unstructured text comments, however in some systems like these there currently is not a user interface for retrieving or viewing the unstructured portion of the message (Verplanke et al. 2010).

*Interactive SMS Messages*

While initially SMS was frequently chosen for public services as an extremely simple solution for broad-based information collection and broadcasting, SMS-based systems are increasingly being used for much more. Several open-source platforms to facilitate more sophisticated data collection from mobile devices have been introduced in the last several years and are largely responsible for the wide utilization of SMS systems in M4D projects. The FrontlineSMS software, developed in 2005, allows for two-way messaging between a computer and mobile phone. RapidSMS works in a similar fashion and also includes options for smartphone capability (RapidAndroid) for computer-free data processing. These programs function in the absence of a mobile internet signal—requiring mobile telecommunication capability only—and offer a simple framework for data storage and scalable messaging to multiple users.

*Native Forms on Basic Phones and Smartphone Applications*

Forms are applications installed on phones that are particularly useful when complex or customizable sets of data are needed. They have most often been used when the reporting is conducted by paid workers who can be supplied with phones by their employers.

Applications can be supplied on phones or can be downloaded from the internet, though they can also function directly through a web interface. For instance, the FrontlineForms client in FrontlineSMS allows Java-enabled phones to receive simple forms via SMS message. FrontlineSMS is an open-source system (i.e., it is distributed freely) and allows information to be sent and received through a data hub consisting of a laptop and an inexpensive mobile phone. FrontlineSMS allows residents in remote areas to communicate their specific problems and needs directly to service providers who would not otherwise have the capacity to interact with disparate populations (Freifeld et al. 2010). Medic Mobile, a spin-off from FrontlineSMS, also recently introduced the first SIM (Subscriber Identity Module) application for healthcare, whereby the application is stored on a removable SIM card and can enable structured data collection and text menus on very basic phones (Medic Mobile 2011).

On Java-enabled mobile phones, the JavaROSA platform is also available to aid in data collection. The emergence of GPS-ready and broadband/WiFi-capable smartphones has also led to greater mobility, instant location tracking, and greater complexity in data collection. For example, the World Food Program Vulnerability Analysis and Mapping branch uses smartphones to store up to 1000-2000 independent data fields while performing food security assessments (Mu'ammar 2011).

Forms and applications can also help overcome issues in transmitting a lot of information. The availability of a general packet radio service (GPRS) data connection allows more efficient transfer of form data in the absence of internet access. Connections with GPRS usually charge subscribers by volume of data sent, rather than the length of connection time. This is helpful when network coverage or signals are not strong, which can prevent data from being sent even if a connection has been made. There is also the option to send form data as a series of SMS messages, or as a structured SMS message to a form database (reviewed for EpiSurveyor software on the Datadyne website); which are all functions performed automatically by the system (i.e., not the user). An application can also be developed as a "store and send" system (Berg et al. 2009). When there isn't a mobile phone signal, store and send systems keep the information on the phone until connectivity is reestablished.

Entry fields in the form or application can be modified according to the specific reporting needs of the end user, such as limiting the number of characters that can be used, or requiring numbers rather than letters to be entered. Forms also enable reporting through one system in multiple languages (Swedberg 2011).

*Interactive Voice Response*

For systems operating in areas with low literacy levels or with users who are less familiar with mobile phones, text-based data collection is not always the best option. Interactive voice response (IVR) systems are a common alternative. In a general IVR setup, a database gathers information through a series of short, pre-recorded or dynamically generated options according to caller input. When prompted, the user interacts with the system, either by voice commands or entering numbers in their phone keypad. This type of system has several advantages, including ease of use, an increase in data integrity and accuracy, the ability to use a local language, and immediate feedback and verification during the call. Additionally, the back-and-forth between the system and caller generally results in a larger amount of collected data than is usually gathered through citizen reporting by SMS. Factors to consider in selecting an IVR system include audio design, costs, and technical maintenance (Loudon 2010). IVR does not require internet access and can connect through a mobile phone SIM card or Voice over IP (VoIP).

FreedomFone, an open-source IVR software developed in Zimbabwe, is widely utilized in public service projects to gather and provide information. The system contains voice menus for news dissemination, polling capability, and a callback functionality to maintain contact and information flow to users. The

### *INTERACTIVE FORMS ON UNDER-$30 QWERTY FEATURE PHONES*

#### CASE HIGHLIGHT: USAHAKU BY APPLAB INDONESIA

Application Laboratory (AppLab), an initiative of the Grameen Foundation, is a mobile-services innovation and business-incubation center. AppLab Indonesia is focused on creating a suite of livelihood applications, called Usahaku, which generate income, reduce costs, and provide opportunities for the poor that otherwise are not available (poverty alleviation). Of the 250 million people in Indonesia, three-quarters live below USD $2.50 a day, and two-thirds have mobile phones. The average price of mobile phones in Indonesia is USD $30-40. Poor and rural populations often lack access to important information and knowledge that would enable them to improve their lives and their livelihoods. The AppLab Kerjalokal application aims to facilitate easier procurement of local day jobs for “blue collar” workers. Mobile Survey aims to provide incremental income to those earning less than USD $2.50 per day.

AppLab Indonesia found that QWERTY feature phones, or basic phones with keyboards, were highly popular in Indonesia and provided a unique opportunity for poor people to earn supplementary income. Working with a local telecom company, BTEL, they are pre-loading the Usahaku suite of applications on 2 million under-$30 QWERTY feature phones to provide easy opportunities for Indonesians to earn incremental income. Targeting QWERTY feature phones allows for higher levels of communication and interaction from the user, without relying on the sophisticated systems of more expensive smartphones.

### *FROM BASIC TO MORE ACCESSIBLE: SMS TO IVR*

#### CASE HIGHLIGHT: HUMAN SENSOR WEB

The Human Sensor Web (HSW) system was designed to make it easier to collect and share data over time on the state of water sources and services in Zanzibar, Tanzania. Many residents of Zanzibar are only able to access piped water for a very short period each day, or must access community sources far from their homes. Developed by University of Twente, Faculty of Geo-Information Science and Earth Observation, Twente Institute for Wireless and Mobile Communications, and the 52° North Initiative, the HSW system is an SMS gateway application that accepts user reports as structured SMS messages, as well as automated sensor data through both water and power monitors. The data is meant to be used by communities to forewarn against dry wells, as well as to advocate for better water services. The water readings are used to corroborate user reports, and the electricity readings are incorporated in the system to determine whether power failure is the reason behind pump failure and lack of water availability. All this information in displayed publicly on a Google map.

The developers chose SMS technology to support the complex system architecture in order to allow collection of reports from anyone and everyone with a mobile phone. They found that people wanted to describe issues in lengthy detail, which SMS does not support well. They are now moving to implementation of an interactive voice response (IVR) system, which will allow for long descriptions, as well as remove a barrier for low-literacy residents who want to submit reports.

implementation of IVR in combination with SMS broadcasts allowed users to listen to information in Swahili if they were not familiar or comfortable with SMS messaging.

Open Data Kit (ODK) Voice, another IVR system currently available for basic phones, was created under a suite of open-source tools centered on the Open-ROSA/XForms form-specification language (Hartung et al. 2010). ODK Voice was piloted in a data collection survey for teachers in rural Uganda to determine the role of different user interfaces (UIs) in system accessibility and command by untrained users (Lerer et al. 2010). The organizers found that successful task completion with the system jumped from 0% to 75-100% with changes to the UI design, and subsequently suggested guidelines for IVR systems in developing countries where the users have no previous experience with interactive voice response programs. Among their observations, they found that a request for touchtone keypad input from the user caused problems for many people, that the use of a warning SMS message prior to initiating an IVR call was extremely helpful, and that having a native Ugandan design and record the prompts was essential for user comprehension (Lerer et al. 2010). Thus, while IVR can be an extremely useful tool for data collection, it must be fit to the needs of the population to function effectively.

*Geolocation*

Finally, the ability to aggregate collected data on maps is dependent on the additional collection of geographic or location data along with the other information submitted in the initial reporting. It can be impacted by both the socio-cultural context as well as the technology used.

There are a number of methods for obtaining this data, depending on the format of data collection. Locations can be indicated using pre-determined codes in a structured SMS message. But there are often a much larger number of potential location points, such as tracking utility service to individual households. Utility companies with SMS-based customer service systems will often request an address (e.g., Cape Town Electricity SMS) or a pre-assigned customer number (e.g., Kerala State Electricity Board) to determine location. A project to reduce waterborne illness in Haiti uses near-field-communication (NFC) -enabled phones to read radio-frequency identification (RFID) on water treatment and storage buckets, allowing technicians to identify and distinguish individual households (Swedberg 2011).

SMS messages can also be integrated with online mapping through programs like the open-source web software GeoChat, which is built around the idea of shared geospatial awareness (InSTEDD 2012). Users communicate their location using an address or GPS coordinates, and this information is transferred to an interactive map, where users can further collaborate and communicate between distinct groups. This software is frequently used in disease mapping projects, such as the Mekong Basin Disease Surveillance Network (Kass-Hout 2009).

However, the primary driver for SMS-based interactive mapping was the development of the open-source Ushahidi software platform, which is based on the idea of crowdsourcing. Ushahidi was designed to collect and display reports of violence during the 2007 presidential election in Kenya. Since then it has been heavily utilized in both election monitoring and real-time reporting after several natural disasters, including earthquakes in Chile and Haiti (Schuler 2008), and it is currently the most widely used tool in mobile-phone-based citizen reporting. Ushahidi accepts user submissions via SMS, web, and phone and geocodes events onto a Google Maps interface. Unstructured messages containing an address can be manually geo-tagged and placed on a map (a process heavily utilized during the Ushahidi Haiti project). The Ushahidi project HarassMap additionally uses cell tower triangulation to assist in determining a location (HarassMap 2010) though this method in general is not always entirely accurate and often requires network cooperation. Finally, Ushahidi has also developed smartphone applications with automatic geo-tagging (Hersman 2008), which has emerged as one of the most consistent and effortless forms of location tracking.

The built-in GPS capability of smartphones has allowed for development of specialized mobile phone applications. There is also more general smartphone software available for collecting and mapping data, such as EpiCollect, which links GPS data and other information to a web database to display the data using Google Maps (or Google Earth). This software has been utilized for diverse purposes, including ecological and epidemiological studies (Aanensen et al. 2009).

**Data Dissemination and Analytics Options**

The technical options for data dissemination and analytics are numerous. Table 2 summarizes the technical design options most frequently being used.

**Table 2. Technical design options for data dissemination and analytics**

| Category | Technical Design Features |
|---|---|
| Web-Based Dashboards | Web-based dashboards display the collected data to convey information useful to the user. Web-based dashboards can make different controls available to support different roles. For example, a system administrator may use the dashboard to view maintenance logs, failures, or bug reports. A government regulator may use the same dashboard to access summary reports. An individual resident may use the dashboard to track a specific issue or file an update on an existing issue. A community organization may use it to access an ongoing discussion on a message board or to look up announcements from the service provider. |
| Web-Based Mapping | This places instances of reports on the associated geographic location on a map. The maps are by nature collaborative, and are often interactive. Interactive maps allow for visualization of reports by different categories and zooming in and out in order to view specific locations for specific reports. |
| Broadcasting or Bulk SMS | Information can be disseminated by sending out identical information through SMS to a large group of users. |
| Interactive Communication | Interactive Communication systems handle collection, analysis, and dissemination of data at the same time. |
| Other Reports and Data Formats | Data can be provided in the form of graphs, plots, interactive graphics, spreadsheets, photos, videos, and so forth. These reports are designed based on the intended audience and how the data will be used. |

*Web-Based Dashboards*

Web-based dashboards are web pages that function as control panels for a software system and allow viewing and management of information in the system. Most web-based dashboards for mobile phone projects are utilized primarily by project organizers and formal stakeholders or system users who collect data as part of their job. Publicly available dashboards tend to consist only of displayed information, such as in tables. The functionality for further visualization on dashboards exists with several popular software platforms. The data collection tool Episurveyor "allows for real-time visualization of the survey responses and analysis of the aggregated and disaggregated data through graphs, charts, and maps as well as data exporting to common third-party data analysis programs such as Microsoft Excel or Access" (Schuster and Perez Brit 2011).

RapidSMS also provides the option for a web portal with data analysis and charts, with projects like ChildCount+ having a web dashboard available to community health workers to input and monitor the health status of their patients. Similarly, organizers of the Water Quality Reporter project maintain a local database with reporting results. The advantages of online data tracking and benefits of a community portal have led many projects to plan more complex dashboards, like Medic Mobile, which wants to create an online disease alert system for health officials (Bulkley 2010). While none of these dashboards are available to residents, web-based mapping, which we discuss in the following section, is a major exception for public online interfaces.

*Web-based Mapping*

Web-based maps are used when it is beneficial to visualize the spatial relation and distribution of reported data or information. Text and media (e.g., photo) reports are placed either automatically or manually on the associated geographic location on a map. Collaborative maps are those where mapped information has multiple sources, such as multiple users within a community submitting reports or crowdsourcing. The "clusters" of reports are in one sense a collective voice of underserved people and the issues they experience. Clusters can also help highlight geographic prevalence of issues that bring location-based causes and solutions into consideration. For example, in the case of disasters, the clustered reports can help aid organizations to better plan and distribute support resources. Interactive maps allow for variations in visualization of the placed reports, such as features to zoom in closer to a specific report location, or to view only a portion of the reports by filtering categories such as the topic of the information reported, the time the report was submitted, and so forth.

*Broadcasting or Bulk SMS*

Broadcasting, or bulk SMS, systems allow for one user, usually an institution or organization, to send out a high volume of messages at the same time to a large number of recipients. These systems are being used for purposes similar to other mass media, such as direct mail campaigns and email blasts. They are useful for dissemination of general public service information in a targeted way, such as disaster warnings and disease outbreaks for specific geographic locations. For example, the Urban Service Monitoring System (UrSMS) in India is designed to rapidly spread information regarding flood risk and other natural disasters to warn residents about evacuation (ACCCRN 2012). These systems can also be used for making mass appeals for support, such as advocacy or fundraising campaigns. There are commercial systems with these features, such as MySMS in Kenya and Nokia Life Tools for emerging markets, as well as open-source alternatives such as FrontlineSMS and RapidSMS.

### *GETTING THE INFORMATION OUT – MAPS AND SMS BROADCASTS*

#### CASE HIGHLIGHT: MEDIA CENTER BY YAYASAN AIRPUTIH

In disaster situations, timely information from on the ground is hard to obtain and communications to individuals can be challenging. The open-source Ushahidi system was developed to help residents and aid organizations in crisis situations by displaying near-immediate, crowdsourced information about issues arising from the crisis, and since has been used in situations of civil unrest, elections, and natural disasters. Media Center is an Ushahidi-based site developed to assist communities and aid organizations in Indonesia, a country prone to earthquakes, volcanic eruptions, floods, and landslides. The maps display SMS reports by categories such as disaster type, humanitarian posts, and important resources. The developers coupled the map-based system with SMS broadcasts to ensure that the people who needed or wanted the data could receive it as quickly as possible rather than having to consult the website or send information requests. For example, they worked with the Bureau of Meteorology, Climatology and Geophysics to send out urgent weather reports.

### *USER-FRIENDLY DATA FORMATS*

#### CASE HIGHLIGHT: WATER QUALITY REPORTER

In South Africa, water quality testing in rural areas is extremely challenging, given that almost all labs are located in urban areas and rural areas tend to be isolated from a number of government services. Water Quality Reporter was developed as a mobile phone-based tool to transmit information from a field water quality test kit to relevant authorities, in order for appropriate actions to be taken at the municipal or provincial level. This system will enable more people in rural areas to meet reporting needs, potentially increase support from government institutions by creating a data connection to community water management, and increase the responsibility of managers in the water quality scheme.

For data collection, the Water Quality Reporter mobile phone application supports both a JavaRosa platform version to enable the sending of complex forms, as well as an SMS-based collection method to enable reporting from basic phones that do not support the Java platform.

The application also provides the data in the formats most useful to the end user. The local manager responsible for water quality receives direct SMS reports for immediate analysis, as well as a weekly Excel spreadsheet summarizing all reports. There is currently an internet database for viewing and entering data. Generally, there has been high demand for more detailed analytical data, such as graphs and maps, which the organizers are also developing.

*Interactive Communication*

These mobile applications facilitate various forms of interactive communication between a user and the system, or among two or more users. There are different ways in which systems facilitate interactive communication, including: a) an automated or manual prompt for further details; b) a unique reply with information addressing the submitted report; and c) transmission of reports to other users within a membership or subscriber group. This interactive communication can be essential for building user trust in the system and allows for more advanced data collection as well as data distribution back to users who might otherwise not benefit from the collected information. For instance, many SMS-based customer service systems for utilities are set up to send a response to an SMS message from a customer. In Delhi, the electricity company BSES Yamuna sends an immediate acknowledgement of an SMS message complaint. Several companies also have advanced systems with the capability to follow up with a customer when their specific issue has been addressed, although this may require previous registration of their mobile number (Chennai Metrowater 2012). Group SMS is used to expedite distribution of information from one user to a group of other users. This is useful when timely exchange of peer information is needed, such as among co-workers in disparate locations within a city.

*Other Reports and Data Formats*

There are many other formats for disseminating and displaying information which cater to the unique information needs of the users and the intended usage of the data. For example, reports can be transformed into graphs, plots, and spreadsheets. Photos can be transformed into interactive graphics. These reports and data formats can be displayed statically on a web-based dashboard or website, sent back to mobile phone devices, or provided as downloadable documents.

## Program Design

Program design refers to the management structure of a particular solution. A specific entity, whether an NGO, government agency, or private sector provider, designs a particular solution or application, develops a plan for implementation, involves other stakeholders, and creates and implements a plan for the ongoing sustainability of that solution or program. Designing successful development projects requires ensuring an effective support structure for longevity and sustainability of a system or application. There are specific areas that are particularly relevant to mobile phone for development programs, including financial models, strategic technical partnerships, and metrics to evaluate effectiveness.

**Financial Models**

Despite informed preparation of social and technical design, a key challenge which persists for all types of information and communications technologies for development (ICT4D) projects is financial sustainability. The core of this challenge exists in providing equal access to the underserved and those without resources (a not-for-profit objective), which can often act in opposition to the generation of sufficient income to financially sustain the project (a for-profit objective) (e.g., Kuriyan et al. 2006; Batchelor et al. 2003).

Ideally, a mobile phone for development (M4D) solution should include an appropriate plan which considers both the up-front costs such as programming and hardware, as well as the ongoing operational and maintenance costs (Lehr 2007). But because a variety of donor organizations continue to support ICT4D and M4D projects, some argue that ICT4D project planners should not hesitate to utilize such donor funds for all start-up costs and implementation, while mindfully developing strategies for sustaining the ongoing operation. (Ibrahim et al. 2010; Batchelor et al. 2003)

### *GOVERNMENT INVESTING IN LIVELIHOOD SUPPORT PROGRAMS*

#### CASE HIGHLIGHT: E-PASAR IKAN/FISH MARKETING INFORMATION SYSTEM

Fishermen in Aceh province, Indonesia were struggling to get good value from their daily catches. Their profits were being threatened by middlemen who created a market monopoly. The e-Pasar Ikan (Fish Marketing Information) system was developed by the UN FAO and the Department of Maritime Affairs and Fisheries (DMF) in Aceh Province to support fisherman and ensure they could earn the best prices for their catch. The fisherman could receive direct data by SMS or the web, as well as through radio and newspapers.

DMF was involved in the project from the beginning. The system bridged different supportive functions of the department by leveraging mobile phone and internet technology. Two reporters in each of 18 municipalities/districts positioned themselves at the landing site (a port) and at the market. Using a mobile phone with special software they easily entered the species and up-to-date minimum and maximum prices of up to 20 species of fish. By the end of the second year, UN FAO was able to hand over the project fully to DMF, which also established the Aceh Traders Organization through this project in order to further support fisherman.

We summarize some of the financial strategies used in M4D projects, mainly to fund upfront development costs:

*Funding from External Donors*
A variety of donor entities, including for-profit and nonprofit organizations, charitable foundations, and international organizations and government agencies, fund projects through grants and award programs and initiatives specific to mobile phone technology, as well as the sector they serve. International organizations and government agencies continue to play a major role in this sector of development, including UN-HABITAT, the Ministry of Foreign Affairs in the Netherlands, and the European Union.

For-profit entities are also funding projects with and without built-in cost-recovery strategies. Funds come through charitable initiatives and sub-entities, as well as corporate social responsibility (CSR) programs. Additionally, many receive partial or full funding from charitable foundations making contributions in this space, including the Clinton Global Initiative and the Gates Foundation.

*Funding from Project Underwriters or Partners*
Project underwriters and partners establish relationships with projects that go beyond philanthropic support. Project underwriting usually takes the form of acknowledged sponsorship, and often supports a project's operations. Partners, in these cases, not only co-implement, but provide financial support for the project as well.

*Funding from Local, Regional, or National Governments and Agencies*
For mobile phone projects focusing on needs usually fulfilled by governments and public entities, such as the provision of water and sanitation services, financial support from local, provincial, or national governments is desirable. Where the application is fulfilling a function that would otherwise be filled within the agency, it makes sense for the government to invest funding to support the system or service. Indeed, where projects are oriented toward social services, particularly those often provided by governments, it can be difficult to introduce viable payment or income-generation schemes (Batchelor et al. 2003), where it is assumed that the service is already covered by public funds. It is also effective to consider options for cross-subsidizing key social goals. For example, a health agency in the government could use a portion of its budget to fund a project that improves water and sanitation services, since the significant health impacts and the economic returns in terms of reduced health costs have been well documented.

*Internal Funds*
Many projects develop from a need identified internally within an implementing organization such as a community-based organization or an NGO or aid organization, and internal funds are then used to develop the initial system.

*Fully Self-sustaining*
The last model can follow a more traditional, for-profit business model, where initial funding (whether from loans for for-profits or internal funds for nonprofits) is secured to cover capital costs, as well as overhead and some time-specific expansion costs necessary for getting systems in place for sustaining ongoing maintenance and operation. Most businesses that target the poor have a relatively low profit margin and therefore are unlikely to attract serious equity investment (Mulago Foundation 2011). Development projects which aim to be self-sustaining systems then must develop an ongoing revenue stream.

Revenue streams in mobile phone for development projects can be derived from any one of the users or stakeholders, especially the change agent that is deriving greatest benefit from the information intervention. For example, residents frequently pay for the minimal cost of sending SMS reports, but they might opt to pay to receive special reports or to access special system features that provider greater convenience. Government agencies could pay for content management and system operation services, especially where the system fulfills a business function that improves or enhances operations.

### *PROVIDING INCREMENTAL INCOME THROUGH SURVEYS*

#### CASE HIGHLIGHT: JANA (FORMERLY TXTEAGLE) AND MOBILE SURVEY BY APPLAB INDONESIA

Market research and advertising can be controversial topics in the development sector, but sustainability without the assistance of large donations continues to be a challenge. Organizations like Jana and AppLab Indonesia have created their own platforms to enable market research among underserved communities, while providing incremental income opportunities.

Working with proprietary survey platforms, mobile telecom companies, and large organizations seeking information about emerging markets, both developers have achieved a program model that is financially sustainable. Jana and AppLab Indonesia earn money by offering their application and services to companies seeking data on emerging markets or other target groups, including private companies and international NGOs. The local telecom companies earn money through the airtime purchased for participants. And the participants earn mobile phones or free airtime, freeing up some of their income for other uses as well as providing more airtime than they might otherwise be able to purchase.

**Technical Partnerships**
In technology management, system procurement and maintenance costs are required for hardware purchases such as servers, modems, and computer and phone terminals; specialized labor and technicians to develop and maintain the system; and the need for frequent software and hardware upgrades due to how rapidly technology changes.

In the development sector, many organizations have limited resources which prohibit or limit their ability to utilize existing resources for implementation and ongoing operation of a mobile phone solution. Strategic technical partnerships can help bridge this gap in implementation. For mobile phone applications, this can take the form of human resources and hardware in system research and development (R&D), subsidized or donated hardware, ongoing technical support, and subsidization or donation of user costs, such as mobile phone air time or mobile phones.

While there are many companies and corporate social responsibility (CSR) programs that allow for donations and subsidies with few strings attached, the goals and activities of these companies can raise ethical issues for recipient programs. These should be considered as well, especially in terms of any potential public relations drawbacks or other social costs.

**Metrics for Effectiveness**

A final component in program design is evaluating whether a project has achieved a desired effect or result, and whether specific aspects of the supporting program design contributed positively or negatively to achieving the desired results. The private, for-profit, and government sectors have long tracked and evaluated indicators of performance and impact, but it is still an evolving and not entirely accepted practice in the nonprofit and development sectors. Program evaluation can help an organization extract relevant information from past and ongoing activities that can be used as the basis for adjusting or redirecting activities (i.e., risk management) and for future planning (UNDP 2009). Without measuring effectiveness, it would be impossible to determine if work in progress is going in the right direction, whether success can be claimed in the absence of clearly negative results, and how future work, especially for other projects, might be improved.

Program evaluation plans include identifying specific measures of effectiveness or success, collecting data to demonstrate those measures, and reviewing the data to determine the results. Specific measures are called indicators, and can be quantitative—objective data that can be used empirically to measure "how much"—or qualitative—subjective data that helps understand human behavior and social factors. For example, in for-profit businesses indicators can measure monthly revenue and customer satisfaction. In nonprofit and development, indicators can measure social impacts such as increased gender equality or reduction in poverty and disease. There are currently a few technical means in place to measure direct impacts of mobile phone solutions in the development sector, such as sensor-related statistics that can measure electricity or water flow, or follow-up surveys sent via form or SMS direct to a user's phone. This data can be used to evaluate whether a system is succeeding or failing in the short-term such as whether particular aspects of the system design impact user uptake or the system's usefulness, as well as in the long-term such as whether a specific goal has been achieved and whether improvements or decline can be tracked over time.

Program evaluation clearly benefits individual program implementers, but such information can also benefit a sector or field if information is exchanged among peer change agents working toward similar objectives. Specific information about why one program succeeded or failed can help other implementers follow best practices and avoid mistakes. Information on problems and challenges is especially important in new and quickly evolving fields such as M4D, or where there are many change agents with common objectives. MobileActive.org, an organization interested in advancing the field of mobile technology for social change and development, developed a website, blog, and event called FAILFaire to encourage organizations to learn from each other by openly sharing and examining their failures (FAILFaire 2012). In the WASH sector, a group of NGOs, funders, and academics formed the WASH Monitoring Exchange to develop common indicators (Davis and Cardone 2012), which could assist the sector, for example, to get a better understanding of why many water and sanitation projects were failing even when implemented by different organizations. The use of common indicators across WASH projects could also result in better sector coordination, as well as provide a basis for better transparency and accountability. Measuring a project's effectiveness is recognized as beneficial at all levels of implementation, but it must start with individual projects.

Many useful tools, guides, and forums exist to help organizations develop plans for program evaluation and gain as much benefit as possible from the data. Such tools are often sector-specific. For example, the United Nations Development Programme's *Handbook on Planning, Monitoring and Evaluating for Development Results* provides guidance for the entire process for international development projects, including how to develop a monitoring plan, and also provides example documents. The Information for Development Program (infoDev) developed the *Monitoring and Evaluation of ICT in Education Projects: A Handbook for Developing Countries*, which includes a section on core sector indicators as well as dos and don'ts in monitoring and evaluation. The Rainer Arnhold Fellows Program, established and funded by the Mulago Foundation, teaches social entrepreneurs with ideas on how to solve problems in health, poverty, and conservation in the developing world about how to design their work to ensure it is scalable. Their main tool in the program, the Rainer Arnhold Fellows design iteration flow format (available online), includes project design exercises that can directly feed into program evaluation planning. However, information on monitoring and evaluation of mobile phone for development projects is still extremely limited.


NOKIA
XpressMusic
11:45am
Next Drop
Your valveman has opened the area valve. Water will start soon. NextDrop
Options
Reply
Back

# Section IV. Review of Mobile Phone Solutions for WASH Sector Needs

In this section we review the choices in social, technical, and program design of the mobile phone application case studies, and then highlight how these choices impacted performance of the systems as information interventions in various contexts.

A global survey of mobile phone for development (M4D) systems revealed a large sample of current mWASH projects which serve development needs in the water, sanitation, and hygiene (WASH) sector (Figure 4). In Table 3, we summarize these systems and their improvements in water, sanitation, and hygiene. The information communicated through all of these projects aimed to either empower residents, strengthen institutions to improve services, or improve the flow and collection of information for long-term usage.

We then look more closely at the case studies to identify their design options and how these informed the successes and challenges experienced in project development and implementation. Because a lot of options are involved for the case study projects, this review is presented as a results section, followed by a discussion of the major lessons learned from the selections made by implementers of the case study projects.

Finally, we discuss some key lessons from these systems which future change agents may consider in the development of mobile phone for development (M4D) applications.

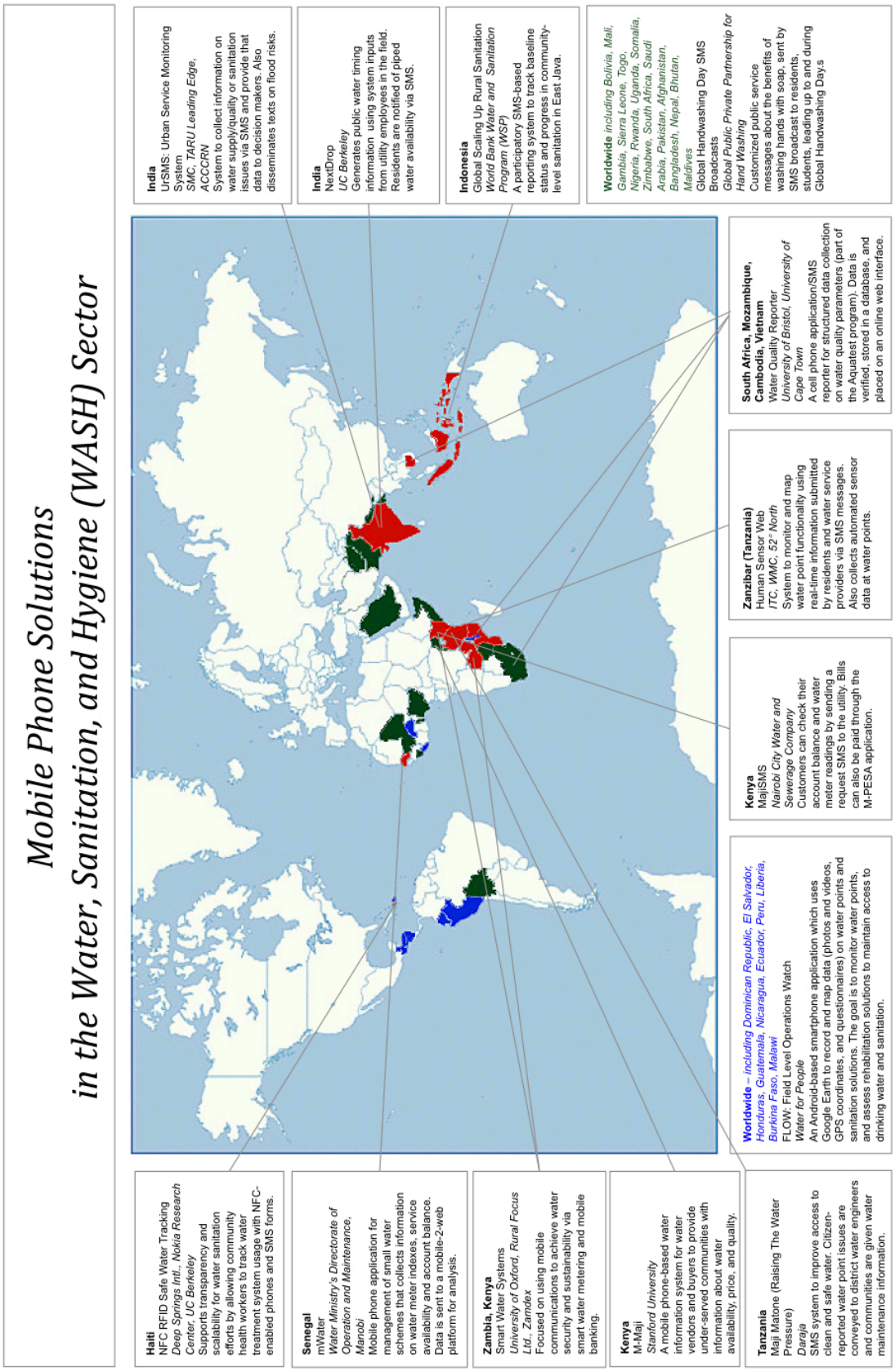


**Figure 4. World map of mobile phone for Water, Sanitation, and Hygiene (mWASH) solutions**

**Table 3. Mobile phone for Water, Sanitation, and Hygiene (mWASH) projects**

| Project(s) | Function | WASH Governance Problem | | | |
|---|---|---|---|---|---|
| | | Poor or non-existent access | Post-construction failure | Service unreliability | Long-term sustainability |
| M-Maji; mWater; Smart Water Systems (SWS) | Track informal water vendors and pricing, integration with mobile banking | ✓ | | ✓ | |
| Cape Town City Utility SMS Reports; Chennai Metropolitan Water Supply and Sewerage Board SMS; Delhi Jal Board SMS; UrSMS | Utility-run complaint mechanism for piped water service | | | ✓ | |
| Maji Matone | Community-submitted information on water point maintenance | | ✓ | ✓ | |
| FLOW; Human Sensor Web | Map functional water points | | ✓ | | |
| Nairobi MajiSMS; Smart Water Systems (SWS) | Track piped water via SMS-based metering | | | ✓ | |
| NextDrop | Track piped water via employee input | | | ✓ | |
| NFC RFID Haiti Drinking Water Tracking; Water Quality Reporter | Facilitate and monitor water quality testing | ✓ | | | ✓ |
| WSP Global Scaling Up Rural Sanitation | Monitor access to improved sanitation | ✓ | | | ✓ |
| Global Handwashing Day | SMS broadcasts for hygiene information | ✓ | | | |

In Section II, we identified four broad categories of problems in water, sanitation and hygiene, with the majority of the mWASH projects in the broad survey (Table 3) dealing with issues of access, failure or breakdown, and service unreliability. Only two projects addressed long-term sustainability of the water resource and monitoring access to improved sanitation. This suggests there is an untapped potential to use mobile phone applications for long-term monitoring and planning. For example, although there has been a lot of interest in participatory hydrologic mapping in recent years, to the best of our knowledge mobile phones are yet to be used on a large scale to collect data and develop dashboards for this long-term planning purpose. To make improvements in governance, substantial information is needed. Mobile phone solutions hold the greatest potential for amassing data quickly, thoroughly, and directly for making lasting improvements in WASH.

## Trends in Mobile Phone for WASH (mWASH) Applications

The global survey revealed that the water, sanitation, and hygiene (WASH) sector already has examples of mobile phone projects using various levels of technology options, from simple SMS data entry reports and SMS broadcasts for public service information campaigns, to the use of more sophisticated technology for mobile banking transactions and sensor-based measurements of water flow. The mWASH projects surveyed addressed development objectives through multiple pathways: some projects aimed to make markets work for the poor through methods such as tracking prices of water from informal vendors. Some empowered customers with information that also helped to improve service delivery and strengthen water provider operations, such as through the monitoring of water and sanitation points. Others collected information to track and monitor supply, demand, service, and functionality to inform current operations and future planning, or distributed information that provided preventative, behavior change information.

This report aims to provide a snapshot in time of a fast-changing sector. Not all of these mWASH projects were studied in depth for this report—only a sample of projects meeting our case criteria are covered. From a general review of this sample of mobile phone applications in the WASH sector, we observed the following trends.

**External User Reporting**
Reporting by customers and residents serves multiple objectives in the water, sanitation, and hygiene (WASH) sector. This type of user-generated content is an important feature of ensuring improvements in water supply and sanitation for the poor. It allows for direct communication of information from the resident, customer, or user's perspective. This is helpful not only in ensuring that the voices of the underserved are heard, but also to strengthen governments with direct information about vulnerable constituents. When this information is crowdsourced, it can also empower residents with collective information useful for advocacy, and strengthen institutions by highlighting prevalent issues that may not arise in traditional data sources. In the long term this information can help governments understand the challenges that the poor face, how those challenges might evolve over time, and more importantly whether strategies are actually bringing about real and lasting improvements for the poor.

**Transparency and Accountability Features**
Public information features of mobile phone solutions assist service providers and governments in improving transparency and accountability. Such features are important in the water, sanitation and hygiene (WASH) sector, where corruption, service inequities, and resource shortages exist. These features not only help to inform residents and customers, but also strengthen service providers and agencies by helping to monitor performance and enforce standards.

For example, government entities in India such as the Municipal Corporation of Delhi and the Greater Hyderabad Municipal Corporation are using photos from GPS-enabled mobile phones along with basic SMS messages to allow both resident and employee tracking of public sanitation issues (Kaur 2010, Jha 2011). Currently, more than 3,000 phones have been given to sanitary inspectors, health officers, sanitary superintendents, and horticulture officers at the Municipal Corporation of Delhi after a pilot program found that junior engineers used the phones to improve response times. These projects also incorporate social media and a publicly accessible online site where progress can be monitored by those submitting the reports and in greatest need.

**Baseline and Progress Data for Long-Term Usage**
There is a lack of information on water supply, sanitation and hygiene which is hindering effective resource allocation, management, and planning. Many of the projects were focused on short-term issues that required immediate attention; only a few dealt with information that will assist in managing future risks, especially among vulnerable populations.

In East Java, Indonesia, the Water and Sanitation Program (WSP) is working with communities on participatory monitoring to improve sanitation and hygiene behaviors in their Global Scaling Up Rural Sanitation project, but faced issues with timely and accurate transfer of data (Mukherjee et al. 2011). Using participatory mapping techniques, the information collected was inherently public and transparent, and motivated continued participation in tracking community access to improved sanitation. The communities were able to generate regularly a large amount of high-quality data aligned with Joint Monitoring Program indicators, which eventually became too labor- and time-intensive for government outreach staff to collect from the communities; the information was not reaching local and regional government in a timely manner for it to become actionable data. In early 2010 they piloted an SMS-based reporting system, which increased regular reporting of both baseline and progress data, and reduced errors since data records were stored in the users' mobile phones. By the end of the year it was being used in half of their districts in East Java to regularly report baseline and progress data, with further plans to collect hygiene behavior change data and expand the system nationally.

## Case Study Summary

In this section, we review the social, technical, and program design aspects of the mobile phone applications in the case studies and any challenges or successes that were indicated during case interviews or supporting research.

Table 4. Summary table of mobile phone solution case studies

| Project Name | Sector | Function | Data Collection | Data Dissemination and Analytics |
|---|---|---|---|---|
| e-Pasar Ikan | Fisheries management | Employee reporting | Structured SMS entry | Web-based dashboard, Bulk SMS |
| FLOW | WASH (water) | Employee reporting | Data entry through Android (smartphone) application | Web-based mapping |
| Human Sensor Web | WASH (water) | Utility information dissemination<br>Crowdsourced citizen reporting | Structured SMS entry to system<br>Broadcast SMS messages to users | Web-based mapping, Bulk SMS, Other data formats |
| Kerjalokal (AppLab) | Employment | Information dissemination | Native form entry<br>Broadcast messages to subscribed users | Other reports and data formats |
| Klik Jkt; Klik Papua (Yayasan AirPutih) | Civic Engagement | Crowdsourced citizen reporting<br>Information dissemination | Unstructured SMS entry to system<br>Broadcast SMS messages to users | Web-based mapping |
| Maji Matone | WASH (water) | Crowdsourced citizen reporting<br>Two-way interactive communication | Unstructured SMS entry to system | Bulk SMS |
| Media Center (Yayasan AirPutih) | Disaster Management | Crowdsourced citizen reporting | Unstructured SMS entry to system | Web-based mapping, other reports |
| Mobile Survey (AppLab Indonesia) | Market Research | Incentivized reporting | Native form entry | Other reports and data formats |
| NextDrop | WASH (water) | Utility employee reporting<br>Information dissemination<br>Crowdsourced citizen reporting | Interactive Voice Response for valve operators and data verification by residents<br>Broadcast SMS messages to residents | Web-based dashboards |
| Project Kopano; Project Zumbido (SHM Foundation) | Health | Peer-to-peer exchange | Group SMS messages | Interactive Communication |
| Jana (formerly txteagle) | Market Research | Incentivized reporting | Native form entry | Other reports and data formats |
| Water Quality Reporter | WASH (water) | Utility employee and health technician reporting<br>Two-way interactive communication | Data entry through Java (smartphone) application | Web-based dashboards, SMS, spreadsheets |

## Social Design

*Data Collection*

**Some projects factored possible user perceptions into design or subsequent analysis of their systems.** The SHM Foundation knew through working with a group of HIV positive persons in Mexico that stigmas and discrimination associated with their disease was impacting their quality of life. This impacted their perception of the benefit of support groups, where users felt they would bring more harm than assistance. By recognizing this perception, Project Zumbido provided a way to change the patient's perception of the support groups themselves by changing the format for engagement (from on-site at health centers where one could be seen, to virtual through private mobile phone groups). In the case of Maji Matone, Daraja recognized from the beginning that while residents frequently made general calls for the government to act on problems with public services, they did not always expect government would actually do anything. The system was able to show that government did respond to specific reports submitted by residents, which would provide evidence to refute user perceptions about government taking action. But Daraja found that residents simply did not submit many reports, even when they knew about the Maji Matone system, and this was where user perception was recognized as potentially influential. If a user did not expect a government agency to respond in general, why should they submit a specific report at their own cost? Further, some users said that they initially did not use the system because they did not think it actually existed, and they would have adopted the program earlier if the organizers had conducted in-person demonstrations to prove that the system was real.

**A variety of barriers to community participation impacted uptake and effective usage of the case study systems.** NextDrop found that the cost of sending an SMS was an issue for the valve men in their initial system. When they switched to IVR (interactive voice response), NextDrop originally paid the valve men to make reports, but later found that reporting did not decrease when they discontinued payment because the utilities had made it mandatory for the valve men to submit reports. The cost of SMS messages during the Project Kopano and Project Zumbido pilots was paid for in order to incentivize participation (by SHM Foundation, and in South Africa in part by donations from BulkSMS), and for Project Zumbido the mobile phones were also provided since many of the participants did not have them. The purpose of the Mobile Survey and Jana systems were compensation in itself, and both maintained large numbers of users. Trust in the utility was an issue for users of Human Sensor Web, where people were scared to report because they did not want the utility to punish them for complaining. Poor mobile network coverage was a barrier to participation for some users of Project Zumbido. Both Maji Matone and NextDrop faced issues of utility responsiveness prior to and during implementation of their


**Figure 5. Viewing translation options**
Source: Jana

systems. Similarly, the Human Sensor Web project found that user engagement with the system was complicated by the existing relationship of customers with the local water authority, which was thought to be unreliable and unresponsive. Socio-cultural factors also prevented users of Human Sensor Web from participating in an effective manner, where men typically keep possession of the family mobile phone, which prevented women from being able to report water issues during the day.

**Features to maintain privacy and protect identity were common, but significant in only a couple of cases.** Protection of identity was the basis of Project Zumbido and Project Kopano. It was also a deep concern for users where retribution was feared, such as with Human Sensor Web users.

**The validity of submitted data was also a potential barrier for systems including e-Pasar Ikan, FLOW, and those requiring follow-up action by a utility or service provider.** They wanted to prevent the potential for wasted time and resources and subsequent drop-off in participation. In the Maji Matone and e-Pasar Ikan systems, an operator replied manually to the submitter, requesting clarification or confirmation to ensure validity as early as possible. For the Water Quality Reporter system, organizers had to make changes to meet needs in different settings. For example, one partner regularly tested water from different types of sampling points, each with distinct acceptable limits for each water quality parameter. The application was designed so that data exceeding these thresholds would trigger an SMS alert, however this automated SMS feedback system had to be extended to support multiple thresholds to meet the reporting needs of the users in different jurisdictions.

*Data Dissemination and Analytics*

**Several of the case study projects worked in partnership with government agencies from the early stages of project development.** NextDrop, Human Sensor Web, and Maji Matone worked with water utilities. e-Pasar Ikan worked with the Department of Maritime Affairs and Fisheries. Water Quality Reporter sought partnerships with government agencies working on water quality issues, including water utilities, health departments, and NGOs. In Indonesia, Media Center partnered with the Bureau of Meteorology, Climatology and Geophysics.

**Dissemination of information to media was utilized systematically by only one of the projects.** The developer of the Maji Matone system forwards relevant SMS messages both to district water engineers as well as the local media to elicit external pressure. e-Pasar Ikan published fish stock prices directly in newspapers as a public service rather than to inspire news coverage. Similarly, NextDrop intended to explore media partnerships to disseminate project information through local newspapers.

**Many of the projects included partnerships with NGOs or community-based organizations that intended to utilize or assist in distribution of the data.** The purpose of FLOW was to directly provide data for monitoring and evaluation of Water for People's own projects. The UN's Food and Agriculture Organization partnered in the development of the e-Pasar Ikan system in Indonesia to add complementary data to similar fish price tracking mechanisms utilized or coordinated by UNFAO in the Southeast Asia region. For the Klik Jkt system, the Rujak Center for Urban Studies is the main end user of the data, utilizing it for their work with government agencies to develop more environmentally sustainable cities.

**Figure 6. Water for People using FLOW to interview a community member in rural Honduras**
Source: Elias Assaf/Water For People

Data dissemination through peer-to-peer exchange was utilized by Project Zumbido and Project Kopano. With the exception of one medical professional in each group, all group members were exchanging information directly with other people with HIV or AIDS patients, or in the case of Project Kopano, pregnant women with HIV or AIDS.

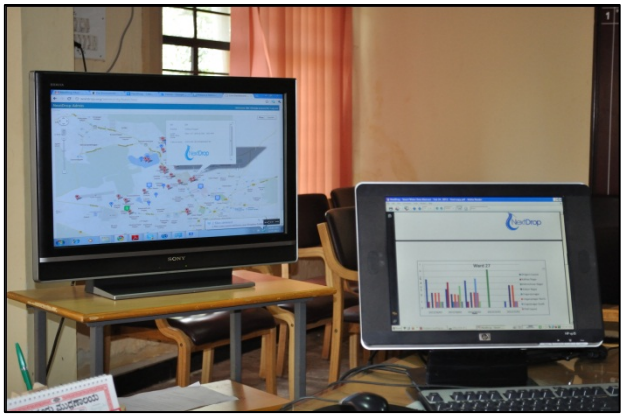

**Figure 7. Data outputs for NextDrop system showing open and closed water valves.**
Source: Ari Olmos/NextDrop 2012

**Crowdsourcing data analytics was used in several of the projects**, including Media Center, Klik Papua, Klik Jkt, Mobile Survey, and NextDrop. NextDrop intended to build on the idea of making crowdsourced data available to the public to enable them to advocate for equitable distribution. However, since the primary goal was to have more reliable information on water services and it proved difficult to crowdsource water delivery information in some areas, they shifted to utilities reporting and making primary use of the data.

## Technical Design

*Data Collection*

**Submission of data through SMS, whether simple or interactive, was the preferred data collection method in many of the case study projects, especially those with residents and customers as the reporters.** Virtually all mobile phones are technically capable of sending and receiving SMS messages, hence choice of SMS entry cleared an important technical barrier to access in projects targeting those with limited resources, whether they were residents, customers,

or employees. All of the projects using SMS entry—Human Sensor Web, Klik Jkt, Klik Papua, Maji Matone, Media Center, Project Kopano, Project Zumbido—had residents and customers as the front-end users.

**Figure 8. Rural water system operator submits results from a Presence/Absence bacteria test via the Water Quality Reporter in the Battambang, Cambodia.**
Source: Zarah Rahman/The Aquaya Institute 2011

**Disadvantages can be seen in both structured and unstructured message formats in the case study projects.** Some of the projects reported issues with requiring a structured SMS format both at the user and server end. First, the structured SMS format proved to be difficult and unintuitive for users without prior training, and resulted in a minimal amount of information collection, such as with Water Quality Reporter. Second, the server systems were unable to process messages which weren't an *exact match* for pre-defined entry codes, such as with Human Sensor Web. With unstructured message formats, the messages do not always include the necessary information to determine the meaning, or there is difficulty in understanding messages that include abbreviated words. In order to utilize such reports, Human Sensor Web considered accepting a combination format of structured and unstructured since users showed agility in sending detailed reports, although not in the required structure. Another option was to integrate an interactive voice response (IVR) feature, which bypassed text entry altogether. Water Quality Reporter, on the other hand, simply developed a form-based Java application to replace the SMS application, although the SMS application was still made available for use.

**Many of the case study projects utilized forms and applications, particularly to collect technical information and large volumes of data.** Forms allowed for structured responses without requiring lots of training, such as the survey questionnaires utilized by the Jana and AppLab Indonesia applications. Forms and applications were also useful for submission of lots of data that required accuracy for improved processing. The applications used in e-Pasar Ikan, FLOW, and Water Quality Reporter utilized customized forms to collect large amounts of technical data. All of the projects developed methods to bypass the potential barrier of requiring a form or application to be downloaded to a phone, such as AppLab Indonesia, which worked with a mobile telecommunications company to pre-load new mobile phones with the applications. Other projects which relied upon employees to submit data would simply provide the staff with phones on which they had preloaded the application, such as FLOW and e-Pasar Ikan.


**Figure 9. Answering a water survey question in Water Quality Reporter (WQR)**
Source: iCOMMS 2012

**While data collection for geolocation did not impact a user's technical interface of the case study systems like the previously mentioned features, it is additional information which broadened the usage of the other data in a report.** The Human Sensor Web project utilized structured SMS messages with pre-determined codes which corresponded to fifty different locations already mapped to a geospatial database. The system was able to accept messages with the following formats: "maji A TAG" for good water at water point TAG or "maji D TAG" for no or bad water at TAG, with the tags being numbers that are posted at given water points (Verplanke et al. 2010). Field Level Operations Watch (FLOW), on the other hand, utilized the built-in GPS capability on Android smartphones for the large-scale mapping of thousands of water points worldwide. The Ushahidi web-mapping system was chosen where near-immediate placement of reports on maps was desired, such as for the disaster management information project, Media Center. The Ushahidi system employed different methods to make geotagging as easy as possible (and sometimes automatic) given variety in front-end user technology.


**Figure 10. Job Category selection menu (in Indonesian) on Kerjalokal**
Source: AppLab Indonesia

*Data Dissemination and Analytics*

**Web-based dashboards were chosen as an end-user interface to present aggregated information through a web page customized for the end user's needs**. Such dashboards were most frequently designed for formal groups or organizations, such as for the Department of Maritime Affairs and Fisheries with e-Pasar Ikan, the local water utilities with NextDrop, and utilities and health departments with Water Quality Reporter. The dashboards provided static information, such as a list of the submission date and time and content of a report, as well as dynamic information, such as data which could be sorted by report category.

**Web-based mapping allowed for visualization of reports on digital maps in many of the projects.** This was useful in organizing maintenance operations, such as in the FLOW project. But many projects found the greatest utility of web-based mapping for crowdsourcing of data. By visually displaying a large number of reports as clusters, it helped to strengthen and bring integrity and validation to each individual report. Human Sensor Web, Media Center, Klik Jkt, and Klik Papua utilized crowdsourced mapping. In the case of Human Sensor Web, they found that individual users such as residents did not frequently reference the maps, so they considered shifting its use for those doing oversight, such as the utility or UN-HABITAT.

**Broadcasting or bulk SMS was chosen as a method of disseminating data directly to all end users in a specific group for immediate access through their mobile phones.** Human Sensor Web set up a subscriber model whereby users were automatically signed up to receive targeted updates pertaining to a given water point based on previous information submissions into the system. In a slightly different set-up involving piped water, the NextDrop project in Hubli-Dharward, India used broadcast SMS messages to inform customers when their water would be turned on. Kerjalokal, e-Pasar Ikan, and Maji Matone also utilized a subscriber model. In these cases, the SMS messages were not sent as a response to a specific request for information or customer report, but rather were sent to relay specific information relevant to a location, group, interest, or other category at specific intervals over time. This dissemination method was useful when users may not have had easy access to a computer or internet, when users wanted aggregated data that was relevant but not necessarily specific to them, or when users wanted access to the data as soon as possible, such as in advance of water service being restored or when a time-sensitive job listing was posted.

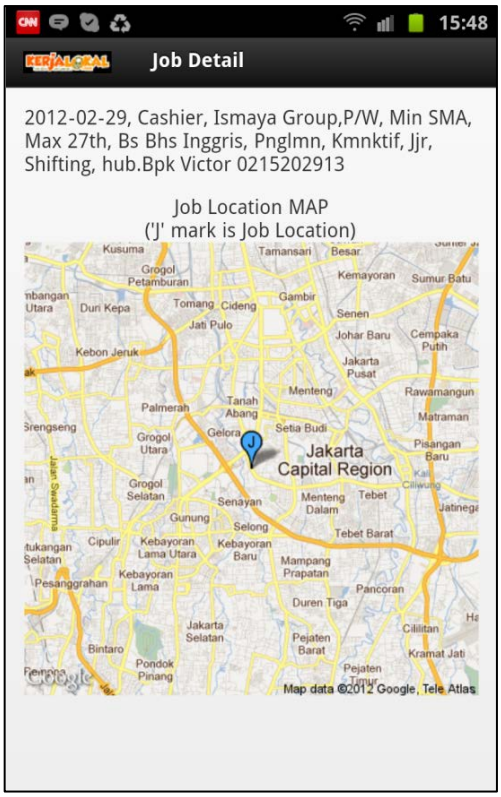


**Figure 11. Mobile phone view of job ad on the Android version of Kerjalokal**
Source: AppLab Indonesia

Through interactive communication, end users could receive data based on a specific report submitted as a front-end user. Interactive SMS and forms could be on the data collection end of this when data was sent to an end user automatically, such as with Human Sensor Web or Kerjalokal. But end users could also receive information in SMS format which had been sent manually by a person. For example, in Project Zumbido and Project Kopano, the system facilitated communication or data dissemination only, and did not collect data. The users were not seeking specific or aggregated data, but rather conversational responses from peers within a group. Any one of the group members responded at a time when they were able to and the information communicated was the full original message, which may have been subject to moderation for social appropriateness.

**The intended use of the data sometimes required particular formats for the data.** The end users for systems like Mobile Survey and Jana were organizations that were seeking demographic and other information about specific groups of people. Data sets and graphs would be useful for these users' purposes. The Human Sensor Web provided data in exportable table format as they found that users were not frequently accessing the map. The Water Quality Reporter system automatically sent weekly reports of raw data compiled in an Excel spreadsheet to the relevant local manager. There was also demand for summary statistics, separation of data categories into individual reports, and alternate visualization options, which prompted development of Water Quality Manager.

**Dissemination of data back through the mobile phone was the most accessible method for reaching the range of possible users, but could restrict the way and how much information could be displayed depending on the type of phone.** Many of the projects were in the process of implementing or exploring different ways to present the data to the end-users, such as Water Quality Reporter exploring data mapping and Human Sensor Web exploring alternatives to mapped data. They found that as the end users gained experience with the data, they were able to also provide feedback on alternate formats that would better assist in making use of the information.

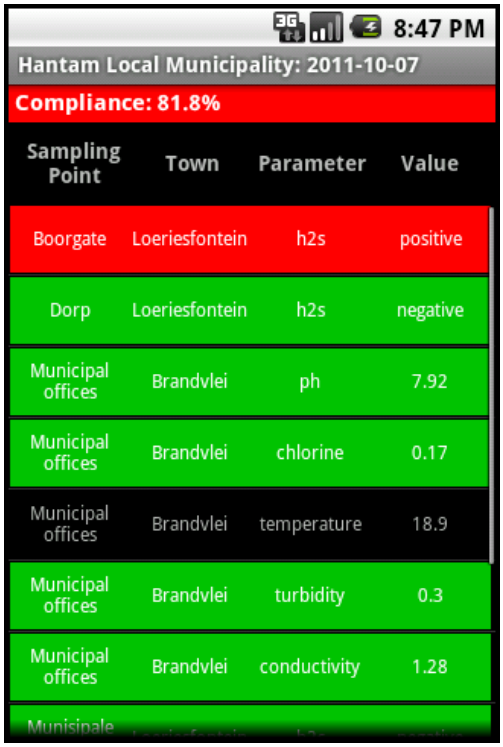


**Figure 12. Calendar overview of daily test results in Water Quality Manager (Android application)**
Source: iCOMMS 2012

## Program Design

*Financial Models*

Many of the case study projects relied upon funding from external donors including: Human Sensor Web (Google.org, UN-HABITAT); e-Pasar Ikan (Government of Spain, United Nations Food and Agriculture Organization (UN FAO)); Maji Matone (Twaweza, the United Kingdom's Department For International Development (DFID), Daraja Trust); NextDrop (Gates Foundation, Clinton Global Initiatives, Center for Information Technology Research in the Interest of Society, Knight Foundation, GSM Association); Jana (Spark Capital, RBC Venture Partners, Qualcomm Ventures, Flywheel Ventures); and Water Quality Reporter (European Union, Gates Foundation).

The AppLab Indonesia applications and Klik Jkt were funded by project underwriters or partners. All research and development for AppLab is underwritten by Grameen Foundation, and business operations for Jual Pulsa, one of AppLab's products in the Usahaku suite, are underwritten by PT Ruma.

**Of all the case study projects working in partnership with government agencies, only one was receiving financial support from the government (both at the local and provincial levels) from the planning and implementation phase through to ongoing maintenance and operation** (e-Pasar Ikan), while another received initial support in co-funding and co-producing the system, and then developed into a management/content provider relationship (Media Center). A few of the projects used internal funds to finance their mobile phone projects, including FLOW, the SHM Foundation, and AirPutih.

**Finally, only three of the projects developed financial plans that included both funding for project start-up costs as well as for later financial sustainability.** Jana and the Usahaku applications were specifically designed to generate income for each of its users, although Jana is a for-profit organization while AppLab is nonprofit. The e-Pasar Ikan system was developed in partnership with a government agency, which planned for the allocation of public funds to sustain the project after the pilot period. Although not implemented from the beginning, during implementation NextDrop explored options to incorporate as for-profit in India. Initially, utilities were targeted as the primary customers, but the project implementers moved to target residential customers to pay monthly fees for the information service.

*Strategic Technical Partnerships*

**Many of the case study projects attempted or implemented technical partnerships to assist in covering costs of acquiring, developing, and/or maintaining the hardware and software for the systems.** AppLab Indonesia received funding, hardware, and research and development support from Qualcomm's Wireless Reach Initiative. They also partnered with Bakrie Telkom (BTEL) to pre-load the applications onto 2 million phones that would reach their target users. The Human Sensor Web partnered with Zantel, the local mobile telephone company partly owned by the Government of Zanzibar, and Inet/Zanzibar Datacom Ltd., a local internet service provider. FLOW received 20,000 Motorola phones from Craig Newmark (founder of Craigslist). While not partnerships, some of the systems made use of existing open-source platforms, such as Ushahidi (Media Center) and JavaRosa (Water Quality Reporter), which had already been proven to work and also significantly decreased the software development costs.

*Metrics for Effectiveness*

**The case study projects used a variety of metrics to measure the effectiveness of their mobile phone solutions, but few were comprehensive enough to understand how their design choices impacted success.** AppLab Indonesia's metrics included number of people served, generation of income, reduction of costs, and provision of otherwise unavailable income opportunities. Project Zumbido and Project Kopano used quantitative and qualitative measures, such as the number of messages sent and improvement of quality of life (reduced feelings of anxiety, depression, or isolation; drug regimen adherence). Water Quality Reporter performed a pilot evaluation through interviews with both end users and managers to get feedback on user experience and the value of the system. e-Pasar Ikan and Human Sensor Web conducted a final pilot evaluation on user experience, but did not have ongoing metrics measuring system effectiveness. Both Human Sensor Web and Maji Matone indicated that their primary focus was on developing a working system, so metrics were not planned or measured from the outset. FLOW's objective was to make monitoring more efficient, and to improve evaluation of their projects; this was achieved. NextDrop developed impact metrics such as household opportunity costs due to time loss, days of school missed by children, health costs based on coping behaviors, and health sector savings. Jana's main metric was profitability.

## Lessons Learned: Key Challenges and Factors for Success

In this section we discuss the key lessons that can be drawn from the social, technical, and program design options chosen by the implementers of the case study systems. The lessons can be considered based on the type of user—at the community or resident level, as well as for those in governance, including local government agencies and service providers—however, they may all be considered by any change agent seeking to implement a successful mobile phone for development (M4D) application.

### Considerations for User Participation and Experience

*Understand the Socio-Cultural Context*
Some of the projects experienced unanticipated challenges that were based in a specific socio-cultural context. While these are not always easy to anticipate, documented successes and challenges of others can help to inform planning for future projects. Issues experienced in the case studies during implementation included:

- target users not reporting immediately or at all due to not having a complete understanding of target users' mobile phone access and usage individually and as part of a household;
- target users having attitudes and expectations of what government agencies will do that did not change based on proven government action;
- target users preferring verbalized communication rather than written; and
- target users not utilizing the system due to fears of retribution from the government agency.

*Build the User Base Through Well-Planned Outreach To Achieve Uptake*
Outreach is important both during project development and implementation. Some implementers found that outreach during the initial months of implementation was important for uptake and building the user base. Some also found they could have benefited from preparing target users in the pre-implementation phase as well, to ensure that users' expectations about the system were correct, and that they were anticipating the project's launch. If users do not know the system is coming nor clearly understand its purpose and benefit to them, user uptake of the system may be impacted.

*Ensure the System is Easy to Use for Your Target Users*
The success of a system and level of user participation depended heavily on the creation of a technically accessible and usable system. In the pathway of information flow in mobile phone solutions, the data collection step included the user's first, and sometimes, only interface with the system. Hence, this feature of the system was the subject of careful consideration and reconsideration for all the case studies. The data collection technical options impacted what the user saw, the format in which data was submitted, how much data they could submit, and the number of interactions necessary to complete a single report or submission. Careful consideration of technical options for data collection was therefore very important when user participation was voluntary. While forms are becoming more common, most of the projects which employed SMS and/or IVR did so to ensure the greatest accessibility based on factors such as type of phone owned and literacy of user. Issues common in both structured and unstructured reports can be overcome through interactive SMS and forms.

The data dissemination and analytics options in mobile phone solutions determined whether and how the collected information was utilized. While mobile phone systems sometimes only serve as an alternate method of data collection whereby the collected data fits into existing operations, such as in customer service systems, some technical options in data dissemination and analytics provide new or alternate data formats and ways of visualizing the information. The technical options can also make it easier to collect and create data that did not previously exist, or facilitate easy access to it.

Many of the case study systems relied on dissemination of information back through the mobile phone of the user. This is often the most accessible method, but restricts visualization options and amount of data that can be shared. Many of the projects were in the process of implementing or exploring different ways to present the data to the end-users based on feedback. They found that as the end users started to find the data more useful, they were able to also consider alternate formats that would better assist them in using the data.

*Fulfill a Key Need, Which Makes Monetary Incentives Unnecessary*
One project started with monetary incentives to encourage uptake, but found when the incentive was removed it did not impact participation in or use of the system. Other case study projects were able to operate without incentives or user subsidies, with users willing to bear minimal costs. While the only projects with a sustainable financial model provide positive incentives to their users through compensation, these projects are not designed to meet a community need other than the compensation itself.

**Use of the Data**

*Implement and Promote User Access to Data*
For all the projects that are aimed toward benefiting underserved groups, not all of them provided customers and residents with access to the data, either comparable to the government agency or at all. Many projects intended for the data to be utilized directly by government agencies, and the reporting itself was considered advocacy by residents and customers. But a key opportunity is missed when residents do not have access to the same reporting results as the agencies they are trying to hold accountable.

*Ensure Government Agency or Service Provider Responds to Reports*
Issues in sustaining interest in the system were the short-term expectation that government authorities or service providers would not respond and perception of whether participation would actually fix the problem in the long-term. The most important aspect of these systems was the recognition that submitting information alone does not always bring about change or action; in the systems dealing with service reliability, it needs to be tied to something with repercussions. Projects managed this component in different ways, whether through drawing scrutiny to water problems and the relevant authorities through publication of the data, or by creating a structure for data collection with more comprehensive documentation—leading to greater accountability at the responsible level of government. When service providers are confronted with negative data about their performance, they are pressured to respond. However, it was found that low expectations of government services based on prior unresponsiveness created a lack of motivation for users to report issues at all. Service providers and government agencies can benefit from these systems by gaining their customers' and constituents' trust through timely acknowledgement of and response to reports, even when an immediate solution is not possible. Proactive communication and information sharing with residents provides a similar benefit.

*Use Verification Features to Create High-Quality Data*
Data quality is important in information interventions, and multiple options exist to ensure that the data collected through mobile phone solutions can provide long-term benefits. When data entry was causing a high rate of unusable or unprocessed reports, the data collection method was altered or changed. Some project implementers found it effective to verify reports manually as they came in, and prior to the data analytics level. Other case study systems employed mechanisms to provide auditing and verification of data quality at the data analytics level, generally through follow up with the active involvement of the user to identify directly problems with submissions. Follow up was performed with both employee and independent verifiers. Some of the case study systems also found automated data checks through the system to be efficient; the system would cross check data with other reports to find potential anomalies, and a person would review the flagged data and decide whether to do manual follow up. In the long term mobile phone applications have the potential to improve the quality and quantity of data that is collected by helping to make manual data transfer more efficient, reduce manual data entry errors, and increase the frequency of monitoring due to relative cost effectiveness.

**Plans for Success and Sustainability**

*Identify and Measure Indicators of Short and Long-Term Success; Use This Information to Refine System Design*
Interestingly, most of the case study projects—information interventions to empower through the collection or dissemination of data—did not develop and track a variety of metrics of effectiveness that would help them to understand how different social, technical, and program design factors might have impacted their success in the short and long term. Because mobile phone for development (M4D) applications are still relatively new and still evolving, and since there was an urgent need for some of these projects, it makes sense that the implementers' energy would be focused on just getting the system up and running. Project performance and evaluation data has the potential to help understand and overcome short-term issues, but also to serve as factual proof of the need for and relevance of the system. Such data can be used as powerful evidence of success when seeking funding.

*Secure a Future for the System through a Plan for Long-Term Sustainability*
Almost all of the projects did not have plans in place prior to implementation to financially sustain their systems. The technical and maintenance requirements can be significant for certain mobile phone solutions. In interventions dealing with critical needs of vulnerable populations, such as equitable access to sanitation and reliable water service, the implementers risk failing their beneficiaries when they can't keep the system running.

Numerous grants and awards exist for mobile phone solutions in development, and more are emerging as excitement grows about their potential impact, but other options and financial models should be pursued if implementers want a system to have deep and long-lasting impact. Some of our cases show that mobile phone solutions can be sustained with strategies such as ensuring key user-stakeholders invest in maintaining the project (e.g., local governments), or leveraging technical partners to relieve some of the burden of developing, acquiring, and maintaining software or hardware. And as more systems record their successes, including the benefits achieved by facilitating communication and information sharing for residents, service providers, and governments, it will be easier to make the case to stakeholders that the benefits will outweigh the cost of their investment.

# Section V: Conclusion

This report provided a snapshot of existing mobile phone applications to assist future change agents in the global water, sanitation, and hygiene sector. Key lessons from this study are meant to help guide careful consideration of social factors, technical options, and program management strategies that can impact the success of a mobile phone solution.

Globally, mobile phone solutions are still taking off quickly, fueled by desires to bring rapid and effective change, but they run the risk of failing due to poor program management in planning for financial and technical sustainability, and measuring system effectiveness in the short and long term.

The major untapped potential remains in use of these systems for long-term monitoring and planning for data that benefits the WASH sector as a whole. We have identified four broad categories of problems in water, sanitation, and hygiene, with the majority of the WASH-related projects in the broad survey dealing with issues of access, failure, or breakdown and service unreliability. To make improvements in governance, substantial information is needed and must be put to effective use. mWASH solutions hold great potential for amassing data quickly and thoroughly, directly from the underserved populations who are most in need.

Future research of mWASH applications could explore:

1) Use of external sensor modules to collect technical data, such as water quality, flow, and pressure;
2) Automated screening of unstructured SMS messages with artificial intelligence software;
3) Creation of a hybrid system that accepts both structured and unstructured SMS messages, or includes multiple choice questions to reduce the user burden and increase data quality;
4) A focus on smartphone-based applications;
5) Greater use of GPS integration;
6) Integration of social networking sites;
7) Development of mobile broadband applications;
8) Development of online dashboards which incorporate visualizations beyond mapping (e.g., charts and reports of collected data) and enable issue tracking and follow up;
9) The ability to provide different levels of information and analysis for the range of change agents, including governments, utilities, individuals, communities, etc. (negotiation of public/private ownership of data);
10) Participatory design;
11) Training requirements for front-end and back-end users;
12) Creative models and strategies for financial sustainability; and
13) Methods, best practices, and lessons learned in monitoring and evaluation specifically related to mobile phone for development (M4D) and WASH sector applications.

Mobile phone applications are powerful mechanisms for achieving or supporting the achievement of development goals. Through this report we have presented a review of the many ways in which mobile phone for development (M4D) applications and information interventions could be designed to serve better all change agents in good governance. Key considerations to create an ecosystem for successful mobile phone solutions include attention to social, technical, and program design. Effective mWASH projects will be designed to ensure ease of use and access, be appropriate and targeted to the local context, make use of community-based reporting and share that information publicly, and collect data that contributes to long-term planning and risk management. The potential for mobile phone applications to address key governance challenges in the global WASH sector is tremendous. Taking advantage of this transformative opportunity will require well-designed systems that achieve social goals, are responsive, adaptively managed, involve users in design and use of data, and plan for long term financial, social and technical sustainability.

# Appendix A. Mobile Phone for Development Global Survey

### Mobile Phone for Water, Sanitation, and Hygiene (mWASH) Applications

| Project | Location | Organizations Involved |
|---|---|---|
| Cape Town City Utility SMS Reports | Cape Town, South Africa | City of Cape Town Water Services |
| Chennai Metropolitan Water Supply and Sewerage Board SMS | Tamil Nadu, India | utility |
| Delhi Jal Board SMS | Delhi, India | utility |
| FLOW (Field Level Operations Watch) | Worldwide | Water for People |
| Global Handwashing Day | Worldwide | Global Public-Private Partnership for Handwashing |
| Human Sensor Web | Zanzibar, Tanzania | ITC, Ti-WMC, 52North |
| Maji Matone (Raising the Water Pressure) | Tanzania | Daraja |
| M-Maji | Kibera, Kenya | Stanford University, Umande Trust |
| mWater | Senegal | Manobi SA, Water Ministry's Directorate of Operation and Maintenance |
| Nairobi MajiSMS | Nairobi, Kenya | utility |
| NextDrop | Hubli, Karnataka, India | UC Berkeley, Hubli Water Board |
| NFC RFID Haiti Drinking Water Tracking | Haiti | Deep Springs International, Nokia, Berkeley SPH |
| Smart Water System | Kenya, Zambia | University of Oxford, Rural Focus Ltd., ZamDex |
| UrSMS (Urban Service Monitoring System | Gujarat, India | Asian Cities Climate Resilience Network |
| Water Quality Reporter | South Africa | University of Cape Town, University of Bristol |

## Other Mobile Phone for Development (M4D) Applications

| Project | Location | Organizations Involved |
|---|---|---|
| Aceh Besar Midwives with Mobile Phones | Indonesia | UNICEF, UNFPA, JHPIEGO, IBI, University of Southern California, Nanyang Technological University |
| Avian Flu Surveillance System | Indonesia | Voxiva, GSM Association Development Fund, USAID, Winrock International, Microsoft, Indonesian Ministry of Agriculture |
| Central BNN | Indonesia | Telkomsel, Badan Narkotika Nasional, Polri Kemendiknas |
| ChildCount+ | Kenya, Tanzania | Millennium Villages project, Earth Inst., Ericsson, Millennium Promise, Zain, MTN, UNICEF |
| Community Health Information Tracking System (CHITS) | Philippines | University of the Philippines, Manila |
| Community Led Total Sanitation Tracking | Indonesia | World Bank Water and Sanitation Program |
| DatAgro | Chile | Datadyne, Zoltner Consulting Group |
| Election Monitoring | Indonesia | National Democratic Institute, LP3ES, Yappika, and JAMPPI |
| e-Pasar Ikan (Fish Marketing Information System) | Indonesia | Department of Maritime Affairs and Fisheries – Aceh, UN FAO |
| Greater Hyderabad Municipal Corporation | Hyderabad, India | Greater Hyderabad Municipal Corporation |
| HarassMap | Egypt | Volunteer-based |
| HIV/AIDS SMS | Uganda | Text to Change |
| Kerjalokal; Mobile Survey (Usahaku suite) (AppLab Indonesia) | Indonesia | Grameen Foundation, Qualcomm and Bakrie Telecom |
| IrriSATSMS | Australia | CSIRO Land and Water |
| Jalin MERAPI | Indonesia | COMBINE Resource Institution |
| Media Center, Klik Jkt, Klik Papua (Yayasan AirPutih) | Indonesia | Bureau of Meteorology, Climatology and Geophysics Rujak Center for Urban Studies, Ford Foundation, UNESCO |
| Mekong Collaboration Program | Cambodia, Thailand, Lao PDR, Vietnam, Myanmar, China | Mekong Basin Disease Surveillance Network, InSTEDD |
| M-Governance | Kerala, India | Kerala State IT Mission |
| Mobile Technology for Community Health (MOTECH) | Ghana | Grameen Foundation, Columbia University School of Public Health, Ghana Health Service |
| Mobile Telemedicine System | Indonesia | ITB, IDRC of Canada, UNDP-APDIP, Sukabumi Health Office, Sukabumi |

| | | |
|---|---|---|
| M-PESA | Kenya | Safaricom |
| National Malaria Control | Nigeria | UNICEF, National Malaria Control Program |
| PLN Banda Aceh SMS Center | Indonesia | utility |
| Project Masiluleke | South Africa | iTEACH, Pop!Tech, The Praekelt Foundation, Frog Design |
| Project Zumbido, Project Kopano | Mexico, South Africa | The SHM Foundation |
| Rapid Field Assessment of Health Infrastructure | Indonesia | Charles Darwin University, Australia |
| Request and Public Complaint System SMS | Indonesia | Indonesia House of Representatives |
| SMS Reporting for Supreme Court | Indonesia | Judicial Reform Team Office, Supreme Court of Indonesia |
| Transjakarta | Indonesia | Jakarta administration, BLU Transjakarta Busway |
| Ushahidi Haiti | Haiti | Ushahidi, The Fletcher School of Law and Diplomacy at Tufts University, UN OCHA/Colombia, Crisis Mappers Net |
| WFP Food Security | worldwide | UN World Food Programme (VAM) |

# Appendix B. Research Goals and Study Questions for Global SMS Survey

**Research Goals for Indonesia WATER-SMS Project:**

1. What existing software should we build on?
2. What are the lessons to learn around building the technology, scaling the technology, and sustaining it over time?
3. What are the constraints?
4. What are incentive models/ways to engage the community?
5. What are effective methods to ensure that information generation/creation leads to improvements/changes?

**General Overview:**

- What is the region where the program is employed?
- When did the project begin, and is it still operational? If not what was the duration?
- Please give a brief description (what is being tracked, what is the end goal).
- Is there an official web presence for the program?
- Are there additional organizations involved (either via funding or actual development of the program)?

**Development Questions:**

- Were the community/customers/field workers involved in the design and development of the system?
- Was there ongoing development of the system once it was running? Were there any major redesigns?
- How do you take in feedback from the users and turn it into further development and implementation?
- How is this system sustained financially and technically? If funded by a grant, what is the plan for sustaining this system over time?

**System Details:**

- What is the process for sending a follow-up message in response to an SMS and who is responsible for this? (If no follow-up, please specify).
- Is there use of an interactive voice system to supplement or verify SMS reporting?
- If there is mapping, is mapped data accessible or provided anywhere aside from web (e.g. mapkiberia distributes hard copy “atlas” of mapped information)?
- Are there other types of reporting in addition to SMS (email, etc.)? What are input formats (multiple choice or other) which have been used? Does the input message need to be in a fixed format? Are there numerical “codes” used within the message? How is the location encoded (e.g., using address, customer number, etc., or automatic)?
- If possible, please provide examples of SMS messages received by the system.
- How do people handle different languages? If there is a website platform, is it available in English in addition to the local language?

**Technical Questions:**

- Does the project use a mobile phone, SMS modem, or an SMS Gateway Service?
- If it uses an SMS Gateway service, which one? Is that through the mobile phone operator or an independent company?
- Which mobile phone operator does the project use? What are your experiences (good and bad) with this operator?
- What is the cost of sending and receiving SMS Messages?
- Are people paid back for submitting reports?
- Is there a need for specialized phones or for software to be installed on the phones?
- What software/application is used to send, receive, and display SMS Messages?
- Is the data generated publicly available? Where is generated data housed?
- Is there in-country technical support?

**Metrics:**

- How do you evaluate whether the system is providing a benefit?
- How do you evaluate how well the system is working?
- How many people report using the system (per month/per year)? How has this increased over time?
- How do you evaluate how many people are using the system and if they are satisfied?
- Is the data verified (if so, by whom)? Is there a tipping point for the number of reports regarding a particular issue which initiates action?

**Collaboration and Community Involvement Questions:**

- Who is reporting/generating the messages (customers, field workers, etc.)? If reporting is being done by public/customers, are there any incentives in place to encourage participation and how were residents alerted to the presence of an SMS system (public service announcements, individual visits/sessions with residents)?
- What are the roles/responsibilities taken by involved stakeholders? How do you create maximal efficiency of response and follow-up while being sensitive to additional work created?
- If there is more than one organization involved in the project organization and implementation, are there any major issues which have arisen in the course of project development in facilitating communication between different groups as well as stakeholders in the community and local government?
- Who is utilizing the information provided by the program (local govt., international NGOs, etc.)? How have they integrated this data into planning/decision-making?

# Appendix C. Full-Length Case Studies of Selected Mobile Phone Projects

## AppLab Indonesia Case Study — Kerjalokal and Mobile Survey (Usahaku)

**Location(s)**
Usahaku suite of applications for Indonesians currently includes:

Kerjalokal — Jabotabek (Jakarta-Bogor-Tangerang-Bekasi) and Serang
Mobile Survey — Managed Channel in Jabotabek (Jakarta-Bogor-Tangerang-Bekasi) and Serang, as Mass Market in locations throughout Indonesia

**Dates Operational**
Usahaku official launch June 30, 2011

Kerjalokal — 6-month pilot from January to June 2011, soft launched on 30 June 2011
Mobile Survey — Managed Channel, under pilot since August 2009, official launch in Q1 2012

**Project Organizers**
Application Laboratory (AppLab) is a mobile-services innovation and business-incubation center, an initiative of the Grameen Foundation. Grameen Foundation established its second AppLab initiative, AppLab Indonesia, with Qualcomm's Wireless Reach Initiative in April 2009.

**Technology**
AppLab Indonesia is focusing on specific capabilities of 3G technologies rather than SMS. They believe 3G offers a richer user experience than SMS and may provide easier access to key information services than most traditional mobile applications. They utilize the BREW platform, Binary Runtime Environment for Wireless, created by Qualcomm for CDMA phones on the Esia (Bakrie Telkom–BTEL) network. BREW runs on phones with features, although not smartphones, and allows for easy downloading and operation of small programs which can also send message and other media, such as photos. AppLab works only with Bakrie Telkom and a select number of their sub-$30 USD QWERTY feature phones.

**Role Summary**
Users of any of the Usahaku applications are BTEL customers.

Kerjalokal (Indonesian for 'Local Job'), is an application designed to provide cheap, easily-accessible information about blue collar day jobs. Users could subscribe to the service through a village phone operator (VPO) or directly via an application on the handset. They receive daily job information that matches their selected categories and location (geotagging is used to make appropriate matches). Grameen has staff that verifies the jobs before they are released to subscribers. Subscribers can also generate income by subscribing friends to the service through sending SMS messages to those without the application. AppLab is working on creating web and income-generation opportunities for the employers (supply side) as well.

Mobile Survey allows users to earn income by conducting third-party surveys. This program was also launched in Uganda, giving phones to surveyors who would pay off the cost of the phone by

conducting surveys for organizations such as the World Food Programme. The model in Indonesia allows surveyors to earn airtime credit (Indonesian, *pulsa*) with phones they already own. One Mobile Survey project, Managed Channel, works with major corporate partners such as Kimberly-Clark, Nestle, and Indonesia's state-owned electricity company PT PLN for sending out consumer surveys.

**Problem Statement**
Poor and rural populations often lack access to important information and knowledge that would enable them to improve their lives and their livelihoods.

Of the 250 million people in Indonesia, three-quarters live below USD $2.50 a day, and two-thirds have mobile phones. Of these users 90% buy prepaid airtime credit instead of paying a monthly bill.

**Project Goals**
AppLab Indonesia is focused on creating livelihood applications which generate income, reduce costs, and provide opportunities for the poor that otherwise are not available (poverty alleviation). Kerjalokal aims to facilitate easier procurement of local day jobs for "blue collar" workers. Mobile Survey aims to provide incremental income to those earning less than USD $2.50 per day.

**System Highlights**
By the end of 2011, App Lab Indonesia's Usahaku Suite of applications will come embedded in 2 million phones.

They are also exploring creating versions of their applications to reach more Indonesians, such as through other smartphone applications.

**Outreach/Participation/Engagement**
AppLab Indonesia works through its village phone operators (VPOs) and its partners on outreach for new users. Village phone operators sell airtime credit through their own mobile phones. In Uganda, AppLab has launched its other applications through the existing base of VPOs and other shared phone operators, which provide additional income-generation opportunities beyond airtime sales. As part of its Ushahaku Suite, AppLab Indonesia started a village phone network called Jual Pulsa to provide not only income-generation opportunities, but also to develop a network to disseminate other AppLab Indonesia applications.

Jual Pulsa, or Top Up, is modeled after the programs in AppLab Uganda and Grameen Telcom in Bangladesh, which established local village phone networks through mobile microfranchising. Mobile microfranchising provides income generation opportunities for those that need to supplement their base incomes. A VPO issues credit to buyers by entering the buyer's phone number and airtime purchase details into the VPO's own mobile phone. This system formerly used SMS, but now uses an embedded mobile phone application. The SMS capability is still there as a backup.

In addition to the current VPO network and user base developed through its pilot project (est. 9,000 as of October 2011), the Usahaku Suite of applications will be embedded in 2 million

phones by the end of 2011. Managed Channel VPOs have served over 900,000 unique airtime customers.

**Data Collection**
Usahaku is seen as a clearinghouse or data aggregator. Data collection and reporting is built into the system so they can study performance. For example, Kerjalokal records a log of applications submitted.

**Data Distribution**
Most of the currently available Usahaku applications are not specifically designed for multi-directional exchange of information. For Kerjalokal, a user must subscribe in order to receive job opening information; the employers receive information from prospective employees. For Mobile Survey, the surveys are distributed through the VPOs on an opt-in basis—that is, a person must agree to take the survey before they receive it. The collected data is used for a range of purposes, mostly audience research.

**Successes/Evaluation Metrics**
Performance data on the Usahaku applications is only available to AppLab. All of the AppLab Indonesia applications are geared toward income generation. Through Jual Pulsa's network of 9,000 VPOs as of October 2011, Usahaku applications served over 900,000 customers.

AppLab Indonesia's work is informed greatly by the successes and challenges of AppLab Uganda's work.

**Partners**
AppLab Indonesia's main technology partners are Qualcomm and Qualcomm's Wireless Reach Initiative (WRI) and Bakrie Telkom (BTEL).

For developing the VPO network through Jual Pulsa, they worked with PT. Ruma, a local Indonesian organization that sells VPO franchise businesses called *Rumah Isi Ulang*, a "business in a box" which includes a phone, promotional materials, and an operation manual.

For Kerjalokal, they are working with PT. Ruma. For Mobile Survey, they are working with Salesforce and PT. Ruma. Salesforce is assisting in back end management, survey analysis, and new application development for an Android-based version.

**Scalability/Future Directions**
Because they are in their beginning phases, AppLab is working within only a few areas, those closely tied to their pilot locations. In Indonesia their applications are scalable because their applications are targeted at poverty alleviation (poverty is high in Indonesia); mobile phone use is high in Indonesia; and they have multiple outreach channels.

In addition to the Usahaku applications launched in June 2011, AppLab Indonesia is also working on another Mobile Survey application to be launched in early 2012, which will target consumers who make around Rp. 15,000 per day. Potential targets for this mobile survey will be fast moving consumer goods companies; research companies like Nielsen; NGOs; development agencies like World Food Programme, UNDP, and World Bank; and government agencies. Under development are a mobile mentoring application for peer-to-peer networking and a mobile

collect-call business application. While SMS is still a backend option for Jual Pulsa, they are looking more toward expanding their applications to newer platforms and capabilities.

**Financial Sustainability**
All of the research and development is underwritten by Grameen Foundation and funded by Qualcomm. For Jual Pulsa after the pilot, the business has been underwritten by PT. Ruma. They are achieving sustainability through business, taking a no-grant approach after the pilot phases.

**Sources**

- Informational Interview with Farid Maruf, Country Technology Manager, Grameen Foundation Indonesia

## e-Pasar Ikan (UN FAO Fish Marketing Information System) Case Study

**Location(s)**
Banda Aceh, Indonesia

**Dates Operational**
2009 to present

**Project Organizers**
The Fish Marketing Information System Project, or e-Pasar Ikan, was a project initiated by the UN's Food and Agriculture Organization (FAO) and supported by the Government of Spain.

**Technology**
Price information is processed by a computer-based system (primarily a website and MySQL database) using FrontlineSMS as the SMS gateway.

**Role Summary**
- Reporters who send news of prices (from the port or the market) generally are current employees in the Department of Maritime Affairs and Fisheries (DMF).
- IT coordinator in the government who enters information into the system as it comes.
- Local fisherfolk, fish farmers, traders, processors, and government agencies receive pricing information.

**Problem Statement**
The profits of local fishermen were being threatened by middlemen who created a market monopoly.

**Project Goals**
The original intent of the project was to support the livelihoods of local fishermen by giving them up-to-date information on prices before they went to the market. This would allow them to better negotiate the price for the day's catch and support the development of conducive and fair trade practices for economically competitive fish products from Aceh in the local, national, regional, and international markets.

**System Highlights**
There were no major changes to the system during the development phase, save that the system originally ran with one desktop and one cell phone. In the second year, they decided to use two cell phones, one to receive and one to send messages.

**Outreach/Participation/Engagement**
Outreach and socialization was achieved through meetings and outreach, such as sticker and t-shirt distribution. Because resources were focused on the enumerator and data collector, outreach was not significant in the first year. In the second year the project engaged local government to assist in the information collection, which allowed the enumerator to work to expand distribution to twice weekly information broadcasts.

There are over 500 recipients of the mobile phone service and others who use the internet information service. There are relations with the Chamber of Commerce (Kadim) to give

workshops and raise awareness. They established through this project the Aceh Traders Organization. The hope is to make this one single provincial organization (instead of many little ones)—and this can help provide information and resources to fishermen.

**Data Collection**
Software called "Enumerator" was developed for the data-collection process. The reporters were given a mobile phone with the software pre-loaded, which allows them to easily enter the species and price of the fish in pre-defined fields. The data is sent as an SMS message and processed through the FrontlineSMS software.

The project hired two people in each of 18 municipalities/districts, one at the landing site (a port) and one at the market. These people would quote the up-to-date prices (both maximum and minimum) for up to 20 species of fish. When there was a discrepancy and wildly different data than normal, the IT coordinator called to the market/port to ask for a second source to verify the data. This was expensive. In the second year they engaged local government to participate in information collection. The enumerator was then recruited from civil servants and was able to expand the distribution up to twice a week. By the end of the second year, FAO was able to hand over the project to local government. The IT staff from FAO trained local civil servants to be able to handle the system.

**Data Distribution**
The project used a combination of mobile phones and a desktop computer to receive up-to-date prices from the market and from fishing ports, and relay these to registered users. The prices were sent via SMS to registered users once a week, were posted on the internet at the project's website, or were disseminated through local radio and newspapers. In addition to information on fish pricing, the website has a capability for photo upload/viewing and lets the user access other material about fish.

**Successes/Evaluation Metrics**
Before the project, information was scarce and prices for fish were low. It is unclear if an evaluation has been done to judge how much the price for fish has risen, but we understand that fishermen benefited. During the program they measured simple metrics, such as the number of hand phone users. In the evaluation users said it was helpful, but since information is sent only twice a week they would prefer it to be sent every day. There is thus room for refinement.

There were over five hundred recipients of the mobile phone-based service at the time of the interview, and an unknown number of others who use the internet information service.

**Partners**
The main partner of the project is the Aceh provincial Department of Maritime Affairs and Fisheries (DMF). The technical partner is Infofish, which signed a Letter of Agreement with DMF for technical support. Infofish is a similar system run in Malaysia. They designed the website and still provide ongoing technology support. There are relations with the Chamber of Commerce (Kadim) to give workshops and raise awareness. Through this project they also established the Aceh Traders Organization. The hope is to make this one single provincial organization (instead of just having many little ones) and this can help provide information and resources to fishermen.

**Scalability/Future Directions**
In the first year, the program covered nine municipalities in Aceh, then during the second year expanded to cover 18 of the 21 municipalities in the region. After two years the project transitioned from being a stand-alone project, and was handed over to the DMF. Prior to the transfer, the department was trained to control and maintain the system. The idea was originally to expand to additional provinces in Indonesia.

**Financial Sustainability**
The original program was initiated by the UN Food and Agriculture Organization (FAO) with funding from the Government of Spain. The program is currently being implemented by the provincial government and the Department of Maritime Affairs and Fisheries. It also receives local government funding. There were no other funding sources at the time of the handover.

**Sources**
- Informational Interview with Aulia Zulkarnaen, Pilot Project Manager, e-Pasar Ikan
- *FrontlineSMS: Fishing Meets Texting at Banda Aceh.* (http://www.frontlinesms.com/2009/12/15/fishing-meets-texting-in-banda-aceh/)

## FLOW (Field Level Operations Watch) Case Study

**Location(s)**
*On website*: Malawi, Rwanda, Uganda, India, Dominican Republic, Honduras, Guatemala, Nicaragua, Ecuador, Bolivia, Peru
*Mentioned in interview*: Liberia, Nepal, West Africa, Burkina Faso, Mozambique

**Dates Operational**
2010 to present

**Project Organizers**
Water for People (WFP): Ned Breslin, CEO; John Sauer; Erin Wright

**Technology**
FLOW is mapping software originally created for data collection for monitoring the functionality of water access points installed by Water for People. It uses mobile phones on Android (smartphone) platforms, which allows users to take GPS coordinates, take pictures and videos, and fill out questionnaires. This information is then translated to Google Earth data and placed on online maps.

**Role Summary**
- Originally users submitting data were staff members or people associated with WFP. Now, users include community members, partners, and volunteers, without the need of WFP staff as intermediaries.
- WFP staff verifies the quality of data collected by conducting independent audits.

**Problem Statement**
Millions of dollars are spent every year on tens of thousands of water systems around the world that break and become abandoned. The efforts to build these systems are wasted; continued development and aid in this form is unsustainable. People in developing countries are then forced to rely on unsafe water sources once again, which has devastating impacts on the communities' health. In order to address this problem, these water systems need to be regularly monitored and evaluated so that repair can be dispatched in a timely manner and service can continue.

**Project Goals**
Overall, Water for People works to improve access to safe drinking water and sanitation, and reduce water- or sanitation-related diseases. FLOW was created as an analytics tool to systematically monitor water points, identify broken systems, and assess solutions for rehabilitation in an efficient manner. WFP is committed to ten years of post-project monitoring, and FLOW was designed specifically to facilitate this task.

**System Highlights**
Prior to 2006, WFP did not have any monitoring system in place; to address this, FLOW was created. WFP has gone to every district around the world (60-70) where they work, with the exception of India and Malawi. Thirteen thousand water points are included in the database. The Android platform was chosen on the speculation that it will become more available and cheaper around the world, especially given that smartphones are getting much faster than computers.

**Outreach/Participation/Engagement**
Initially they worked with in-country District Administrators, providing them with Android-based phones which would be used to do the monitoring, then would be given back to WFP staff from headquarters. Now, the phones are left in country and are recharged with extra credit by headquarters. In the case of Honduras, the phones are left with the districts. Incentives such as airtime compensation are created to motivate regular and accurate monitoring.

**Data Collection**
Data in the form of GPS coordinates, photographs, and flow parameters are taken at each water point and compiled using Google Earth to produce a map. FLOW is advantageous since the program internally performs basic analytics to compare and bundle projects. A repository of data can thus be created such that the projects can be tracked over time, allowing for more comprehensive research.

The quality of the data is checked with installed sensors, which are computer chips affixed to outlet pipes of handpumps. They are powered by the pumping motion. The sensor is able to record water quality, water quantity, and system –functioning-time data, but rather than having WFP staff make regular rounds to record the information, the community can collaborate by recording the data themselves and sending the information to WFP. To verify the quality of the data submitted, WFP teams are sent to perform unannounced independent audits. They also interview people in the area who are no working with the monitors in order to obtain unbiased verification. Reporting accuracy increases the amount of incentives given to the monitors.

Questionnaires are designed specifically for individual projects that assess five outcomes: quality, quantity, access, downtime, and finance (parts replacement and overall system). One hundred questions will probably be needed to get to all these outcomes, which will be web-based. One of the challenges is how to deal with excessive data and discern actionable data from the rest.

**Data Distribution**
The data is publicly available and WFP is trying to find a home for its meta-platforms. Local data can be downloaded onto a phone when the phone itself is in that locale. The data is available on FLOW's website, and they are currently converting three years of tapered data so it can be available as well. Household and behavioral data will be available, but it is currently unknown if financial data will be displayed on the web.

**Successes/Evaluation Metrics**
The goal to make monitoring more efficient and improve evaluation of their projects was achieved.

Over 120 organizations such as the Inter-American Development Bank and other internal IDB programs want to implement FLOW in their sites. The government of Liberia uses FLOW for its water and sanitation program to plan future interventions and rethink poorly functioning technologies. The usage of FLOW will be expanded to fisheries. Nepal wants to use it for monitoring their orphanages.

**Partners**
Cisco; Founder of Craigslist (donation of 20,000 Motorola phones); Hilton Foundation; WaterAid; IRC; Portland State (Evan Thomas): Suite Pilot program for Mercy Corp in Indonesia.

**Scalability and Future Directions**
FLOW has become a large venture that is detracting WFP's time and energy from their core mission work. To address this, they are trying to find an appropriate company to house the project. The stipulations for potential companies are that there must be a low barrier of entry (current costs are very low: USD $1.00 to set up and $0.72/month for data storage) and maintain the underlying premise of WFP. WFP will advise, but not require, the company to make the information publicly available. This venture will require a significant amount of initial technical support and training.

**Financial Sustainability**
The premise of FLOW is for low barrier to entry—one of the most significant ones being cost. Commercial mapping software like ArcGIS is extremely expensive, in contrast to FLOW.

**Sources**
- Informational Interview with Ned Breslin
- FLOW website

## Human Sensor Web Case Study

**Location(s)**
Zanzibar region of Tanzania – http://geonetwork.itc.nl/zanzibar

**Dates Operational**
2008 to 2010

**Project Organizers**
ITC – University of Twente, Faculty of Geo-Information Science and Earth Observation
TI-WMC – Twente Institute for Wireless and Mobile Communications
52° North – Initiative for Geospatial Open Source Software

**Technology**
The Human Sensor Web system is an SMS Gateway application that accepts user reports as structured SMS messages required to contain a specific code corresponding to a specific water point. The system is also enabled to collect automated sensor data through both water and power monitors. The water readings are used to corroborate user reports, and the electricity readings are incorporated in the system to determine whether power failure is the reason behind pump failure and lack of water availability. Data is displayed through a dedicated website using the Google maps API.

**Role Summary**
- Water point reporters are local residents who act as "human sensors" to provide geographic information and observations about issues with local water points.
- ZAWA service provider technicians and ZAWA Maji-Managers have specific codes to report to the system via SMS on the status of the problem.

**Problem Statement**
Scarce and unreliable water availability in Zanzibar is due to a number of issues, including aging infrastructure and lack of accountability in the water sector. Many residents are only able to access water for a very short period each day, and if a water pipe is broken, they are often forced to pay for water from a private vendor (on top of costs they are already paying to the local utility).

**Project Goals**
To create a system able to monitor water service and supply using real-time information submitted by residents and water service providers via their mobile phones. The project was designed to incorporate both geospatial information systems (GIS) and information from the local community.

**System Highlights**
The system involves the use of a publicly accessible web interface with a map automatically updated in real-time with information coming through the local community. Each monitored water point is listed as "Dirty water", "No water available", or "Water service ok."

**Outreach/Participation/Engagement**
Zantel, a local mobile phone provider, funded 50 signboards to be placed by water points and kiosks to explain the purpose of the project and provide the number and code for an SMS report. Ultimately it was determined that the outreach was insufficient. While the data sent in was good, they received few reports.

**Data Collection**
The data collected was limited to 50 fixed water points, meaning that a pipe break or pollution issue with unregistered water points can't be registered with the Human Sensor Web system. The system was built to accept very specific SMS codes, which they found was difficult given the verbal culture in Zanzibar. The system received a number of highly relevant text strings explaining specific problems with a water point, but it was not set up to accommodate unstructured user submissions. Considered alternatives included implementation of Interactive Voice Reporting or setting up the capability to receive hybrid structured/unstructured text by manually screening messages.

**Data Distribution**
Each water point has a number of registered subscribers, from residents who have submitted reports about that location to the relevant authorities. Any message submitted successfully through the system is sent to the subscriber list, both to notify utilities of a problem and to update residents once the problem has been fixed. The data collected is visualized on a live web interface which is built on Google Maps and is able to show the status of all monitored water points. During the course of the project, the organizers found that the map was not frequently utilized by individuals using the system, and felt that it might be more useful for an oversight board. There is also the option to view the data in table format and export it from the HSW website.

**Successes/Evaluation Metrics**
The project, as a research endeavor, was initially focused on getting the technical system running, which was successful. They did not look at additional evaluation metrics, though while the data was good there were difficulties in getting voluntary submissions to the system and having active participation from the local community.

**Partners**
UN Habitat, google.org, GTZ Kenya, Water Services Trust Fund Kenya, WaterAid, Zantel, Zanzibar Water Authority (ZAWA), Upande, iNet/Zanzibar Datacom Ltd.

**Scalability/Future Directions**
The organizers are interested in expanding their goals to look at the intersection of water and other issues such as health, to focus on the organization of streams of information. In the future, they would also like to explore methods that will increase outreach, and have allocated money to increase media exposure to explain the system and hopefully provide more public awareness of its purpose. A new four-year (2012-2016) research project from ITC – University of Twente and the University of Dar es Salaam has started to investigate this.

**Financial Sustainability**

Initial financial support was provided by google.org and UN Habitat through the h2.0 Monitoring Services to Inform and Empower Initiative. ITC focuses on capacity building in developing countries and is funded by the Ministry of Foreign Affairs in the Netherlands.

**Sources**


- Informational Interview with Jeroen Verplanke (University of Twente) and Simon Jirka (52 North)
- Verplanke J., R. Becht, G. Miscione, H. Kimara, H. Benz, E. Jürrens, C. Yen Sung, and S. Yusra. 2010. *H2.0 inform and empower initiative. HSW final report: Empowering Communities in East Africa in Water Service Provision through Information from Human Sensor Webs. 23 December 2010.*

## Jana (formerly txteagle) Case Study

**Location(s)**
Almost 100 countries worldwide

**Dates Operational**
2009 to present

**Project Organizers**
Dr. Nathan Eagle (Co-founder and CEO); Dr. Benjamin Olding (Co-founder and CTO)

**Technology**
Jana, formerly txteagle, built its own universal cellular messaging protocol (UCMP) platform on top of the unstructured supplementary service data (USSD) protocol, which is provided free on all mobile phones. This is the same system customers use to check how many minutes they have left, their billing information, and so forth. The company is able to leverage the use of these protocols with telecom companies because they bring business through an otherwise non-revenue-generating platform. Further, the subscribers are not charged for usage but rather are compensated with airtime. By allowing Jana to use their USSD services, the operators increase profit through the compensation airtime Jana offers its users.

**Role Summary**
- Individuals sign up to be a subscriber and join the network. Anybody can do this via his/her mobile phone. The company then segments the users based on their demographic information provided upon joining.
- Companies interested in consumer preferences create, with Jana, surveys for their target audience. Jana then sends the surveys in multiple-choice format to their target population.
- The data is compiled and sold to the companies.

**Problem Statement**
Global organizations do not easily find information about consumers in emerging markets.

**Project Goals**
Jana is a business that capitalizes on connecting customers from emerging markets with companies that want to tap into that market. It serves as a mechanism to increase brand awareness and to assess customer preferences. For global organizations it provides direct and real-time insights, or market intelligence, from consumers. For potential customers in emerging markets it provides increased economic empowerment. The company also provides services to other organizations, though in general they avoid government clients. The goal is to create technology that allows for subscriber-generated content, like craigslist.

**System Highlights**
The technology is a proprietary UCMP platform, and is among the first of its kind in the area of market research.

**Outreach/Participation/Engagement**
Outreach varied significantly from region to region. For instance, referral networks worked very well in the Philippines, somewhat in Bangladesh, but poorly in Pakistan. The method is chosen based on previous in-country experience. Because of the nature of the technology, the primary users are young, male, educated, urban, and have easy access to technology.

**Data Collection**
Quality of data collected is tested by asking questions with known answers. Fifty languages are used to increase user uptake, however, literacy remains their biggest hurdle.

**Data Distribution**
Data is compiled based on location and demographic information, then sold to companies seeking market data. This technology has been used not only for private enterprises, but also by other organizations such as the United Nations and Mexico's Ministry of Health (for sending out health alerts).

**Successes/Evaluation Metrics**
As Jana is a for-profit company, the main metric is profit. Other metrics for success are number of countries, users, and clients (especially those with high profile) that employ their services.

**Partners**
Their financial partners include Spark Capital, RBC Venture Partners, Qualcomm Ventures, and Flywheel Ventures. They work with over 220 mobile telecommunications operators in almost 100 countries.

**Scalability/Future Directions**
Nathan Eagle also has a project called EPROM that builds on the concept of txteagle/Jana. EPROM empowers computer science students across Africa to build applications that they can adapt to their communities. This venture has been very successful; dozens of companies have started from EPROM. He strongly advises students against engaging with governments and NGO's since many EPROM enterprises that did so have failed.

**Financial Sustainability**
They have raised significant venture capital (over USD $8.5 million).

**Sources**
- Informational Interview with Nathan Eagle
- Jana website

## Maji Matone (Raising the Water Pressure) Case Study

**Location(s)**
Tanzania

**Dates Operational**
Phase 1: November 2010 to December 2011

**Project Organizers**
Daraja

**Technology**
Maji Matone accepts and manually processes unstructured SMS messages about rural water point issues. The relevant messages are forwarded to local district water engineers (DWE). The customer-generated reports are maintained in a database by Daraja. IVR is being considered to make the system more accessible to low-literacy users.

**Role Summary**
Residents submit SMS messages with information about the location of a non-functioning water point. Local media (radio and newspapers) are also forwarded the relevant SMS messages which they publicize and highlight to put pressure on the government for a solution. District water engineers are notified directly of the issue and are responsible for restoring water point functionality whenever possible.

**Problem Statement**
Only about half of rural water schemes in Tanzania are currently functioning, and the situation has actually declined in the past several years with over 4 million people lacking access to potable water. Sustainability of constructed water points is a major issue, with many water points eventually becoming dried up or broken down. Issues with infrastructure, communication, and a lack of funding and resources make repairs of these unusable water points difficult and infrequent.

**Project Goals**
To increase access to clean and safe water in rural Tanzania, by encouraging residents to monitor water infrastructure giving them the opportunity to submit reports about water points which are forwarded to the relevant local authorities.

**System Highlights**
Daraja found that it was helpful to empower communities with knowledge, so they set up a three-part program. The first part was to set up an educational program to make residents aware of water points, using both through written materials and a weekly 30-minute radio program, which was also a platform for DWE to provide water management information. For the second part, the media would also publicize complaints and run stories on reported water issues, often conferring with both the resident who noticed the issue as well as the accountable government official/DWE, thereby encouraging engagement with water management. The third part was to collect and disseminate information via SMS.

**Outreach/Participation/Engagement**
Daraja conducted programs in rural areas to talk to communities and water committees, telling them about Maji Matone, and additionally promoted the program through flyers and radio programs. They did not implement any incentives for participation, one concern being that it might flood the system with unimportant messages. It would also require additional financial resources to supply prizes for participation. However, they determined that because there was only a minimal cost to report a problem via SMS, there was not as much of a need to provide participation incentives. Daraja also found sometimes that people did not submit an SMS even if they were experiencing problems and were aware of the program, which might stem from a lack of trust in public services, specifically the water sector.

When the system was initially introduced to the DWE, they felt that they might be subjected to additional criticism and scrutiny by the organizers. There was less cooperation until they realized that Daraja had same objectives as they did, after which they actively utilized and acted on the information provided by the SMS system. Pressure from Daraja and the villagers also prompted greater participation by DWE.

**Data Collection**
The SMS format requested by Daraja is the name of district and the village where the water point is located, followed by a report of the problem. Despite the requested format, Daraja receives a number of messages which do not contain all the necessary information, at which point there is an attempt at a manual follow-up. Out of 900 messages received during the pilot period, approximately 400 contained sufficient information. The issues which are submitted through the system include water shortages, infrastructure problems such as broken water pipes and pumps, and problems with water management.

While Daraja currently manually processes SMS messages, they are exploring the possibility of utilizing a program such as FrontlineSMS. They are also interested in incorporating an Interactive Voice Reporting (IVR) system such as FreedomFone, due to observations that some residents in rural Tanzania are unable to read and write but are very comfortable using their mobile phones.

**Data Distribution**
Daraja forwards relevant SMS messages both to DWE and the local media. This way, the system provides update information to the local government and aids in the monitoring and evaluation of water service in rural areas.

**Successes/Evaluation Metrics**
Currently 20 water points have been restored to functioning status due to residents' SMS reports to Daraja. It is estimated that each water point affects 250 people, and that the total impact of the project to date has been to provide access to water for 4000-5000 people.

**Partners**
District Water Engineers (informal partnership)

**Scalability/Future Directions**
For September 2011, Daraja initially planned to launch Phase 2 of Maji Matone, a national program based on lessons learned from the initial implementation. They planned to shift from residents to trained volunteers to carry the program, and to use mobile phone based data collection to create an information web of "water point functionality and water-related household practices." This information would then be used in a national advocacy campaign. They would additionally like to implement additional options for reporting such as voice and email.

As of December 2011, Daraja has postponed implementation of Phase 1 due to low reporting from residents. During the first six-month period they received and forwarded only 53 messages from all three pilot districts to district water departments, with an initial target of 3,000. Their initial thoughts on the reason for failure include the potential for mismatch between the communities' characteristics and behaviors (e.g. low literacy rate, tendency to use voice over SMS) and the technology; characteristics of water policy in Tanzania that allow place responsibility for operation and maintenance of water points on communities and hence low expectation among communities for engineers to respond; and low sense of agency with and high apathy toward the government in solving community issues.

**Financial Sustainability**
The program is currently financially dependent on funding from Twaweza, DFID's Accountability in Tanzania (AcT) programme, and Daraja Trust.

**Sources**
- Informational Interview with Richard Lucas, Program Manager, Maji Matone
- Daraja blog (http://blog.daraja.org)
- Ben Taylor, Raising the Water Pressure video presentation, May 2011 (http://vimeo.com/23534524)

## NextDrop Case Study

**Location(s)**
Hubli-Dharwad, Karnataka, India

**Dates Operational**
2010 to present

**Project Organizers**
UC Berkeley School of Information, Department of Civil and Environmental Engineering, and Goldman School of Public Policy

**Technology**
The NextDrop platform is built on Django (Python). It also utilizes Kookoo, a program that allows web applications to interface with an interactive voice reporting (IVR) system. The software was not initially released, but the goal is to make everything open-source within two years of the project start. They plan to integrate some flow meters to benchmark their water updates but do not plan on broad-scale use of sensors.

**Role Summary**
- Residents of Hubli (customers of the local utility) verified water availability reports from utility and received information regarding water timing in their geographical location
- Employees of the Hubli-Dharwad Municipal Corporation
- Valve operators call into the IVR system when they open and close valves across the city
- Engineers monitor progress on internal dashboard, allowing them to track valve activity, and learn about diversions due to power and infrastructure issues

**Problem Statement**
For approximately 1 million residents in the city of Hubli, water comes in once every five days for a five hour block. Information flow within the utility doesn't work well; data is entered into a handwritten logbook, making it difficult to analyze and share. As a result, households lose time waiting for water, are stressed by uncertainty of water availability, and may have to resort to other water sources (e.g. tanker trucks or bore wells).

**Project Goals**
To generate high quality water timing information using inputs from utility employees in the field and local residents to alleviate the social costs of intermittent water. The project is built on the idea of collecting data and making it public and accessible, and enabling the community to advocate for more equitable distribution.

**System Highlights**
NextDrop is the only project currently running which uses mobile phones to track delivery through piped water systems (as opposed to monitoring water point functionality or following informal water service).

**Outreach/Participation/Engagement**
Initial outreach to the community was a collaborative process with the local Deshpande Foundation, mainly through door to door visits. They started by surveying people about water issues and asking them if they would be interested in a service providing water timing information.

NextDrop originally paid 5-10 Rupees in phone credit to the first person to call in regarding running water. They found that when they discontinued the payment it did not impact the number of reports made by the community, so they stopped paying people to verify accuracy. The organizers believe that the system users are incentivized by the ability to receive information as well as the idea of helping the community. The participation of valve men and water utility engineers is required by the utility company, but enforcement is up to NextDrop. They are still trying to determine the most effective method of ensuring participation and system use by valve operators and engineers, such as giving recognition for contributing to the system.

**Data Collection**
The initial method of data collection was based on crowdsourcing water timing information via SMS. However, since the primary goal of the project was to have more reliable information on water services, and it proved difficult to crowdsource water delivery information for some areas, the project shifted to work more closely with the utility company and collect data from the control point of the system—the valve men who were opening valves and starting the flow of water. NextDrop also found that residents preferred to be notified in advance of running water.

During the initial pilot, the older population had issues with the SMS system since it asked for specific code lines. This prompted a switch to an IVR system in Kannada, both for customer verification and for data input by valve men in the field. The cost of sending an SMS message (a couple of rupees) also was raised as an issue during the pilot.

**Data Distribution**
The engineers have access to a central dashboard built on Google maps, which is focused on updates of when water is turned on, information gathered from the IVR system (NextDrop initially worked with the utility to map the valve locations). The project utilizes verifiers in the community who they randomly call to validate reports of running water by the utilities. Initially, NextDrop would broadcast the information via SMS to residents in the relevant areas following verification, or once the valve men updated the system. Now, the updates are sent immediately. They still randomly call residents, but only do so to “spot check” the accuracy of the data.

**Successes/Evaluation Metrics**
The goal is to have the system pilot fully functional in 1,000 households by March 2012; this was completed in December 2011. In their Final Report, NextDrop provides a quantitative analysis focusing on four key areas: 1) opportunity costs to households due to time loss; 2) days of school lost due to time loss in the child population (not monetized); 3) health costs based on coping behaviors, and 4) health sector savings. They estimate that NextDrop will reduce costs in each area by 50%.

**Partners**
Deshpande Foundation, Karnataka Water Board, Hubli-Dharwad Municipal Corporation (HDMC)

**Scalability and Future Directions**
The organizers are interested in scaling to all cities in India with intermittent water service, and additionally moving beyond water to other public services like electricity, using a similar model where residents or public utility workers ("human sensors") report information to improve unreliable delivery. They are ideally interested in having the current dashboard monitor additional factors such as reservoir levels and equipment function. They are exploring the creation of a publicly available dashboard to facilitate better advocacy coordination among the public. Finally, they are exploring the use of media partnerships and disseminating information about the project through local newspapers.

**Financial Sustainability**
Initial funding was provided by grants from the Gates Foundation via the UC Berkeley School of Information, the Center for Information Technology Research in the Interest of Society, and Clinton Global Initiatives.

NextDrop currently plans to incorporate as for-profit in India. Initially, utilities were targeted as the primary customers. The service would be advertised as a means to decrease water-loss by providing a dashboard to track water service across the city. But they have moved forward to target residential customers as the primary revenue source. Over 30,000 households have now signed up for NextDrop and agreed to pay 10 rupees per month for the service.

**Sources**
- Informational Interview with Ari Olmos
- Thejo Kote and Ari Olmos, NextDrop Final Report, May 2011

## SHM Foundation Case Study – Project Zumbido and Project Kopano

**Location(s)**
Project Zumbido - Mexico, Project Kopano - South Africa

**Dates Operational**
Project Zumbido – 2007 to 2008
Project Kopano – February – April 2010

**Project Organizers**
The SHM Foundation is a charitable foundation set up by a strategic insight company called SHM (an acronym of the founders' names, Sophie Manham, Professor Henrietta Moore, and Professor Maurice Biriotti). Anna Kydd is director of the Foundation and co-founded Project Zumbido and Project Kopano with Yale School of Medicine and the University of Pretoria. The staff from SHM also work on certain projects at the Foundation.

**Technology**
Due to poor internet connections in Mexico, SHM Foundation chose to design a pilot system that used the more accessible SMS technology. Both Project Zumbido and Project Kopano used ZygoHubs, a group SMS technology, to connect virtually a group of people living with HIV/AIDS in order to share information about access to services, medication, and emotional support. The technology uses one single number for messages that are relayed through an online facility to everyone within a restricted membership group, and allows for online invitations and moderation of messages. The technology was originally developed for commercial business uses, such as for taxi drivers and lawyers. The SHM Foundation now has the rights to use the technology for charitable purposes.

**Role Summary**
- Users of technology: in Mexico, people living with HIV/AIDS; in South Africa pregnant women with HIV/AIDS
- Moderator: SHM Foundation staff

**Problem Statement**
Stigma and discrimination impacts the ability of people living with HIV/AIDS to access services and support, and leads to high levels of social isolation. In Mexico, despite the fact that all HIV positive persons have access to medication, the quality of life of those living with HIV/AIDS is low. In South Africa, pregnant women who are recently diagnosed with HIV are in need of regular support services to ensure that both the mother and her newborn remain healthy and HIV is not passed on to the newborn.

**Project Goals**
The SHM Foundation developed Project Zumbido in Mexico and Project Kopano in South Africa to reduce social isolation and provide support for people living with HIV/AIDS. The projects helped create a virtual network for those in rural and urban areas which could help them to share information about access to services, medication and emotional support.

Following the success of Project Zumbido, Project Kopano aimed to address the issues around preventing mother-to-child transmission of HIV in Pretoria, South Africa.

**System Highlights**
There were 10 members in each group, including participants who had been living with the condition for a long time, some who had been recently diagnosed, some who live in rural areas, and some in urban areas. There was also a health professional in each group. Each group of 10 had its own number.

**Outreach/Participation/Engagement**
In Mexico participants were recruited by establishing links with local health centers and asking them if they felt there would be anyone who would benefit from such a project. The participants did not pay for the SMS messages. In the case of South Africa messaging costs were paid for by the project and could be paid online. In the case of Mexico participants were given phones as many of them did not have one. In Mexico, participants still have their phones and quite a few of them still use them to meet up with the friends they made on the project.

Workshops or one to one interviews with the participants were held depending on issues around stigma in order to stimulate ideas about what participants wanted to get out of the project and to have them establish their own ground rules for how the project would work. In Project Zumbido the participants were sending on average six SMS messages a day which is very high. In South Africa, it was much less.

**Successes/Evaluation Metrics**
In Mexico, there were forty participants in the pilot and they sent 250,000 SMS messages in 3 months. The evaluation showed that a number of important aspects in relation to their quality of life improved, such as levels of anxiety decreased, depression and feelings of isolation. Two participants admitted that they had started to take their medication again when they previously hadn't. It was particularly empowering for a number of women in the project who improved their reading and writing.

**Partners**
For Project Zumbido there were no partners.
Project Kopano worked with Yale School of Medicine and the University of Pretoria.

**Scalability/Future Directions**
The Project Zumbido pilot was sustained for three months and finished in 2008. Project Kopano was finished in 2010. At the moment, there is a project in the UK for parents living with HIV/AIDS which incorporates a new element of having guest SMS speakers from the public health field, such as a nurse, or a nutritionist.

The organizers suggest a potential model of government agencies funding such projects if it can be proven that the adherence rates of the participants improve significantly as a result. Another possibility is working through a model receiving donations from the public via part of the cost of a SMS message. Another potential source of funding is through advertising on the SMS messages sent, which could help to cover the costs.

The SHM Foundation is now exploring how the model and the technology can be used in other sectors such as the environment.

**Financial Sustainability**
The pilot in Mexico was funded by the SHM Foundation.

In South Africa, a portion of the SMS messages were donated by BulkSMS, a commercial web based messaging service. This was quite straightforward because the company was a major provider that already worked with all the major mobile phone carriers, so they were able to donate messages for the specific carrier used in the pilot. Technically, all the participants could be with a range of different carriers, but cost wise it would have been more complicated if they were with different carriers.

**Sources**
- Informational Interview with Anna Kydd
- The SHM Foundation website

## Water Quality Reporter Case Study

**Location(s)**
South Africa (original), Mozambique, Vietnam, Cambodia

**Dates Operational**
2009 to present

**Project Organizers**
The University of Cape Town's iCOMMS team developed the Water Quality Reporter (WQR) mobile phone application and backend components. The pilot tests in Mozambique, Vietnam, and Cambodia were a collaboration between University of Cape Town and the Aquaya Institute. WQR was developed under the Aquatest Research and Development Program. The Aquatest Consortium includes the following organizations: University of Bristol, Aquaya Institute, Health Protection Agency, PATH, UC Berkeley, University of North Carolina, University of Southampton, and University of Surrey.

**Technology**
The Water Quality Reporter mobile phone application is built on an open-source JavaRosa platform and utilizes data transfer by general packet radio service (GPRS), which is cheaper than SMS and enables the sending of completed forms with water quality information. The project also employs an SMS-based collection method which uses RapidSMS to manage incoming messages from basic phones that do not support the Java platform.

**Role Summary**
The application was designed for use by professionals and semi-professionals who are already required to manage and obtain information on water quality status, generally due to governmental mandates or utility standards, and who don't have sufficient equipment or financial resources to fulfill their testing and reporting needs. Therefore, the reporters change according to the country and context of use:

- South Africa: environmental health practitioners reporting to the district health services
- Cambodia: rural water system operators overseen by a local NGO
- Vietnam: water utility treatment plant operators reporting to quality control managers
- Mozambique: district health technicians reporting to district and provincial health departments.

**Problem Statement**
Monitoring drinking water quality and water source status is critical to the delivery of safe drinking water. Water quality testing in rural areas is particularly challenging given that labs for water quality analysis tend to be concentrated in urban areas. Whether conducted by health staff as part of a health surveillance program or by water suppliers as part of their operations, monitoring data needs to be collected and compiled efficiently in order to guide corrective actions and long-term planning.

**Project Goals**
Water Quality Reporter was developed to transmit water quality data to relevant authorities, in order for appropriate actions to be taken at the municipal or provincial level. This system will enable relevant water sector institutions to meet reporting requirements, and potentially to increase support from government institutions by increasing their connection to community water management structures and increasing the accountability of water scheme managers.

**System Highlights**
A major highlight of the WQR system is its adaptability to different water management structures depending on context and needs. The process to introduce the reporter in different locations begins by assessing legal requirements, the local policy/regulatory structure, and determining the responsibility of each party in the drinking water sector. This information about local context dictates the configuration of the system.

**Outreach/Participation/Engagement**
Incentives were not required because the WQR system was deployed in contexts where reporters have a professional obligation to monitor water quality and submit data, and where managers have a demand for improved data collection and management. The project focused on facilitating monitoring in professional contexts, recognizing the challenges inherent in recruiting volunteers (e.g. households) to conduct water quality testing and submit data.

**Data Collection**
The system was initially designed to support data collection via structured SMS, but found this caused issues with data quality, as users did not find it intuitive to enter multi-field, structured SMS messages. Additionally, reporters had to submit data about multiple water quality parameters, which was too complicated to send by SMS. The primary collection method is currently the Java-based application, which aggregates information through a single form. Use of the form-based application has increased the data quality as it provides constraints on what constitutes a valid entry. When a user has successfully submitted a form through the phone application, they receive feedback in the form of a confirmation message if the parameters are acceptable (or would receive notification that thresholds had been exceeded). There were issues with some users ending the application prior to the successful submission message, at times because the GPRS network was too weak to submit completed forms. Thus, the application was changed to save forms in the absence of a sufficient phone network signal so the data would not be lost.

The pilots also revealed that if the application was moved around on the phone or if the user downloaded additional media/music onto the phone, this would cause application errors. While mobile phones were provided to the water quality reporters, they might change the SIM card or otherwise alter the phone, which sometimes impacted application functionality.

**Data Distribution**
Once a form has been successfully submitted through the application, the results are forwarded to the local manager responsible for water quality, who also receives a weekly Excel spreadsheet will all compiled raw data. The database automatically sends via SMS all of the information from one site to all involved stakeholders, which they have found was not necessarily relevant to each stakeholder. Feedback from managers suggested that further tailoring of reports may be necessary since different stakeholders prefer different levels and types of information in the

reports. Additionally, individual tests results within the submitted form are able to trigger warnings that are sent via SMS to managers and operators, providing a real-time status update for important parameters.

Generally, there is high demand for more detailed capabilities on the analytics end, with requests for graphing and mapping data, more sophisticated data dissemination to mobile phones. There is currently a web database for viewing and entering data, but there remain some challenges, for example, in developing a map-based web interface, where the necessary GPS coordinate data is often not available or the location using the application can't be located on Google Earth. Municipal managers in South Africa were provided with Android-based phones and an additional application called Water Quality Manager, which synchronizes daily with the database. This application provides a distilled view of submitted data, allowing them to monitor test sites and results while on the move.

**Successes/Evaluation Metrics**
The system has been running for two years in South Africa and is still in use. Through pilot evaluation, the implementers have learned that WQR has helped alert the government to regional challenges, the challenges of data collection, and additionally highlighted how busy local operators are. The operators have stated that they feel more linked to municipal water quality managers and are able to hold them responsible by having documentation of the reporting and data generated. The collaboration with government works well because water is a highly regulated service. Reporters and managers in Cambodia, Vietnam and Mozambique have indicated that the application has the potential to improve accuracy and efficiency of data reporting.

**Partners**
Varies by location

**Scalability/Future Directions**
As a professional tool, the WQR application is not necessarily scalable globally without optimization, as it is changed according to the needs in each location or context. Each country has unique actors and associated reporting structures in water quality management. The application will likely have the most value when offered as a subscription service for relevant water sector institutions which can set up their own configurations.

**Financial Sustainability**
Initial funding for the pilot study came from the European Union and was followed by funding from the Bill and Melinda Gates Foundation to build a field test kit as well as a system to communicate results to decision-making bodies. Plans for financial sustainability going forward are through collaboration with government agencies involved in water management.

**Sources**
- Informational Interviews with Ulrike Rivett and Michael Champanis (University of Cape Town), Zarah Raman (Aquaya)
- University of Cape Town's iCOMMS (Information for Community Oriented Municipal Services) Water Quality Reporter website
- University of Bristol Aquatest website

## Yayasan AirPutih Case Study — Media Center, Klik Jkt, Klik Papua

**Location(s)**
Indonesia, including:
Media Center — national http://www.mediacenter.or.id
Klik Jkt — Jakarta http://klikjkt.or.id
Klik Papua — Papua http://tabloidjubi.com/klikjpr/

**Dates Operational**
Media Center — June 2009 to present
Klik Jkt — June 2011 to present
Klik Papua —June 2011 to present

**Project Organizers**
Yayasan AirPutih is an Indonesian nonprofit IT organization which aims to strengthen civil society through ICT by setting up Ushahidi-based information portals, during emergencies and disasters providing IT and communication support and free web hosting for other NGO's and communities, and promoting and supporting open-source software.

**Technology**
AirPutih focuses on open-source platforms, and utilizes Ushahidi and broadcasting programs for their mobile-phone mapping projects. Initially they created basic web information portals, and then began incorporating maps using the Ushahidi platform. Map-focused portals eventually became the primary information-sharing format for all of AirPutih's projects.

**Role Summary**
Users of any of the AirPutih applications are Indonesian residents.
Media Center is a disaster-tracking and information portal for all locations in Indonesia. It was initiated in 2005 in Aceh after the Indian Ocean tsunami disaster, but didn't take its current format with mapping until 2009. The site focuses on providing information on missing persons, accurate information for media, and timely information for aid organizations. Residents in disaster-struck areas send observations and information about emergency situations and needs. In the aftermath, aid organizations broadcast information about services locations and volunteer posts.

Klik Jkt is an information portal for which AirPutih developed and provides technical support to the organization Rujak Center for Urban Studies in the city of Jakarta. It provides information on city services to residents of Jakarta. Residents can report blight, service interruptions, community alerts, and community organizing efforts such as greening initiatives.

Klik Papua is an information portal developed for and managed by Tabloid Jubi, a news portal in the province of Papua. The site is a citizen journalism pilot project aimed at recording timely information from residents about traffic, crime and abuses.

**Problem Statement/Goals**
A strong civil society can play a role in the process of exchanging information and knowledge with each other and their local governments through the use of information and communication technology (ICT).

Indonesia is a disaster-prone area, experiencing a frequent series of natural disasters such as tsunamis, earthquakes, volcanic eruptions, landslides, and flooding, resulting in significant loss of life and property.

AirPutih aims to increase human resource capacity in using ICT, increase people's understanding of public information services, undertake research and development, improve the ability of the parties involved in disasters in using ICT for emergency response programs, build wider access for communities to be able to use ICT through open source platforms.

**System Highlights**
AirPutih have changed and customized Ushahidi for various projects. For instance, they added document upload to Media Center. They mainly use FrontlineSMS for broadcasting, but have also used Nokia Life Tools.

**Outreach/Participation/Engagement**
AirPutih develops independent projects and socialization campaigns, but also partners with local organizations that have their own existing members and networks. AirPutih's outreach and socialization techniques can include trainings, and media broadcasts through SMS, email television and radio.

AirPutih worked on active promotion of both Media Center and Klik Papua, through broadcasts and trainings. Media Center was promoted through a comprehensive television campaign with the support of their project collaborator. Klik Jakarta is being promoted exclusively by Rujak.

**Data Collection**
AirPutih works with a combination of report types, accepting both structured and unstructured reports. The reports can be sent by SMS, email, Twitter, and web forms located on the web portals.

AirPutih utilizes both auto- and human verification. They can mark phone numbers as trusted or untrusted users, and administer cross-checks for reports that are difficult to categorize.

Basic data collection and reporting on system or site performance is built into each system.

**Data Distribution**
All incoming and verifiable reports are displayed publicly in the system through stock Ushahidi formats, including maps and graphs. Opt-in broadcasts are sent to users to promote traffic to the information on the site, as well as to distribute supplementary content, such as weather reports on Media Center.

Performance data from existing Ushahidi functionalities, such as total reports, daily averages and percentage of verified reports, are available publicly to viewers of AirPutih's sites.

**Successes/Evaluation Metrics**
They do not currently have systemized evaluation of their projects.

**Partners**
AirPutih manages independent projects from system development to outreach and socialization, but also partners with civil society and other community-oriented organizations or functions as only the technical manager without engaging with targeted users.

The Media Center portal was initially developed in cooperation with the Bureau of Meteorology, Climatology and Geophysics in response to the 2004 Indian Ocean Tsunami, but became a project of AirPutih as they developed the mapping functionalities beginning in 2009. Klik Papua is a joint project of AirPutih and Tabloid Jubi. Klik Jkt was developed for Rujak Center for Urban Studies which manages the overall project, including outreach; AirPutih functions as the site developer and technical team.

**Scalability/Future Directions**
AirPutih is actively working on developing additional information mapping portals in Papua province, including a portal to map location information and activities of a Papuan seminary called STT Walter Post, a site with Human Rights Defense to track information during elections, and a citizen journalism site with ALDP (Democratic Alliance for Papua). They have also been working since early 2011 to find financing for a site that focuses on information tracking and communication around religiously motivated violence and civil unrest. The project, called Bebas Beribadah, already has one partner, Muhammadiyah, a reformist socio-religious group that focuses on education, social welfare, and charitable causes such as disseminating public service information about bird flu.

**Financial Sustainability**
Media Center and Klik Papua are funded through grants and donations to AirPutih. AirPutih's previous funders include Ford Foundation, Hivos, and UNESCO. Klik Jkt is funded by Tifa Foundation and Rujak Center for Urban Studies.

**Sources**
- Informational Interviews with Nanang Syaifudin (Program Officer), Agus Triwanto (Coordinator), and Kaka E. Prakasa, Yayasan AirPutih
- Annual Reports by Yayasan AirPutih

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