# INFORMATION SHARING IN THE GOVERNANCE OF PUBLIC SERVICES

## *The challenges of Mobile Sensor Web development in Uganda*


*March 26, 2013*

THESIS FOR THE DEGREE OF
**MASTER OF SCIENCE**


**AUTHOR** Judith Schoot Uiterkamp

**INSTITUTION** University of Twente

**PROGRAM** Philosophy of Science, Technology and Society

**SPECIALIZATION** Science and Technology Studies

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# SUMMARY

With the introduction of the Internet, Web 2.0, and mobile technologies, there is a growth in citizen generated content and increased possibilities of sharing information. The private and public sector start to collect, organize, and use this information provided by citizens. Governments use this information to improve governance of public services. This trend is also visible in developing countries.
This thesis focuses on the development of a specific information system in the governance of public services in developing countries: Mobile Sensor Webs. It uses mobile phones to collect data from citizens about public services connected to a geographical position. The system provides feedback to the citizens about the actions of the government. This way socio-technical hybrids are created, aiming to increase information sharing between citizens, government, and intermediaries, which should contribute to increased accuracy of data, transparency, and improved accountability lines.
To reflect on the socio-technical hybrids in Mobile Sensor Webs and the Mobile Sensor Webs as a whole two case studies in Uganda, Taarifa and Mobile4Water, are studied. This is examined by the following research question:
*Which aspects contribute to the development of a stable Mobile Sensor Web, by identifying the challenges encountered in the development of Mobile Sensor Webs?*

Semi-structured interviews, directed content analysis, and a combination of two conceptual frameworks are used to analyse the two case studies. The four phases of translation of Callon (1986) are used to describe the challenges in the development of a stable Mobile Sensor Web. The framework of Callon focuses on the way the network is built by its initiating actors and it describes the shaping negotiations and challenges between technology, users, and other stakeholders. To identify these challenges the ITPOSMO-model of Heeks (2002) is also used. This model describes seven dimensions, which influence the implementation of information systems in a development context. Heeks gives special attention to possible differences between designers in the Western world and users in a development context.

Based on the identified challenges, it is concluded that the following aspects contribute to a more stable Mobile Sensor Web:
First, existing societal hierarchies and various administrative levels of society should be taken into account when defining the relevant actors for the Mobile Sensor Web. This improves accountability lines and scalability of the Mobile Sensor Web.
Secondly, focusing on actor's short-term personal interests will get actors to join and keep actors interested in the network. Besides that, it increases their trust in the project; provided that the actor agrees with the objective of the network, as is not the case for corruptive actors. Sensitizing stakeholders about the Mobile Sensor Web's benefits, based on their interests, contributes to the stability of the network. It also increases the commitment of actors to the project, which increases the effort that they put in learning how to use the devices, including the required standardized formats.
Thirdly, data collection should not depend on an Internet connection; this includes the collection and saving of a geo-location. Also, data should be accessible to the relevant actors. Online platforms are not yet widely accessible in Uganda and are therefore not suitable as information sharing platform. However, it is suitable as a device for a specific user to manage the collected data. Moreover, resources should be available to collect and access data, including transportation, computers, mobile phones and trainings.
Finally, conditions external to the Mobile Sensor Web should be considered, as they influence the actor's ability to receive or make use of the information. This includes accessibility challenges caused by the landscape or climate and resource distribution, often restricted by political issues.

Because of the explorative character of this thesis, it is recommended to verify the generalizability of the identified aspects and if all relevant aspects are covered. Besides, it is recommended to conduct an elaborate study to the effectiveness of Mobile Sensor Webs towards improved transparency, accountability, data accuracy, and information sharing in governance of public services.
Regarding the conceptual frameworks, it is suggested to use the ITPOSMO-model of Heeks in data collection and not for data analysis, since it lacks the strength of putting findings in their relevant context. The framework of Heeks, in particular the soft/hard gaps approach, could add to Callon's framework by concretize the definition of 'identities' used in the problematisation phase. Besides that it is suggested to include a new dimension in the ITPOSMO-model to include the geographical and climatic circumstances.

# SAMENVATTING

Met de opkomst van het internet, web 2.0 en mobiele technologieën, wordt er meer informatie gegenereerd door burgers en publiek gedeeld. De private en publieke sector gebruiken deze informatie. Zo gebruiken overheden de informatie om het bestuur van publieke diensten te verbeteren. Deze trend is ook zichtbaar in ontwikkelingslanden.
Deze scriptie focust op een specifiek type informatiesystemen gericht op het bestuur van publieke diensten in ontwikkelingslanden: Mobile Sensor Webs. Een Mobile Sensor Web maakt gebruik van mobiele telefoons om data van burgers te verzamelen. Deze data gaat over een publieke dienst, gerelateerd aan een geografische locatie. Via het systeem wordt vervolgens feedback gegeven aan de burgers over de ondernomen stappen van de overheid. Op deze manier worden er socio-technische hybriden gecreëerd, met als doel om het delen van informatie tussen burgers, overheden en tussenpersonen te verbeteren. Dit draagt bij aan het verhogen van transparantie, data-accuratesse en verbeterde accountability. Twee casussen in Oeganda - Taarifa en Mobile4Water - worden onderzocht om een reflectie te geven op de socio-technische hybriden in het Mobile Sensor Web en het Mobile Sensor Web als geheel. Daarvoor is de volgende onderzoeksvraag opgesteld: *Welke aspecten dragen bij aan de ontwikkeling van een stabiel Mobile Sensor Web, door de identificatie van uitdagingen waar tegenaan is gelopen tijdens de ontwikkeling van Mobile Sensor Webs?*

Door middel van semigestructureerd interviews, gerichte inhoudsanalyse en twee conceptuele kaders zijn beide casussen geanalyseerd. De “four phases of translation” van Callon (1986) zijn gebruikt om de uitdagingen in de ontwikkeling van een stabiel Mobile Sensor Web te beschrijven. Het kader van Callon focust op hoe de initiërende actoren een netwerk opbouwen en beschrijft de vormende onderhandelingen en uitdagingen tussen technologie, gebruikers en andere stakeholders. Om deze uitdagingen te identificeren is het ITPOSMO model van Heeks (2002) gebruikt. Dit model beschrijft zeven dimensies welke invloed hebben op de implementatie van informatiesystemen in een ontwikkelingscontext. Heeks besteedt in dit model specifiek aandacht aan de mogelijke verschillen tussen westerse ontwikkelaars en gebruikers in een ontwikkelingscontext.

Gebaseerd op de geïdentificeerde uitdagingen is geconcludeerd dat de volgende aspecten bijdragen aan een stabieler Mobile Sensor Web:
Allereerst zouden bestaande sociale hiërarchieën en verschillende bestuurslagen in de maatschappij moeten worden meegenomen om de relevante actoren voor het Mobile Sensor Web te definiëren. Dit verbetert de accountability en schaalbaarheid.
Ten tweede zal het richten op de actors korte-termijn en persoonlijke behoeften ervoor zorgen dat actoren zich aansluiten bij en geïnteresseerd blijven in het netwerk. Daarnaast verhoogt dit het vertrouwen in het project; gegeven dat de actor zich met het einddoel identificeert, wat vaak niet het geval is met corrupte actoren. Actoren bewust maken van de voordelen van het Mobile Sensor Web, aansluitend bij hun behoeften, draagt bij aan de stabiliteit van het netwerk. Dit verhoogt ook de betrokkenheid van de actor bij het project, waardoor ze meer moeite zullen steken in het leren omgaan met de technische apparaten, inclusief het door het apparaat voorgeschreven format.
Ten derde mag dataverzameling niet afhankelijk zijn van een internetverbinding, dit geldt ook voor het bepalen en opslaan van de geografische locatie. Daarnaast moet de data toegankelijk zijn voor de relevante actoren. Online platforms zijn niet breed toegankelijk in Oeganda, waardoor ze niet geschikt zijn als medium voor het delen van informatie. Desalniettemin zijn online platforms wel geschikt voor het managen van de verzamelde data door een specifieke gebruiker. Bovendien moeten de middelen voor het verzamelen van en toegang hebben tot informatie beschikbaar zijn, dit omvat onder andere transport, computers, mobiele telefoons en trainingen.
Tenslotte moeten factoren die indirect verbonden zijn aan het Mobile Sensor Web meegenomen worden in de ontwikkeling, omdat zij het vermogen van de actor om informatie te gebruiken en te ontvangen beïnvloeden. Hieronder valt de soms beperkte bereikbaarheid en toegankelijkheid tot informatie, veroorzaakt door het natuurlijk landschap of klimaat; en de distributie van middelen, die vaak beperkt wordt door politieke motieven.

Vanwege het verkennende karakter van deze scriptie, wordt het aanbevolen om de generaliseerbaarheid van de geïdentificeerde aspecten te verifiëren, alsmede of alle relevante aspecten zijn geïdentificeerd. Daarnaast wordt het aanbevolen om een gedegen studie te doen naar de effectiviteit van Mobile Sensor Webs als middel om transparantie, accountability, data-accuratesse en informatiedeling te verbeteren in het bestuur van publieke diensten. Met betrekking tot het conceptuele kader wordt voorgesteld om het ITPOSMO model van Heeks alleen te gebruiken in dataverzameling en niet voor data-analyse, aangezien het model de kracht mist om de bevindingen in een relevante context plaatsen. Het kader van Heeks, in het bijzonder de “soft/hard gaps approach”, kan Callons definitie van “identities” concretiseren. Daarnaast wordt het voorgesteld om een dimensie met betrekking tot de geografische en klimatologische omstandigheden aan het ITPOSMO model toe te voegen.

# ACKNOWLEDGEMENTS

This thesis did not only enable me to indicate the challenges of developing a stable Mobile Sensor Web in developing countries, it also enabled me to experience certain challenges myself. Many people made it possible to overcome these challenges, and I would like to thank them all.

First of all, defining and writing a thesis is challenging; how to frame the chosen topic, which collected information is relevant to highlight, and which conceptual framework describes this best? I would like to thank my supervisors of the University of Twente for supporting this process. Nelly Oudshoorn, thanks for reading my draft versions very carefully and providing it with useful comments. Discussing several conceptual frameworks and your methodological guidance helped me in understanding the practice of conducting research. Jeroen Verplanke, thanks for your content guidance. Your knowledge about the situation in East Africa and provision of local contacts helped me in this research. Also providing feedback on the structure of my report, repeating the importance of a 'narrative' table of contents helped me in writing. Both Nelly and Jeroen, thanks for your enthusiasm towards my research. As an objective reader in the end of the whole process I would like to thank Ellen van Oost. Your comments made it possible to reflect on my whole process and describe the core of this thesis in a more structured way.

Secondly, my research got more challenging by my decision to do fieldwork in a foreign country; how to find the relevant case studies, how to deal with an unknown environment and find my way around? I would like to thank all people who supported me during my stay in Uganda and provided me with useful contacts. Kris Kisinde thanks for organizing a working spot at the Ministry of Local Government in Kampala. As well for your patience with explaining the Ugandan governmental structures, habits and being there when necessary. Thanks for all the lunches and I hope you still enjoy the Dutch sandwich place. Mark Illife, thanks for giving me the opportunity to work on Taarifa. Because of our Skype meetings, I realized the relevance of my own thesis and I learned many new English expressions. Also, thanks to Peter Wakholi of Makerere University to explain the basics of M4W and introducing me to other useful contacts of this project. Chemisto Satya and Peter Magara, thank you for taking me to the most remote and beautiful places with many interesting people in West Uganda. It has made my stay in Uganda even more memorable. Also thanks to Gerald Kwizera and David Sparkman of Water for People for introducing me to relevant users of Akvo FLOW and answering all my questions. And of course, many thanks to all other interviewees, for your useful information about the interesting networks you are part of.

Besides these process related challenges, I got challenged by working several months of this research without a computer. I kind of became subject of my own study interests; how important is this technology-user relationship to reach the final goal of writing my master thesis? I experienced how much agency technology has in my daily life, but I also experienced that many creative solutions can be found in dealing with these challenges. With the help of many people in my surroundings, in all kind of ways, I was able to deal with my situation in Uganda and in the Netherlands. Special thanks for making this possible goes to my parents, Annelies and Ton and my sisters Lian and Anja. I would also like to mention Johanneke, Rik, Pien, Laura, Renske, Rachel, Dimphie, Sylva, Mirte, Hanke, my roommates, my sorority Quenouille and all other friends who joined me in ups and downs, with patience, advices and many drinks.

Thanks all for making this challenging journey a pleasant one to remember!

# PREFACE

Mobile Sensor Webs use various information and communication technologies to connect people, share information, and increase transparency within the governance of public services. The impact of these information systems, connected to globalization and information sharing trends, fascinates me. As an STS-researcher, Mobile Sensor Webs raise several questions as it brings together various topics.

The Mobile Sensor Web combines local and global knowledge into one system, which raises the question of how local and global knowledge relate to each other. What kind of information can be generalized and what definitely needs to be studied in its local context? This combination triggered me to explore its challenges.
Besides that Mobile Sensor Webs uses technologies, which are part of every day life in Western societies, in a developing context. I am interested in seeing how and to what extent these two contradict or strengthen each other.
As an STS-researcher exploring the implementation of these technologies in Uganda is even more fascinating. In a Western society many aspects of technologies are black boxed and taken for granted, while a developing country shows the impact of technologies in a rather direct way. What I take for granted is not always as obvious in developing countries. Staying in another society and culture made me aware which aspects are black boxed in my own routines.
The use of maps in Mobile Sensor Webs, to visualize and communicate issues in the public sector, also motivated me to conduct this research. As Industrial Design Engineer I am very much interested in the strength and weaknesses of information graphics and problem visualization; it is a challenging task to create clear information graphics, which communicate all relevant information in its correct context.
Besides that I really enjoy the diversity of people that are connected in Mobile Sensor Webs, from people living in slums to people working at the national ministry. It shows the possibilities Information and Communication Technologies create and in what way it can fit a variety of interests.

This intertwines of local and global knowledge, variety of information and communication technologies, different habits and circumstances in Western and developing societies, and the diversity of users and interests, has puzzled, inspired and challenged me.
I hope that all these intriguing, sometimes complex, and variety of topics, all combined in one Mobile Sensor Web can also fascinate you as a reader.

Judith Schoot Uiterkamp
March 26, 2013

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# 1. INTRODUCTION

## 1.1. BACKGROUND

Since the introduction of the Internet and Web 2.0[1], new cultures arise in the field of information sharing. There is a growth in user generated content, local information gets globally visible and individuals or small groups can reach a worldwide audience. As Borja, Belil, Castells and Benner (1997) say: 'The new technological infrastructure, the process of globalizing, the economy and communication has changed the way we produce, consume, manage, inform and think' (p. 7).

This growing access and amount of data caused a trend that ordinary citizens provide more data to online platforms and databases. This data is often connected to a geographical position, collected by using mobile phones. Governments use this data to improve their transparency, efficiency and effectiveness of government services (Brewer, Neubauer, & Geiselhart, 2006; Budhathoki, Bruce, & Nedovic-Budic, 2008; Johnson & Sieber, 2013; Saebo, Rose, & Flak, 2008). This trend increased after Google, Microsoft and Yahoo! made their web mapping application programming interfaces (APIs) public (Budhathoki et al., 2008; Rouse, Bergeron, & Harris, 2007). In the Netherlands for example applications (apps) are produced that empower people to provide information to the municipality, like the app 'Verbeter de Buurt'[2], in which one can report problems in the street, like a broken lamppost. 'Verbeter de Buurt' is an example that shows that bottom up collected data can provide useful information to local governments or other actors, to support local situations.

The possibilities of such applications are also recognized in developing countries. Many see collecting information by using the mobile phone as an opportunity to solve great challenges, especially since mobile technology in developing countries spread rather quickly in a very short period of time (Bott & Young, 2012; Heeks, 2008; Sharma, 2010). Figure 1 shows this rather quick growth of mobile phone use in Uganda. It caused that, Non-Governmental Organizations (NGOs), local programmers and companies started to develop all kinds of applications for different sectors. For example for the health sector to provide information to patients or monitor their satisfaction with the service (Kahn et al., 2010). It is applied in economic development, for price information and collection of the production data, or in education, agriculture, natural resource management, disaster relief and the water, sanitation and hygiene sector (Hutchings et al., 2012). Inspiring examples of using mobile devices as reporting mechanisms are found in crisis situations. Like the project Voices of Africa, where local reporters

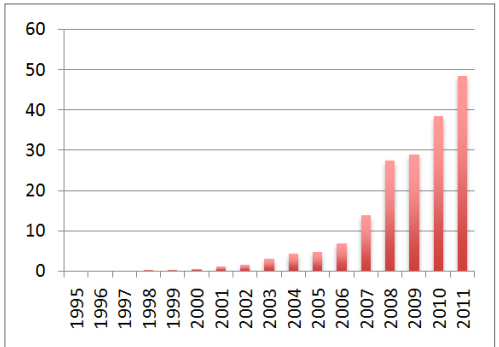


*Figure 1: Mobile cellular subscriptions in Uganda (per 100 people) (http://data.worldbank.org/country/uganda#cp_wdi)*

1. *Web 2.0 is defined as 'the second stage of development of the Internet, characterized especially by the change from static web pages to dynamic or user-generated content and the growth of social media'. (Augarde, A. J. "Web 2.0." The Oxford Dictionary. Oxford: Oxford UP, 1981)*

2. *http://www.verbeterdebuurt.nl*

used mobile phones to publish reports of post election violence and riots (Makinen & Wangu Kuira, 2008).

Harder to find are complete success stories of apps developed to improve public services used in everyday life, although the development of such apps increased rapidly in the past five years. For example, apps and networks are created to improve water service delivery. They enable citizens to report a non-functioning water source, by using the mobile phone. Reports could be sent by sending a SMS or by filling questions on the specifically developed mobile phone application. The report is processed by a Geographical Information System[3] tool, and used by the service provider[4] or authority to provide quicker and better services to citizens. Most of these apps are under development, in the pilot phase, or their implementation already failed (Kahn et al., 2010; Moraa et al., 2012; interview Executive Director Ermis Africa, July 7, 2012; interview product leader and co founder Spatial Collective July 14, 2012). This makes it an interesting topic for further research.

This thesis focuses on the analysis of such applications and networks, which from now on will be called Mobile Sensor Webs. Section 2.1 will introduce Mobile Sensor Webs in more detail.

## 1.2. ADDRESSING THE CHALLENGES OF MOBILE SENSOR WEBS

Concluding, the trend of using mobile phone applications to collect information, to create more transparency between stakeholders, and to increase accountability[5] within public service delivery networks is going on in many developing countries. This whole trend resulted in many pilots and ideas of how to connect stakeholders throughInformation and Communication Technologies. However not much (empirical) research has been done to reflect on these developments and not many apps are successfully working yet.

It is an interesting field to explore by using several concepts from Science and Technology Studies, since these concepts focus on the interaction between technology and user, the creation of networks and its societal effects. It could clarify the concept of a Mobile Sensor Web, which is still rather vague in terms of who are the users (citizens, authorities, providers and intermediaries), what their interactions are and how stable systems can be established.

This thesis examines two case studies to reflect on such questions and aims to get a clearer picture of the specific challenges of developing stable Mobile Sensor Webs. The main focus of this research is therefore to investigate the aspects that contribute to a stable Mobile Sensor Web, based on the existing challenges. This results in the following main question of this thesis:

Which aspects contribute to the development of a stable Mobile Sensor Web, by identifying the challenges encountered in the development of Mobile Sensor Webs?

## 1.3. OUTLINE OF THE THESIS

This thesis is divided in three parts and seven chapters. Following this introduction, the first part starts with framing the topic of this research; it defines Mobile Sensor Webs, and follows with challenges identified in recent studies of these Webs. Subsequently the conceptual frameworks, which are considered to be useful to address and analyze the challenges encountered in these studies, are presented. From this framework the research questions are formulated. Chapter three introduces the two case studies and the methodology used to collect and analyze the empirical data. After these chapters the second part is presented. This part contains the findings of the fieldwork in Uganda. Chapter four presents the findings of the case called Taarifa, chapter five discusses the findings of the case called Mobile 4 Water. This is followed by the final part, which presents the chapters containing the conclusions, the discussion of this study and recommendations for further research.

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3. *Geographic Information System is defined as 'A system designed to capture, store, manipulate, analyse, manage, and present digitally all types of geographical data' (Hutchings et al., 2012).*
4. *'Service providers have to develop and manage the public service in an efficient and effective manner while being accountable to the recipients of the services' (Moraa et al. 2012).*
5. *Accountability is defined as 'The obligation of an individual or organization to account for its activities, accept responsibility for them, and to disclose the results in a transparent manner. It also includes the responsibility for money or other entrusted property'(Accountability, 2013)*


# PART 1

# 2. THEORETICAL FRAMEWORK

The use of mobile phones and other information technologies in developing countries is a relatively new phenomenon. That is why this chapter starts with a short literature review on this topic, addressing several related research areas. This finally frames the topic of research by defining a specific information system called Mobile Sensor Web (section 2.1). Section 2.2 discusses literature in this specific frame related to the main question, which gives an impression of the current state of the art. Subsequently, section 2.3 introduces two conceptual frameworks; the four phases of translation of Callon (1986) and the ITPOSMO-model of Heeks (2002). Based on the findings of section 2.2, these frameworks are considered to be relevant to address and analyze the challenges of Mobile Sensor Webs, to define the aspects that contribute to stable Mobile Sensor Webs.

## 2.1. FRAMING MOBILE SENSOR WEBS

The described combination of locally collected data through mobile phones and Geographical Information Systems surrounded by a web of stakeholders, to increase information sharing and transparency, is a rather new phenomenon. There is not one simple term to describe such information systems. A perusal of the literature indicates that several terms are being used which connect to this configuration.

The terms "e-government"[6] and "eParticipation"[7] put focus on the use of Information and Communication Technologies within governmental practices (Chen, Chen, Huang, & Ching, 2006; Saebo et al., 2008). Using mobile phones to improve information sharing and governance of public services is part of that. But these concepts leave citizens as rather passive users of the service. This makes literature on e-government and eParticipation relevant to describe challenges of implementing an information system in a certain context, but it mostly lacks the shaping input from users, which is highly relevant for Mobile Sensor Webs.

Other authors introduced terms, which focus less on the technology, but more on the inclusion of citizens and their local knowledge within the process of collecting geographical information. Like Goodchild (2007), who describes the changes in processes and relationships through which geographical information is produced, using the term "Volunteered Geographical Information". Turner (2006) focuses on the 'everywhereness' of spatial information in our daily life, which he calls "neogeography"[8] (Budhathoki et al., 2008; Coleman, Georgiadou, & Labonte, 2009; Elwood, 2009; Goodchild, 2007; Turner, 2006). Also the term Participatory Geographical Information Systems (PGIS) is used to describe the inclusion of citizens. PGIS has a specific focus on the empowerment of citizens by providing them with GIS-tools, which should improve decision making on higher levels (Rouse et al., 2007).

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6 *'Broadly defined, e-government includes the use of all information and communication technologies, from fax machines to wireless palm pilots, to facilitate the daily administration of government, exclusively as an Internet-driven activity that improves citizen's access to government information, services, and expertise to ensure citizen's participation in, and satisfaction with government process' (Chen et al., 2006).*

7 *'eParticipation is a recently invented term meaning ICT-supported participation in processes involved in government and governance. Processes may concern administration, service delivery, decision-making and policymaking' (Saebo et al., 2008).*

8 *'People using and creating their own maps, on their own terms and by combining elements of an existing toolset. Neogeography is about sharing location information with friends and visitors, helping shape context, and conveying understanding through knowledge of place' (Turner, 2006).*

Finally, terms are being used to focus more on specific features necessary to create the networks, which include citizens and government, and which aim to increase information sharing between them. Geospatial Web 2.0 (Geoweb) is used to describe a set of geospatially enabled online tools and data that can be used to support the type of initiatives as described in the introduction (Rouse et al., 2007). Goodchild (2007) introduced the term "Sensor Networks", which include "Human Sensors", referring to the necessity of humans equipped with the means and ability to compile and interpret what they sense.

### 2.1.1. DEFINITION OF MOBILE SENSOR WEBS

The topic of this thesis links to all these described terms, but can be narrowed to a specific type of geographical information collection, using specific tools for a specific aim.

To frame this specific research topic this thesis uses a new term, "Mobile Sensor Webs", which is defined as follows:

A Mobile Sensor Web is an information system, which uses mobile phones to collect data 'on the ground'. The collected data is connected to a geographical position and used to monitor public services used in daily life. It aims to increase information sharing between citizens, government and intermediaries, which should contribute to increased accuracy of data, transparency and accountability of the service provider or authorities' actions. The system has a feedback loop to the data providers on the ground.

### 2.1.2. OBJECTIVES OF MOBILE SENSOR WEBS

As described in the definition of Mobile Sensor Webs, they are generally designed to:

1. Monitor public services, and
2. Share information between stakeholders of the Mobile Sensor Web about the public service and related activities. This happens in two directions:
   a. Citizens can report about the status of public services towards service providers;
   b. Service providers can communicate their decisions and actions towards citizens.

Both aims are supposed to increase transparency, improve accountability lines and data accuracy and it empowers the poorer groups of society. Provided that the conditions are in place to enable the communication between citizen and service provider. Figure 2 illustrates this general idea of Mobile Sensor Webs, which is based on the descripted cases by Hutchings et al. (2012), Georgiadou et al. (2011), Verplanke et al. (2010) and Daraja (2009). As shown in figure 2, box 1, these first direct aims of Mobile Sensor Webs are translated to a C2G2C (Citizen To Government To Citizen) information system. So it is a two-way process. The citizen reports the status of a public service to a service provider or authority, who in his turn, shares information regarding his decisions and actions towards the public service. Box 2 and 5 show the supposed consequences once monitoring and information sharing are improved. This involves increased information sharing, transparency, data accuracy and improved accountability lines. to finally improve the public service (box 5). The currently known necessary conditions to achieve these aims, shown in box 3 and 4, are described in section 2.2.

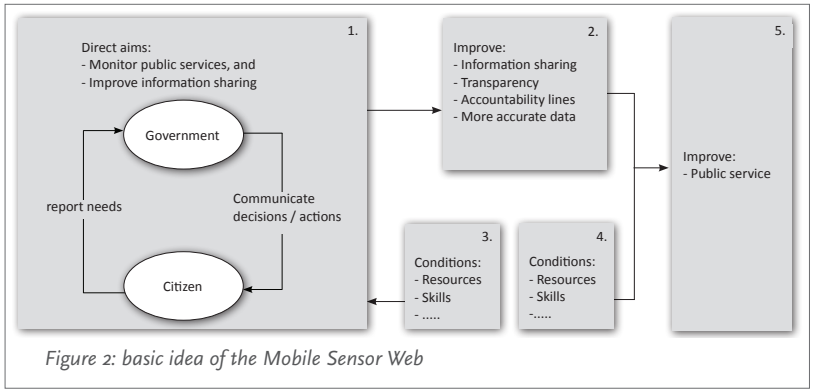


*Figure 2: basic idea of the Mobile Sensor Web*

It differs among the Mobile Sensor Web designs which objective of this set-up is more important. For example, Georgiadou et al. (2011) mostly emphasize the part of a Mobile Sensor Web, which gives citizens the possibility to hold service providers accountable. It is a way to circumvent bureaucracy and it gives citizens a tool to

influence policy makers directly through virtual globes[9] (Georgiadou et al., 2011).
Hutchings et al. (2012) focus more on the importance of better use of information by stakeholders to address the challenges in the Water, Sanitation and Hygiene (WASH) sector. In which the challenges refer to general problems in the WASH sector, such as: 'lack of access to basic water and sanitation services [..], a high failure rate of water services [..] and poor quality' (Hutchings et al., 2012, p. 10). Besides that, the contribution of Mobile Sensor Webs to more accurate data about public services is considered to be a benefit for several other activities, like measuring and forecasting Millennium Development Goals (MDGs) or to facilitate monitoring and evaluation activities (Georgiadou et al., 2011; Hutchings et al., 2012; Moraa et al., 2012).
These different approaches show that it is not clear-cut how the boxes of figure 2 are connected. Does improved information sharing result in better services or is the empowerment of citizens more important to achieve that? Or are both necessary? Does improved information sharing automatically means improved accountability lines among stakeholders, or should there be something in between? These questions are not answered yet.
Also the opinions about the importance of the conditions necessary to improve the service differ (box 4). Ben Taylor, executive Director of NGO Daraja[10], emphasizes in an interview to Cambridge area radio station 105 FM[11] that systems like Daraja (which is a Mobile Sensor Web) solve political issues, since they empower citizens to speak up. Taylor argues that the problems in for example water supply are not caused by lack of resources or skills, but it is a political issue. These political issues ask for a political answer, which can be given by empowering citizens with this technology'[6]. So Taylor makes box 4 (conditions) in figure 2 subordinate to the impact of box 2 (improved transparency/accountability). While Moraa et al. (2012) indicate several challenges next to the political issues, which should be solved to improve public services. They highlight the importance of resources to meet the increased energy costs of delivering water, and the discharges to river systems. Also, the influence of storage levels of the country, which needs to be increased to meet the demand of water. So in this case they mention several other issues necessary to solve public service delivery. Again the connection between actions and consequences is not agreed upon. Ben Taylor argues that box 4 is less significant than the other boxes while Moraa et al. (2012) emphasizes the importance of several conditions.

This thesis focuses on the challenges of Mobile Sensor Webs to reach the first aims, improved information sharing and monitoring (box 1), and which aspects are necessary to achieve this (box 3). This focus leaves the posted questions about what the connection between accountability and information sharing, and the connections between the other aims of box 2, 4 and 5 subordinate. These are described to give an impression of the use, intention and indirect objectives of many systems. The next section will give a more detailed description of how box 1 in figure 2 is generally realized. Section 2.2 focuses on the encountered challenges and necessary conditions to realize this.

### 2.1.3. GENERAL DESIGN OF MOBILE SENSOR WEBS

To facilitate the communication between government, service providers and citizens (as indicated in box 1, figure 3), Mobile Sensor Webs use mobile phones and online platforms. Figure 3 shows a rough scheme of how these technologies are generally placed in the network of stakeholders. This figure is based on several projects in the WASH sector (Georgiadou et al., 2011; Georgiadou, Budhathoki, & Nedovic, 2009; Hutchings et al., 2012; Verplanke et al., 2010), but could be applied to other sectors as well.

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*9 'Virtual globes are places where citizens and the private sector gather to provide and acquire geo-located knowledge, experiences and information about services. The specific nature of information provided on virtual globes is the spatial information attached to all available data' (Verplanke et al., 2010).*

*10 ' Daraja means raising the water pressure and is a three and a half-year programme promoting and harnessing citizens' agency as a force for greater accountability, equity and sustainability in rural water supply. The programme draws on water point mapping, mobile technology and media partnerships to create user-friendly opportunities for citizens to bring problems to the attention of local government authorities' (Daraja, 2009).*

*11 http://vimeo.com/23534524.*

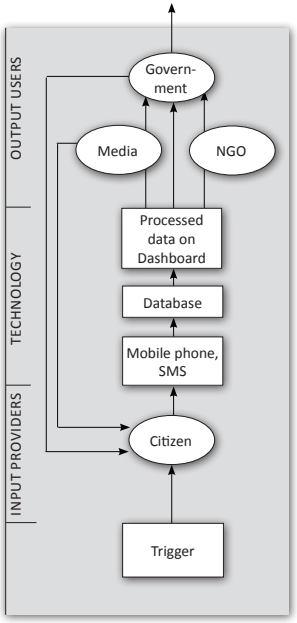


*Figure 3: Scheme of the Mobile Sensor Web, based on projects described by Daraja, 2009; Georgiadou et al., 2012; Hutchings, 2012.; Verplanke et al. 2010*

As shown in figure 3, citizens can submit SMS messages with information about the location and problem of a non-functioning service[12]. For example, they text the problem with a water source and mention the specific location code of the source in this text message. This information is collected on in a database and shown on a dashboard[13]. The receivers of this information use it to improve service delivery and provide feedback to the citizens about their decisions.

Hutchings et al. (2012) describe several cases in which differences are noticed on how the collected information is given voice. They describe some systems that use the media, which puts pressure on the water authorities to improve the situation. They also give feedback to the citizens about the reports and actions. Other systems are managed by staff of NGOs. They forward the information to the relevant people. Or sometimes it is directly send to the people in charge (Hutchings et al., 2012).

Who ever are involved and whatever kind of input or output is generated, the network is supposed to stay roughly the same. It can at least be categorized in two kinds of user groups, as shown in figure 3: the input provider and the output users. There is a mediating technology, which makes communication and information flows between the users possible. This way socio-technical hybrids are created. Some conditions are necessary to actually reach a certain result (see figure 2 and section 2.2). Finally this set up should result in achieving the objectives described in the previous section.

Important to notice from this set up is that the input is provided from the bottom, while organizations or persons at the top use the output. Most of the time, in a development context, this situation is the other way around, top-down; authorities impose information and policies on the community. Mobile Sensor Webs try to reverse this dynamic, while also focusing on improving the transparency of the top-down actions and decisions.

## 2.2. CHALLENGES OF MOBILE SENSOR WEBS

Several studies show that the development and implementation of Mobile Sensor Webs does not go unchallenged (Georgiadou et al., 2011; Hutchings et al., 2012; Verplanke et al., 2010) At the moment limited empirical research is available on the encountered challenges and necessary conditions to let the Mobile Sensor Webs function. So this section only provides a rough indication about the constraints of developing stable Mobile Sensor Webs.

Figure 4 shows that in every part of the network constraints can occur. This figure is primarily based on findings of the Human Sensor Web project in Zanzibar[14] (Georgiadou et al., 2011, 2009; Verplanke et al., 2010), cases described by Hutchings et al. (2012) and the pilot of Daraja (2009). As described by the 'general design' (section 2.1.3.), one can divide the Mobile Sensor Web in input provider, technology

12 *The SMS could be processed automatically or manually. It could use a geo-location code or require a smartphone, which takes GPS coordinates. In this last case one could also fill questions on an app instead of sending a text message. (Hutchings et al., 2012; Daraja, 2009)*

13 *Some systems also use other sensors to complement the data of the SMS messages, for example sensors that measure the water activity at a well. (Hutchings et al., 2012)*

14 *Human Sensor Web project was a pilot study in Zanzibar, which worked with billboards to trigger citizens to demand for their rights. They had to send SMS messages according a certain format <888> <'dirty' or 'no'> <location code as indicated on the billboard> This data is processed automatically and put on a public website. These open publications should put pressure on the government. But it resulted in no response and only a limited number of SMS messages were received. (Verplanke et al., 2010; Georgiadou et al., 2011)*

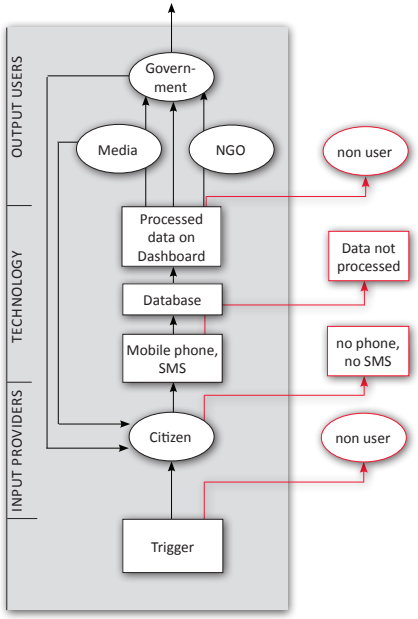


*Figure 4: Challenges appear in every step of the general Mobile Sensor Web design.*

will probably result in a failing or unstable system.

Previous studies describe several of such constraints. Many constraints, which have to do with reaching the actants and their ability to participate, can be introduced by the digital divide as describe by Bertot, Jaeger and Grimes (2010) in their study about e-government and social media (section 2.2.1.). Constraints due to the willingness to participate are often discussed in the light of 'trust issues' (section 2.2.2.). These two sections indicate the importance of knowing who the actual user is. This knowledge seems to lack from the indicated pilot studies. This is discussed in section 2.2.3. Over all the sections will give an overview of the current state of the art of challenges of Mobile Sensor Webs and indicate conditions to let the system work.

and output user. All these actants[15] have to be reached, should be willing to participate and be able to participate. If one of these aspects is not possible, successful implementation of the system will be hard. Every red arrow in figure 4 indicates such disability, unwillingness or not reached aspect, resulting in actants not participating. For example, if the citizen is not reached by a trigger to start using the system it will not become a user. If the citizen has no phone, he will not be able to participate or if he does not see any relevance in sending a message he is not willing to participate. All these situations

### 2.2.1. THE ABILITY TO PARTICIPATE; THE DIGITAL DIVIDE

As introduced, many users are willing to participate, but they are not able to participate or sometimes not even reached. Many of these challenges can be described by using the concept of 'digital divide'. The digital divide is 'broadly defined as the gap between those who have access to technologies and those who do not' (Bertot et al., 2010, p. 268). Bertot et al. (2010) subdivide this divide in different issues:

- 'Technology literacy—the ability to understand and use technologies;
- Usability—the design of technologies in such ways that are intuitive and allow users to engage in the content embedded within the technology;
- Accessibility—the ability of persons with disabilities to be able to access the content through adaptive technologies; and
- Functionality—the design of the technologies to include features that users desire'.

(Bertot et al., 2010, p. 268)

The Human Sensor Web project in Zanzibar showed that all these issues appear to be important to a Mobile Sensor Web design as well.

Georgiadou et al. (2011) provide an example how usability and functionality constrain the input provider to use the system in the right way. Citizens often send SMS stories about the lack of water, instead of texting the prescribed text ('no' or 'dirty'). For example: 'Greeting, how are you today? In the area Mwembe Shauri, there is no water since 7:00 in the morning; we do not know what the problem is. We request you to come and help us' (Georgiadou et al., 2011, p. 292). The system will not be able to process this message into the automated standard. This issue refers to a gap between the rational ways of thinking of developers in contrast to the local actual user situation. One could say that the usability is not working well, since the design does not meet the intuition of local users. They are used to politely greet everyone they talk to. It could also be linked to a functionality divide, since this is something that users desire, while the technology tries to discipline them in another way.

Also accessibility is an issue in Mobile Sensor Webs. According to Sung (2010) in this case gender issues play a role. 'In many rural areas it is men who have phones but

15 *Actants is a term described by Latour (1992) indicating both humans and non-humans as equal participants in a network. Section 2.3.1. will describe this in more detail.*

woman who have grievances to report because they are usually in charge of collecting water. This issue causes delays in responses and makes information transmitted by a third party less reliable' (From Verplanke et al., 2010, p. 196). So the phone might be the wrong instrument to reach the right users.
Another example of an accessibility issue is encountered by the output users in the Human Sensor Web project. This project aimed at directly reaching the government by putting the collected data online, but the pilot showed that this does not reach the government. The relation between the output of the technology and reaching certain officials is far more complicated. The fact that they were not reached could also be a trust issue or another interest, which is discussed in the next section.
Finally, the literacy issue is encountered in several projects, which is why some designers are thinking of including voice recordings (Hutchings et al., 2012).

These challenges make it hard to include the citizen as input provider directly into the network. Especially if the used technology does not fit the users' needs, which only gets to the surface while using it the field. That's why many organizations pilot their project with trained staff, instead of trying to involve the citizen directly. The staff goes into the field and collects the data by talking to the citizens. They fill standardized forms on the mobile phone or send pictures. So instead of empowering the citizen directly, many projects choose to let trained staff translate the citizen's need into standardized forms. This way many described challenges for the input provider are solved, but the aim to directly empower the service user is brought down[16].
This approach also causes that in many pilots the feedback loop to the citizens is not in place yet, since the citizens are not yet included. Focus is on collecting the information by using mobile phones, and find matching technologies with the local situation.
Because of this, this thesis mostly adds to identifying challenges in the first part of a Mobile Sensor Webs and not so much for the feedback loop.

16 *This way of dealing with including the citizens' information is based on several e-mail conversations with different organizations when looking for a relevant case study for this thesis.*

### 2.2.2. THE WILLINGNESS TO PARTICIPATE; TRUST

Besides the digital divide, also trust is a constraint that appeared in the Human Sensor Web project. This constraint is mostly linked to the willingness of actors to participate. The aspect trust can be interpreted in several ways.
First, citizens should trust the technology. As Georgiadou et al. (2011) indicate, they are used to report to close ones whom they trust. The Mobile Sensor Web might not be the first means to use when they want to report their grievance. As Barrett, Sahay and Walsham (2001) mention, trust is important in adopting new technologies. Trust appears both in adopting the new technologies, but also in accepting new groups of people with whom the technology interacts. A shift takes place from trusting individuals to science-based technologies (Barrett et al., 2001). So in this case citizens have to trust that their send information reaches the right persons. Instead of complaining to a village chief or any in their own network they have to count on a SMS send to 'somebody'. Feedback functionalities could be very important in getting this trust, but not much is known about this impact yet. Moraa et al. (2012) indicate that citizens encounter major problems when demanding for their rights, like intimacies, complex processes and bureaucracy. This might not be stimulating in trusting new systems.
Secondly, the citizen should trust that this data is used in a legitimate, responsible way. If it is not used legitimately, he might not want to provide any information anymore. As Bott and Young (2012) mention, 'the biggest issue with government-controlled platforms seems to be that individuals do not trust that their information will be used responsibly. [..] Under authoritarian regimes, it is also more difficult for NGOs and social entrepreneurs to launch a crowdsourcing initiative'[17] (Bott & Young, 2012, p. 53). Also Puri & Sahay (2003) shows that distrust about the legitimate use of data is not unfounded. They give an example of how Geographical Information was used in India in a decision process for placing new wells. 'There are two processes

17 *Crowdsourcing initiatives differ from Mobile Sensor Webs, since they do not include any feedback loop, but the indicated trust issue by Bott and Young (2012) seems applicable for Mobile Sensor Webs as well. Especially if focus is put on collecting data by using mobile phones.*

taking place in parallel – the scientific and the political. Decisions over here are made by political process, and Geographical Information Systems (GIS) helps to legitimize what we do' (Puri & Sahay, 2003, p. 181). This illustrates that GIS is not a neutral way to collect and present data. As Warren (2004) says, GIS data could be seen as politically driven representations. It is not a value free tool, but it views the world through particular filters by presenting it in a certain context.

The awareness of citizens that the government might use their provided information in such ways could constraint their participation.

Non-legitimate use of data does not only have to appear within governmental organizations. Verplanke et al. (2010) mentions the role of commercial companies involved in mapping. 'In trusting commercial companies, we may be running the risk of developing public delusion over what is happening in the world, since image currency and resolution reflect perceptions of market potential not of public interest' (Verplanke et al., 2010, p. 190).

Thirdly, the aspect trust is also important for the output users to participate. Barrett et al. (2001) mention that agencies (at the top) also have to trust the information provided from the bottom, and all new actors who provide this to get them involved in the network. Also, Johnson and Sieber (2013) mention that it could be challenging to let the government accept non-expert data.

So the aspect trust has a big influence on users' decisions to participate or not, both on personal and institutional level. It has to do with trusting the technologies and the way data is used or provided. Both ends of the Mobile Sensor Web should put trust in the system and use it in a legitimate way.

### 2.2.3. THE IMPORTANCE OF KNOWING THE USER

The examples in the previous sections indicate several challenges link to unknown behavior and interests of users. What makes users to trust other users and the system? How can they be reached and enabled to participate? These questions are rather complex to answer for Mobile Sensor Webs, since many actors are involved. It differs per the case study who they focus on and whether there are any intermediaries.

In case of Human Sensor Web project Georgiadou et al. (2011) argue that 'Involvement of different actors – NGOs, community based organizations, local leaders, engineers, media – is crucial' (Georgiadou et al., 2011, p. 292). All these different actors already show the complexity of possible users of the output of the Mobile Sensor Web. And 'little is known about the behavior of water and health officials towards information volunteered by ordinary citizens and their willingness of reluctance to grant legitimacy to citizen-generated data on their core business, provision of water and health services' (Georgiadou et al., 2011, p289) Also Johnson and Sieber (2013) describe a complex mix of actors, 'in a governance context roles are shared by citizens, community organizations, NGOs, universities, information technology (IT) companies, and multiple levels of governments' (Johnson & Sieber, 2013, p. 70). The complex interaction between these users and their hidden agenda is hard to unravel, while it is important to know something about its users to design well-matching devices.

Overall, who is the user and how can he be reached stays a prominent question for the design of Mobile Sensor Webs. Lack of information about the users' identities, challenges successful development of stable Mobile Sensor Webs.

## 2.3. USING A STS-APPROACH

The previous section indicated several challenges to develop Mobile Sensor Webs. The intended actants are not always reached, willing or able to participate. Overall the intended webs are far from stable. Science and Technology Studies offers several conceptual frameworks to investigated the interaction between technology, users, society and other stakeholders. This thesis will use two of them, which are introduced, in the following sections. Section 2.3.1. introduces Actor Network Theory (ANT), as a precursor of the four phases of Callon (1986). This is followed by the introduction of the ITPOSMO-model of Heeks (2002), which is used to specify the four phases of Callon (2002) to a development context using information system. Finally a summary is given of the most important concept discussed in this chapter, resulting in the research questions of this thesis.

### 2.3.1. ACTOR NETWORK THEORY, FOUR PHASES OF CALLON

Actor Network Theory is considered to be specifically relevant for this thesis, since ANT-scholars do not make any differentiation between the role of technology (non-humans) and stakeholders (humans). Non-humans and humans are treated symmetrically. They argue that technologies cannot be considered as neutral actants[18]. Instead, they understand technologies as mediators, which 'constitute, transfer, and translate meanings and human behavior' (B. Latour, 1992). This idea corresponds to many challenges described in section 2.2. Like the technology design that requires codes from the user to communicate the geo-location and problem across, but the user sends a full story, is an example where the technology tries to discipline the user. Because of a mismatch between the technology and user this does not work.

ANT-scholars argue that technologies can only become successful if the developer or initiating actors succeed in building heterogeneous networks that bring together actants of all types and sizes, whether human or non-human. According to Latour (1999), what actants are, and are able to do, depend on how they are bound up with each other in a network (B. Latour, 1999). So in this case all actants indicated in figure 4 are bound to each other in a certain way, which enables them to do things. The citizen is empowered by a mobile phone and connection to the service provider, who is empowered by being able to receive this information, because of this he can report more to his boss and so on.

The building of heterogeneous stable networks can be understood as a translational process, which consists of the mutual adjustment of actants' objectives, needs, interests and all other elements that constitute the network. The translation process 'occurs as actors enroll allies in the actor network and align their interests in a continuous process of renegotiation where claims become well-established facts and prototypes are turned into routinely used pieces of equipment' (Latour, 1987, p. 132). This claim is very interesting for the development of Mobile Sensor Webs, in which the prototypes are definitely not routinely used pieces of equipment yet. Stakeholders are still negotiating how and why they should join the network. What is their interest? Callon (1986) offers a very useful conceptual framework to analyze this negotiation process, to get understanding of how networks are build, how actants align their interests and how networks become stable in the end.

In this thesis the development of Mobile Sensor Webs is conceptualized as the building of heterogeneous networks that require a translation process. To investigate this translation process the four different phases of translation[19] distinguished by Callon will be used. These are problematisation, interessement, enrolment and mobilization. These four phases offer a framework to deal with the dynamic situation of Mobile Sensor Webs. It can be conceptualized as something unstable, being in a certain phase of its development. It is also supposed to give insight in the weak parts of the network, due to mistranslations in needs, objectives and interests. It identifies which actors are hard to lock in the alliance. In practice these different phases of translation can overlap.

**Problematisation**

In this first phase some actors (the initiating actors) come together to 'determine a set of actors and define their identities[20] in such a way as to establish themselves an Obligatory Passage Point (OPP) in the network of relationships they are building' (Callon, 1986, p.6). In this process, the initiating actors define a problem or question, which they expect to be of importance for all the actors they aim to enroll in the network. So in case of the Mobile Sensor Web, a NGO could come up with an aim that can be achieved by implementing a Mobile Sensor Web. The organization defines which actors should be part of the network to achieve this aim. These defined actors could

18 *Actants is a term introduced by Latour (1992), referring to equal treatment of humans and non-humans.*

19 *The English translation of Callon's theory uses the term moments instead of phases.*

20 *Callon uses 'defining the identities' mostly in the sense of defining the interests of actors. He does not define what is meant by 'the identity of an actor'. In the case studies analysis of this thesis, the identity of an actor is associated with its interests, since this meaning is mostly emphasized by Callon.*

both be parts of the social and natural worlds. The NGO defines a question, which is of importance to all these actors. For example 'How can we improve information sharing within the operation and management systems of the water sector?' This might be relevant for water authorities to develop policies and keep track of the current state of the water sources, but also to the water users so they know where to go in case of a breakdown etc. By defining all the interests of the actants and linking it to their question, the NGO established themselves an Obligatory Passage Point. If the actors accept the proposed central problem or question, they must 'recognize that their alliance around this question can benefit each of them' (Callon, 1986, p.8). So the problematisation describes a system of alliances, or associations between entities, thereby defining the identity and what they 'want'' (Callon, 1986, p.8).

**Interessement**

'Interessement is the group of actions by which an entity attempts to impose and stabilize the identity of other actors it defines through its problematisation. Different devices are used to implement these actions' (Callon, 1986, p.8).

In this phase all the actors have to be convinced that the way they are defined in the network fits their identity. In case of the example, the initiating actors thought that the water authorities should join the network because it enables them to get information from the ground for establishing their policies and to keep track of the water sources. But the water authorities might also say that they want to connect to the alliance, for different reasons, like they want to track people instead of the status of water sources. In this case the interest is redefined.

Devices are placed between the actors to stabilize the connection, and weaken possible links between them and entities that can threat the alliance. For example water users get the possibility to report their grievance through the mobile system, this should keep them from going to other water sources and not report anything about the breakdown. The mobile phone device weakens the link to alternative water sources further away.

'The interessement, if successful, confirms (more or less completely) the validity of the problematisation and the alliance it implies' (Callon, 1986, p.9-10).

**Enrolment**

Interessement achieves enrolment if it is successful. Enrolment describes how several roles are interrelated by the interessement device and the actors who accept this role.

It thus describes the 'group of multilateral negotiations, trials of strength and tricks that accompany the interessements and enable them to succeed' (Callon, 1986, p.10). For example the mobile phone links the water user and the water authority together. If both use the phone in the correct way to report and to receive information they are enrolled. This might only be achieved after negotiations between the initiating actor and the users. The enrolment phase determines and tests the previous defined identity of the actor.

**Mobilization**

This term refers to all the necessary displacements. So for example the mobile phone displaced the communication of the water user with the village chief about the problems with the water source. The devices in the Mobile Sensor Web displace previous actions with devices like the mobile phone and the dashboard. In this phase it is analyzed how these displacements mobilized all the actors. 'To mobilize, as the word indicates, is to render entities mobile, which were not so beforehand' (Callon, 1986, p.14). So the water user becomes part of operation and management system, while he was not included before. But 'this consensus and the alliances which it implies can be contested at any moment. Translation becomes treason' (Callon, 1986, p.15).

### 2.3.2. ITPOSMO-MODEL OF HEEKS

In this thesis Callon's approach will be used to investigate the weak parts within the network and identify possible treason to it. It is supposed to provide understanding about the unstableness of the case-specific Mobile Sensor Webs, and the role of every actant in the network. Because Callon's approach is generally about technological development, another conceptual framework will be used, which is specifically developed to understand the implementation and development of information systems in developing countries. This approach is developed by Richard Heeks

(2002), specialized in Development Informatics. He builds on 'literature on social construction of technology (e.g. Suchman, 1987; Akrich, 1992) and on contingency in organizational change (e.g. Venkatraman, 1989)' (Bass & Heeks, 2011, p. 5). Heeks' (2002) model identifies elements that might threat successful implementation of Information Systems in developing countries. This model is called the ITPOSMO, which is an abbreviation of the first letters of the seven dimensions, which might help to identify actor's interests and possible challenges. These dimensions are:

1. Information (data stores, data flows, etc.);
2. Technology (both hard and software);
3. Processes (the activities of users and others);
4. Objectives and values (the key dimension, through which factors such as culture and politics are manifest);
5. Staffing and skills (both the quantitative and qualitative aspects of competencies);
6. Management systems and structures; and
7. Other resources (particularly time and money)'.

(Heeks, 2002, p.105)

He approaches these dimensions in three different ways: mismatch between design and actuality of local user, current situation versus intended change, and soft/hard gaps.

**Mismatch between design and actuality of the local user**

The fact that Heeks builds on STS-approaches appear in his conception of design and mismatches between design and actuality of the local user. This is similar to Akrich's script theory (1992), but since Heeks focuses especially on information systems in development countries his conceptions are used in this thesis. He defines design 'as a representation of an intentional future' (Heeks, 2002, p.105). And he suggests that mismatches occur between the design and what he calls "The actuality of the local user". To get a better hold on these mismatches, Heeks (2002) uses the seven dimensions to understand the gaps occurring between design and actuality of the local user.

Heeks proposes that the dimensions can be used to assess the gaps between design and actuality and whether the intended change is feasible. He rates every dimension (e.g. low, medium, high). In which high represents a big gap and low a small gap. 'Overall ratings will give a sense of mismatch between design and actuality and, hence, a view of the likelihood of failure' (Heeks, 2002, p.105). This qualitative method will not be used to analyze the Mobile Sensor Web, but the dimensions will be used to identify possible challenges.

**Current situation versus Intended change**

Heeks uses his dimensions also to describe organizational change. This refers to the change that the system causes between actors and within institutions. Heeks focuses on the intended organizational change that is inscribed in the information system. For example Mobile Sensor Webs for the WASH sector try to improve the water supply by introducing new social mechanisms. Interaction with the water authorities takes place via the technology instead of via the chief of the community or any other person. If all actors accept this shift a 'change' takes place in social mechanisms within the community. By empowering people with the information system, a change of communication is intended. This intended change could be feasible or not.

This interpretation of the seven dimensions will also be used to identify possible challenges of implementing a Mobile Sensor Web.

**Hard rational design versus Soft political actuality**

Heeks (2002) finally argues that the seven dimensions are 'overlain by a typical country context. Meaning that most information systems are developed by industrialized countries and introduced to less developed countries. '"The West" (as shorthand for industrialized countries) is not just a physical location: it is also a state of mind that has now come to exist for increasing numbers of key figures in developing-country organizations' (Heeks, 2002, p.106). This happens through education, globalization, politics, economics etc. He argues that 'information systems for development have been affected by the intimate three-way association of information technology, modernization, and Western rationalism'. He calls this paradigm 'hard" rational design. Heeks argues that 'the problem is the gap that can sometimes exist between

the rationality of Information System design and the political/behavioral actualities of developing country organizations', called "soft" political actualities. A summary of these differences is shown in table 1 (Heeks, 2002, p.107).
This way of looking at all the seven dimensions might expose more challenges in creating the network around Mobile Sensor Webs.

| DIMENSION | "HARD" RATIONAL DESIGN | "SOFT" POLITICAL ACTUALITY |
|---|---|---|
| Information | Emphasis on standardized, formal, quantitative information | Emphasis on contigent, informal, qualitative information |
| Technology | A simple enabling mechanism | A complex, value-laden entity: status symbol for some, tool of oppression for others |
| Processes | Stable straightforward, and formal; decision outcomes as optimal solutions based on logical criteria | Flexible, complex, constrained, and often informal; decision outcomes as compromises based on "power games" |
| Objectives and values | Formal organizational objectives | Multiple, informal, personal objectives |
| Staffing and skills | Staff viewed as rational beings | Staff viewed as political beings |
| Management systems and structures | Emphasis on formal, objective processes and structures | Emphasis on informal, subjective processes and structures |
| Other resources: time and money | Used to achieve organizational objectives | Used to achieve personal objectives |

*Table 1: Differences between hard and soft models (Heeks, 2002)*

## 2.4. RESEARCH QUESTIONS

This chapter started with defining and framing the topic Mobile Sensor Webs. This was followed by a description of the current state of the art of Mobile Sensor Webs and the challenges encountered in some pilots. It was found that there is a limited amount of empirical research available on this topic. There are many comparable systems which use Geographical Information Systems to collect data, but not with the specific aim of improving information sharing, to contribute to accountability by empowering citizens and using mobile phones. The discussed studies reveal several challenges, which are described by the digital divide, trust issues and the lack of information about the specific users.
Actor Network Theory is a way to address and analyze the challenges encountered, because it describes how technological design and users interact and shape each other. The four phases of Callon (1986) were presented, since they focus specifically on the translation processes that take place to stabilize the network. It addresses the weak parts of the network and which actants encounter specific challenges.
Finally Heeks was introduced, who provides a model containing seven dimensions to identify the challenges with using and developing a Mobile Sensor Web. He approaches these dimensions in several ways: mismatch between design and actuality of local user, current situation versus intended change, and soft/hard gaps.

These considerations are translated in several research questions for this thesis. Two case studies are investigated to address these questions. The case studies are presented in the next chapter.

The main question of this thesis is:

- Which aspects contribute to the development of a stable Mobile Sensor Web, by identifying the challenges encountered in the development of Mobile Sensor Webs?

By taking an Actor Network Theory approach, using the four phases of Callon and some insights of Heeks the following sub questions are formulated:

Problematisation phase:

1. Who are the initiating actors of the Mobile Sensor Web?
2. Who are the defined actants and how are their interests defined?
3. What did the initiating actors define as the Obligatory Passage Point?
4. How is this translated to a system of alliances between the entities?

Interessement phase:

5. Which interessement devices are used to create and stabilize the identity of the actors? And how are they implemented?

Enrolment phase:

6. How do the actants respond to this initial plan?
    a. If they refuse it, how do they define their own identity, goals or interests? And does this redefinition cause any challenges for the Mobile Sensor Web development?
    b If they accept, which are the strengths and tricks to accompany the interessement and enable them to succeed?
    c. Do they encounter any challenges in the fields described by the ITPOSMO-model, caused by mismatches between design and actuality of the local user, by intended changes or by soft and hard gaps?

Mobilization phase:

7. Did any actants become mobile which were not mobile before?

Reflection:

8. What are the weakest and most challenging parts of the network?
    a. Are these challenges caused by specific gaps as identified by Heeks?
9. How do these challenges relate to information sharing between the actants?

# 3. INTRODUCTION OF THE CASES AND METHODOLOGY

Before the case studies were selected, two weeks were scheduled in Nairobi, Kenya, to gain a better understanding of the field, local projects and visions. The research was specifically done in Africa, since Africa is currently the fastest growing mobile phone market in the world (Eagle, 2009). East-Africa is in the forefront of these developments (Eagle, 2009), with Nairobi as one of the most important cities. Developments like mobile money services were developed here. M-PESA is the most successful example of this (Mas & Morawczynski, 2009). Overall Nairobi was a good starting point to explore the field in a local context, and to get to know many running projects.

In Nairobi a two-day conference was visited, focusing on open data and developments related to Mobile Sensor Webs. Besides that, a workshop on water governance[21] was attended, and 15 orienting interviews were held with local organizations and initiatives. A list of these interviews can be found in Appendix A. After these two orienting weeks and based on the theoretical framework, three case studies in Uganda were selected, Taarifa, Mobile4Water and Akvo FLOW. The first two were finally used for analysis. These will be introduced in section 3.1 and 3.2. Appendix B describes the excluded case study. Section 3.3 will describe the considerations for this selection and the reasons for the exclusion of the third case study. Finally section 3.4 describes the methodology used to collect and analyze the data of both cases.

## 3.1. TAARIFA

Taarifa is a Mobile Sensor Web designed for reporting water infrastructure failures through mobile phones or the web. A dashboard system manages the reports for service providers, and helps providers to respond to users with updates on the status of repairs[22].

This thesis focuses on a specific pilot conducted in Uganda at the Ministry of Local Government (MoLG), which started in February 2012. This pilot moves beyond the water sector, since it is used for a range of public services in multiple sectors. These services are part of Community Driven Development projects. 'Local governments come up with proposals and the MoLG takes them into procedure, provides budgets and the Local Government implements the project' (Data manager program support team MoLG, July 30, 2012). Taarifa is used to monitor these Community Driven Development (CDD) projects, which enables the MoLG to take responsible decisions and interventions. It increases information sharing about the CDD projects between the ministry and citizens, which increases transparency and accountability of Local Governments and the MoLG[23]. Figure 5 shows the four districts in which Taarifa is piloted.

21 *'Water governance involves the upholding of the policies, strategies and legislation' (Moraa et al. 2012).*

22 *taarifa.wordpress.com*

23 *ugtaarifa.org*

## 3.2. MOBILE FOR WATER (M4W)

Mobile for Water (M4W) is developed in 2011 by cooperation between Makerere University School of Computing and IT (Mak-SCIT), SNV[24], WaterAid[25] and Triple-S[26], a project funded by SNV and IRC[27]. The project has participation from the Ministry of Water & Environment (MWE), local governments at the implementing districts. They completed the system deployment phase in February 2012 (Wakholi, 2012).

M4W focuses on improvement of water source functionality. It does this by improving information sharing at different levels. This should also improve the accountability lines between different actors of water service delivery. M4W enables water users to report faults of water sources. It monitors the actions taken on these reports and provides feedback to the water users. M4W wants to trigger these actions and empower people to be part of the service delivery network[28]. Figure 5 shows the seven districts where M4W is piloted.

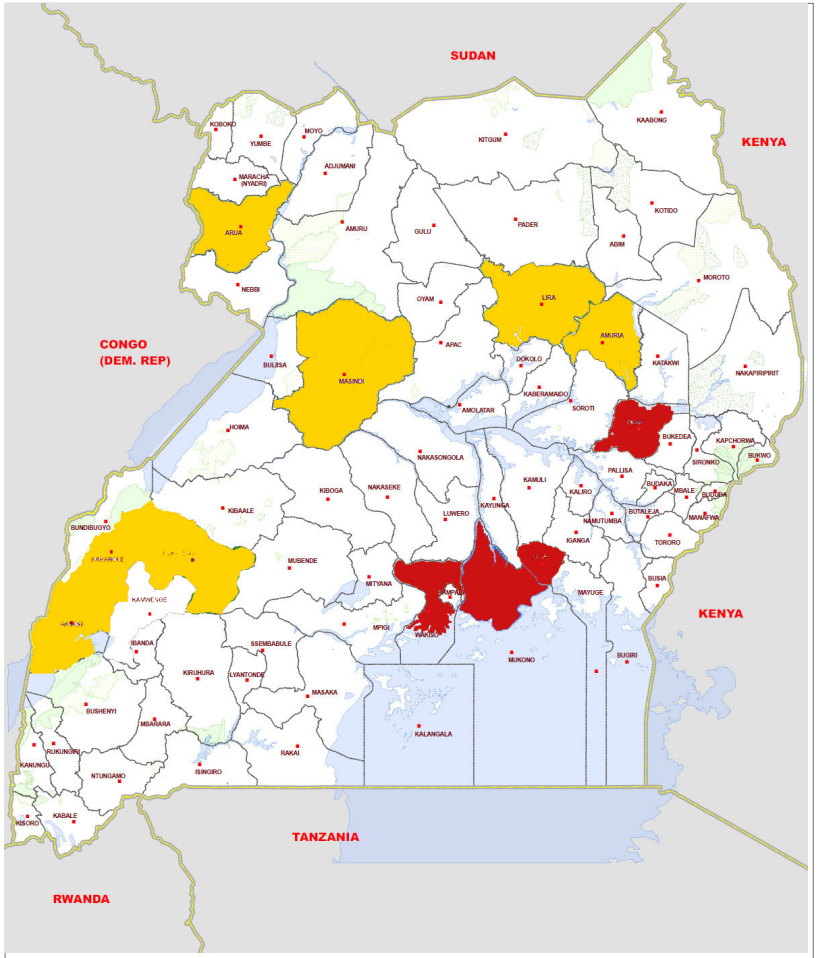


*Figure 5: pilot districts of the case studies.*
*Red: Taarifa, Mukono, Wakiso, Jinja, Kumi*
*Yellow: M4W, Arua, Kasese, Kyenjoj, Masinidi, Lira, Kabarole, Amuria*

*24 SNV is an international not-for-profit development organisation, who believes that no one should have to live in poverty and that all people should have the opportunity to pursue their own sustainable development. They started 40 years ago in the Netherlands and now operate in 36 countries worldwide (SNVworld.org).*

*25 WaterAid is an international non governmental organisation with a mission to transform lives by improving access to safe water, improved hygiene and sanitation in the world's poorest communities (WaterAid.org).*

*26 Triple-S (Sustainable Services at Scale) is a six-year, multi-country learning initiative to improve water supply to the rural poor. It is led by IRC International Water and Sanitation Centre (waterservicesthatlast.org).*

*27 IRC International Water and Sanitation Centre is a knowledge-focused NGO, working with a worldwide network of partner organisations in order to achieve equitable and sustainable water, sanitation and hygiene (WASH) services (irc.nl).*

*28 m4water.org*

## 3.3. CONSIDERATIONS TO SELECT THESE CASE STUDIES

After exploring the field in Nairobi and some days in Kampala, Uganda, it became clear that most cases are still in the phase of piloting and face many challenges. There are no real success stories or fully completed systems yet. In this stage an explorative research seems to be more valuable than an in-depth research. That is why multiple case studies were selected. The advantage of selecting multiple cases, instead of one, is that better predictions can be made about challenges faced and how these connect to specific users or project set ups. It is assumed that this approach will enable to grasp a variety of challenges. Selecting multiple case studies will also be valuable, because there is not much empirical research available in this field yet. An explorative research provides a better overview of possible interesting fields for further research.[29]

This section starts with the reasons to exclude the third case study, Akvo FLOW. Subsequently, it describes the differences between the two analyzed case studies, which are considered to be interesting because they might influence the encountered challenges. These differences can be found in the backgrounds of the initiating actors (section 3.3.2.), the interessement devices (section 3.3.3.), and the inclusion of users (section 3.3.4.).

29 *A limitation of this decision is that it might be harder to go in depth and draw generalizable conclusions, since only a limited number of interviews can be done in the time planned for collecting data. However from the practical context in Uganda, it became clear that by choosing only one case study it would still be questionable if more interviews could be arranged. To interview more people in one position, it is necessary to visit different districts, since within one district only a limited number of actors are present. Reaching the right persons appeared to be very time consuming. Traveling from one area to another is rather challenging. Without guidance it would be hard to reach the right persons. This could already be challenging when going with guidance. By choosing three case studies, time could be spend more efficient, since it was possible to work on one case study while waiting for responses of contact persons of the others. So in the end one case study would not result in many more interviews and information. These practical reasons were part of the consideration between one or more cases.*

### 3.3.1. EXCLUSION OF AKVO FLOW

During data analysis it was decided to exclude Akvo FLOW from this thesis. Main reason is because, during the interviews, it appeared that the objective and the way Akvo FLOW is used differ too much from the other two cases and the objective of this thesis.

Water For People (the initiating actor) sticks to using Akvo FLOW for monitoring and improving information sharing within their own organization. At the moment they do not aim to improve information sharing outside their NGO, for example towards the ministry. Also they will not use the technologies to empower people on the ground. The monitoring is an objective in itself. It is not intended to connect new people and extent the information sharing. It mostly replaces paper-based work. So during the interviews it appeared that Water for People uses Akvo FLOW for horizontal information sharing, while Taarifa and M4W use it for vertical information sharing. This is a completely different network and it is based on different aims. That is why the case study of Akvo FLOW does not fit to the intentions of this thesis and why it was decided to exclude it.

The one thing how Akvo FLOW would add value to this thesis, is because it is implemented at global level as well. This takes the information sharing to a whole new level and different users are included. This influences the development in a certain way and the way it is implemented. This part will be considered in the discussion, but it does not add enough value to completely describe the whole case and all the findings in this thesis.

### 3.3.2. ORIGIN INITIATING ACTORS AND EXPECTED DESIGNS

The first reason why it would be interesting to include both Taarifa and Mobile4Water in this thesis, is because the origin of the initiating actors is different. Some are from Uganda, others from Western countries. In the latter situation one would expect to encounter some gaps between hard rational design and soft political actuality, as described by Heeks (2002). This could cause challenges in the development of the Mobile Sensor Web.

As described, M4W is developed by cooperation between Makerere University, SNV, WaterAid and Triple-S. Although the NGOs originate from Western countries, Ugandan people developed the M4W devices, like the phone application and the dashboard. Also support is given by the local departments of the organizations, and thus by local people. Because of this, its design is expected to include more soft political actuality factors, but hard rational design might also be present, because of the objective of the organizations they work for.

In this case, Taarifa is developed for the Ministry of Local Government (MoLG). The data manager of the program support team of the MoLG is highly involved in the implementation. Because of this, it is expected that many elements of the soft political actuality will be recognized. But the development of Taarifa software happens mostly in the United Kingdom, although anyone around the world can add his or her expertise, since it is an open source initiative. Right now around 40 people are within the network, from different fields and with different purposes. Although these developers use user experiences in their development process, one would still expect that their design tends to go to the hard rational side, since the development stays within the Western context.

So based on the origin of the initiating actors of both case one would expect to find different challenges during the development and pilots.

### 3.3.3. DOMAIN OF THE INITIATING ACTOR

Besides the origin of the initiating actors, also the domain in which they work differs. Taarifa's initiating actors operate at the Ministry of Local Government and as an open source initiative. The initiating actors of M4W work at NGO's and at Makerere University. This might cause different considerations during development and when defining the Obligatory Passage Point or inclusion of actors. On its turn, this might influence the encountered challenges of developing the Mobile Sensor Web.

### 3.3.4. INTERESSEMENT DEVICES

The cases use similar hardware technologies to create their network, namely mobile phones to collect data and an online dashboard to communicate this information to people at the top, which can be put on a public website. But there are some differences. Taarifa uses an Android based smart phone with a mobile optimized website, while M4W uses a featured phone, with an offline Java Open X data application. This difference asks for different skills and conditions, which is considered to result in different challenges.

Also the website is included in different ways. Taarifa uses the website as an interactive medium, to communicate to the citizens and receive reports, while the website of M4W is rather passive. They mostly use the website to show what is going on to a random public, but it is not used for interaction within the network. Automated SMS messages are used to communicate and provide feedback.

In both cases the dashboard, the platform were most information comes together, is still rather basic, but the users of this software were highly involved in carrying out the pilot, so this is not considered to bring up many challenges.

The findings, described in chapter 4 and 5, will explain in more detail how the devices are used and by whom.

### 3.3.5. USER INCLUSION

The final interesting difference between the cases is that the initiating actors made different considerations towards the inclusion of levels of society, and thus which actors they want to join the network. Figure 6 illustrates on which 'levels' they included actors during the pilots. The last three levels are colored the same, since these are all administratively registered as parish level and the distance between these actors is relatively small.

Taarifa includes actors of the government, at national and district level, while M4W also includes the sub county level. Besides that the initiating actors of Taarifa include people from the district to collect information from the citizens by filling questionnaires on the phone. This explains the term 'representation of citizens', as indicated in figure 6. Future plans are to involve more actors on the ground, by sensitizing citizens to report information through SMS. But these levels were not included in the pilot. M4W includes the actual citizens within their pilot, although in the current pilots citizens did not send any reports.

Figure 6 also illustrates the "distance" between the people that communicate with each

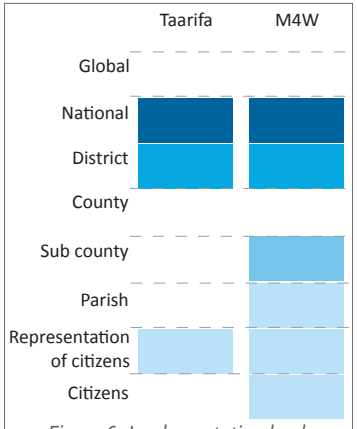


*Figure 6: Implementation levels of the Mobile Sensor Web per case study. The colors indicate the different administrative levels.*

other. The closer people are together the more likely it is that they actually know each other. At parish level you might know somebody at sub county level, but an authority at the top is further away. These distances might have their influence on the system processes as well.

Figure 7 indicates why it is expected that the different levels of society are important for the variety of challenges that might be found. The pictures show the office building of the Ministry of Local Government at national level and the building of Local Government at district level. It indicates that the circumstances and context per level can be very different and thus are expected to have a major influence on the kind of user and its interests.

*Figure 7: The building in which the Ministry of Local Government is situated. And the building where the District Local Government is situated. It illustrates that the context between these levels differs a lot.*

## 3.4. METHODOLOGY

After selecting the case studies, data collection started by doing individual in-depth, semi-structured interviews with the initiating actors. These interviews clarified how they defined the actants and which actants actually were included during the pilots. All defined actors where interviewed, and some were interviewed twice. It only was not possible to interview the citizens defined for the network of M4W, since they were not reached and did not know about the project. Table 2 shows per case study which actors are interviewed.

The semi-structured interviews were conducted in English during July, August and September 2012. Most were individual and two in focus groups, being the monitoring teams of Taarifa. As described by Dicicco-Bloom & Crabtree (2006), the first question was broad and open-ended. Following the interviewee's response, questions were asked that touched upon several predetermined topics and questions. To make the interview as non-directive as possible, the interviewer responded with prompts that repeated the words used by the interviewee and also the order of questions was led by the responses of the interviewee (Dicicco-Bloom & Crabtree, 2006).
The ITPOSMO-model of Heeks guided the interviews. The seven dimensions were used to touch upon specific parts of the Mobile Sensor Web, because it was expected that the challenges could be found in these parts. Besides these dimensions, the interviewees were asked to tell about their own experiences, so careful consideration could be given to emergent topics. As suggested by Dicicco-Bloom & Crabtree (2006) during data collection questions that were not effective were dropped and based on collected information new ones were added. Appendix C contains an overview of the frequently asked interview questions.
Besides the interviews, documentation is studied. This documentation contains the websites of the projects, publications of the initiating organizations and blogs. Appendix D contains an overview of these sources.

All the interviews were audio recorded, transcribed and coded, using directed content analysis as described by Hsieh and Shannon (2005). The goal of using this directed

approach, was to validate or extent the conceptual framework of Callon (1986) and of Heeks (2002), which is discussed in chapter 7. And of course it aimed to identify and categorize all occurring challenges and benefits.

The transcripts were read and all parts that on first impression appeared to represent a challenge or improvement, were highlighted. Also, defined interests by initiating actors and actual interests of users were marked. Subsequently, all highlighted passages were coded using the seven dimensions of Heeks (2002), distinguishing between design/actuality gap, intended change and current situation, and hard/soft gaps. Besides the ITPOSMO-model of Heeks the code trust was added. Accessibility, functionality, usability and literacy as described in the digital divide, were not used, since the ITPOSMO-model was considered to be sufficient and more specific. Any text that could not be categorized in the initial coding scheme, was given a new code (Hsieh & Shannon, 2005), these elements will be discussed in chapter 7. Besides that some codes were specified, like the technology-dimension of Heeks became technology_battery; technology_internet etc. [30]

Using this method a lot of data was collected and analyzed, which is discussed in the final part of this thesis.

30 *Several ways of coding were tried before the described methodology was used. First only the seven dimensions of Heeks were used, but it appeared that these were hard to apply, since many challenges were a mix of codes. The conceptual framework of Callon (1986) was added to provide a better framework to discuss the encountered challenges. Chapter 7 discusses this in more detail.*

**M4W**

| ORGANIZATION | FUNCTION | ROLE | INFORMANTS | INTERVIEWS |
|---|---|---|---|---|
| Makerere University | PhD + software developer | Initiating actor | 1 | 2 + e-mail conversations |
| Triple-S | Water advisor | Initiating actor | 1 | 2 + several conversations |
| SNV | Water Advisor | Initiating actor | 1 | 1 + several conversations |
| Hand Pump Mechanic Association | Chair Hand Pump Mechanic Association | User | 1 | 1 |
| Government | Assistant District Water Officer | User | 1 | 1 |
| Government | Health Assistant | User | 3 | 2 |
| Independent | Hand Pump Mechanic | User | 2 | 2 |
| | | | **10** | **11 + ...** |

**TAARIFA**

| ORGANIZATION | FUNCTION | ROLE | INFORMANTS | INTERVIEWS |
|---|---|---|---|---|
| MoLG | Data manager Program Support Team of CDD projects | Initiating actor and user | 1 | 2 + many conversations |
| Taarifa | Team leader Taarifa | Initiating actor | 1 | 2 + several conversations |
| Taarifa | Software developers + researchers | Initiating actor | 5 | E-mails |
| District LG Wakiso | Monitoring /planning department | Users | 5 | 1 |
| District LG Mukono | Monitoring / planning department | Users | 4 | 1 |
| | | | **16** | **6 +...** |

*Table 2: Overview of the two case studies' interviewees.*

# PART 2

# 4. FINDINGS TAARIFA

The findings of the first case study, Taarifa, will be presented using the conceptual framework of Callon (1986). The problematisation and interessement phase discuss the intentions of the initiating actors. The last two phases describe how the actants in the pilots respond these thoughts, translated to the Mobile Sensor Web design. In the end of every phase the dimensions of Heeks are shortly discussed, but as described in the methodology chapter it is challenging to link specific challenges to specific dimensions. That is why Heeks' framework is discussed more thoroughly in chapter 7.

## 4.1. PROBLEMATISATION

The Mobile Sensor Web Taarifa is an open source initiative, developed by the Taarifa team. In this case the Mobile Sensor Web is implemented at the Ministry of Local Government (MoLG). The MoLG and the Taarifa team are the initiating actors of this case study.

The MoLG was looking for a more effective way to monitor the Community Driven Development (CDD) projects, which they support. These micro projects are set up all over the country in far reaching areas, which makes it hard to keep track on them. To do effective monitoring and to make well-based decisions, the Program support team at the Ministry needs up to date information. That's the start of creating a new system to share information between stakeholders. Creating more transparency about decisions made by the ministry and to increase accountability at the district and national level is an important aim. Getting information from the bottom and communicating it from the top should be realized. Together with the Taarifa team who is providing the interessement devices, the Ministry of Local Government is creating this system with the corresponding alliance. They thought of important stakeholders to include in this network and what their interests are is in this new system (Data manager program support team MoLG, July 17, 2012). This way the problematisation was made (section 4.1.1). From there they could establish themselves an Obligatory Passage Point (section 4.1.2).

### 4.1.1. DEFINED ACTANTS AND THEIR INTERESTS

The Ministry of Local Government (MoLG) defined several actors, which they want to include in the network. Beside themselves, these actors are a monitoring team at the district local government and community members receiving care from the projects (see figure 8 and table 3). The monitoring team at district level consists of several political leaders and the technical planning committee, which contains the heads of every department within the district.

The monitoring team goes into the field to monitor the status of the projects. They do this by talking to the responsible persons of the projects and to the community who is supposed to receive the care (figure 8) For example they could monitor a project, which aims to build a new water source. They want to know if the given money is spent well and how far they progressed with realizing their aim. They will also check if the intended beneficiaries are reached (Data manager program support team MoLG, July 30, 2012). At the moment this process is very time consuming and expensive. A lot of paper work has to be taken into the field and entered into the computer once coming back to the office. Besides that, field trips are done with a group, so they can check on each other.

Reports from these field trips may take a couple of months or a year before they reach the ministry, because the district will compile all their reports and deliver them personally, hard copy to the ministry, since mail cannot be trusted. Then the

| | WHO? | CURRENT TASKS | INTEREST DEFINED BY TAARIFA/MOLG |
|---|---|---|---|
| Ministry of Local | Data manager Program Support Team | Make decisions on program interventions | - More up to date data, to base their decisions and interventions on<br>- Increase transparency (no ghost projects)<br>- Track impact/progress[1]<br>- Show accountability to citizens<br>- Do cost effective monitoring<br>- Faster info flows |
| District monitor team | 2 or 3 Political Leaders (in monitor team) | Spokesperson for the community | Know what is going on for the community |
| | Technical Planning Committee<br>- Heads of every department | Monitor CDD Projects | - Cheaper way to do monitoring<br>- Have more accurate data<br>- Easier way to do their task (not carry paper work – or bring it to the ministry)<br>- Faster info flows |
| CDD projects | Spokes persons for the project | Get funds to set up micro projects to help the community | - Know about the procedures of the ministry (where is the money going)<br>- Get money for their projects |
| | Care receivers | Beneficiaries of the projects | - Know about the procedures of the ministry (where is the money going)<br>- Be able to voice complaints and hold people accountable |

*Table 3: Defined actors and corresponding interests according to MoLG and Taarifa team. Based on Interview Data manager program support team MoLG, July 30, 2012.*

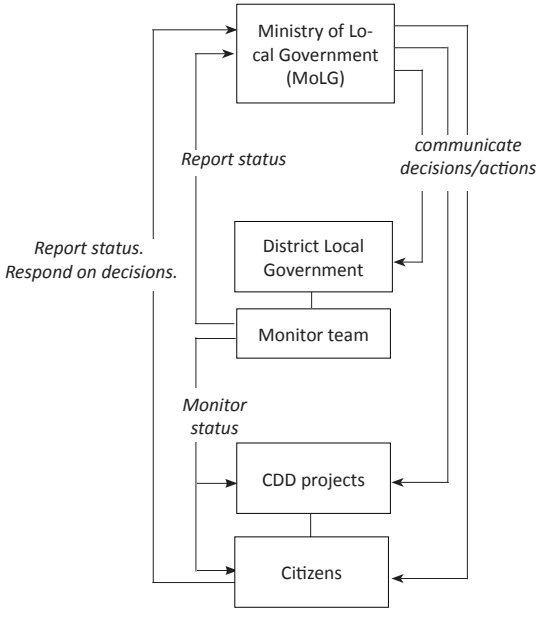


*Figure 8: Information flow within the intended alliance (Based on interview Data manager program support team MoLG, July 30, 2012).*

Program support team at ministry might find half-filled forms, and they need to call the district again to complete all data. All these actions take a lot of time and involve transportation costs (Data manager program support team MoLG, July 30, 2012).

The MoLG would like to make the monitoring easier and cheaper. Also they want to make it more transparent, so it is not necessary to send multiple people to check on each other during the monitoring. This way the data should become more reliable.

> *With the implementation of a project, somebody has to go into the field and confirm that it actually happened, standards are being maintained etc. But that is only one person. So we depend on that person's word'. 'With this Taarifa system we are trying to cut down issues of faking the data' (Data manager program support team MoLG, July 30, 2012).*

Besides that they want to give the community an active role in reporting faults once they see that projects are not there or not functioning well. To enable this they need to be able to communicate all their decisions and subsidies projects to the public, so they can respond to it (Data manager program support team MoLG, July 30, 2012) (See figure 8).

These supposed benefits and interests are summarized in the last column of table 3.

To reach this aim they intend to include the political leaders (the ones elected by the people), and also the technical planning committee within the monitor team.

> *'The technical planning committee is a multi disciplinary team, it picks personal from different departments. So they constitute the team and every quarter they go out and monitor.' 'On top of the monitoring team we have the political leaders, because they represent the communities. They are the ones to push the technical people and report back to the people' (Data manager program support team MoLG, July 30, 2012).*

Once the information is collected the technical person of the corresponding department should send the information directly to relevant persons, without delays, this includes heads of departments and the program support team at the ministry.

The described intentions focus on several dimensions of Heeks. Information since they want to make it more accurate and transparent. Processes, management structures and staff, which have to do with whom they want to include. Resources is a discussed dimension, since it should decrease time and money spend. Finally Objectives and values could be seen as an important dimension as well, since politics manifest themselves through corruptive practices.

#### 4.1.2. OBLIGATORY PASSAGE POINT

Based on the identified interests of the actors and the requested information flow as shown in figure 8 the MoLG and Taarifa team aim to make themselves an Obligatory Passage Point (OPP) for the identified actors. This OPP comes down to more transparent information flows, which should contribute to the accountability of all parties and make monitoring more efficient. The MoLG voiced that they want to improve communication between them and the community (Data manager program support team MoLG, July 30, 2012).

So in this case the initiating actors established themselves as an OPP by aiming to develop a system which answers the following question: 'How can we improve information sharing and increase transparency between the governmental actions and community?' Governmental actions both include actions at the district and at national level.

The initiating actors implemented several interessement devices, which should lock the stakeholders in place and answer this question. Since it is supposed to enable the interests as defined in table 3, it should lock them in the alliance.

## 4.2. DEVICES OF INTERESSEMENT, LOCK THE ALLIES IN PLACE

During the interessement phase it is attempted to impose the previous defined interests on the actors, to stabilize the alliance. This is done by interessement devices, which draw on the actors' interests and link them together. Figure 9 shows the interessement devices, which are supposed to lock in the allies, by enabling communication, improving information sharing, accountability and transparency. This system is not fully developed yet, but the first pilot is running in four districts (Mukono, Wakiso, Kumi and Jinja). The pilot focuses on the solid lines in figure 9. The dashed lines are to be developed. So it is being tested within governmental bodies, mostly top-down and the information flow from the bottom to the top will be realized

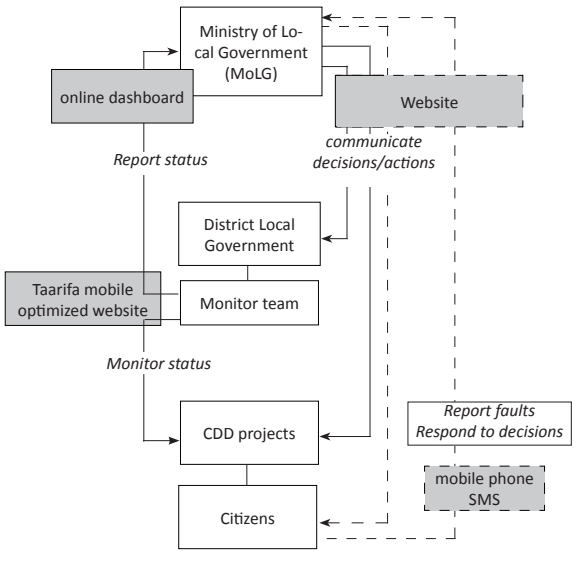


*Figure 9: Putting the interessement devices in place to enable the intended info flows. The solid lines are piloted, the dotted lines will be implemented in the future*

in the future[31]. It works with the representation of the citizens collected by the monitoring team. The following sections will discuss the devices, as shown in figure 9, one by one. This explains the setup of the whole Mobile Sensor Web and which socio-technical hybrids are intended to be created.

### 4.2.1. TAARIFA MOBILE OPTIMIZED WEBSITE AND THE MONITORING TEAM

- The monitoring team goes into the field, to collect information about the status of the project. This has to be communicated to the MoLG in a standardized format. This used to be paper-based forms, but now it is done with mobile phones (android based smartphone).
- The team interviews people of the project and fill standardized forms on their phone by going to the mobile optimized website of Taarifa. The complete form has to be filled, else it cannot be sent.
- Together with a picture and automatically filled GPS coordinates, this information is submitted.

In this set up the mobile phone facilitates direct information sharing from the monitor team in the field, to the national Ministry of Local Government. No delays are encountered with processing the data. Also the location is directly added to the information, which makes it possible to map it. The picture provides evidence that the situation as described by the answers of the standardized questions is correct. As the data manager of the Program Support team at the MoLG explains:

> *'In the 'normal' monitoring procedure the paperwork had to be send to the district and from the district to the ministry, which could not be done by mail, but had be brought personally. Now we try to establish a system whereby the last person on the ground, the person involved in the monitoring, just submits direct to the ministry. This is far more cost efficient and faster.' (Because bureaucracy and many people are skipped) 'Monitoring goes faster and according to them [the district] it is much more easier then carrying around the papers. You just take the picture, capture information and submit it.' (Data manager program support team MoLG, July 30, 2012)*

He also explains the importance of the capacity to take a picture:

> *Taarifa has functionalities that try to cut down issues of faking the data. Because we take the picture and the location of the project. If you are not at the location there is no way you can give this information. So we expect you to have gone to the project. The picture is where the strength of the whole system is. (Data manager program support team MoLG, July 30, 2012)*

So the picture provides the evidence of the situation on the ground. The combination of these functionalities gives the mobile phone a prominent position within the network. It shapes the way its users are intended to communicate and it is responsible for providing the location.

### 4.2.2. THE DASHBOARD AND THE MINISTRY OF LOCAL GOVERNMENT

- The submitted information is sent to the dashboard. This interessement device is meant to collect all the information. The MoLG, which has to make decisions about the CDD projects, manages this. At the moment the Program Support Team of the MoLG comes down to one person, so he manages the incoming information.
- This holds that he has to approve incoming reports, which subsequently appear on the website. The dashboard enables him to have a clear overview of all projects going on. This simplifies his task. So in the end, the responsibility about which collected information becomes public is up to the data manager of the MoLG.

### 4.2.3. THE PUBLIC WEBSITE

This website is the third interessement device (see figure 10). On the website people can find the report per category or view it on a map. It is also possible to submit reports at this website, through the same forms as on the phone. Besides that it is possible to comment on the submitted reports.

This last part is not really promoted yet during the pilot, but in the future citizens should be able to comment there. This really needs some attention, for example media should be involved to bring the awareness.

> *'This is necessary, because at the end of the day these reports are meant for the*

31 *At the moment there is a possibility for community members to respond on reports on the website of Taarifa, but since this is not communicated yet and the intended SMS function is not in place, this part is considered to be not included in the pilot.*

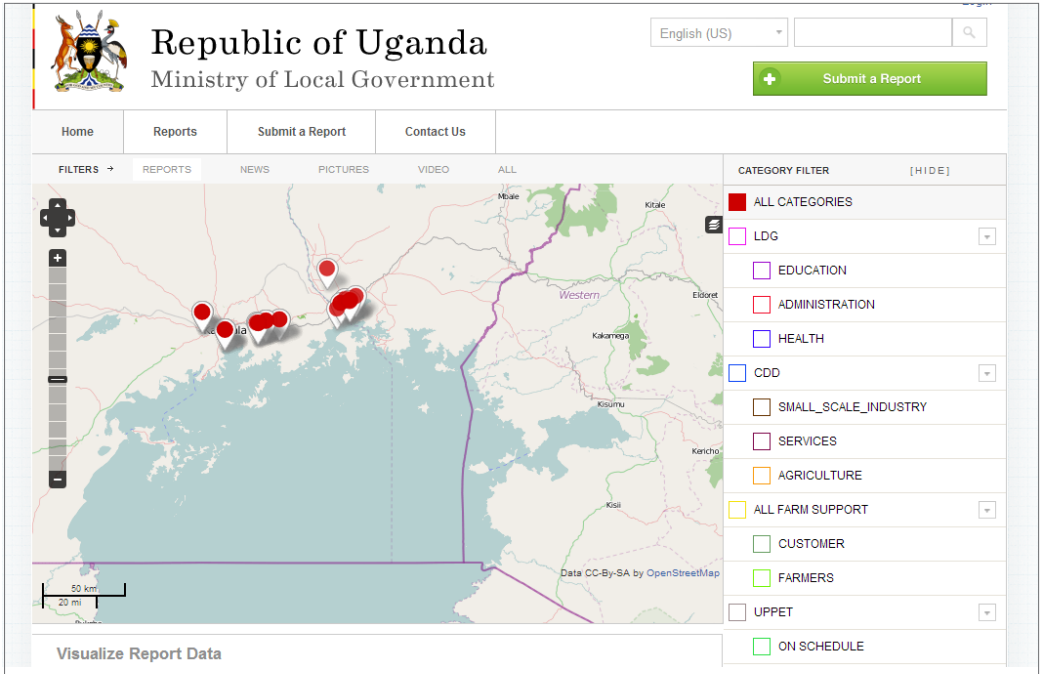


*Figure 10: A screenshot of Taarifa's website used by the Ministry of Local Government (ugtaarifa.org).*

*public, that is why it is an open website. It increases transparency and it markets what we are doing, because a lot of things that are done, nobody knows about' (Data manager program support team MoLG, July 30, 2012).*

Taarifa is also thinking to include SMS texts in this system, so citizens can report faults by using their mobile phone. In what way this is going to be integrated within the system is not clear yet. First the system should be in place within the ministry.

So right now three interessement devices are implemented during the pilot to facilitate communication and information sharing between the different stakeholders, the smartphone, the dashboard and the website. In the future a fourth device might be included, namely basic phones from citizens. The devices have a prominent role in the network. They shaped the communication and oblige the user to provide certain information in a specific way. The website is meant to become an interactive platform to exchange all this information, if approved by the MoLG. The described use of the interessement devices links the dimension 'Technology'.

During the pilot it should become clear if the stakeholders accept the roles defined for them, and whether the interessement devices, to lock this position, constraint or facilitate these roles.

## 4.3. ENROLMENT

As being said the part of reporting faults is not included in the pilot yet. So no citizens or persons from Community Driven Development projects are interviewed, because they are not enabled yet to comment on reports. But from the interviews with the other actors some elements became clear that might influence this future part of the process as well. These elements will be discussed when discussing the (non) enrolment of the other stakeholders. The position of the Taarifa team, MoLG and the monitor team at the local government, together with their interessement devices, are presented below.

### 4.3.1. TAARIFA TEAM

As initiating actor, the Taarifa team is of course enrolled in the alliance, although indirectly. They are not taking part in the full system, but as designers of the interessement devices they have a major influence on the functioning of the alliance. In the future the responsibility of the system management should be with the MoLG. So if they are able to stabilize the network by finding a balance between technology and users, and solve all the technological challenges, they will not be of any influence to it anymore.

### 4.3.2. MINISTRY OF LOCAL GOVERNMENT

The data manager in the Program Support Team is also one of the initiating actors of Taarifa. The benefits envisioned in the previous paragraph still count on his part. So he is fully enrolled in the system, but he is depending on the information coming from the district. If the district is constrained in collecting information or hesitant to enroll in the system, it might be hard for the MoLG to get fully enrolled.

**Usability and functionality of the dashboard**

The dashboard he is working with, limits him in doing some things he would like to do, but that is mostly due to the development phase this project is still in. An example is that during the interview it was not possible to filter the incoming reports, which makes it hard to get an overview on for example reports from one particular parish. But these functions are being developed. He expressed that it would also be very helpful to filter on user groups.

> *'The way it is right now, everyone can submit. But for us the target is Local Government. So what that means is everyone who submitted means more work for me, because you have to go through everything. To see what is relevant, approve it. So we need to create some kind of login, where the local governments can login, submit their reports' (Data manager program support team MoLG, July 30, 2012).*

This might give the impression that the MoLG is not really interested in reports outside of the government. This is not intended, but (so he replied)

> *'The information we are looking for is money spend, implementation period etc. You do not expect a local person to know that. Their reporting would be on functionality, how effective, quality of the project' (Data manager program support team MoLG, July 30, 2012).*
>
> These remarks are important to take into account for future development. If other, less motivated people at the MoLG have to work with the dashboard, it should be user friendly. This includes features like filters and user groups.

Also, the comments that are to be expected from community level needs some thoughts. What is the capacity at the MoLG to respond to these reports? They have to send this information to the right people, which will extent the whole network and ask for more devices to get this communication in place. Especially because communication tools like e-mail are not in place yet.

> *'Local government have not yet picked the discipline for effective communicative through e-mail. If you go there, they might even not have e-mail addresses' (Data manager program support team MoLG, July 30, 2012).*

Also scaling up the problem might cause problems at this level. At the moment only one person is involved. It is already hard to keep track of all the reports coming from four districts, if all 112 districts are included in the system, a whole team will be needed at the MoLG, or processing information should be automated more.

Overall, the MoLG is satisfied with its role in the alliance, but some of the data manager's remarks identify possible future challenges. How to deal with scaling the project, how to deal with incoming information outside the government, which does not align with the information necessary for the MoLG, and which features are necessary to make the dashboard user friendly?

### 4.3.3. DISTRICT LOCAL GOVERNMENT AND SMART PHONE

For this thesis two of the four involved monitoring teams are interviewed. It appeared that they are not completely enrolled yet for several reasons. First of all the monitoring team did not contain the actors as defined by the MoLG and Taarifa team. Secondly, the interessement devices limited the monitoring team in fulfilling their task. By seeing the mobile phone as an actant, one could say that the mobile phone did not enroll either, since it could not function as planned. Thirdly resources were found to be a constraining element. These will be discussed one by one.

**Actor involvement – accessibility of the technology**

During the interviews it appeared that no political leaders were involved in the pilot. Only people from the department of planning and the community development department took part in piloting the system, while it was intended to include the heads of all nine departments and the political leaders. That this did not happen makes sense, since the political leaders do not get any information from this

system, which is relevant to them. They are not involved in the information flow. The department of planning and community development department are especially involved in monitoring activities of CDD projects, while the other departments might not have the budget or time to go into the field, if they do not have specific interest at that moment. The monitor team of Mukono mentioned:

*'In this new case you go to the field capture info and send it directly to the ministry. So all these in between steps are skipped' (Monitor team Mukono, August 8, 2012).*

These skipped steps refer to the involvement of other actors at the district. This is seen as a problem that will reflect on the appreciation of the platform.

The non-involvement of actors in the information flows is disputable. As the MoLG before the interviews with the district mentioned, all actors could access the information if they like to see it.

*'They are not really skipped it is just limitation in appreciating technologies. Because this is a public platform, if they really want to know what is happening they can see it and even comment. So it is a step-by-step process, and we'll get there and have them involved' (Data manager program support team MoLG, July 30, 2012).*

So the MoLG sees the website as a successful tool to communicate the information.

*'The information can 'easily be accessed by anyone, by any interested party. This to help us in planning; increase transparency, track impact, progress etc.'(Data manager program support team MoLG, July 30, 2012).*

Problem with this indirect, passive involvement is that the Internet culture is not really integrated at the district yet. Most people do not even have an e-mail address. Or local governments do not have tele-connectivity in their offices.

*'There is no local government that is a 100% not connected to the Internet. It is just in some spots. It is just a matter of moving to a spot where there is connectivity' (Data manager program support team MoLG, July 30, 2012).*

So online information cannot be seen as directly accessible information, since using digital information is not part of the culture. The accessibility of the website as interactive platform limits the functionality of the Mobile Sensor Web.

Also the monitoring team themselves, mentioned that online reporting is not enough. They need hard copy reports of what they do, to show their accountability.

*'We get the information straight out of the field and send it to the ministry but we've not remained with a copy. When we send it, it goes. We only remain with a photo. I would like to download the info from the website, because you come from the field with your info, go to the district, compile it, get it to the CAO (chief administrative officer) for approval and submit it to the ministry. We need to report to the departments and the CAO about the exercise we've done' (Monitor team Mukono, August 8, 2012).*

This constraint, of solely using online information, is also mentioned by the monitor team in Wakiso. And even if there is a download button in could appear that the reports are not there yet, since the MoLG has to approve them before they are visible on the website.

This indicates that the shift to a completely online, digital system is a rather big one. It could be a matter of time and sensitization, but for lower, less organized levels, like the community, this might be too hard. So to include all the intended actors of the monitoring team, one should reconsider how they are locked into the system and whether the website really is an accessible option, and if the role which is has is reasonable or too decisive for the whole Mobile Sensor Web.

**Actor involvement - corruption**

Another element that could constrain people at the district from full enrolment might be the transparent characteristic of the system.

*'One issue I saw coming up a bit silently is the fact that now you are exposing... the system is too transparent. Before we depended on the paper based, but here you are looking at the picture and actual location of the project. So if the project does not exist, there will not be a photo. So that is not possible with a project that does not exist. This paper based kind of used to hide their skeleton. But with Taarifa it exposes everything, so that might cause negativity to the system' (Data manager program support team MoLG, July 30, 2012).*

The refusal of corruptive actors is also noticed in the M4W case. It really could be a problem for districts to get enrolled, and no real solution is given to it. Although the MoLG is thinking of putting penalties in place.

> *'We target incentives on the submission of these reports.' 'They have to use it, they do not have a choice, and otherwise the local government will be finalized. And that would be a disservice to your people. If you want to bring the services you have to submit the reports through Taarifa' (Data manager program support team MoLG, July 30, 2012).*

Also the Taarifa developers think this is an issue to be solved for the ministry and not part of the devices. They aim to develop a more transparent system.
They actually try to exclude corruption as much as possible. 'It is important to ensure that software is open to as little abuse as possible. The suggested method of doing so is by ensuring that all governmental actions are transparent to the public. This means, for a site such as Taarifa, that an administrator cannot delete any information, which the public has submitted.' (Glassberg-Powell, 2012)

> *'So that (referring to actors who do not want to participate because of the transparent character) is something that they need to deal with and get in the program, it is part of where we are going' (Team leader Taarifa, November 5, 2012).*

Overall, the interessement devices try to make the alliance as transparent as possible, but this might cause that some stakeholders will not enroll, since it counters their personal practices.

From the interviews it became clear that using the mobile phones with the optimized Taarifa website did not go unchallenged. Getting the devices enrolled is challenging.

**Device involvement - battery**

First of all, the battery lifetime of the smartphones is limiting. All interviewed people mention this. Going somewhere could take a whole day. While doing all the work they run out of battery. Some teams took several phones into the field, but in the future they will not go as a team but by themselves, which does not make this an option. This could be seen as a technological challenge, but also as a challenge to reach the field in a reasonable time span.

**Device involvement - Internet**

Secondly, there is the problem with the Internet connection. It is very weak in some places or not even possible to connect. Since a mobile optimized website is used, Internet is necessary all the time. Not only to submit the report, but also to access the form. If this is not possible it reflects on the trustfulness of the data.

> *'Sometimes we take a picture and submit once there is network again. The GPS coordinates are then taken from the point where there is connectivity. This results in mismatches between the project and the location' (Mukono monitor team, August 8, 2012).*

It would be very useful if the information can be captured offline. The ideal scenario, for them, is to take the picture and coordinates in the field, go to the office, fill in the other details, organize the data and send it all at once (Monitor team Wakiso, August 7, 2012).
The reason for MoLG and Taarifa to use a mobile optimized website is because the forms can be managed centrally, without the necessity of teams to first update an app or anything else. This assures that the right information is collected.
The initiating actors tried to solve this issue of constant need of Internet connectivity. The Taarifa team explained: 'The local government in Uganda asked for a feature which enables them to store reports on their phone when without internet connection for later upload. As the Taarifa platform is using a mobile optimized version of their website for reporting on the go this feature request got implemented using html5' s local storage and offline cache abilities'[32]. But it appeared that this solution did not work for the problem encountered by the MoLG. So it is not used in the current version. When asking the Taarifa team leader about this, it appeared that he was not aware of it.

**Device involvement - skills**

Besides the network and the battery lifetime, using the smart phone also asks for

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*32 http://taarifa.wordpress.com*

certain skills. People are not used to the phones. Training really helped them in using it, but still typing is hard and goes slowly. For large descriptions or other information they would like to have an option to record what people are saying, or connect it to a computer so they can type it. Also remarks were made that screens are too small and sensitive. But still they are a lot happier with this device than working with paper-based forms. So skills are necessary to use the phones, but with some training this is doable.

**Constrained by standardized forms**

The request for integrated voice recordings was not only referring to difficulties with typing. It also appeared that they collect information, which does not fit the standardized forms, but seems to be important. The MoLG responded that the information options of the standardized forms are sufficient. Being obliged to fill all the fields also solves the problem of the Ministry that sometimes paper-based forms were not fully completed. The reason for this might be that not all the fields are clear sometimes, or the district wants to add more information, which is not possible. An example is a question about the financiers of the projects.

> *'You can only fill in one financier, but some projects have more, or it changes over time. It is hard to capture the complex situation of financing in this one field. For example building projects might take a couple of years, depending on the money that comes in. Many buildings are not finished. It could be improved by adding the possibility of adding more financiers or describe it per phase of the project' (Monitor Team Wakiso, August 7, 2012).*

The standardized form which have to be filled completely before submitting constrain some users, but this suits the aim of the MoLG.

**Constrained by resources**

Finally some problems are encountered with lack of resources. This consists of the costs for smartphones. But this is supposed to level out with the costs they will save on traveling (to bring the paper-based reports to the MoLG) and the less people necessary to go into the field (since the picture provides the evidence). Only the district should recognize this as well.

> *'The challenge is how do we get local governments to budget for it. Because Taarifa is using Internet credits to submit the reports. How do you get them to appreciate the use of this, and incorporate it in their budgets? How do we cap down misuse of the phones, because you give somebody a smart phone, he gets excited. If they are wise enough they use it for other things, because there are a lot of things besides Taarifa. How to control that. If you put credit, how do you prevent somebody to use Facebook instead of Taarifa?' (Data manager program support team MoLG, July 30, 2012).*
>
> The districts mention that there is no funding to visit all the CDD projects. Logistics, to move into the field, are the problem. There are areas, which are very hard to reach.
>
> *'We also have islands, you can get there, but do not come back, because there is no transportation' (Monitor team Wakiso, August 7, 2012).*

And they encountered that the relevant persons were not always there when they arrived. Or the people of the project were scattered in the parish, which makes it hard to talk to them. So reaching the projects and budget for it is challenging.

**Revision of tasks**

District Mukono suggests that a revision of tasks of the stakeholders can make this logistical problem a bit easier.

> *'There are people there at the sub county level close to the projects. They should submit it to the district, they approve and then send it to the local ministry. So the district should be supervising and be supervised. It will give the right info at the right time' (Monitor Team Mukono, August 8, 2012).*

By moving the report-verifying-task from the MoLG to the district and the monitoring to the sub county level, also scalability of the project becomes more feasible, since the ministry will not have time to revise the thousands projects coming in. Also the district has more information to actually verify the reported data. This would also create more appreciation not to jump to the other stakeholders. The district has more possibilities to distribute it to their community, the Chief Administrative Officer, finance people etc. Information can be compiled and send at once. This prevents double work, because they have to do it any way for accountability. So according to

the district, people at the bottom should be empowered, and the district should get more control.

To summarize, the main challenge to get the district actors to enroll is getting them to shift to online communication, or the interessement device (the website) should be adjusted to their 'hard copy attitude'. This challenge will in the future also count for the citizens, who are expected to go to the website by themselves. This challenge links to the mismatch of design and the local actuality as defined by Heeks. The dimensions Information, Objectives and values, Technology and Processes play a role in this case.

Also the interests of the intended actors for the monitor team, which did not participate in the pilot, should be re-identified. The proposed revision of task already identifies some of the interests. Besides that battery and network issues should be solved to get the mobile phone enrolled (dimension Technology), and resources are necessary to go to the projects and to budget for the phone (dimension Other resources). Skills and standardized from do not seem to be the decisive constraints to finally reach enrolment.

## 4.4. MOBILIZATION

Since the full project is not in place yet, the phase of mobilization did not start yet. First the challenges at the district should be solved before they will mobilize others. The suggestion about the revision of tasks links to the mobilization phase. It is suggested that decentralizing the system will divide responsibilities in a more feasible way.

## 4.5. SUB CONCLUSION

From this pilot it appears that none of the actants, besides the initiating actors, are fully enrolled. This is due to the devices, which are not working properly yet (dimension 'Technology'), and are unable to enroll. Also because not all intended actors see the value of the network, like the political leaders and corruptive actors. The Ministry wants to put penalties to enroll them, but has to think about how to enroll more actors within the district then only the Department of Planning. Penalties will get the job done, but will not ensure that the intended actors actually participate. Their participation will be necessary for feedback to the community and action on reported faults.

It is questionable if staying with a fully online system will fulfill the identified interests and lock people into this alliance. This might be a too big shift from the current situation where not even email is used to communicate and where everything has to be reported hard copy (dimensions 'Technology', 'Information', 'Objectives and Values' and 'Processes').

Still the included actors in the pilot do see a lot of benefits in the Taarifa system, which keeps them connected to the alliance. Using the phone in the field is far more easy than using paper-based forms, and it goes a lot faster, since with one click it is send to the right persons (dimensions 'Information', 'Processes'). It also saves money and staff for fulfilling their monitoring task (dimension 'Resources'). The MoLG should consider the revision of tasks to a more decentralized level.

Finally the Taarifa team has to come up with a design to trigger comments on the reports and find a way to communicate the reports to the community. Right now it is challenging for the district monitoring team to reach all the remote places.

# 5. FINDINGS MOBILE 4 WATER

The second case of this thesis is Mobile 4 Water (M4W). The findings will be described as the previous case, using the four phases of Callon (section 5.1–5.4). This results in a sub conclusion presented in section 5.5.

## 5.1. PROBLEMATISATION

Mobile 4 Water (M4W) is an initiative of IRC /Triple-S, SNV, Makerere University College of Computing and Information Science and WaterAid in partnership with the Ministry of Water and Environment (MWE). These NGOs and Makerere University can be seen as the initiating actors of implementing the Mobile Sensor Web called Mobile 4 Water. They aim to 'improve functionality of rural drinking water sources' (Makerere University, 2012).

M4W should improve the functionality of this public service by improving information sharing between relevant stakeholders and accountability lines between them. To define who these relevant stakeholders are, the initiating actors first looked at the current service delivery model. They defined the challenges in this model and what interest every actor could have in the M4W system. This way the problematisation was made. From there they could establish themselves an Obligatory Passage Point (OPP) in this network of relevant actors. These steps will be discussed in more detail below.

### 5.1.1. DEFINED ACTANTS AND THEIR INTERESTS

To define which stakeholders should be involved in the alliance of the initiating actors, to improve the functionality of water sources, the initiating actors used the current Operation & Maintenance (O&M) framework, called Community Based Maintenance System (CBMS). 'The CBMS is the main service delivery model for rural drinking water services in Uganda, introduced in 1986' (Koestler & Lieshout, 2012). Table 4 describes the responsibilities of every actor according the CMBS. Figure 11 visualizes this framework with the solid arrows. The responsible actors are: the Water User, the Water User Committee, the Hand Pump Mechanic, the Health Assistant, the District Water Offer and the Ministry of Water and Environment.

Interesting to see in figure 11 and table 4, is that on every level of society people are responsible for the water service delivery. The water user has to pay for minor repairs, while the district budgets for major repairs. Policies are made at national level and the district and Sub County are responsible to carry out the different parts of these policies. The actual repairs of water sources are done by the private sector or local Hand Pump Mechanics.

The initiating actors had meetings with the defined relevant stakeholders of this system to discuss the mal-functioning of water sources. This highlighted that the Operation & Maintenance system is functioning poorly. Besides that the downtime of water sources was considered to be too high.

The initiating actors promote that the M4W system can improve these two things. M4W puts specific focus on the information related challenges, which are considered to be a big part of the poor functioning of the Operation & Maintenance system and the downtime of water sources. These information related challenges are:

1. 'Information from the Water User Committee at grassroots level is scarcely received and documented which makes it difficult for the other stakeholders to support the effective management of water sources and redress emerging issues;
2. Water sources often malfunction due to technical problems and climate conditions [like floods]. However, with timely access to this information it

is possible to make informed decisions to mitigate such risks and avoid the disastrous outcomes.

3. Information received from sub county extension workers and district staff is often inaccurate and hard to verify.
4. Most information collected by the different stakeholders is neither shared, nor updated regularly which makes the plans and strategies based on irrelevant [information] to the rather dynamic functionality of water sources.'

(Wakholi, 2012)

So timely access to information, more accurate data and more information sharing should improve the downtime of water sources and improve the O&M system. This should add to better functioning water sources.

The initiating actors of M4W translated these encountered challenges to a Mobile Sensor Web, called the M4W system, which should connect to the interests of every stakeholder. The last column of table 4 shows this translation from the challenges to the interests of the relevant stakeholders. It indicates which information the stakeholders would like to get, according to the initiating actors, in order to perform their task as defined by the CBMS-model. But also other interests are identified which should bind the stakeholders to the alliance of M4W. For example the Ministry wants accurate information about the status of the water sources and a cheaper way to perform monitoring tasks. While the levels below the ministry are supposed to like the M4W system because 'it will improve accountability between users, local government and the artisans responsible for repairs as their actions can be tracked and results publicly made available. This increased accountability should improve the engagement of the consumers with their drinking water services, resulting in a higher willingness to pay', which is beneficial for the Water User Committee (Makerere University, 2012).

Interesting to see, is that the private sector is excluded from the network, while this sector is included in the Community Based Maintenance System to carry out repair work (see table 4). In the intended M4W alliance the Hand Pump Mechanic is responsible for all the repair work. They are not part of specific companies, but voluntary community members. Next to the M4W initiative, SNV is supporting the attempt of several Hand Pump Mechanics to form associations, which can also be registered as companies. (SNV, 2012) This way the district can assign paid jobs to them. This does not mean that other actors in the private sector, providing repair services, cannot disassociate the Hand Pump Mechanic included in M4W.

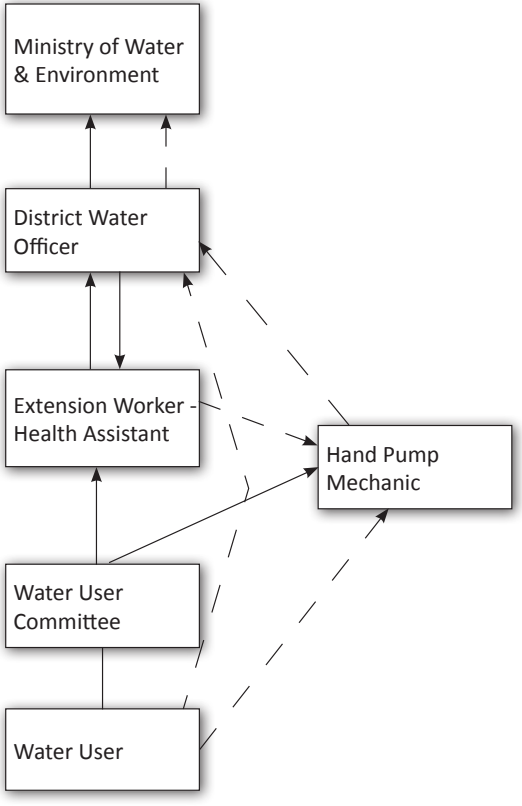


*Figure 11: solid arrows, current information flows in CBMS, dashed arrows, new info flow by M4W (Makerere University, 2012).*

| ORGANIZATION / LEVEL | ACTOR | TASK ACCORDING TO THE CBMS MODEL (FIGURE 13 SOLID ARROWS) | WHAT THE ACTOR WANTS, ACCORDING TO THE INITIATING ACTORS OF M4W (FIGURE 13 DASHED ARROWS) |
|---|---|---|---|
| **National** | Ministry of Water and | - 'Policy formation, legislation, regulation, setting standards and guidelines for Operation & Maintenance<br>- National level planning and budgeting for O&M, mobilization of funding, capacity building of local governments, supply of inputs and implementation.<br>- Ensuring that policies are followed, and approaches used contribute towards the attainment of sector objectives'.[3] | Up to date data for the water atlas[1,2,6,7,8,9]<br>Cost reduction on their sector monitoring task[1,2,9] |
| **Private sector** | Companies | 'Carries out maintenance and repair work. It supplies and distributes inputs and spares-parts as well as undertaking community mobilization and training'.[3] | |
| **NGOs and Community Based Org.** | SNV, WaterAid, .... | 'Finance construction and maintenance of water facilities and are also involved in capacity building of Local Governments and monitoring the functionality of water facilities and conducting studies'.[3] | - Make M4W function, by capacity building of the actors[1,6,7,9]<br>- 'Real time information to monitor actions to improve functionality<br>- Trigger action for response on non-functional water points<br>- Information sharing and learning among stakeholders<br>- Equity in resource allocation<br>- Innovative and sustainable solution<br>- Advocacy and people empowerment'[10] |
| **District** | District Water Officer | 'The district budgets for major repairs/rehabilitation; provides the required guidance and supervision in ensuring established standards for O&M; responsible for routine water quality monitoring and performance of O&M; plans for and co-finances training Hand Pump Mechanic, plumbers, masons and scheme attendants and provides tool kits for O&M and stocks spare parts'.[3] | Information about the current status of actions of Hand Pump Mechanic and water source functionality so they can generate at any moment, a full status report, which has real time status information on all the water sources in the district. [1,5] |
| **Sub County** | Health Assistant | 'The sub county prepares plans and budgets incorporating O&M aspects and supervises the private sector carrying out such activities. The sub county should hire and train Hand Pump Mechanics or Scheme Attendant and provide custody for the tool kits. It should also enact by laws on O&M'. [3] | Information about the actions of the Hand Pump Mechanic [1,3] and functionality of the source[3] |
| **Sub county** | Hand Pump Mechanic | The role of Hand Pump Mechanic in CBMS is rather unclear, besides repairing the water sources. | Information of where to go for assessment, so they can repair malfunctioning sources. [5,6,8,9] |
| **Community** | Water User Committee | The Water Using Committee consists of elected people from the community. 'The committees collects fees at the households' for minor repairs. Their further role in CBMS is unclear.[4] | Increased engagement of consumers with their drinking water services so that they are willing to pay.[1,6] |
| **Community** | Water User | 'The community is responsible for management and maintenance of their water facilities. It does this through participation in planning and contribution of O&M funds for preventive maintenance and repairs as well as payment of the caretakers'.[3] | Possibility to report directly faults to the Hand Pump Mechanic [5,7,9] assuming that this will result in repairing of the water source]. Know where money is going and which actions are taken [1,3,4,8,9] – improved accountability lines. |

*1: Makerere University, 2012*
*2: Wakholi, 2012*
*3: Presentation Triple-S, 2012*
*4: Koestler & van Lieshout, 2012*
*5: Interview, PhD, July 17, 2012*
*6: Interview, PhD August 22, 2012*
*7: Interview, National learning facilitator, Triple-S, July 30, 2012*
*8: Conversations, National learning facilitator, Triple-S, September 4-7, 2012*
*9: Conversations Senior Advisor WASH – SNV, September 4, 5,6 and 7 2012*
*10: Presentation M4W*

*Table 4: Actor's responsibilities in Community Based Maintenance System and interests as defined by the initiating actors towards M4W*

The defined interests of table  result in a new intended way of organizing the information flows as shown in figure 11. The solid arrows indicate the current flow with the Community Based Maintenance System, the dashed arrows the information flows as intended to create by M4W. It is a way to build the system of alliances based on their identified interests. So the water user can directly contact the Hand Pump Mechanic and the District. Also at sub county level contact with the Hand Pump Mechanic is improved. The solid arrows will still be there in the new system because of other current tasks or personal contact, which is already present.

Remarkable to see in this information flow scheme is that the initiating actors only indicate the flows from the bottom to the top. While it is intended to let the system give feedback to the information providers as well. This programmed feedback is discussed in the next phase of Callon, since it is related to the interessement devices. So based on figure 11 provided by the initiating actors, one could think that less focus is put on the feedback information. This could possibly weaken the network.

### 5.1.2. OBLIGATORY PASSAGE POINT

Overall many translations are made by the initiating actors. First the stakeholders of the current Operation & Maintenance system are identified together with their current challenges and interests. This is a translation from the question 'how can we improve the functionality of rural water sources' to the assumption that the stakeholders of the CBMS-model are the most relevant stakeholders to solve this question. Defining the actors in such way could fit the 'Management Structures' dimension of Heeks, since the CBMS-model defines this structure. It also fits 'Processes' and 'Staff', since it looks at the actions performed by the users.

Secondly the challenges of these stakeholders are translated to the question 'How can we improve the information flows between the stakeholders of the Community Based Maintenance System (CBMS)?' With this question the initiating actors also want to improve accountability lines between stakeholders. This fits to the dimension 'Information' since a change is intended in the information flows.

The initiating actors assume that all the actors in the current CBMS have a benefit in solving this question, since it links to the challenges mentioned above. The development of the M4W system should answer this question by improving the information flows, and keep the actors together. This way they made themselves an Obligatory Passage Point to the other actors.

### 5.1.3. POSSIBLE THREATS TO THIS ALLIANCE

Based on the identified translations several threats for the defined alliance come to the surface. These threats are not discussed in the Taarifa case, since the included actors of that pilot stick to people within the government. So less people have to be locked in.

First the exclusion of private companies might threat the M4W alliance. If the district hires people outside the network to do the job this will not be registered by the system and Hand Pump Mechanics are out of jobs.

Secondly the initiating actors chose to use the CBMS-model, but there are more service delivery models uses in Uganda. For example the WSSB (Water Supply and Sanitation Board) is a stakeholder of water delivery services as well. The network they are in 'was originally designed for small towns but later adapted to smaller piped water schemes. It has a separation of management, operational and authority functions and with aspirations for higher private sector involvement in the drinking water sector' (Koestler & Van Lieshout, 2012). This system involves other actors than the Community Based Maintenance System. Actors from the WSSB might want to connect to users in de M4W system, which could be a threat for the stability of the network. How many other O&M systems there are rolled out within Uganda is unclear, but the differentiations between these systems will mostly be on actors on parish and village level. So actors on this level of the network might be harder to lock in. The M4W should use such strong interessement devices in order to present that actors outside the defined network will not threat the M4W system.

## 5.2. DEVICES OF INTERESSEMENT, LOCK THE ALLIES IN PLACE

During the interessement phase it is attempted to impose the previous defined interests, as shown in table 4, on the actors, to stabilize the alliance. This is done by interessement devices, which draw on the actors' interests and link them together. So in this case devices are used to improve the information flow and accountability line of every actor as defined in table 4. Without the devices this connection would not be possible.

For example the Hand Pump Mechanic and the Water User are linked by mobile phones, while they could not reach one another before. The possibility of this communication should prevent the Water User to get linked to any other "threatening" entity outside the network.

Besides mobile phones M4W uses a database, online dashboard and website to put the network in place. Figure 12 shows how these interessement devices are put in place to build the alliances. The next sections explain the interessement devices in more detail. The database is not discussed on its own, since this device manages all the information, and is an intermediary between the other devices. So information send by a mobile phone goes 'through' the database, which forwards it to the relevant devices, like another phone or the dashboard. Figure 12 shows the created information flows between actors through the devices. Figure 13 illustrates the process described in the following sections. The added numbers in this figure refer to the numbers in the text.

The following description is based on the following sources: Makerere University, 2012; Wakholi, 2012; Interview, PhD, July 17 and August 22, 2012; Interview, National learning facilitator, Triple-S, July 30, 2012 and September 5; Conversations Senior Advisor WASH – SNV, September 4, 5,6 and 7, 2012. Since they all explained the system in a similar way no specific sources can be identified for each paragraph.

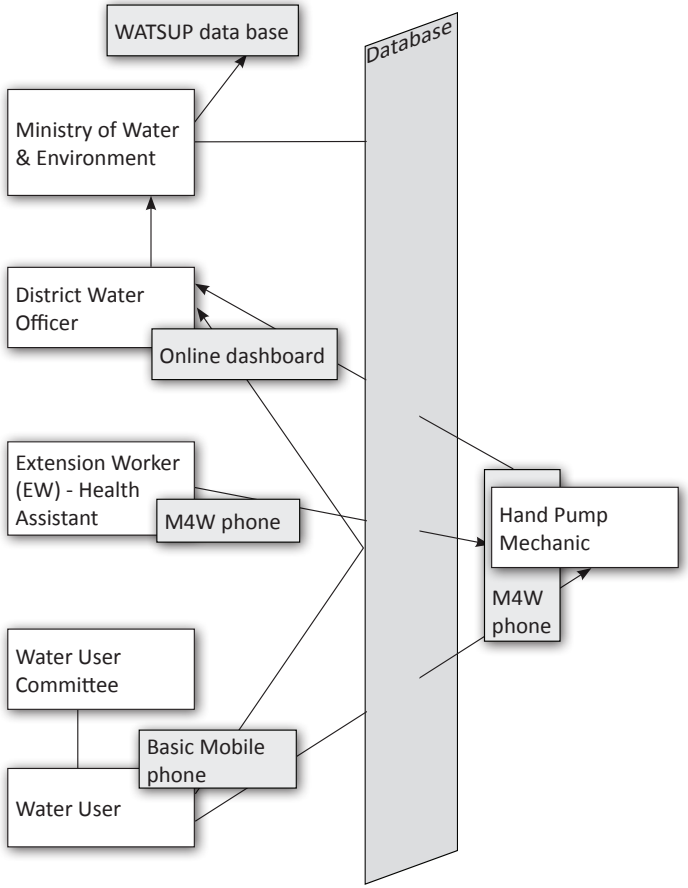


*Figure 12: interessement devices are put in place to build the alliances, using the defined interests of every actor.*

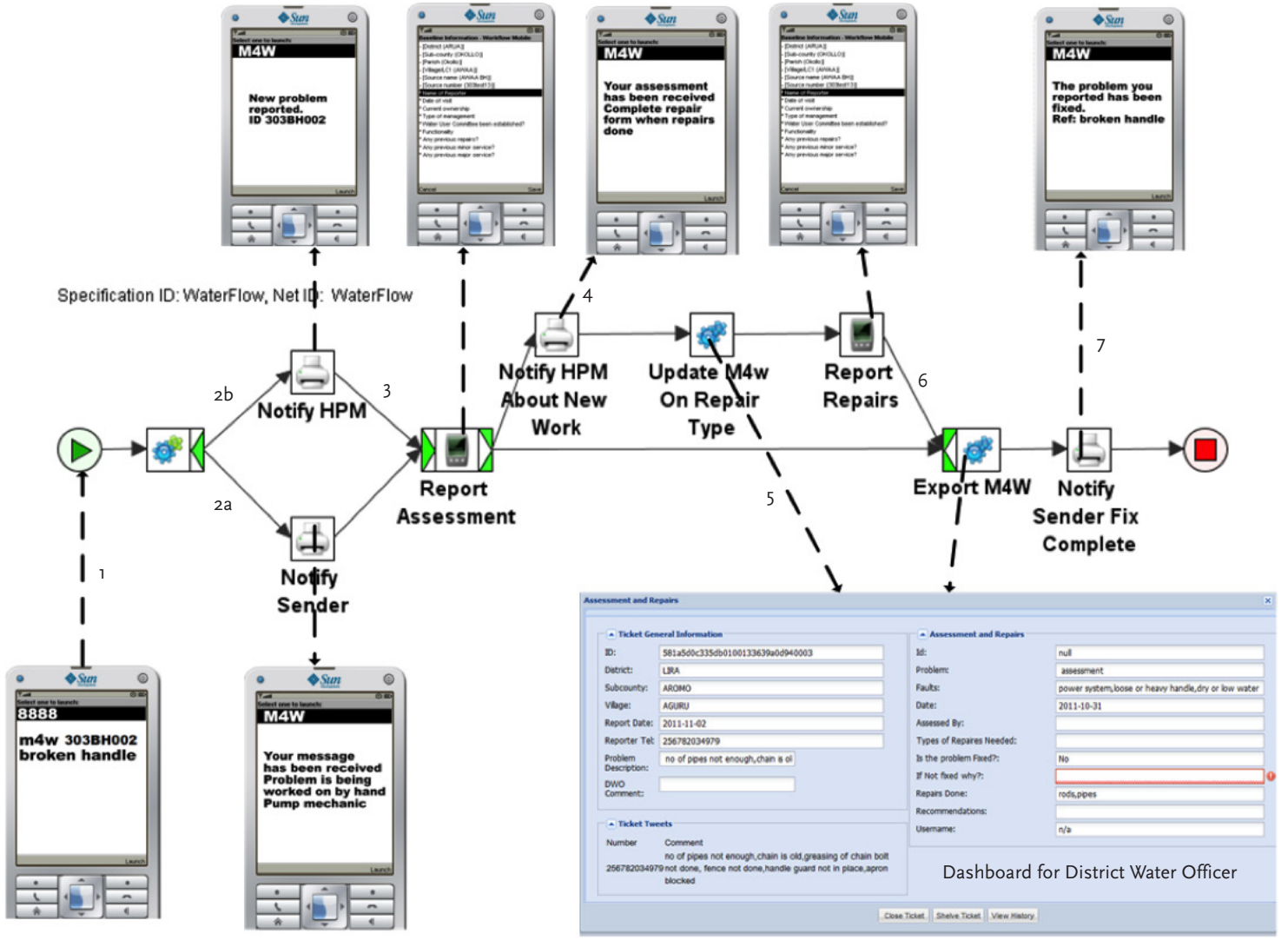


*Figure 13: interessement devices are put in place to build the alliances, using the defined interests of every actor. The numbers refer to the numbering in the text (Makerere University, 2012)*

### 5.2.1. BASIC MOBILE PHONE AND THE WATER USER

1. The system starts with the water user, who is enabled by M4W to report a problem by sending a SMS with his mobile phone to 8888. This SMS needs to contain the ID of the water source and the problem. This is explained to the user by a sticker on the water source itself. Also this sticker could be seen as an actant.
2. The database receives the SMS, and creates a ticket for the report. This ticket can be followed by the District Water Officer on the dashboard. The database also sends a SMS of the report to the Hand Pump Mechanic (figure 13, b), and a SMS back to the water user that the report is received (figure 13, a). This way the water user can directly send its demand to the Hand Pump Mechanic and the District Water Officer, which was not possible before. The possibility to demand for a repaired water source should lock the water user in the alliance.

### 5.2.2. M4W MOBILE PHONE AND HAND PUMP MECHANIC

3. The Hand Pump Mechanic has a featured phone of M4W (see figure 14). This way he can directly receive the reported faults out of the field. Information he could not get before unless he went there personally. When receiving a report from a water user, the Hand Pump Mechanic will go to the water source to make an assessment of the problem. His phone contains a Java application with different surveys and all the pending reports. In this case he needs the assessment survey. He fills the questions of this survey on his M4W phone. The Water User Committee can provide information to the Hand Pump Mechanic if needed.
4. Since the information of the assessment in entered in the phone it can directly be send to the relevant stakeholders. This holds feedback to the Hand Pump Mechanic that his assessment has been received (4) and information to the dashboard, which enables the district to track the actions of the Hand Pump Mechanic (5).
5. If the water source can be repaired right away the Hand Pump Mechanic can close the ticket. If not a repair form will be created, which asks follow up action

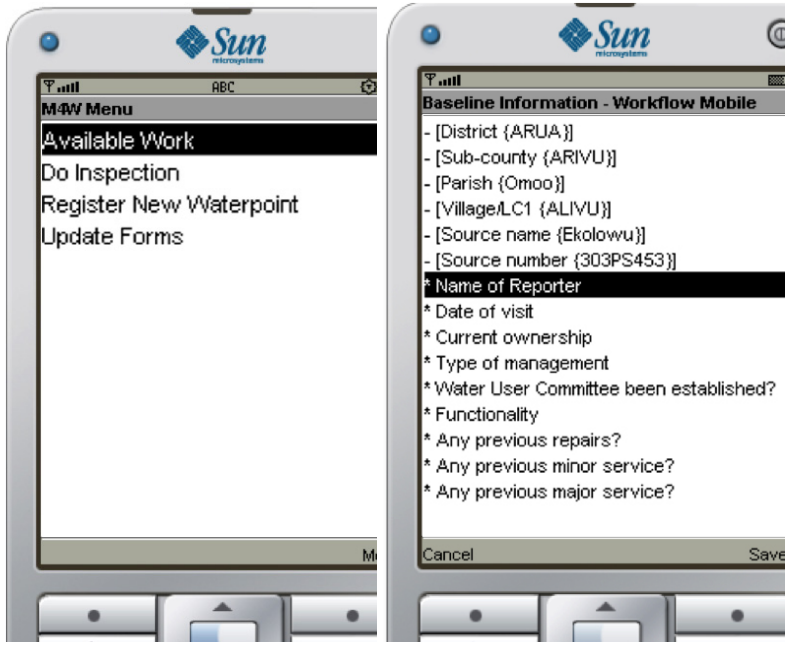


*Figure 14: The M4W mobile phone with the java application, used by the Hand Pump Mechanic and the Health Assistant (Makerere University, 2012).*

from the district. Because all information on the status of assessment is shared with the district through the dashboard, it is easy to keep track of the actions.

6. Once a ticket is closed this will be send by a SMS to the water user who reported the problem. So feedback is given with an automated message.
7. This way of receiving a report of information makes the work of the Hand Pump Mechanic far more efficient. Before he had to visit the water sources to know it states. This benefit of M4W should lock him in the alliance.

### 5.2.3. M4W MOBILE PHONE AND THE HEALTH ASSISTANT

If the Hand Pump Mechanic does not go for assessment within 48 hours the database will send a SMS to the sub county, this M4W mobile phone is managed by the Health Assistant[33]. He will contact the Hand Pump Mechanic why no action has been taken yet. This way also the Health Assistant is informed about the actions of the Hand Pump Mechanic. If the Hand Pump Mechanic is performing well the Health Assistant will not be informed by the system. In case of collecting baseline information the Health Assistant has a more prominent position. This will be explained in section 5.2.6.

### 5.2.4. DASHBOARD MANAGED BY THE DISTRICT WATER OFFICER

As mentioned in the previous sections the District Water Officer receives a lot of information on the dashboard about activities performed by the Water User, Hand Pump Mechanic and Health Assistant. This should be of such an interest that it would bind him to the alliance.

### 5.2.5. WATER ATLAS AND THE MINISTRY OF WATER AND ENVIRONMENT

Finally all checked information will be put publically online and in the future it will be synchronized with the Water Atlas of the ministry. The Water Atlas is a publicly available, online database, which contains information about the water sources in whole Uganda. The Water Atlas is synchronized with the WATSUP database. Since M4W aims to provide very accurate information this will improve the information of the current Water Atlas, which is of specific interest for the MWE.

### 5.2.6. COLLECT BASELINE INFO

With the start up of the system and the first pilot, baseline information of the water sources had to be collected. Baseline reports check the status of the water sources reported in the Water Atlas of the Ministry. It checks if this information is correct. This process is similar as when a water uses reports a fault, only in this case reports do not come from the water users, but the District Water Officer assigned jobs to the Hand Pump Mechanic. So the dashboard enables the district to directly assign jobs to M4W phones, managed by Hand Pump Mechanics and Health Assistants.

The Hand Pump Mechanic receives an SMS with the job and goes into the field to collect the information of all the assigned water sources. After finishing the baseline surveys, the Health Assistant at the sub county is noted by an SMS. The Health Assistant is assigned to verify the received information by filling in the inspection form on his M4W phone.

So in collecting baseline information the Health Assistant has a more prominent job, since he has to check information. Only after verification the information can be used for the Water Atlas of the ministry. This way M4W enables effective monitoring of the water sources by giving the responsible persons devices to do this more efficient and track actions of others to whom they assign jobs. Appendix A contains the different surveys on the M4W phones en shows close ups of the mobile phone interface.

(Interview, PhD, July 17 and August 22, 2012; Interview, National learning facilitator, Triple-S, July 30, 2012 and September 5, Conversations Senior Advisor WASH – SNV, September 4, 5,6 and 7, 2012)

In summary, the interessement phase shows in what way the use of these interessement devices should lock the actors in place. The devices (dimension 'Technology' of Heeks) and corresponding actions (dimension 'Processes') are intended to improve information accuracy and sharing (dimension 'Information'), which connects to the interest of every actor as defined in table 4.

The new possibilities of this alliance, like communication with actors, which were out of reach before, should prevent actors from connecting with people outside this defined network, which can threaten the stability of it. Still this threat is there, since more O&M systems are active in Uganda and the ministry gets many offers from other NGOs or companies with similar systems, as described in section 5.1.2.

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*33 The Health Assistant could also be a Community Development Organizer or any other Extension Worker. For the clarity of this thesis only the term Health Assistant is used.*

## 5.3. ENROLMENT

During the pilot in seven districts it should become clear if the actants accept their defined role, and whether the interessement devices lock the allies as intended; do the socio-technical hybrids enroll? Interviews with all the described actors clarify how they experienced the pilot and whether they enroll or not. The description of the Water Users is based on interviews with the other actors and documentation as indicated in appendix D.

### 5.3.1. INITIATING ACTORS

Although the NGOs and Makerere University are not directly included in the M4W alliance by interessement devices, they are very important, since they help in building capacity of the other actors. They provide trainings about the devices and advocate the system at the ministry. Also the database is managed by Makerere University. Over time they do not intent to be part of the alliance anymore. In theory this should not threat the network, but without checks from the NGOs it could be imagined that their exclusion will weaken the system.

### 5.3.2. MINISTRY OF WATER AND ENVIRONMENT

The Ministry of Water and Environment is not contacted during this research, since the link between the M4W database and WATSUP (Water Atlas) database is not realized yet. To make this connection possible, at least the verification procedures of the collected data should be very clear.

**More accurate data**

From the collected data during the pilot it already shows that '19 % of the sources identified by M4W were not entered in the WATSUP database' (Makerere University, 2012; Wakholi, 2012). Such results can have big consequences to the responsible actors because correct information is their responsibility. So verification of the numbers is important. M4W initiators note in their briefing report that 'the verification should be carried out under the responsibility of the District Water Officer, who can delegate to the sub county level. The data that has been uploaded by the Hand Pump Mechanic should not be approved before it is validated by the Health Assistants supervising the Hand Pump Mechanic. Clear guidelines for verification also need to be provided to the district water office, like sample size, and methods such as physical visit and verification by phone' (Makerere University, 2012). These are all future implications, which do not change the pilot set-up a lot.

**Cost reduction**

Besides improvement on the verification system, the pilot suggests that it is indeed possible to reduce the costs of monitoring. Wakholi (2012) reports that 'it has been projected that 785.2Million Uganda shillings would be required for initial nationwide deployment of the system. Subsequent data collection would cost an estimated 303.2 million shillings making regular data collection a more viable venture and creating savings and efficiency in data collection, because right now such efforts cost approximately 2,5 billion shillings and the exercise has only been done twice since 2000. The latest being 2010' (Wakholi, 2012).

These should be convincing reasons for the Ministry of Water and Environment to join the alliance. Other challenges or demands that will hold the MWE from joining this alliance do not show from this thesis. Only that many initiatives like this take place, so to keep them interested only in this system might be challenging.

### 5.3.3. DISTRICT WATER OFFICER AND THE DASHBOARD

The enrolment of the District Water Officers differs per district. During the start-up of the project it already became clear that the districts reacted to the project in different ways. Some really focused on their own benefit, while others thought more of the system as a whole (Senior Advisor WASH – SNV, September 6, 2012).

**Personal benefit, attitude and corruption**

The assistant District Water Officer of Kasese really likes the system, and underlines the defined interest of wanting to have accurate information about the water sources, and improved accountability lines:

> *'Using this system has improved accountability. At times people ask questions about some water facilities and you are not aware. But now we can make sure that they*

*are functional' (Assistant District Water Officer Kasese, September 4, 2012).*

In this case using the new online dashboard is not a problem. It enables her to get the accurate information.

*'The more you love your work, the easier it becomes to me. I got used to the system and you do not always have to check how these water points are functioning. So you'll love the work and you'll enjoy it' (Assistant District Water Officer Kasese, September 4, 2012).*

In Masindi it appeared to be more challenging to get the District Water Officer being part of the alliance. A Senior Advisor in Water and Hygiene Sector of SNV tells that first the inclusion of the district went very well, but after some time it stopped because results of the system did not fit the interests of the District Water Officer.

*'50% of the water sources were collected in one week. Then all the sudden it stopped, because corruption was exposure. Around 180 fake water points were in the Atlas, which the Hand Pump Mechanics could not find. So them [referring to the district] willing to cooperate is a challenge' (Senior Advisor WASH – SNV, September 5, 2012).*

Also a PhD'er at Makerere University, working on M4W, notices this corruption problem.

*'They have to see a benefit to join. If the benefit is not for them, they will not use it. If you falsify figures, you get more funding. So that is common practice here. Ghost schools, ghost hospitals, ghost water sourcing' (PhD, July 17, 2012).*

He also mentions that the information, which the District Water Officer receives on the dashboard from the field, is not always used;

*'There is no compulsion to use it, since it is about public services. It is in the countries so public servants really do not care about it. That is a challenge. That is why we to organize imposed guidance' (PhD, July 17, 2012).*

So joining the alliance in the end comes down to the attitude and interests of the individual public servant. Corruptive practices are a huge constraint in this case.

**Skills**

Besides that, other challenges are found in the required skills.

Training is necessary to teach District Water Officers how to deal with the dashboard.

*'It really differs per person how fast they pick it up' (Senior Advisor WASH – SNV, September 5, 2012).*

*'Additional training was necessary in some districts' (Makerere University, 2012).*

**Resources**

To be able to use the dashboard the District Water Officer does not only depend on skills, having a computer and Internet might be even more important. This is possible but maybe not always in the most efficient way:

*'The district has access to the Internet, but they do not always have resources in the offices. Still they will be able to get the information, that is not a problem' (PhD, July 17, 2012).*

From the districts visited the possible accessibility was underlined, but it might be different in the North of Uganda where there is more poverty.

Beside the computer there should be budget at the district to do all the intended actions. 'One of the recommendations that are made by some of the District Water Officers of the pilot districts is that their budgets should have an allocation to facilitate activities needed to use the system. This would include a budget to organize follow' up team meetings and training of the stakeholders' (Makerere University, 2012).

The last two challenges, skills and resources (also mentioned by Heeks), link to the first challenge, 'personal benefit and attitude' (dimension 'Objectives and values'). If the District Water Officer is willing and sees the benefits he will put more effort in learning to work with the dashboard. The inclusion of the initiating actors is very important to this part. They build the capacity of others and motivate people to use it (dimension 'Skills' and 'Processes'). Resources like hardware, but also budgets for necessary activities, also link to the previous indicated challenges. If the District Water Officers see the benefits of implementing the system, they will probably try to get the budget for it, if they do not see any benefit it will be left aside and focus is on other projects (dimension 'Resources').

### 5.3.4. HEALTH ASSISTANT AND M4W MOBILE PHONE

From the conducted pilot it appeared that the Health Assistants did not perform as well as most Hand Pump Mechanics. They were lacking behind in doing inspections (so checking the baseline information send by the Hand Pump Mechanic). Question is what their position really means within the alliance. Does the defined interest fit with the reality, and is this sufficient to lock them into the network? An interview with the Health Assistant of sub county Watiti clarifies this situation. These reasons were recognized by people from SNV as being important for other sub counties as well.

**No new information and lack of feedback**

First of all the Health Assistant indicated that the system did not meet his expectations. He does not get enough feedback or results.

> *'What my expectations were, that if I send information, if there is a problem with the water sources. I expected that at least in the long run, I would get feedback. I don´t know the reason why they collect this information, because we don´t see anything. What we told the community, once we put the stickers, is that when they had problems, send the information, the SMS, that we shall be able to get assistants or support from our funders. Or in the long run, but I have never seen it. So I am wondering what is happening. So sometimes some members fail the formality to collect data and send information' (Health Assistant Watiti, September 5, 2012).*

Secondly, M4W does not give much new information, which he could not get before. So what would be his actual benefit then?

> *'As far as the district is concerned. The mobile phone has not helped; it has not changed anything, to be honest. Because any information we share with the District Water Office is on paper, is in forms' (Health Assistant Watiti, September 5, 2012).*

**Fits with existing responsibilities**

He does experience some benefits from the system, but these are rather small. They connect to already existing practices.

> *'Hmmm, what can I say. It gives you time, to go, and do much about it. At least you can trace the problems, I need to go there, and do something about it. And at least we are trying to bring the Water User Committee back, and face the challenge of attitude' (Health Assistant Watiti, September 5, 2012).*

He indicates that checking the functionality of the Water User Committee, which is part of the inspection, is an important element of their position in the network. This is something he adds to the M4W alliance and where he feels appreciated.

> *'For Hand Pump Mechanics it might be hard to trace the functionality of the Water User Committees. They reach the water source and sometimes they don´t look for the sanitation manager about the water committee. So for us as extension workers, we can assess that and most water user committee members will know that' (Health Assistant Watiti, September 5, 2012).*

**Improved contact with Hand Pump Mechanic**

Besides the already existing activities one benefit is mentioned which he did not have before, namely the connection to the Hand Pump Mechanic is improved.

> *'I only know one Hand Pump Mechanic if there are more I am not aware of that. There is more coordination between us' (Health Assistant Watiti, September 5, 2012).*

This should be a big benefit of M4W, since it improves the accountability line between the Health Assistant and the Hand Pump Mechanic, but he did not really seem to experience it that way, as also shows from the way he expresses his non-awareness of possible other Hand Pump Mechanic. Apparently he is not really associated with his task of the CBMS-model to hire and train Hand Pump Mechanics.

These findings show that there are no real big benefits for the interest of the Health Assistant identified. This gives him a rather weak position within the M4W alliance. Especially if one imagines what is necessary to let him perform his defined task. This weak position is made weaker by the following challenges.

**Lack of Resources**

Resources are necessary to visit the water sources for inspection, but there is a lack of this. This keeps the Health Assistant of visiting them all. He just verifies some information from the Hand Pump Mechanic without checking.

> *'I pick some because you might get five source, scattered in different areas. To reach*

*all of them is costly. So it becomes hard to reach all the systems' (Health Assistant Watiti, September 5, 2012).*

**Skills**

Besides that the Health Assistant does not only have to go to the water sources; he also has to use the mobile phone.

*'Filling one page on one water point takes a long time. It contains a lot of questions. So if I have a lot to do, sometimes I fail doing it'. [..] Also 'sending sometimes give me a hard time. You send and it bounces, you send and it bounces and you end up giving up' (Health Assistant Watiti, September 5, 2012).*

These technological challenges do not strengthen the already weak position within the alliance. It will really depend on personal attitude whether he will continue in fulfilling his part in the network.

So the interview with the Health Assistant in Watiti indicates that the system demands a lot from him and the sub county, like resources, time and skills (similar dimensions of Heeks), while he does not receive much back. There is no feedback to his submitted inspections and he does not get much new information (dimension 'Information'). Only the coordination with the Hand Pump Mechanic is improved and M4W gives him reason to check on the Water User Committee, which is part of his position anyway (dimensions 'Processes' and 'Management structures'). It depends on the person whether these benefits are sufficient to overcome the indicated actions that M4W devices requires from the Health Assistant (which request 'Skills').

From previous research it was concluded that 'there are indications that the sub county still see themselves more as scheme managers than service authorities. [..] they did not seem to have a clear vision and awareness about their responsibility beyond the consumers served by the water supply scheme' (Koestler & van Lieshout, 2012). This might also be part of the problem of their position in M4W. If they do not see themselves as an authority, being responsible for the Operation and Maintenance of services in the sub county, they will not feel the urge to show their accountability towards this position.

### 5.3.5. HAND PUMP MECHANIC AND M4W MOBILE PHONE

Three Hand Pump Mechanics are interviewed. One who was performing really good and finished all his baseline surveys, which is his task assigned by the district. He has to go to the water source, check if it is there as indicated by the Water Atlas, and fill a baseline questionnaire on the M4W phone. He was from sub county Muhokya, district Kasese. One who did not perform so well sub county Lake Katwe, district Kasese, and the chairman of the Hand Pump Mechanic Association of Kasese district. The following paragraphs discuss their findings after this first pilot.

**Improved information**

All recognize the benefit of M4W, as defined for them by the initiating actors, namely getting reports from the citizens so they know where to go.

*'This phone helps me to know where the tap stand is broken whether there is damage somewhere. When people do not have water, they send, they also become happy' (Hand Pump Mechanic2, September 5, 2012).*

Since the Hand Pump Mechanics have between 40-80 water sources to assess in a wide area it really is beneficial for them to know where to go.

**Improved knowledge and skills**

Other benefits which lock them into this alliance, is that they receive trainings, which increases their changes to earn money with it, since most Hand Pump Mechanics are working voluntarily for the community. Although gaining these skills can also be challenging.

*'The Hand Pump Mechanic are not used to the technology, to the phone. All they do with the phone is call and receive. Some do not even send messages. So that is a problem. It takes longer then the three months we estimated it to take, because the Hand Pump Mechanic needed a lot of support' (National learning facilitator Triple-S, July 30, 2012).*

Next to this it is challenging that they will not admit if they do not understand the training.

*'The Hand Pump Mechanic did not speak openly that they did not understand the system. So we found out that there were lacking behind in collecting data' (Assistant*

*District Water Officer Kasese, September 4, 2012).*

For elderly Hand Pump Mechanics it is more challenging to use the mobile phone.

> *'They are not always able to read or fill it in. But we are seeing how to mobilize them. If he can have somebody to assist him in read and write he can assist the Hand Pump Mechanic in delivering the data. But if he cannot find anyone, we engage another person' (Assistant District Water Officer Kasese, September 4, 2012).*

'In principle they can also enter information in any local language, but the questions and format remain English. The Hand Pump Mechanics are encouraged to find their own solution, for example by asking a family member (often a child) to help them use the phones. In the longer run it may need to be considered to include basic English in the capacity building package of the Hand Pump Mechanics' (Makerere University, 2012). So the user is requested to adjust itself to the technology.

Overall gaining skills could be a challenge, but most Hand Pump Mechanics benefit from the trainings. So if they are willing it should be possible to learn how to use the phone.

**Improved accountability**

It also gives them an opportunity to show how much work they are actually doing for the community. As Senior Advisor in WASH of SNV noticed:

> *'They were already doing their job, but now they get the credits for it, because they can report on their actions' (Senior Advisor WASH – SNV, September 5, 2012).*

**Personal attitude**

But to perform their part within the system, they face many challenges. It was noted by SNV that it comes partly down to personal attitude or personal situation how willing they are to solve these challenges.

> *'It depends on local heroes, are they willing to learn and put some work in it' (Senior Advisor WASH – SNV, September 5, 2012).*

This is similar to the challenge of the District Water Officer, although the Hand Pump Mechanics are not expected to directly encounter real disadvantages from the system, as might be the case for corruptive district people.

**Different areas, different challenges**

From the interviews it appeared that the difference between the performances of Hand Pump Mechanic does not only rely on attitude, but also on the area where they operate. Some sub counties have many shallow wells and springs, which are mostly in the mountains, which makes them harder to reach. A sub county with mostly taps will be easier to serve, also in the sense of necessary repairs.

> *'Yes, you know because for us here we do not have a lot of boreholes, we have taps. So it is easy, you go there replace and done' (Hand Pump Mechanic1, September 5, 2012).*

*Figure 15: Four different water sources are shown; a gravity flow scheme tap stand, a rain water tap stand, a bore hole and a natural spring with a water reserve. The accessibility and repair activities differ between the water sources.*

or something else, this is too demanding. 1500 Uganda shillings are offered by the project as compensation for each source reported, but this is insufficient, especially for the more remote places.

Besides lack of transport other lack of resources constrain the Hand Pump Mechanic to do his job.

> *'Access to spare times is a bigger problem than money. The market of parts is a monopoly. Distribution is very hard. It stays in stock or only the fast replaced parts are delivered, since they make more money out of that' (Senior Advisor WASH – SNV, September 4, 2012).*

'As individuals, Hand Pump Mechanic rely on local shops and they cannot benefit from economies of scale, which increases the costs of these spare parts. They have limited access to tools, financial services, subsidies and knowledge' (Hand Pump Mechanic Association improving rural water service delivery, 2012).

So also tools and protection (like hand gloves) are lacking. All actors in the network mention this. The Health Assistant explains that:

> *'Hand Pump Mechanic used to get some tools. But when I consulted for it they said that it got lost in the field. And the tools were expensive; they could not put more money into it' (Health Assistant Watiti, September 5, 2012)..*

**Technological challenges**

With respect to the technology the initiating actors mention four main issues. These make it hard to enroll for the technological actant.

Sometimes the server is down, and the phones cannot connect (Makerere University, 2012)

> *'Hand Pump Mechanic put their own SIM card in the M4W phone, this changes the settings. If they put the other one back again then you do not know that it is changed. You are not able to troubleshoot that. They are not allowed to change SIM cards, but they do. They change the battery. If they have weak batteries then they use this one. Again the phone loses its configurations. Shortcuts are easy to remove, which causes that the Hand Pump Mechanic do not know where to go on the phone' (PhD, July 17, 2012; National learning facilitator, Triple-S, July 30, 2012; Senior Advisor WASH – SNV, September 4, 2012).*

These challenges are mismatches between the user and the technology.

Also the Hand Pump Mechanics themselves experience that the battery of the phone is rather weak, it holds for 2 or 3 days.

> *'So it makes my work difficult, because every two days you find me charging. Even if I am not using it' (Hand Pump Mechanic1, September 5, 2012).*

Since in some areas there is no electricity, people have to go to charging shops, where they have to pay to charge their phone. This might be the reason why they experience 2 or 3 days as too weak and too much to charge, but this was not mentioned by the Hand Pump Mechanic themselves.

So important to solve are the problems with the server and the issues that appear when settings change due to unexpected use. Whether the battery lifetime really is a constraining element for the alliance is questioned.

The interviews showed that the Hand Pump Mechanics have a rather strong will to join the alliance, since it improves their position within the community (dimension 'Objectives and Values'). They can show their accountability and improved information helps them to perform their task (dimensions 'Information' and 'Processes'). But they are challenged to fulfill these tasks in several ways. It depends on the area where they operate how challenging it is to reach the sources and how difficult it is to repair them. This also has to do with available resources (dimension 'Resources'). In combination with technological challenges, design mismatches, and lack of skills this might threat the position of the Hand Pump Mechanic in the network (dimensions 'Skills' and 'Technology'). Some Hand Pump Mechanic are very enthusiastic and see so much benefit in the system that they work hard to overcome the challenges, others do not have the possibilities to overcome the challenges or are not willing to overcome them.

Sufficient information is not the only necessity to improve the functionality water sources. More is needed, for example spare parts, to let them do their job. This also weakens the position of Hand Pump Mechanic. M4W is not designed to tackle these problems.

### 5.3.6. WATER USER COMMITTEE

The Water Using Committee is not really locked into this alliance by interessement devices, as shown in figure 12. This committee consists of water users and community members, which gives them the same position as the Water Users. But as Committee their position is not really included.

Hand Pump Mechanics and Health Assistants need the Water Using Committee to collect information, and their position is monitored with M4W (are they functional or not), but not part of M4W. The Water Using Committee is also supposed to collect money for minor repairs from the community, which is necessary for the Hand Pump Mechanic to function. So in these ways they indirectly influence the alliance of M4W.

Collecting money from water users, kind of is a topic on its own. 'People are not paying because they believe that water should be provided for free. [..] many of the stakeholders at the decentralized level complain that it is actually the politicians that interfere with the policies of tariff setting and influence the mind-set of consumers towards the belief that water should come for free' (Koestler & Lieshout, 2012).

Also 'Consumers complain that there is lack of transparency about how many funds are collected and what they are spent on. There is sometimes mistrust that revenues collected from the piped schemes are diverted to other activities, and that sub county officials appoint their cronies for financial or political gain' (Koestler & Lieshout, 2012), If there is no money for repairs this becomes a problem to improve the functionality of the water sources.

So the Water Using Committee might benefit from M4W because it improves accountability of officials spending the money of water users, which might make it easier for them to collect the money. But since the transparency towards the water user is not there yet, this benefit will take some time.

It could be considered to use the knowledge of the committee, about the water source and its users, directly into the network. As appeared from the Hand Pump Mechanics, it really gives a positive boost to the system, if people can show what they are actually doing. Since they are part of the community this might encourage water users to report and give the Water Using Committee more responsibility towards their task.

### 5.3.7. WATER USERS

As indicated in the problematisation phase, the water users are a vulnerable group for the M4W alliance, since they are more likely to connect to other actors outside the alliance made by M4W. Instead of sending a SMS about their grievance they might go to other water sources to get water, since they know how to do this, while using the phone is a new phenomenon. In the pilot a very limited amount of SMS messages were send, which underlines this, although there was not a full focus on the water users yet by the initiating actors. The following findings are expected challenges for enrolling the water users, based on interviews with the other actors. It was not possible to interview water users themselves.

**Removed ID stickers**

The main reason according to the initiating actors that the water users did not enroll is because they were not aware of M4W. The ID stickers were ripped of the water sources by children, so no instructions were left to them (PhD, July 17, 2012; National learning facilitator, Triple-S, July 30, 2012; Senior Advisor WASH – SNV, September 5, 2012). However, Hand Pump Mechanics and Health Assistants indicated that water users should know about the system, since they informed them. The ID number is written down by the chairmen of the Water User Committee, but of course he is not always available for all the people (Hand Pump Mechanic1, September 5, 2012; Hand Pump Mechanic2, September 5, 2012; Health Assistant Watiti, September 5, 2012) .To find a sustainable, cheap solution for identifying all the water sources in Uganda is very challenging. The initiating actors of M4W are still looking for a solution that matches the users.

**Social challenges**

But if the water users knew the ID number and were aware of M4W it would still be questionable if they would join, because they are not used to require their demands.

> *'It is also a social problem that people do not take action, since they are not used to require their demands. Maybe it is because of the structure. Poor areas do not pay taxes, so they think demand for what? Accountability is not something that people expect. The people do not demand, that is a challenge' (PhD, July, 17, 2012).*

**Interests**

Besides that the water users probably think it is more important to have functioning water point instead of a tool to demand for a functioning water point. If reporting the fault does not result in a functional water point (since the Hand Pump Mechanics need more than improved information flows to repair the source) then their main interest is not met and it will be hard to lock them into this alliance. Sufficient feedback about their report might be enough to trigger them to report, but at the moment feedback to the Water Users is not built into the network unless the problem is fixed. So it is questionable if the defined problematisation - having the possibility to directly report faults to the Hand Pump Mechanic - is sufficient to keep the water user involved.

## 5.4. MOBILIZATION

From the challenges found in the enrolment phase it becomes clear that the alliance is not yet strong enough to let all the actors enroll completely. So for most actors the mobilization phase is not reached yet. The improvements caused by the current status of M4W are sufficient to keep several people interested to stay involved, but mobilization for a full group is one step too far. It does appear that individuals within a user group do perform very well and these actors are asked to help in mobilizing other actors.

For example well performing Hand Pump Mechanics are asked to help less performing Hand Pump Mechanic to mobilize them as well. Also some District Water Officers got enrolled and they help in capacity building of other actors. So the mobilization phase really comes down to the individual level and not for full user groups.

## 5.5. SUB CONCLUSION

From the interviews it shows that there are many challenges encountered which constrain the defined actors to enroll. In some cases this could be because the initiating actors failed in establishing themselves as an Obligatory Passage Point. The translation of the defined interests does not match reality. This is especially visible in case of the Health Assistants, who do not need the M4W system to get the information, which it provides. They do indicate that the system might have opportunities for them, which are worth their efforts, but these things, like feedback information flows, are not in place yet (mismatch in the dimension 'Information').

Also at district level the interest towards the OPP lacks if people are involved in corruption. More transparency and information sharing shows their actions, which they rather keep silent (mismatch in the dimensions 'Information' and 'Objectives and values'). For people at the district, who are interested in improving public service delivery, the defined OPP keeps them locked into the alliance.

The mismatch towards the Obligatory Passage Point and thus the problematisation might also be, because it's not visible to all actors that M4W is a first step in improving the functionality of water sources. The initiating actors are aware that improvement of information accuracy and sharing is just one part of water source functionality, but other actors might like to see that it has a direct impact. Again the Health Assistants are an example of this, and the Water Users are expected to have the same weakness in the system. There are more direct solutions, which solve their challenges than using a "complicated" system like M4W. Long-term thinking is not really part of the social culture of the governmental actors yet (dimension 'Objectives and values').

Depending on the operation area and attitude of the Hand Pump Mechanics M4W does meet their interests enough to stay enrolled. But again they finally aim to fix the water sources, and they need more to do that than just accurate information. On the long run, information improvement might not be the interest, which keeps them in the alliance. Especially since many organizations around them aim to improve the functionality of water sources in different ways. To create the link between improvement of information flows and functionality of water sources especially more resources are necessary; resources in the sense of transportation, tools and spare parts (dimension 'Resources'). Creating Hand Pump Mechanic Associations might be the first step in improving this (dimension Management structures').

And of course the encountered problems with the interessement devices need to be solved (dimensions 'Technology' and 'Skills'). This includes the downtime of the server, changed settings after battery or SIM card change. Battery lifetime is considered to be of less importance, because it seems that as long as the interest of every actor is sufficiently met by M4W, the willingness and possibility to solve

the challenges with the devices is there. Finally the water user should be included. Communicating the existence of the system and ID number of every source is the most challenging in this case (dimension 'Information'), but it might be that also a mind set change is necessary to require their rights (dimension 'Objectives and Values'). All these indicated challenges connect to the dimension 'Processes' of Heeks, since it involves the activities of users and others.


# PART 3

# 6. CONCLUSION

As described in the methodology chapter, the ITPOSMO-model of Heeks (2002) is used to identify the challenges encountered in the development of Mobile Sensor Webs. This framework is not considered to be useful to describe these challenges, since most of the challenges are combinations of dimensions. They cannot be presented separately. That is why this chapter uses the conceptual framework of Callon (1986) to describe the answer to the main question. This framework puts more focus on the development of the network as a whole and its dynamic character. It puts the challenges in a context, which is necessary to grasp the core issues. The next chapter will thoroughly discuss this methodological decision and will refer back to examples from this chapter to justify it.

Section 6.1. is structured by the four phases of translation: problematisation, interessement, enrolment and mobilization. It only indicates the encountered challanges. An introduction to the meaning of the phases is given at the start of every phase. Section 6.2 builds on these challenges and concludes which aspects contribute to a more stable Mobile Sensor Web.

## 6.1. THE CHALLENGES OF MOBILE SENSOR WEB DEVELOPMENT

In every phase of translation, challenges are encountered. These challenges came to the surface during the enrolment phase, but they can be based on misassumptions made during the problematisation and interessement phase. The mismatch between the decisions made in these phases and the local actuality are discussed in section 6.1.1 and 6.1.2. This is followed by the challenges, which are not based on the misassumptions in the first two phases, but were encountered by the actors to get enrolled or get mobilized.

### 6.1.1. PROBLEMATISATION, IDENTIFYING THE RIGHT ACTORS, GET AND KEEP THEM INTERESTED

The problematisation phase describes who the initiating actors[34] intend to include in their network, and why these actors will be interested to be included. They established themselves an Obligatory Passage Point (OPP) in the network they are building. But in both cases the initiating actors did not manage to fully bind the stakeholders to the alliance. Several challenges can be identified to explain this.

First, it is hard to identify all important actors for developing a successful Mobile Sensor Web. For example, The Taarifa case study encountered that some non-identified actors needed to be included. These became clear when other actors hesitated to enroll, because the stakeholders that keep them accountable were not included.

Secondly, it appears to be challenging to get all intended actors enrolled in the systems. This is partly due to several misassumptions about the defined actors during the problematisation phase. In both cases different categories of actors can be distinguished which clarify this challenge. These categories are: actors who directly accept the defined problematisation, the ones who accept the problematisation under

*34 The initiating actors are the actors who want to build a network to reach a certain aim. In these cases the aim is to improve information sharing between actors who have to do with the public service. This should add to the governance of public services.*

certain conditions and those who reject the problematisation immediately.

The first category of actors accepts the problematisation because they directly benefit from the system, both on the short and the long term. This keeps them interested to stay connected to the network. An example from the M4W case is the Water District Officer for whom the system enables better monitoring of the situation on the ground. He receives information, which he can directly use for the indirect aim of M4W to improve public services. Other reasons to stay connected to the network, which occur in both Taarifa and M4W, are the ability to work in a more efficient way and cost reduction of the monitoring activities.
The second category of actors also directly benefits from the system because they receive information they could not access before or their jobs become easier. Only for them this benefit might not be sufficient to stay connected on the long term. An example of an actor in this category is, in case of M4W, the Hand Pump Mechanic. He receives information about the status of a water source from the water user, but if he does not have enough spare parts to repari the water source, he will not be able to do anything with this information. On the long term this does not improve his situation. An example from the Taarifa case is the district monitoring team. They like the mobile phones because it makes their work more efficient (at least if the device is enrolled), but if their chiefs are not directly included in the system, they will go back to other systems, since they need to show their accountability to them.
Finally, there are some actors who are not interested in the system because they do not benefit from the system in the way they want. This is the case for staff at the district, who are into corruptive practices. The system makes these practices transparent which is not of their interest. In both cases it appeared that district staff registered many ghost services. Increased information sharing and transparency will expose this, and they will receive less money. This causes that they will not bind themselves to the alliance.

From these categories it shows that it is challenging to get and keep actors interested to connect to the network. Actors that are not interested in sharing their information will be hard to lock in in. Also actors who not directly benefit from the system on the short-term might be hard to keep interested.
Remarkable is that this categorization cannot be generalized for specific user groups, because personal attitude and benefits are more decisive for their activities than their tasks and official responsibilities. Some individuals of one user group might connect to the first category, while another connects to the third. This was shown in the M4W case in the responses of several district people to the system. Connecting to personal attitudes could be challenging in the development of Mobile Sensor Webs, because it requires a lot of time and effort from the initiating actors.

Finally, keeping the actors interested is also challenged by the fact that they are approached for a lot of such initiatives. This causes that they have a lot of options to choose from and thus options to connect to other networks. Less institutionalized user groups, like the Hand Pump Mechanic, will easier link to new networks, than more institutionalized user groups, like the government. Still the connection of institutionlized groups does not automatically mean an commited connection. The extent to which they put effort in the system is still closely related to their interests.

### 6.1.2. INTERESSEMENT, MATCHING THE INTERESSEMENT DEVICES WITH THE ACTUALITY OF THE LOCAL USER

During the interessement phase, the initiating actors try to stabilize the intended alliance by putting interessement devices in the network in such a way that the interests of all actors are met. These devices should prevent them from connecting to other networks.
In the pilots of Taarifa and M4W it appeared that the devices are not always functioning as the initiating actors envisioned. This is because conditions are not in place or information is not really accessible. There is a mismatch between design and the actuality of the local user, which prevent the devices to get enrolled.

First, a challenge is found in the way the geo-location has to be shared by using the mobile phone. In both cases inclusion of this geographical information in the

message is a challenge. If the citizens have to text an ID code (as is the case in M4W) then this code has to be indicated on every water source. The M4W pilot shows that this does not go unchallenged since it is hard to do it in a sustainable cheap way. Using GPS coordinates (as is the case for Taarifa) requires a smart phone and the coordinates should be obtained at the specific location. In case of Taarifa this does not happen, because Internet connection is necessary to load the coordinates in the mobile optimized website.

Secondly, the mobile phone is in both cases also used to communicate standardized information about the situation on the ground. This information is directly sent to the dashboard, which is managed by authorities[35]. However this function is constrained in several ways, because of challenges with; server connection (M4W), unstable phone settings (M4W), battery life time (both cases), Internet connection (Taarifa) and user skills (both cases).

Thirdly, the dashboard and website are important interessement devices, meant to collect, manage and communicate the collected information. This appears to be a suitable way for the direct users of the dashboard and website, but it is challenging to use it as a way to communicate information to actors, which are not directly linked to it. These actors are not used to use digital communication technologies. The public website does not suit their way of working, so the device will not reach them. The chief of the monitor team of Taarifa is an example of this. The monitor team needs to submit a hard copy report to the chief, to account for their actions. While the chief can actually view their actions and reports on the website. So a hard copy report should not be necessary, but he hardly uses digital information, so this does not fit his actuallity. At the moment slow changes can be noticed which indicate that over time it will become more common to use digitalized information within the government of Uganda. For example, more people get an e-mail address.

### 6.1.3. ENROLMENT, LIMITED BY INDIRECT CONDITIONS

In the enrolment phase it becomes clear whether the actors accept the defined interests and designated devices. In the previous two sections these mis-assumptions, which became clear through the responses of actants, are already discussed. But during the pilots also challenges which do not have to do with assumptions identified in the first two phases became clear. These have to do with conditions that indirectly influence the successfulness of the Mobile Sensor Web. These conditions were not explicitly mentioned in the previous two phases, because they do not connect to the interests of the actors, or the functionality of the devices. Chapter 7 will elaborate more on this remark to Callon's framework.

The most important challenges, which have to do with these indirect conditions, are resource distribution due to political issues and logistical problems caused by the natural landscape and weather conditions. The first appeared in the M4W case. For example Hand Pump Mechanics need spare parts to repair the water sources. These should be provided by private companies. But since they can earn more money with certain parts they only distribute those, or parts are only provided in the capital city since they will not pay for transportation costs. This lack of distribution limits the work of the Hand Pump Mechanic.

The second challenge appears in both cases. In case of Taarifa for example the monitoring team has to go into the field to collect data. This is harder for districts which are located in the mountains, because remote areas in the mountains are harder to reach. Also during the raining season some roads will be blocked. This causes that different districts have different response times in finishing their monitor task.

In both cases the initiating actors are figuring out how to deal with these challenges, but because of the complexity of these problems no clear cut solution can be given right now. These challenges are generalizable for many projects in Uganda, and the impact should be taken into account when developing the system.

*35 Ministry of local Government for Taarifa and the District Water Officer in case of M4W.*

### 6.1.4. MOBILIZATION, SCALABILITY CHALLENGES

The findings indicate that once the actors are enrolled, they will be willing to mobilize others, if these are accessible to them. Besides that not much can be said about the challenges encountered by the actors during the mobilization phase because the cases did not reach this stage yet. The cases do indicate that this phase becomes very important if they want to scale the projects.

By scaling the projects the amount of information will increase. Managing this amount of data might become challenging. In case of Taarifa only one person manages the data on the dashboard, while in case of M4W the dashboard is managed per district and thus by multiple users. Some actors of Taarifa proposed to decentralize the responsibilities. This revision is proposed because it fits better to the current structure of responsibilities, which will probably improve the enrolment of actors. But it is also considered to be a good revision because it seems to make scalability easier, and which probably will decrease the possible challenges encountered in the mobilization phase.

## 6.2. CONTRIBUTING ASPECTS TO THE DEVELOPMENT OF A STABLE MOBILE SENSOR WEB

Mobile Sensor Webs try to create socio-technical hybrids, which can share information with each other. Improved information sharing in a web of socio-technical hybrids can contribute to improved governance of public services. But the identified challenges indicate that these hybrids are not always easy to establish, let alone the Mobile Sensor Web as a whole. The hybrids shape each other in several ways. Based on the case studies several aspects can be indicated that need to be taken into account, in developing a more stable Mobile Sensor Web. These aspects are discussed below and structured according to the challenges as described in the previous section.

### 6.2.1. THE IMPORTANCE OF HIERARCHICAL ACTOR INCLUSION, DIRECT BENEFITS AND ATTITUDE

It is expected that inclusion of actors on different levels of society will benefit the development of a stable Mobile Sensor Web. Including more levels will make the distances between the actors smaller. This seems to work better for the Mobile Sensor Web, than including less people and by that skipping actors which are involved in hierarchies outside the network. Even if this set up means more allies in the web, which can also fall apart. Including different levels is also expected to pay of when scaling the Mobile Sensor Web, because responsibilities can be divided.

To get and keep the actors involved in the network the Mobile Sensor Webs should be designed in a way that actors are interested to use the defined devices and to join the alliance. The findings indicate that focusing on short-term interests, which actors can directly achieve by using the devices, can draw this interest. These interests do not have to be the same within one user group, but depend on personal interest. What can be generalized for the user groups is that providing information without getting useful new information, aiming to improve the network as a whole, will not convince the actor to use the device. He simply does not trust that this will benefit him in the future as well. So, it does not matter if the long-term indirect aim of the implementation of the system is not reached yet (like an improved service), as long as something keeps the actor locked in place.

This way of locking the actors in place is of course provided that they agree with the main aim of the system, to improve information sharing. If this is not the case, like in case of corruptive actors, it will be hard to include them in the system.

But if they do agree with the aim, the contribution of the system to information sharing seems to increase when spending a lot of time on sensitizing stakeholders, to convince them about the benefits of the alliance for them personally as for their official tasks. Sensitizing individuals is expected to pay off in a later phase of the implementation, namely the mobilization phase, when other individuals have to be mobilized. This is provided that the aspects mentioned below are met as well.

### 6.2.2. OFFLINE FUNCTIONALITY, INCLUDE GEO-LOCATION AND ACCESSIBLE INFORMATION

There should be a match between the design of the devices and the actuality of the local user. The cases show that using the devices does ask for some commitment from the actors. The devices require that they work on their skills and get used to

working with standardized information. These shaping aspects of the devices seem to be accepted by the actors, as long as the direct main interest of the actor is met. If not, the actor will not put any effort into using it.
Crucial challenges, to achieve a stable network, are that the mobile phones should not depend on Internet connection, since this is not always present in the field. Besides that it should be possible to add a geo-location to the message.
Also the accessibility of the devices and information is essential. In which accessibility refers to a way that suits the user. If someone has an email address, but does not use it, the information is not considered to be accessible. At the moment online information sharing is not considered to be a widely accessible option in Uganda. This accessibility could also be related to necessary resources to purchase and maintain the devices and provide trainings, or transportation costs to reach the field where they should use the devices. It is expected that Mobile Sensor Webs in the end induce a cost reduction that outweigh the investment costs, but funders should be convinced of that as well.

### 6.2.3. IMPORTANCE OF INDIRECT CONDITIONS

Next to a correct problematisation and matching interessement devices it is important to have certain conditions, external to the Mobile Sensor Web, in place. Because some actants will only be able to use new provided information if these indirect conditions are in place as well. If this is not possible this will affect the stability of the Mobile Sensor Web.
This relates to accessibility of the field, where information has to be collected. This could be limited by conditions like the natural landscape or climate conditions. These conditions are out of control of the initiating actors, but they could respond to it by including stakeholders closer to the field.
In many cases also resource distribution, like the distribution of spare parts, necessary to respond to the new information might limit the Mobile Sensor Web. If new information cannot be used, the interest of receiving this information might get lost. This way the network will fall apart, and the Mobile Sensor Web will not contribute to increased information sharing anymore.

### 6.2.4. INCLUDE SCALABLITY IN THE PROBLEMATISATION

Finally the scalability is important to take into account when developing a Mobile Sensor Web. It reflects on which stakeholders should be included during the problematisation phase and how the responsibility of each actor should be defined. The pilots indicate that scalability becomes more feasible by dividing the responsibilities on different societal levels.

In conclusion, all these described aspects are considered to improve the creation of a stable Mobile Sensor Web, containing several socio-technical hybrids. The more stable socio-technical hybrids are enrolled in the network, the more stable it gets.

# 7. DISCUSSION & RECOMMENDATIONS FOR FURTHER RESEARCH

This research is influenced by several decisions and assumptions. The limitations of this will be discussed in this chapter. First of all the chosen conceptual frameworks of Callon (1986) and Heeks (2002) are discussed. Limitations are discussed and suggestions are made for possible improvements of the models (section 7.1. and 7.2.). Section 7.3 discusses the influence of the case study selection, followed by a methodological discussion. Finally recommendations are made for further research (section 7.5.).

## 7.1. LIMITATIONS OF CALLON'S FRAMEWORK

The four phases of translation of Callon (1986) were very useful in describing the implementation of an information system, which is still under development. It is possible to apply his theory to multiple technologies in any stage of the development, even if the technology is not stabilized yet. The four phases provide a useful framework to describe the dynamics between the interessement devices and its users and how this shapes the whole Mobile Sensor Web.

A limitation of Callon's framework is that the focus of the problematisation phase is mostly on the identities of the actors. This remains a rather vague term. In his theory Callon translates identities mostly to the interests of the actors, while there is much more going on in the context of the actor which can influence the design. For example, in the case of M4W the Hand Pump Mechanics live in different landscaped areas, which causes different behavior, like the way they travel. Right now such aspects come to the surface during the enrolment phase, while the developer might have thought about these elements already when defining the identities of the actors. It would be possible to describe them as part of the identity of the actor, but because the link of these elements to defining the Obligatory Passage Point seems to be very weak this will not happen. In the end of the analysis, it appears that these identity elements have a relatively big influence on the implementation of the system, which might make it interesting to also discuss these considerations of the designer in the problematisation phase. So a more specific definition of "identities" would be helpful in applying it to the collected data. Heeks' model is useful to improve the framework of Callon, because it provides more specific dimensions to define the definition of identities. So it is recommended to use the dimensions of Heeks also in defining the aspects influencing the identity of an actor.

## 7.2. LIMITATIONS OF HEEKS' ITPOSMO-MODEL

In contrast to Callon, Heeks (2002) tries to distinguish several dimensions, which are part of creating the system's network, taking into account three different approaches towards these dimensions. These approaches are the design versus actuality of the local user, the current situation versus the intended change, and hard rational design versus soft political actuality. The distinction between the dimensions worked very well to guide the interviews, since the dimensions point out possible areas for issues. This makes it a more concrete framework, than Callon's. But to describe the encountered challenges appeared to be hard in this way, because one challenge connects to several dimensions. This will be discussed per approach in the following three sub sections. Section 7.2.5 suggests adding an extra dimension to Heeks' ITPOSMO-model, to cover all encountered challenges of developing Mobile Sensor Webs.

### 7.2.1. MISMATCHES BETWEEN DESIGN AND ACTUALITY OF THE LOCAL USER

In both cases several gaps between the design and the actuality of the local user came to the surface. These are described in section 6.1., but it is hard to link them to one

specific dimension. An example of this is the intention of Taarifa to communicate data through a public website. This is a mismatch in the dimension Information, because the intended information flows stagnates if the intended user does not go to this website. It is a mismatch in the dimension Objectives and Values, because using digital information is not part of the current culture for the majority. It also mismatches the dimension Technology, because a website is not accessible for all users, like for the community members who do not have a computer. And finally it is a mismatch in the dimension Processes, because it does not fit the envisioned actions for the users.
Other encountered challenges could be linked to one specific dimension, but still they will also influence the others to some extent. For example the battery lifetime of a mobile phone is highly connected to the dimension Technology. But the same analysis can be made in this example on how it influences the Process or Information flows.

Besides the separation of dimensions, Heeks also separates the designers' intentions from the actuality of the local user. He kind of places the designer outside the network, while in case of the implementation of Mobile Sensor Webs, the user is already included in the design process in an early stage. So the designer is part of the network. By implementing parts of the design, the user has a more active role in shaping the system than assumed by Heeks. It also causes that the system changes fast, this dynamic is hard to include in his theory.

### 7.2.2. CURRENT SITUATION VERSUS INTENDED SITUATION

Heeks (2002) describes that some mismatches between design and current situation are intended by implementing the system. For example the Mobile Sensor Webs will not fit the current information flows of public service governance systems. They want to change the way information flows between the actors, to improve the situation. Some intended changes might be feasible; others might be a too big shift. Besides the shift to using certain technological devices, which links to the dimensions 'Technology' and 'Skills', the intended changes that were described by the initiating actors did not match one specific dimension. Describing intended changes versus current situations connected to specific dimensions seem not to cover the context of the challenges encountered by developing Mobile Sensor Webs. Understanding the (non) feasibility of certain changes needs more contexts than only identifying a dimension as challenging area.

### 7.2.3. HARD RATIONAL DESIGN VERSUS SOFT POLITICAL ACTUALITY

The hard/soft gap of Heeks refers to a 'typical country context' gap, which can occur between Western developers and the culture of developing countries where the system is implemented. Heeks' model suggests that all local users in developing countries think in the "soft way", and all Western designers think in a "hard, rational way". Section 2.4.3. specifically explains the gaps per dimension.
The findings of this thesis do confirm that the design of the systems is in both cases hard rational design, since they use standardized information and are based on simple, straightforward, formal activities. But since the designers of M4W have a Ugandan background it is not confirmed that hard rational design is specifically connected to Western culture.

The soft/hard gap also is not confirmed in connection to the found challenges of this thesis. The gaps between hard rational design and soft political actuality do not seem to be generalizable for all actors. Hard and soft aspects can only be indicated for individual cases. For example, the finding that some actors show that their personal benefit is more important (soft political actuality) than the organizational objectives (hard rational design) confirms the soft/hard gap for the dimension Objectives and Values. This is the case for the situation that corruptive actors report ghost water sources, to receive more money. But other examples reject the soft/hard gap theory for the same dimension. Like the Assistant District Water Officer in the M4W case. She shows that she is very dedicate to her job, and likes to adopt the system, because it is will in the long-term improve her governmental tasks.
Another example can be taken for the dimension Technology. The hard way it is seen as a simple enabling mechanism, the soft way describes a complex value-laden entity

status symbol. The latter is the case for a well performing Hand Pump Mechanic in the case of M4W. He was very proud on his new phone and showed it to everyone. But another Hand Pump Mechanic dropped it in the water, and he did not really mind. Also people at the district in case of Taarifa did not seem to approach the mobile phone as something very complex or status symbol, it just enabled them to do effective monitoring. So again the hard/soft gap is not generally recognized.

Overall the soft/hard gaps identified by Heeks are not fully confirmed in the findings of this thesis. Still the soft/hard gap approach is considered to be useful in identifying and understanding certain challenges, because the challenges can be found in individual cases. It is a very good addition to the definition of 'identities' of Callon, as discussed in section 7.1. Using the soft/hard gaps in identifying the identities of the users makes the problematisation more realistic. This will increase the number of users in the category of users who accept the Mobile Sensor Web.

### 7.2.4. IMPROVING THE ITPOSMO-MODEL, ADDING A NEW DIMENSION

In summary, the independent dimensions will not give a realistic idea of the impact of certain challenges to the whole system. Challenges, like the limited battery lifetime, cannot be valued without the context of the full system. The model presents too little guidelines to include the shaping aspects of users and technology. Actor Network Theory gives better guidelines to do a contextual analysis of found challenges.
Apart from this the dimensions do seem to cover most challenges, so they are very useful to identify them. It is suggested to add one more dimension, since the challenge, which has to do with logistical problems due to natural landscape and climate circumstances, is hard to place. The ITPOSMO-model is improved by adding a dimension which relates to that, like 'Environment' or 'Geography of the Country'. It is also found that the dimensions should be used to consider the conditions necessary to use the output of the system, and not only to consider the possibility to create the output. For example, if new information is provided to the Hand Pump Mechanic it should be considered if he is able to deal with this information, by again considering the seven dimensions of Heeks.

## 7.3. CASE SELECTION

The selected cases resulted in some findings, which indicate challenging elements of developing a Mobile Sensor Web. These were translated to aspects which should contribute to a more stable Mobile Sensor Web. Since the cases are still in a preliminary development stage, it is hard to generalize the findings. This preliminary stage also resulted in a relatively small number of included actors in the pilots. Citizens were not reached yet and only one person at the ministry of Local Government (in case of Taarifa) was included. This might give a biased representation of this user group. Especially if one notices that personal attitude is found important in these cases. Also the Ministry of Water and Environment (in case of M4W) did not connect itself yet to the system yet. Besides that it was only possible to visit a limited number of districts. The situation in Northern Uganda might be different from Western Uganda. This could have influenced the results.
The cases were selected for several reasons. The origin of the initiating actors was expected to influence the design. This is not confirmed. Also no impact could be found of the domain they worked in. The different interessement devices brought up a variety of challenges, like the requested battery lifetime and the necessity of an Internet connection. A more in-depth analysis should be done to get an idea of the impact of all inscriptions. Finally the diversity of user inclusion between the two cases, concluded that shifting to a more decentralized level, including several people of existing hierarchies, would benefit the system's stability. This is specifically based on the issues that were found in the Taarifa case and their considerations to move to a similar set up as the M4W case.
The excluded case of Akvo FLOW included also a global level in their system. It was found that this influenced the questionnaires used on the mobile phone, and thus had an impact on the inscription of the interessement devices. Including new levels will impact the system as a whole. Further research is necessary to draw convincing conclusions about the specific impact of levels on the development of Mobile Sensor Webs. To what extent is including new levels beneficial (as suggested for Taarifa) and when becomes the impact of more levels too big?

## 7.4. METHODOLOGICAL LIMITATIONS

The chosen methodology can have influenced the research in several ways.

First, my own cultural background might have influenced the collected data and its interpretations. The interviewees might have responded differently to my questions, since I am seen as a rich Western woman. Especially interviewees outside the government, who are not used to interact with foreign people. It was tried to reduce this hierarchical influence by sharing information about the project and by making clear that they were the experts in this field. Time was taken to let the interviewees get used to the way of questioning and several questions were asked again later in the interview. In some cases I got the impression that the interviewees might put more focused on necessary resources, since they might feel that I could provide these resources. Although this would probably also happen if I was Ugandan and earned more money. The tendency to ask for resources is present within the whole society. Still it could have given a twisted perspective on the necessity of resources. It was attemted to reduce this influence by repeatedly explaining the aim of the interview and my abilities.

Also, a language barrier could have influenced the data collection, since sometimes questions were not clear, or answers needed more clarification. By discussing the found challenges with different actors, it was tried to limit this constraint. Besides that, a close connection to the Ugandan initiating actors helped in understanding the local situation, since I could have several conversations with them.

These regular conversations with initiating actors might also have biased the research. Actors which were not indicated by them, but which can form a threat to the alliance may be overlooked. Also the presence of the data manager of the MoLG in several interviews, and the NGO staff in case of M4W, might have influenced the result.

Finally, the conceptual frameworks of Callon and Heeks might have created a bias towards the challenges relating to their framework. This bias was tried to reduce by starting the interviews with open-ended and broad questions, the interviews were structured by the given answers, and the interviewees' terminology was used instead of the terminology of the frameworks. With a strong attention to emerging topics, also challenges outside the frameworks of Callon and Heeks could be identified, like the influence of different natural landscapes.

## 7.5. RECOMMENDATIONS FOR FURTHER RESEARCH

This thesis is an explorative research on the challenges of Mobile Sensor Webs development, in order to indentify contributing aspects to the creation of stable Mobile Sensor Webs. It is a nice start for more in depth research, to get better insights on the generalizability and completeness of the identified aspects. Several suggestions can be made to do further research on this topic.

First, this thesis specifically focuses on the development of Mobile Sensor Webs aiming to improve information sharing betweeen the actors of public services. But as indicated in section 2.1.2. many organizations link the Mobile Sensor Web to other objectives, like more transparency, improved accountability lines, empowerment of poorer groups, which should all add to improvement of the public service. In this thesis it assumed that more information sharing would add to these aims. It could be interesting to do further research on the effectiveness of Mobile Sensor Webs to improve these aspects as well. How much information has to be shared to improve accountability, what kind of information is necessary to consider the system transparent? How does this relate to other information systems? Such questions could add to the understanding of the impact of Mobile Sensor Webs.

Another recommendation is to do more research on the individual incentives of actors, since it appeared hard to generalize the findings to specific user groups. The chosen frameworks are not suitable for this. The capability approach of Oosterlaken et al. (2012), which includes personal history and psychology to the interests of users might give better insights on the influence of individual incentives on the system. One could also investigate the incentives of individuals by scaling the research of one case and interview several actors with the same function.

Thirdly, the influence of incorporating different levels of society in the Mobile Sensor Web could be invested more thoroughly. This could be done by questions like; is there a favorable number of actors for the web? Do other cases confirm that staying in the hierarchical system of institutions and society benefits the functionality of Mobile Sensor Webs? What are the benefits or constraints for including extra levels or leaving them out?

Besides that a more in-depth script on the interessement devices, as described by Akrich (1992), could give better insights on the role of the devices towards shaping the user and the other way around. In this research the technologies were still in a preliminary, constantly changing stage and it was hard to take their detailed software design into account. Focusing on the specific socio-technical hybrids might provide new insights on their contribution to the Mobile Sensor Web. It could also give more insight on the impact of things like battery life time and skills.
Finally it was not possible in this thesis to get more insight in the identities of citizens and other users at the ground. Their input is important to the final Mobile Sensor Web. It should be investigated what kind of information they want to receive and in what way they want to provide information. Since previous research, like the Human Sensor Web in Zanzibar, shows that standardized information might not be the best way for them. Also possible trust issues could be investigated more intensively in this user group.

Besides these topic related recommendations, there are several recommendations regarding the conceptual frameworks as presented in this thesis. Overall, both the framework of Heeks and Callon added to the understanding of the development of Mobile Sensor Webs. Heeks offers guidelines to identify the challenges, while Callon is very useful in describing and analyzing these encountered challenges in a more contextual and explanatory way.
It is recommended to use Heeks' model in addition to the phases of Callon, by concretizing his phases. The dimensions can clarify whom to include in the alliance, both for defining the identities of the actors and the interessement devices. Especially the conceptions of soft/hard gaps are important to include, since this puts better focus on cultural aspects. Besides that it is suggested to include a new dimension in the ITPOSMO-model to include the geographical and climatic circumstances.

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# APPENDICES

# APPENDIX A: OVERVIEW INTERVIEWS NAIROBI

**Interviews in Nairobi July 2 - july 11, 2012**

| ORGANIZATION | FUNCTION | INFORMANTS |
|---|---|---|
| KopoKopo | Head of product | 1 |
| Nailab | Liaision and Office Manager | 1 |
| iHub | Research Strategist | 1 |
| Upande | CEO/Founder | 1 |
| Frontline sms | CEO | 1 |
| Ermis Africa | Executive Director | 1 |
| Hivos – NL | Webmaster, Database engineer, CMS professional and Policy Officer | 1 |
| 1% club | Co-Founder | 1 |
| Akvo - NL | Project Coordinator | 1 |
| Akvo - Kenya | Manager East-Africa Hub | 1 |
| Water for People | Regional Manager Africa | 1 |
| Spatial Collective | Founders and software developers | 2 |
| Ushahidi | Software developer | 1 |

# APPENDIX B: AKVO FLOW

As described in the beginning of chapter 3, a third case study was investigated in Uganda, called Akvo FLOW. After the interviews, during analysis, it appeared that this case did not suit the objectives of this thesis, as described in section 3.3.1. That is why it is excluded in this thesis. A description of the case and the conducted interviews is presented in this appendix.

**Akvo Field Level Operation Watch (Akvo FLOW)**

Field Level Operation Watch (FLOW) is a Mobile Sensor Web started by Water for People. It has been under development since 2010. It addresses the need to replace cumbersome paper-based monitoring surveys and the delay in manually compiling the information. It is also designed to provide accountability and transparency to donors and the public. FLOW has mainly been used to track the condition of water points.

In 2011 W4P partnered with Akvo, who now continues the enhancement of FLOW to address the monitoring gap in the development sector. Akvo FLOW has been used in 17 countries for monitoring. The development of Akvo FLOW takes mostly place in Western countries, while the design of processes and implementation is coordinated at national level by the country offices.

In Uganda the first pilot was held in March 2012. This pilot was taken as case study for this thesis . It piloted in three districts; Kyenjojo, Kamwenge and Mukono.

The national office of Water for People temporarily hired local graduates to go into the field and fill the questionnaires on the smart phones. These questionnaires are provided from global level. Questions can be added if the national office finds this necessary. After monitoring in the field, the national office staff collects the mobile phones and sends the information to the online dashboard, using Wi-Fi in the office. The dashboard collects information from several countries, which is managed by several people all over the world. The national office in Uganda puts there collected information online and shares it with some actors in the Water and Sanitation Hygiene sector. The ministry is not included (yet).

**Interviews Akvo FLOW case**

| ORGANIZATION | FUNCTION | ROLE | INFORMANTS | INTERVIEWS |
|---|---|---|---|---|
| | | | | |
| W4P Uganda | Program Analyst-Sustainable Sanitation | Initiating actor and user | 1 | 2 + several e-mails |
| W4P Uganda | Country director / Program Analyst - Water | Initiating actor and user | 1 | 2 + several e-mails |
| W4P Denver | Senior Manager | Initiating actor and user | 1 | 1 |
| Akvo | Product Manager | Initiating actor | 1 | 1 |
| Akvo | Software developer | Initiating actor | 1 | 1 |
| Graduates | Monitoring (temporary staff) | Uers | 3 | 2 |
| W4P Kenya | Regional Manager - Africa | Initiating actor | 1 | 1 |
| | | | **9** | **10** |

# APPENDIX C: INTERVIEW QUESTIONS

## INITIATING ACTOR

Name
Function
Nationality
Organization
Gender

1. What is your position here and how is it linked to the MSW?
2. What are the objectives of your organization?
3. What are your objectives to reach with the development of this system?
   a. Context: local/national/global?
4. Can you describe the way you picture the use of MSW once it is fully developed?
5. What kind of users do you have in mind when developing this MSW (both individual and organizational)?
   a. Skills, education
   b. Resources, like access to the internet, mobile phones, also time, money
   c. The way they handle things at the moment (processes, management systems, information)
   d. Gender
   e. Age
   f. Cultural values/objectives
6. Do you include them in your design process? If so, in what way?
7. What advantages or disadvantages do you see when the MSW is introduced?
8. What are the most important demands the system has to meet to make it successful you think? And which functioning's are subordinate to that, but still on you 'wish-list'?

9. Which constraints do you think to face?
10. Does this change anything to the described scenario?
11. How do you try to reach the users of the system?
12. What are the advantages for the users to start using it?
13. How do you deal with politics, like power differences? Do you think it has any influence?
14. Do you think that once the system is in place it changes a lot for the users or society as a whole?
    a. Information
    b. Processes
    c. Values + Objectives
    d. Management structures
    e. Staffing/ skills

15. What software do you use?
16. Are there any constraints with this software? What can/cannot be coded?
17. In what sense does the technology limit you to achieve your objectives?
18. Which considerations did you make by choosing certain functioning's?
19. In what way did you include local conditions (could be anything, skills, values, environment)?
20. Which considerations did you make by designing the interface of the app and of the website?

21. Which way are you heading with the MSW development? How do you see the future?
22. Any important considerations, challenges, developments or remarks that we did not discuss?

## USER

1. How did you get to know the MSW?
2. Do you like using it?
3. Did you use such a phone/computer before?
4. Was it difficult to learn how to use it?
5. Did you get any training?

6. Did it change a lot for you in the way you work?
7. How did you work before you had the phone?
8. Do you face any challenges with using the phone and during the work?
9. Are you still struggling with the technology or did you get familiar with it?
10. What kind of difficulties do you face?
    a. Go through the steps that he has to do

11. Do you receive a lot of information?
12. Can you use the information?
13. Do you also use the phone for other things then only the MSW-tasks? (calling, texting others.. )
14. Are all the questions clear in the survey?
15. Any questions missing? Or do you want to add more information?

16. Did you have any problems with using the device?
    a. If no answers, mention challenges that other actors mentioned, like battery, internet, add geo-location etc.
    b. Are you are always able to submit the form?
17. Towards the application, are the questions clear, interface...
18. And does it happen a lot that the information isn´t correct.
19. Does that make your work difficult?
20. Are you in contact with the.... (mention other actors)?
    a. Do they support you, provide new information etc..
21. Do you know where the information goes once you send it.
22. Did you ever check a website or anything?
23. Are committees aware of M4W?
24. And how does the community receive it? Because you said that some have send messages?

25. So for you the mobile phone works out very well/or not, it helps you in your work?
26. Are there any other challenges, limitations that you face, we didn't discuss and that you want to address?
27. What more has to be improved in the system? How can we make it better?

# APPENDIX D: SOURCES OF CASE STUDY DOCUMENTATION

**Taarifa**

http://dev.taarifa.org – dev with Ugandan data set
https://docs.google.com/spreadsheet/ccc?key=0AhtyL9ujuEr9dEVwVXkzTG4wUnFJc1pKRTlMLTRTR2c&pli=1#gid=0
https://github.com/taarifa/
http://gm.taarifa.org –current release
http://groups.google.com/forum/#!forum/taarifa-dev
http://h4d2.eu/mark-iliffe-on-taarifa/
http://markiliffe.wordpress.com/2012/02/19/engaging-all-users-not-just-developers/
http://markiliffe.wordpress.com/2011/11/09/ergonomics-of-hackathons-and-code-sprints/
http://markiliffe.wordpress.com/2011/11/08/developing-taarifa-london-water-hackathon-2011/
http://newschallenge.tumblr.com/post/31266047165/taarifa-a-mobile-reporting-platorm-for-citizen
http://Taarifa.org
http://taarifa.glassberg-powell.com/
http://taarifa.wordpress.com
http://www.waterhackathon.org/taarifa-moves-ahead/
http://site.taarifa.org/
http://www.slideshare.net/markiliffe/taarifa -- intro slides
http://www.slideshare.net/markiliffe/taarifa-geomob
http://www.slideshare.net/markiliffe/when-government-20-doesnt-exist-more-mapping-services-in-the-developing-world
http://www.rhok.org/skills/data-visualization-large-scale-manufacture
http://ugtaarifa.org
http://www.waterhackathon.org/development-and-future-of-london%E2%80%99s-winning-hack-taarifa/#more-815

**M4W**

http://m4water.org
http://www.mwe.go.ug/
http://www.snvworld.org/
http://www.waterservicesthatlast.org/Countries/Uganda-Triple-S-initiative
http://www.wateraid.org/

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# APPENDIX E: M4W QUESTIONNAIRES

**Baseline Information**

Collected by the Hand Pump Mechanic when the District Water Officer assigns the job

| GENERAL | OPERATION&MAINTENANCE | OPERATION STATUS |
|---|---|---|
| District | Type of mgt | Functionality of Water point |
| County | Water User Committe established | Date & Detail of last repair |
| Sub County | Water User Committee trained | Date of last minor service |
| Parish | Functionality of Water User Committee | Date of last Major service |
| Village/LC1 | | |
| Source name | | |
| Source number | | |

**Assessment information:**

Collected by the Hand Pump Mechanic when a water users reports a fault.

- Location
- Type of fault (Minor, Major, Rehabilitation)
- Assessment of fault (faulty power system, loose handle, heavy handle, dry/low water yield, noisy sound, leakage, faulty tap,)
- Problem fixed (Yes/No)
- If No, Why not fixed?
- If Yes,
    - Repair done (rods, pipes, chain, nuts & bolts, bearings, pump bucket, sealing rings, valves, cylinder, water tank, handle, axle bolt, pump head, pedestal)
    - Cost (labor cost, spares cost)
- Any recommendations (limit to 100 characters)
- Name of Hand Pump Mechanic

**Water point Inspection**

Done by the Health Assistant after the Hand Pump Mechanic finished his base line info

| COMMON FIELDS | DUG WELL WITH HANDPUMP/ WINDLASS |
|---|---|
| General information (division, parish) | Is the cement less than 1m in radius around the top of the well? |
| Source number | Is the handpump loose at the point of attachment to well head? |
| Recommendations: | Is the drainage channel cracked, broken or need cleaning? |
| Name & title of Inspector: | Are there cracks in the cement floor? |
| Date of visit | Is the well-cover in place? |
| Is there a latrine within 10m of the source? | Borehole with handpump |
| Is the nearest latrine uphill of the source? | Is the apron less than 1m in radius |
| Is there any source of pollution within 10m of the source? (animal breeding, cultivation, roads, industry) | Is the handpump loose at the point of attachment to apron? |