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Not Just a Tool. Taking Context into Account in the Development of a Mobile App for Rural Water Supply in Tanzania

Anna Wesselink
University of Twente, Enschede, the Netherlands; a.j.wesselink@utwente.nl

Robert Hoppe
University of Twente, Enschede, the Netherlands; r.hoppe@utwente.nl

Rob Lemmens
University of Twente, Enschede, the Netherlands; r.l.g.lemmens@utwente.nl

ABSTRACT: The 'eGovernance' hype around the potential of mobile phone and geoweb technologies for enhancing 'good governance' is soaring. In East Africa, the extensive use of mobile telephony adds to the imagined promises of ICT. We reflect on the assumptions made by the proponents of such tools, using our own action research project as an example. We took great care to consider context in the development of software for enhancing empowerment and accountability in rural water supply in Tanzania. However, we found that the rural water supply context in Tanzania is much more complex than the contexts for which successful mApps have been developed previously. Institutional analysis and public administration theory help to understand why. Rural water supply shows institutional hybridity, with water being at the same time a private, public and common-pool good. In addition, in accountability relations, many informal mechanisms prevail where explicit reporting is not relevant. Finally, our proposal sat uneasily with other ongoing iGovernment initiatives. We conclude that we need to consider eGovernance tools as political Apps that can be expected to trigger political responses.

KEYWORDS: mApp, eGovernance, iGovernment, institutional analysis, informal accountability

INTRODUCTION

> *Programmers build exciting new systems and then they watch in dismay as they fail to mesh with the institutional orders around them. The understanding is perhaps now dawning that [ICT] architecture, while certainly a variety of politics, is by no means a substitute for politics. (Agre, 2004)*

The 'eGovernance' hype around the potential of mobile phone and geoweb technologies for enhancing 'good governance' is soaring. Especially in areas of limited statehood eGovernance is expected to substantially contribute to civil society engagement with politics and policy-making through technological strategies that enable more transparency and easier communication (Livingston and Walter-Drop, 2012). It is hoped that eGovernance will thereby increase accountability of public and private organisations which, it is assumed, will lead to benefits like sustained and widespread economic growth and better public service delivery (e.g. Dahlgren, 2009; Campbell and Kwak, 2010;Taylor, 2011). Fueled by the success of web applications (webApps) like Amazon, eBay, Wikipedia and OpenStreetMap and their translation into mobile applications (mApps),

> technologists stress the novel capabilities – such as dramatically lower communication and search costs, many-to-many communication, and the dynamics of crowdsourcing and collaborative production – that these new technologies make possible. Political analysts, on the other hand, are especially attentive to the importance of incentives as drivers of human action and the role of organizations and institutions in producing outcomes such as laws and public actions (Fung et al., 2013: 44).

In East Africa, the extensive use of mobile telephony adds to the imagined promises of ICT for good governance, as do success stories of citizens' uptake of proprietary mobile banking, e.g. mPesa, and election monitoring through Ushahidi.org (Hughes and Lonie, 2007; Gikenye, 2011; Hope et al., 2011). Ushahidi, perhaps the most celebrated ICT platform in the eGovernance domain, is a prime example of political crowdsourcing. Ushahidi (meaning 'testimony' in Swahili) was initially launched by political bloggers to map incidents of post-election violence in Kenya in the beginning of 2008. It aggregated reports regarding violations of human rights that citizens submitted via the web or mobile phones, and tagged them on a publicly available Google map, according to predefined categories (Fung et al., 2013). Mobile telephony has also transformed the conduct of business (Gikenye, 2011) and crisis management (Schade et al., 2010). In Tanzania, the setting of the research presented here, the mobile penetration rate is relatively high at 75% in 2013, and already 10% of Tanzania's GDP is transacted through mobile commerce. On the other hand, the large majority of these are simple Unstructured Supplementary Service Data (USSD) mobile phones rather than (Android, iOS or Windows Phone) smartphones, which limit technical possibilities for interactive data supply and demand. Other established but more expensive ICT-technologies trail far behind, with just 14% of the over 40 million population having a fixed internet at home. Communication, Science and Technology Minister, Makame Mbarawa confirmed that the latest upgrades of mobile infrastructure were "a key part of the important work the Tanzanian government is undertaking to deliver our Vision 2025 programme and use the latest communication technologies as a tool for sustainable development".[1] In April 2012, the government established an eGovernance agency aimed at providing oversight and coordinate the provision of eGovernance services.[2]

The Open Government Partnership (OGP) launched in 2011 by US President Obama is one of the political drivers for these eGovernance propositions, amongst others. The implicit assumptions in its mission statement are exemplary for most of the eGovernance ICT proposals:

> OGP's vision is that more governments become sustainably more transparent, more accountable, and more responsive to their own citizens, with the ultimate goal of improving the quality of governance, as well as the quality of services that citizens receive. This will require a shift in norms and culture to ensure genuine dialogue and collaboration between governments and civil society.[3]

In Tanzania, efforts to improve citizens' access to information and opportunities to exact accountability from government authorities and service providers are increasingly being initiated and supported by the government, civil society and private actors. For instance, in the context of the Tanzanian subscription to the OGP the government has introduced offline and online opportunities for citizens to engage with government authorities (URT, 2011). Offline initiatives include participatory planning approaches and Annual Joint Sector Reviews and Public Expenditure Reviews, etc. Online innovations are exemplified by the launch of the wananchi website[4] in 2007 which collects citizens' opinions and allows them to ask questions. None of these efforts are free of inadequacies; for example, the

[1] http://africaresearchonline.wordpress.com/2014/06/17/tanzania-it-developments

[2] www.ega.go.tz/e/en/about-ega/background

[3] www.opengovpartnership.org/

[4] www.wananchi.go.tz

wananchi website is no longer active. The Tanzanian Non-Governmental Organisations (NGOs) Twaweza[5] and Daraja[6] have also set up such 'participatory sensing' platforms; their Swahili names mean 'we can make it happen' and 'bridge', respectively (Georgiadou et al., 2011). Notable international initiatives are Text to Change[7] and the Making All Voices Count action research programme.[8]

The propositions for eGovernance may be summarised as follows. Because they are equipped with mobile phones with specialised Apps and geoweb services, transaction costs to 'ICT-cyborged' citizens are lowered sufficiently for them to report problems faster, continuously and fully to service providers, responsible authorities, community leaders and fellow citizens. For responsible authorities and service providers, this ICT-mediated information provides relevant information that enables them to respond more timely and adequately to citizens' concerns, e.g. to improve basic public services such as access to education, water, health care and roads, which fragile states often fail to deliver (Devarajan and Reinikka, 2004; Massing and Jonas, 2008). The basic assumptions behind these propositions are the following:

1. Services are provided by the state or by a state-sanctioned monopoly.
2. A lack of information is an important (the most important?) bottleneck to better governance of services.
3. Citizens will be able to provide this information.
4. Increased transparency through public displaying of information will 'name and shame' responsible organisations into action.

In this article, we will show that these assumptions hardly apply in the context of rural water supply in Tanzania. We describe how we coped with this situation in the redesign of the SEMA App and how this changed the possibilities of eGovernance.

Empirical evidence on the uptake and economic, social and political impacts of eGovernance technologies is scarce. This article reports on the SEMA[9] research project Sensors, Empowerment, and Accountability in Tanzania[10] (2012-2016), which contributes to this evidence by conducting action research on eGovernance technologies in rural water supply in Tanzania. The overall research goal of the SEMA project is to investigate to what extent ordinary citizens in Tanzania can, and will, participate directly in exacting accountability from public water and health providers with a human sensor web (HSW). Conceptually, an HSW consists of a large network, or web, of people with mobile phones with specialised mApps, geoweb services to publicise and disseminate (aggregate) information, and users of the information. The HSW thereby enables and facilitates the reporting, sharing and publication of information on the internet using geographic web services about problems 'sensed' by ordinary people in commercial or state service delivery. In the language of Science, Technology and Society studies (STS), an HSW is a socially designed assemblage or socio-technical arrangement of human and nonhuman (but human-designed) elements.

The HSW provides a perfect translation of the eGovernance propositions discussed above into a technical ICT design, which is essentially one of crowdsourcing information to a public website. In this paper we describe the experiment conducted by SEMA. During our research, we learnt that the four

[5] www.twaweza.org

[6] www.daraja.org

[7] www.cordaid.org/en/partners/stichting-text-to-change/

[8] www.makingallvoicescount.org/

[9] Sema means 'tell me' in Swahili.

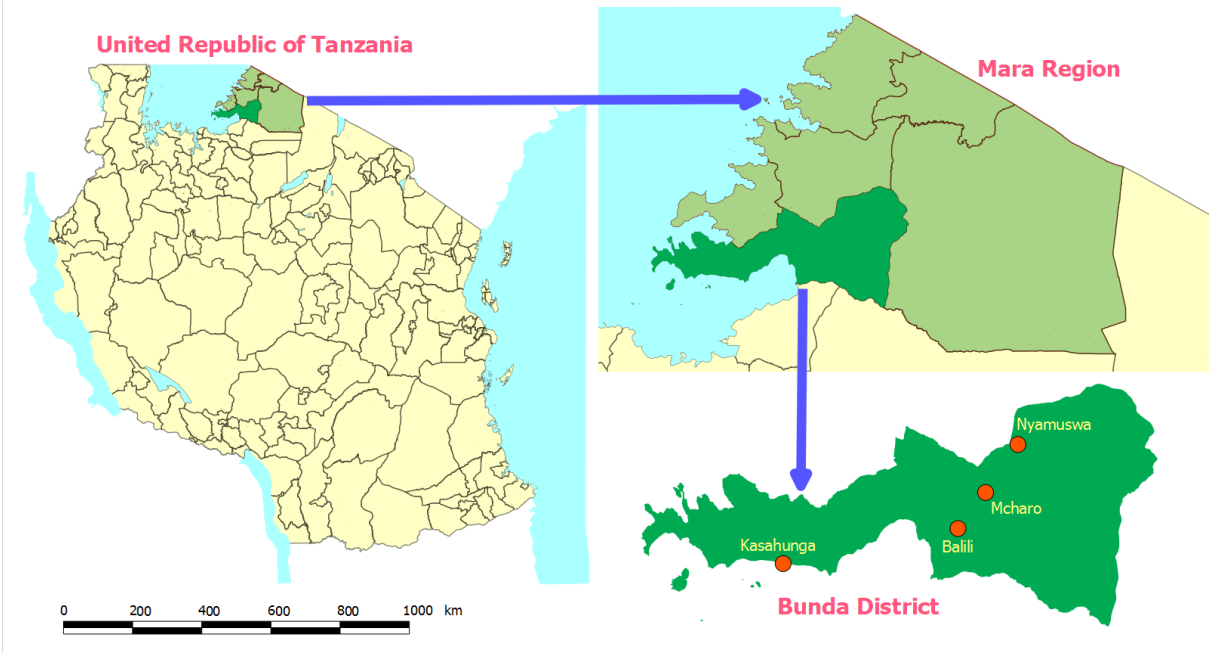
[10] www.sema-research.net

assumptions on eGovernance listed above hardly apply to the context of rural water supply in Tanzania. To produce functioning software, we had to take account of the actual context. After a brief explanation of the research design and methods, we discuss how the context of rural water supply in Tanzania differs from the above four assumptions in eGovernance. We then show how we took account of this actual context in our software design. In the discussion, we analyse the responses from stakeholders and participants when we presented the software to them. To understand our observations, we introduce the concepts of eGovernment and iGovernment. We conclude with some sobering thoughts about the transformative possibilities of eGovernance tools such as the SEMA software.

RESEARCH DESIGN AND METHODS

The SEMA research is set up as a reflective action research experiment in the context of rural water supply in Tanzania (Georgiadou et al., 2011). As a case study area we selected Bunda District in the northwest corner of the country. A key element of the overall SEMA research design constitutes learn-and-deploy cycles, where we developed and tested the SEMA software and improved functionality and usability, i.e. it was made to fit the context. We deployed the software in four wards in Bunda District (Mcharo, Kasahunga, Nyamuswa and Balili) (Figure 1).

Figure 1. Location of four cases (wards), Bunda District, Mara Region, Tanzania.



We employed two principal approaches to take account of context in the design of the SEMA software. The first approach included extensive consultations with stakeholders in Tanzania to create alliances with interested organisations (government, NGOs, telecom providers, donors) and to try to ensure the software would fit with their aims and procedures (see 'Software functionality and assemblage'). The second approach consisted of using computer science approaches to formally model the context as a part of the software design (see 'Context modelling for software design'). To inform our assessment of context, in-depth social science research was conducted by two PhD students. Their ethnographic research consisted of interviews with citizens, officials and politicians, observations at meetings and collecting relevant documents, and subsequent thematic analysis of the texts. Much of this work is still

in progress and reported in unpublished fieldwork notes. Empirical data and analysis on citizens' behaviour, including reporting of faults, are provided by Nganyanyuka (2013-2015) and Nganyangyuka et al. (2014). Data and analysis on bureaucratic and political aspects are provided by Katomero (2013-2015) and Katomero et al. (2014; in review). The confrontation and combination of PhD research and insights developed by the seniors allowed us to design a promising assemblage (see 'Redesigning the SEMA assemblage'). At the time of writing, the first deployment round of the software is ongoing, and the first lessons are included in the discussion section of this paper. This paper provides a theory-informed presentation of, and reflection on, our experiences so far. Thereby, it contributes to the growing scientific evidence on eGovernance.

THE CONTEXT: RURAL WATER SUPPLY IN TANZANIA

Despite decades of government and donor investment, the provision of safe water in rural areas of Tanzania is still poor. Depending on definitions used, statistics show that only around 45-55% of the rural population has access to water from the so-called 'improved' water points (Jiménez and Perez-Foguet, 2011; 2012).[11] A major cause of this low percent is the emphasis on construction of new facilities most of which break down within a few years and are not repaired due to capacity and funding problems at local levels (Jiménez and Perez-Foguet, 2010; Mandara et al., 2013). The Tanzanian government's commitment to provide safe water to citizens is stated in the current National Water Policy (2002) and the National Water Sector Development Strategy (2006-2015). This policy was translated into the mainly donor-funded Water Sector Development Programme (2006-2025) which again dedicates a considerable part of the funds to new infrastructure. Until recently, the evaluation of (lack of) progress regarding the achievement of rural water supply targets was hampered by the absence of a consistent, national database of improved rural water points and their functionality. Following NGO initiatives to collect relevant data in selected regions (Welle, 2010; Jiménez and Perez-Foguet, 2011), the Tanzanian government commissioned a nationwide survey in 2011. The resulting Water Point Map database (WPM) contains extensive information on water point location, technologies, history, and populations served. It is installed at the national offices of the Ministry of Water (MoW), with access from regional and district offices of the MoW being developed. A cursory inspection has shown that the data are not without flaws, and follow-up actions are being discussed between MoW and donors to improve the data quality.

In parallel to these water sector policies and programmes, a reform programme aimed at decentralisation of government responsibilities has been in place since 1998. In the context of rural water supply, this means that more responsibility for budgeting and implementation is transferred to the districts, which are now, at least in theory, the main hubs for rural water supply projects. Decentralisation also means that communities are expected to assume ownership of water supply facilities as soon as possible, including financial responsibility for maintenance (Mandara et al., 2013). To facilitate this, communities are required to establish Community Owned Water Supply Organisations (COWSOs). This process of transfer of responsibility can be described as 'a complex nexus' (Mandara et al., 2013: 83; cf. Cleaver and Toner, 2006), whose result is not yet clear and depends, e.g. on the local specific actor configuration (Katomero, 2013-2015).

The above brief overview provides the general context of rural water supply in Tanzania. We now discuss the specific elements of this context that impact on the feasibility of eGovernance tools, by evaluating whether the four assumptions listed above (page 59) apply in this context.

[11] In addition to issues of definition of access and the not inconsiderable problems of obtaining accurate data, in-depth research has shown that, in fact, a large part of the 'improved' water supply points yields water that is not safe to drink due to bacteriological contamination. Also, many water points yield water only part of the year (Jiménez and Perez-Foguet, 2012).

The institutional context: What kinds of 'good' is water in Tanzania? (assumption 1)

Conventional public service delivery frameworks put the government, or an official, government-approved private operator, as the sole provider of services, through its agencies, public officials and technical personnel. Although such arrangements have had impressive successes particularly in the developed world, the majority of the population in the developing countries are without access to such publicly provided services. We already discussed how this is also the case in rural water supply in Tanzania. Since human beings need water for drinking, cooking and washing, limited access to public services necessarily means that people will look for other sources of water. Empirical studies exploring the way the poor cope with problems of public services show a complex interplay of additional actors in formal and informal networks that mediate the provision of public services. In urban areas in Tanzania, public piped water supply systems run by quasi-state operators exist only in established, wealthier neighbourhoods, but often do not provide water at the required volumes or times, leading inhabitants to look for private tank-operators to supplement the piped supply. Not being connected to this public network, poor urban and most rural areas use wells or small piped schemes installed by the government or donors. In addition, they use informal, private, for-profit provision by water vendors, as well as natural so-called unimproved sources (rivers, ponds). Institutional analysis helps to systematise this complex situation, which in turn allows us to evaluate the degree to which SEMA software can incorporate this entire context in its software design.

Institutional analysis begins by asking about the socially, economically and politically constructed nature of the 'good', in this case domestic water.[12] The well-known typology of goods by Ostrom (2005) is based on the axes of 'subtractability of use', asking whether one person's use limits another person's use or not, and 'difficulty of excluding potential beneficiaries'. This typology of goods and institutional designs are ideal-typical: any concrete case will be a combination of one or more types, they get 'hybridised'. This applies very much to Tanzania as well. Due to its physical characteristics the possibilities for domestic water are threefold (Table 1).

Table 1. The multiple institutional natures of water in rural Tanzania.

Type of good	Subtractability and exclusion potential	Institutional design	Relationship types	Software functionality
Common-pool good	High; high	Community self-rule	Informal	Citizen to citizen; information on state of sources
Public good	Low; high	State or private monopoly	Formal or informal or illegal	Citizen to authority; information on state of sources
Private good	High; low	Market	Informal or illegal	Customer to vendor Information on price and delivery speed

Depending on the nature of a good, different institutional designs for the production and provision of the good are appropriate. These ideal-type institutional designs will result in different functionality requirements in the software design (last column in Table 1). Water as a private good is produced and

[12] We use 'domestic water' rather than 'drinking water' because we include water used for cooking, washing, etc. People use different sources depending on the purpose, if available and affordable (Nganyanyuka et al., 2014).

distributed by private individuals or firms under conditions of competition (thus excluding official, government-approved for-profit private operators that have a monopoly in their area). Water is sold to consumers in a market against a price, so the functionality required by consumers of an App could be to answer questions of speed and price with which a certain quantity of water can be bought from each vendor. Rivers, lakes, natural springs and ponds are common-pool resources that everybody can freely use, most likely subject to local systems of self-rule. The functionality of an App for common-pool water users could be to inform each other and/or an elected committee of the availability of water at a water point, or to report observed infringements. Finally, when water is a public good it is made available to everyone equally, e.g. through free public standpipes, by the natural monopoly of the state or its appointed agency. In this case, an App could inform citizens of the availability of water, and citizens could notify the state of dysfunctional water points.

In Tanzania domestic water in rural areas has characteristics of all three goods simultaneously. In rural areas, the long arm of the state reaches down to local levels with the (nearly) free installation of water supply systems (boreholes, small motor-pumped schemes) by government or donor-funded projects. New Public Management-type reforms begun by external donors are slowly making headway in rural areas. As mentioned above, the water users are now required to establish Community Owned Water Supply Organisations (COWSOs). They can choose whether to keep the management in their own hands, as has been nominally the case in previous governance arrangements (e.g. Village Water Committees, see Cleaver and Toner, 2006; Mandara et al., 2013), or outsource it to public-private partnerships. Local residents are supposed not only to dutifully pay their fees, but also to actively participate in the maintenance of the water supply system. However, the state is supervising the operations of the COWSOs closely, e.g. by requiring regular reports on finances and functionality. This bureaucratic capture turns COWSOs into unpaid, very local 'street-level bureaucrats'. Conceptually, in spite of their local ownership COWSOs are therefore not an example of common-pool management, but remain within the logic of a public good. In addition to this publicly organised supply, citizens also use common-pool natural water sources and small-scale private water vendors to fulfil their requirements. Small water vendors operate a parallel informal water market. They collect water from distant wells or open water and transport it to customers' homes, usually on bicycle. All in all, in rural areas water is a hybrid of all three goods, with emphasis on a combination of a public and a common-pool.

In theory, it is possible to capture such a hybrid situation, where three ontological ideal-types are mixed, into one and the same ontology model. However, each institutional design asks for a different functionality (see last column, Table 1) which necessitates different mApps. In practice, one of these, i.e. common-pool management, has little use for an mApp because people live near each other and will communicate face-to-face or through regular mobile calls. A more important barrier for the usefulness of mApps is the fact that all three institutional designs are wholly or mostly informal, if not sometimes illegal, as we discuss next. By definition, users avoid engaging with formal technologies such as mApps and databases in these circumstances.

The role of information in governance of services: Formal and informal arrangements (assumption 2)

Our fieldwork has revealed that 'there exist parallel worlds of politics', with the real, informal world existing in parallel with the formal laws and procedures; hence the importance of informal relationships and mechanisms (Kelsall, 2008: 10) which affect how empowerment and accountability are enacted in the Tanzanian context. While the rationalities and mentalities in formal institutions are derived from formal bodies of knowledge, belief system as well as state institutions, those in informal institutions draw from unwritten, non-specified rules-in-use guiding spontaneous interactions and shared expectations of actors (Helmke and Levitsky, 2003; Hyden, 2006). Each of the three institutional designs found in domestic water supply in Tanzania has informal elements. Community self-rule in rural areas is

largely informal, although the state is pressurising COWSOs, where they exist, to report the status of their finances regularly. The traders operating on private markets do so mostly illegally and always informally. In urban areas they sell water from private boreholes by tankers without permits, make illegal connections to the public piped network, or they (maybe legally) buy water from private or public water points to deliver to the homes of water users. In rural areas, they transport water from common-pool natural sources or shared water points to sell at the homes of water users (Nganyanyuka et al., 2014).

More unexpectedly, we also found that the supposedly formal state institutions are also permeated by informal relationships and mechanisms that determine, to a large extent, what actions are taken (Katomero et al., 2014; cf. Hossain, 2011 on India). The informal mechanisms in the state originate in three sources: the history of a one party state, individual gain-seeking, and socio-cultural characteristics. First of all, formally, Tanzania has become a capitalist-democratic multi-party state. Informally, practices from the previous one-party state dominate Tanzanian politics and governance, both in urban and even more so in rural areas. The continued dominance of the former single party gives the appearance of centralised power (Khan and Gray, 2006; Tilley, 2014). This is not helped by the fact that the ruling party holds a large majority of the representatives. Party politics has been observed to overrule formal decision making by behind-the-scenes agreements (Katomero, 2013-2015). Second, decision-making is rife with individual gain seeking, for direct financial benefit, for re-election purposes, or for career progress. For most ordinary citizens corrupt practices are a life style and survival strategy (Nganyanyuka et al., 2014). For authorities in the public and private corporate spheres corruption is a political style and policy strategy (Lindner and Banoba, 2014). Thirdly, patrimonial relations prevail (Kelsall, 2008), meaning that anyone who is well connected to top-level politicians and officials can make things happen. Needless to say, these informal arrangements are not mediated through formal communication channels. We concur with Schatzberg (2002) who argues that most studies of Africa are 'out of focus' with local political realities, and urges that "[u]nless we begin to take indigenous understandings of concepts and categories more seriously than we do currently, we shall continue to miss vital and living elements of politics in this part of the world" (Schatzberg, 2002: 70).

The scope of mApps for citizens' reporting (assumption 3)

SEMA builds on the lessons from a pilot study for the reporting of water point failure that was implemented by the same research team on the island of Zanzibar (part of Tanzania) (Georgiadou et al., 2011). In this project on Zanzibar citizens were asked to report water delivery failures at public standpipes through a formatted SMS, the request being displayed on billboards next to the water points. The reported data were displayed on a public website.[13] The Zanzibar pilot ran into several obstacles (for details see Verplanke et al., 2010). First of all, the reporting behaviour of citizens did not fulfil the expectations: very few messages were received, and most of these were not coded as requested but free text, making them unreadable to the system. Second, and likely one of the reasons for the previous ability and/or willingness of the public water utility to use the information for solving the reported problems fell below expectations.

The reporting system Maji Matone[14] set up by the Tanzanian NGO Daraja for citizens to be able to report the quality of water services also attracted very low response rates and is considered by the NGO to have failed (Taylor, 2011, 2012a, b). After a year of running the initiative, Maji Matone had only received 53 text messages out of 3000 anticipated, despite extensive advertising in the local press and the radio. Here, low motivation among the citizens was also found to be an important reason. Taylor

[13] http://geonetwork.itc.nl/zanzibar/

[14] The Swahili words 'maji matone' means 'water droplets'.

(2012b) observed a widespread sense of powerlessness among citizens, a sense that there is nothing they can do to hold local government to account. Low motivations for citizens to participate in political activities have also been recorded in other interventions aiming to empower citizens to monitor public officials, particularly those involving the use of information technologies including mobile phones. Failure to achieve mass participation has driven NGOs to opt for trained staff and volunteers who report when asked on specific questions.[15] During our fieldwork we furthermore discovered that it is considered inappropriate in Tanzania, and may even be politically dangerous, for citizens to *write* concerns about governmental actions to the anonymous public domain. Rather, citizens *speak* of problems in personal interactions with responsible officials (Nganyangyuka, 2013-2015).

Increased transparency through public displaying of information will 'name and shame' responsible organisations into action (assumption 4)

In a context where, as discussed above, informal connections determine to a considerable extent what actions will be taken, the feasibility and value of formal (for public) reporting on service provision is likely to be limited. In addition, as also discussed above, the ability and/or willingness of the state system to use the information for solving the reported problems is a well-known phenomenon (Jiménez and Perez-Foguet, 2010), one which the Zanzibar pilot also encountered (Verplanke et al., 2010). These factors mean that 'naming and shaming' is not likely to be effective in the current conditions in rural water supply in Tanzania.

REDESIGNING THE SEMA ASSEMBLAGE

From these findings on the actual context of rural water supply in Tanzania, we concluded that the original envisaged design of citizens reporting directly to a public website was not going to result in a design that would be used by intended users. Since our goal was to design and test a useful and functional software package, we now ask "what does 'taking this context into account' mean for the SEMA software design?"

Software functionality and assemblage

After consultation with local officials and villagers in our case study area, we decided that rather than ordinary citizens, the COWSO could be the reporter of water supply data, since this is part of their official mandate. On the receiving side, we looked for a partnership with the organisation nationally responsible for ensuring rural water supply to the Tanzanian population, the Ministry of Water (MoW). Fortuitously, MoW was just finalising a nationwide database of water points (the Water Point Map[16]) (URT, 2013) for which they needed an updating mechanism; we were able to propose the functionality that they were looking for.

The SEMA software now consists of two mApps used for reporting and receiving information (**Erreur ! Référence non valide pour un signet.**) which are limited to the current status of the water point (functioning/non-functioning) and the cause of non-functionality, if this is the case. The App is complemented by a back-office database and querying system (Figure 3). There are two versions of the mApp, for low-end mobile phones (USSD) and for Android smartphones (**Erreur ! Référence non valide pour un signet.**). Since most Tanzanians do not have a smartphone, the USSD implementation is the default, but the Android App is developed in parallel with future use, and more advanced users, e.g. in the local authority, in mind. The functionality of the mApps was determined by the formulation of so-

[15] Examples where this has been done can be found at http://twaweza.org/ and www.ihi.or.tz

[16] www.waterpointmapping.org/

called 'use cases' (Annexe 1) that systematise who asks for information, what information is required and for what purpose (why). For example: 'as a water user, I want to know the nearest functional water point so that I can fetch water', or 'as a District Water Engineer I want to identify similar problems in my network so that I can understand common causes'.

Figure 2. SEMA mApp: USSD(left) and Android (right) implementations.

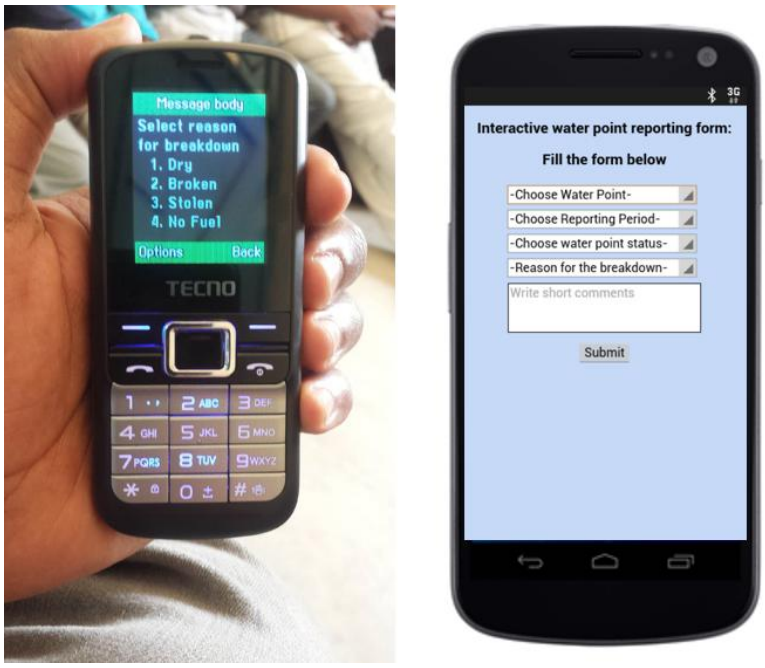
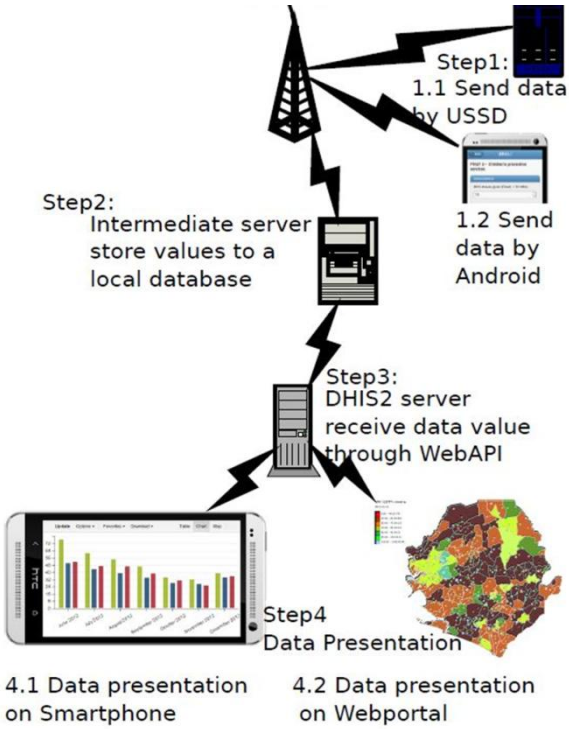


Figure 3. SEMA architecture.



CONTEXT MODELLING FOR SOFTWARE DESIGN

Another element of SEMA software design was the embedding of domain knowledge, or context, in computational and mathematical form. This is the second, more formal way in which we incorporated context into the SEMA software (Figure 4). The importance of this activity is increasingly recognised in computer sciences, because the use of software has dramatically changed over the last decade. The expansion of web applications and mobile applications has resulted in a proliferation of end-users. Application builders are increasingly confronted with often unknown users and a wide variety of know-how amongst them. At the same time, software development is being democratised by the availability of uncomplicated software development platforms and reusable open source software libraries. This means that developers are creating only small parts in a modular software environment, allowing for flexible and adaptive applications. In order to build software in a multifaceted and complex situation, developers need to embark on interoperable solutions and put more effort in dealing with frequently changing user requirements. An advanced method to make the functionality of the software explicit is to use ontology-based models. Machine-readable representations of ontologies facilitate their use within different software applications. This has several purposes (Tetlow et al., 2006): common understanding of domains, defining data definitions used in software components, automated consistency checking, discovery and reuse of functionality over the web.

The notion of modelling and exploiting context has been in use by diverse areas of informatics since 1960s (Coutaz et al., 2005). Amongst the available approaches, ontology-oriented proposals are becoming increasingly popular. Strang and Linnhoff-Popien (2004) advocate ontology-based context modelling for its expressive power, hierarchical organisation, formality, standard, support for efficient reasoning, support for programming abstraction and interoperability. They propose a Generic Context Management Model composed of three functional components: context semantics (ontology), context instance data and context-related rules. Uniquely amongst formal modelling techniques, ontology-

based context modelling allows qualitative data on objects and relationships between objects to be captured, modelled, analysed and used to yield hypotheses (Strang and Linnhoff-Popien, 2004).

Figure 4. SEMA software design including ontological model.

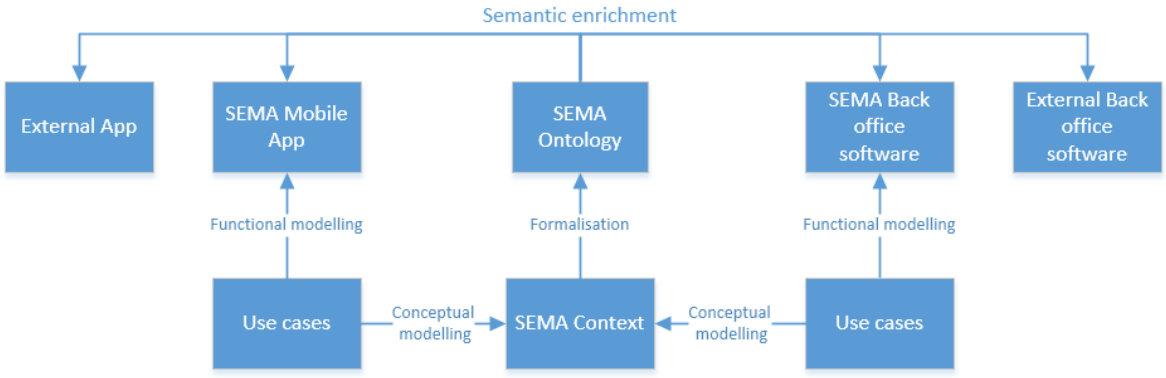
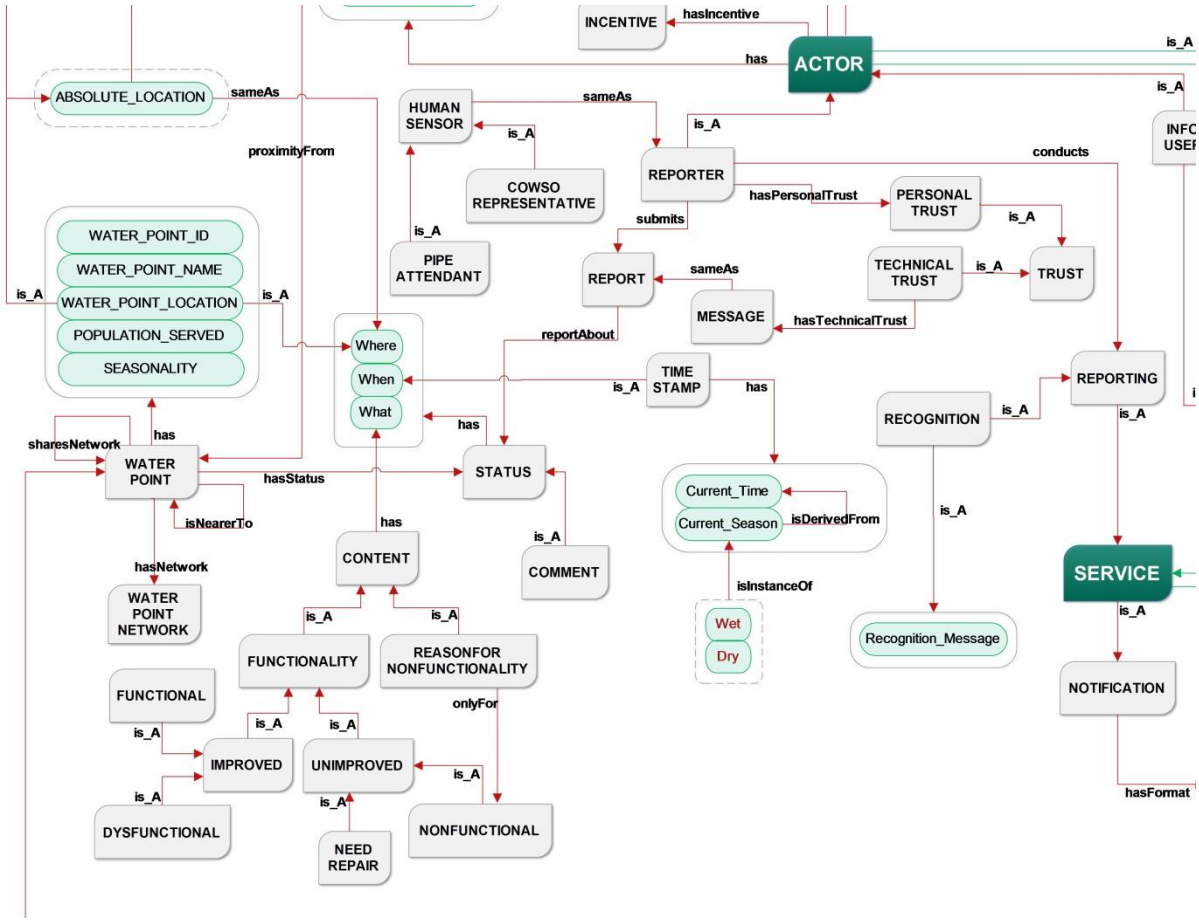


Figure 4 shows that context takes a central role within the SEMA software development. This 'SEMA context' is derived from an intensive exchange between SEMA researchers and is formalised into a machine-readable ontology. This ontology is embedded in the software, both at the side of the mobile App and at the side of the back office. Computer engineering therefore consists of a dialogue between the analysis of the ontology of a domain or life world, and making that domain's decision-making processes physically real (which does not necessarily mean 'completely understood') in the software (Agre, 2004). The ontology is limited to what is considered to be within the context, and hence the importance of the research into context presented above (see 'The context: Rural water supply in Tanzania'). The ontological model (Figure 5) contains concept classes and relationships between them. This allows us to disambiguate the definition and use of, for example, water point status (see the bottom left corner of Figure 5) within the software. This ontological model is represented in the XML-based Web Ontology Language (OWL), which can be easily adapted to changing requirements and is sharable amongst different software components. This supports the above-mentioned principles of flexibility, adaptability and interoperability.

Figure 5. An excerpt of the SEMA ontological model.



By carefully constructing the ontology within the empirical field of study, we also help to avoid mistakes, for example reporting a functional water point as non-functional, due to a misinterpretation of the App's user interface. The advantage of ontological modelling is that such choices will become explicit compared to the often many implicit choices hidden in software. Another advantage is that the explicit concepts can be shared with external software, not controlled by the project. In the water sector there are several examples of projects, such as Taarifa, that are developing applications which could be used in connection which SEMA software. The ontological model eases such connections. For the moment, the ontology model is only used in the SEMA software to determine the context of information requests from users at the district office and the Ministry of Water. By adding the ontology model, their information requests become so-called 'smart queries', meaning that the software interprets the request and provides an answer that is tailor-made for the user's context, e.g. geographical location and position in the hierarchy.

DISCUSSION: LESSONS FROM DEPLOYMENT

Despite our analysis of the context of the Tanzanian water supply, the many discussions with intended users and government officials, and the careful translations of lessons learnt into the software functionality and ontology, the first experiences of deployment compel us to re-think our assumptions yet again.

By taking context into account in the way we did, we 'went with the flow' and adjusted to existing power relationships and communication procedures. Nevertheless, it now appears that we did not sufficiently take into account another important element of context: the internal bureaucratic politics of the MoW. By presenting ourselves as providers of an updating mechanism for the recently completed Water Point Map (WPM) we became a new actor in the existing playing field within the MoW. At the national level, water-technical departments are vying for power and influence with the ICT department, who had close links with the private consultant tasked with updating the WPM as part of a multimillion dollar World Bank project – part of which we are now proposing to arrange for free. At district level, our proposed mApp would enable COWSOs to report directly to the District Water Engineer, eliminating the need for paid field trips by district technical staff. At a more abstract level, our system would not exactly reproduce existing paper-based information flows, along eGovernment ideas that communication could be made more efficient by bypassing long roads through all levels of the hierarchy. We have overcome these hurdles through careful diplomacy and persuasion, so that the App and back-office database are now being tested with MoW approval.

In retrospect, we moved towards the domain of eGovernment, where accountability is predominantly an internal government affair, as distinct from the transformative eGovernance objectives of empowerment and public accountability we started with. eGovernment has been conceived of as a set of processes to reform bureaucracy, achieve efficiency gains and save public resources by automating internal office tasks (OECD, 1998, 2003). In eGovernment, administrative procedures are supposed to become more fluid, faster and taking fewer in-between steps, with some steps being automated. It is supposed to be a technical, thus neutral solution to internal organisational problems, or problems in reaching, or being reached by, other organisations, citizens or consumers. With our choices, we in fact developed a type of eGovernment App that can be labelled 'administrative App'. At first sight, this kind of App looks like it changes only information processing, so it has derivative rather than transformative goals. However, as explained above, we discovered that our administrative App was not free of politics either, since it re-negotiates internal bureaucratic relationships, habits and unwritten rules (cf. Maniatopoulos, 2005; Pelizza, in review). This is where the framing of ICT development as 'eGovernment' has to be complemented by a framing in terms of 'iGovernment' (Mayer-Schönberger and Lazer, 2007). In iGovernment, the analysis of 'hard' digitisation technology is complemented with 'soft' consideration of information flows and actors. Digitisation of governmental information flows challenges the existing institutional order as a whole, and triggers new forms of authority and procedures of legitimacy (Pelizza, in review). In the SEMA project, new actors (COWSOs) are introduced in existing paper-based or digitised management information systems. This implies the bypassing and disappearance of actors, or a redefinition of their roles and functions, which is understandably contested by those who lose out.

From the first experiences with the deployment at district level, it also appears that despite our extensive discussions with officials, the actual introduction of a working gadget gives rise to unforeseen controversies. We envisaged reintroducing the original transformative goal by copying the COWSO digital reports on water supply not only to the district officials and the MoW database but also to the elected councillors and civil society organisations that can then use the data to hold the district officials to account. The councillors welcome this idea, affirming that they need the correct data to be able to fulfil their oversight role. However, the district officials maintain that these are 'technical data that we need for the running of the schemes' and that it is not appropriate for elected councillors to have access to the database. The logical choice of COWSOs as reporters is also now contested, despite the formal requirement for them to report data on water supply. It appears that the Village Executive Officers (VEOs), the lowest-level of government bureaucracy, feel bypassed by COWSO reporting, and are supported in this by the district officials. The debate on who should report was based on two issues: the legal-administrative requirements and the actual practice on the ground. The district officials played their role as bureaucrats, quoting selectively from legal frameworks in order to exclude potential

intruders (i.e. COWSO's reporters) from disturbances in the form of reports. For them, enlisting the VEOs would make things easier because VEOs are part of the bureaucracy and very loyal to higher administrative ranks of the district. We can only wait and see what surprise findings the next steps in this action research will reveal.

Of course, irrespective of what technology is used, the use and spread of water-related information has been always a challenge due to its socio-political impacts (Jiménez and Perez-Foguet, 2010; 2011). However, contrary to paper-based reports, crucially the digitisation of information flows is black-boxed for the user, being a set of algorithms packaged as computer programme. As a domain is analysed in computational terms, patterns emerge that the computer engineer translates by way of settled codes and techniques, or the engineer invents new ones to capture such patterns. In this way, discourses about domains or life worlds are inscribed in the inner workings of computers. More particularly, Agre (2004) elucidates this inscription process as follows:

> Computer people are ontologists, and their work consists of stretching whatever discourse they find upon the ontological grid that is provided by their particular design methodology [.]. In each case, the systems analyst performs a profound transformation upon the domain discourse. The discourse is taken apart down to its most primitive elements. Nouns are gathered in one corner, verbs in another corner, and so on, and then the elements are cleaned up and reassembled to create the code. In this way, the structure of ideas in the original domain discourse is thoroughly mapped onto the workings of the computational artifact. The artifact will not capture the entire meaning of the original discourse, and will distort many aspects of the meaning that it does capture (Agre, 2004: no page numbers).

The last sentence of Agre's argument is important for two reasons. First, to the user of an App, the operations performed by the computer engineer are black-boxed and invisible. As long as the life world and decision-making of the user is sufficiently mimicked by the computational programme in the App, this is not serious and corrigible, although there are many examples of failed ICT-innovations where the translation between life and computational worlds proved not very felicitous. Second, the internet opened ample opportunities for interoperability between multiple users in different life worlds and organisations: between disciplines, professions, workers and management, work places, territorial scales, policy domains, public and private organisations, and between public organisations and individual users or citizens. It is at this point that the 'perils of algorithmic gatekeeping' (Morozov, 2013) really emerge. Pelizza (in review) found that Apps designed for facilitating interoperability often turn out to be 'detonators of controversy': different life and organisational world stress different values that cannot be reconciled computationally, but need political settlements. ICT does not cause a revolution or define a wholly separate 'e' or 'i' sphere. Instead, due to its distinctive qualities, it participates in somewhat distinctive ways in the ongoing political life of institutions (Agre, 2004). Digitization, then, is always in one way or another transformative (e.g. Orlikowski, 2000). Another observation by Agre (2004) explains why this is the case:

> The discourses with which computer science wrestles are part of society. They are embedded in social processes, and they are both media and objects of controversy. [...] This is the great naiveté of computer science: by imagining itself to operate on domains rather than on discourses about domains, it renders itself incapable of seeing the discourses themselves, or the social controversies that pull those discourses in contradictory directions.

From the transformative perspective that is at the origin of many development (research) projects, including SEMA, Pelizza's and Agre's observations are highly relevant. Apps, whether commercial, social or political, generally relieve overburdened individuals of conscious information processing in a multi-tasking social environment; this provides their major appeal. In the relatively simple life worlds of economic transactions or one-to-one social interaction there are very successful 'killer' Apps (but see Carpenter, 2013). But assigning Apps the political role of improving empowerment and accountability is a totally different matter. In the Tanzanian situation of hybridity, where water is at the same time a

public, private, and common-pool good, water is a contested and therefore a politicised concept. People disagree (mostly implicitly) about the proper definition in particular contexts, and by extension they disagree on the right course of action (mostly explicitly). Political and administrative manipulation and bias may be, naïvely or unreflexively, built into the App through ontological models that capture contexts only imperfectly, which are nevertheless used in App design. Therefore, Apps have a Janus face: they are good (they relieve us of certain tasks), but they are also bad (they constitute a means of ideological, political or administrative manipulation and bias). ICT technologies are amenable to one of the key insights from STS studies: any piece of technology is part and parcel of a social context, both emerging out of that context, impacting upon it, and gradually acquiring new, frequently unintended meanings through anticipated and unanticipated use. In other words, context counts, implying that multiple contexts count, and time counts as well. In other words, Apps are technological designs with inscribed administrative or political preferences. This may be unavoidable, but, as consultants or scientists recommending Apps for use in particular politico-administrative contexts, ethics demands us to be conscious of this and make the inscribed political and administrative assumptions visible.

CONCLUSION: ICT TOOLS HAVE POLITICS

The SEMA project set out as an action research project to design and implement software for empowerment and accountability in service delivery in Tanzania, which is clearly a transformative, political goal. However, because we were focused on making the software functional in the circumstances we encountered, we found ourselves producing an instrumental, derivative tool that will not obviously challenge existing power relations, except those within the government bureaucracy, such as the Ministry of Water itself. It may even draw previously 'independent' actors at local levels, i.e. COWSO committees, into the state bureaucracy. The use cases that were included in the software functionality provide the best illustration that we have, in fact, made an App to support the management of water as a public good (Annexe 1).

In the Introduction we identified four basic assumptions behind most e-Governance applications and asserted that our research shows these hardly apply in the Tanzanian context. Assumption 1, 'services are provided by the state or by a state-sanctioned monopoly' refers to water as a public good. This assumption clearly does not apply, since water is a hybrid good. In fact, the state(-sanctioned) monopoly only provides a small proportion of water to citizens, with the larger proportion being arranged through informal (or even illegal) market or common-pool mechanisms. This also has implications for assumption 4, "public displaying of information will 'name and shame' responsible organisations into action" since accountability in informal relations is not arranged through public displaying of information. In turn this means that assumption 2, 'a lack of information is an important (the most important?) bottleneck to better governance of services' would only apply to the share of water supply provided through the formal, state monopoly. However, here we have seen that formal accountability mechanisms, where formal reporting plays a role, are outstripped by informal mechanisms where information is not generally publicly exchanged. As for assumption 3, 'citizens will be able to provide this information', we discussed how this is a problematic assumption because of cultural and political reasons.

From our experiences we therefore conclude that public crowdsourcing in the context of empowerment and accountability regarding public services is not a viable approach in Tanzania at the present time. One way to understand how this proposition could gain such popularity is to compare the purpose of the webApps and mApps discussed so far. Many ICT innovations, whether web- or mobile-based, have a communication model where the applications facilitate trade between producers and consumers in a market, e.g. like Amazon or eBay: these are 'commercial Apps'. Alternatively, the applications could facilitate communications in civil society settings such as Facebook and WhatsApp: these are 'social Apps'. Wikipedia and Open Street map are examples of participatory knowledge-

gathering, or 'knowledge Apps', that use crowdsourcing and are the inspiration of many of the Apps mentioned above, like Maji Matone, Text to Change, Ushahidi, and the Zanzibar HSW. However, the latter have governance goals which make them 'political Apps' and therefore likely to raise more controversy and resistance. Using a very simple conveyor belt model of the political process, at least six different models can be defined in which digital technologies have possible impact on democratic governance (Fung et al., 2013). On the basis of well-known institutional constraints and normal political incentives, the authors argue that only three of these, truth-based advocacy, constituent mobilisation, and crowdsourced monitoring, have a chance to be successful. In each of these three, incumbent intermediaries, notably political parties, vested interest groups and NGOs, use digital technologies to boost the effectiveness of their present roles in the existing governance system, as opposed to challenging the system. This means that digital technology piggy-backs on and may increases the power of existing political actors.

Digital technologies do not then automatically or deterministically empower the public sphere, displace traditional organisations by (digitally) self-organised groups, or lead to digitised direct democracy (cf. Livingston and Walter-Drop, 2012 for a more optimistic view on the potential of ICT for direct citizen action – which focused on the developed world and North Africa). We should note that Fung et al. (2013) do not mention the possibility that governments talk or even strike back by means of digitised counter-technologies as in Russia or China (Kalathil and Boas, 2001; Gorham, 2014). Analogising from, but in fact contextually disconnecting, the success of commercial and social 'killer' Apps, many ICT experts, academics, politicians and practitioners optimistically predicted that digital technologies would boost democracy, transparency and accountability. However, we concur with Fung et al. (2013) that "one difficulty, in our view, with some of the claims about the potential benefit of digital technologies for democracy is that they are excessively attentive to the novel dynamics that technology enables but inattentive to the institutional dynamics of political systems" (Fung et al., 2013: 33).

We find that we cannot escape power relations and politics if we want software that works, no matter how cleverly we include context models – or maybe *because* we include context models! We cannot avoid going with the grain (Kelsall, 2008) in our efforts to respect the context:

> The way to understand the effect of technology on politics is not to generalize or analogize from one or other digital platform – such as the collaborative production of knowledge on Wikipedia – but rather to understand some digital technology as a part and an intervention in a larger political system (Fung et al., 2013).

Thompson (2004: 22) has shown how "the appropriation and discursive deployment of ICT, with its association with progress and rationality, offers a powerful opportunity to further the interests of technocratic, often 'mainstream' stakeholders, acting as a magnifier for dominant discursive interests". It is proving difficult to escape this hegemonic framing. In his well-known ethnographic case study of the establishment of state-run piped domestic water provision in three middle-sized Tanzanian towns, Rottenburg (2009) also implicitly treats domestic water as a public good to be provided by a public water utility on a cost-recovery basis, in spite of the evidence that this arrangement only provides water to some, some time. It is apparently very easy to hide political preferences or decisions and thereby depoliticise a seemingly technical mApp, as we also have experienced. With this focus on official, state-sponsored water supply we are truly not counting what counts for citizens (Nganyangyuka et al., 2014).

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ANNEXE 1. SEMA USE CASES

Use cases for sending information

Use case 1.
(who) As a chairperson of COWSO
(what) I want to send a message about a broken water pump to a technician (private or govt. district level)
(why) so that the technician can come and advise how to repair it.

Use case 2.
(who) As a chairperson of the COWSO
(what) I will send a message about a broken water pump to villagers
(why) to notify them about the reasons of the breakdown and the date it will be fixed.

Use case 3.
(who) As a chairperson of the COWSO
(what) I will send a monthly message about the functionality of the water points to MoW
(why) to enable the ministry to update the water point mapping database.

Use case 4.
(who) As a chairperson of the COWSO

(what) I will send a monthly message about the functionality of the water points to the District Water Engineer (DWE)
(why) to enable him to update his database.

Use case 5.
(who) As a chairperson of the COWSO
(what) I will send a message about a broken water point
(why) to our councilor to enable him to influence the Local Government Authority (LGA) decisions.

Use cases for retrieving information

Use case 1.
(who) As an information end-user
(what) I want to know the water point functionality status within my jurisdiction in a format suitable for me
(why) so that I monitor the up-to-date overall status and distribution of water point facilities.

Use case 2.
(who) As a water user
(what) I want to know the location of the closest functioning water point
(why) so that I will be updated about the possible coping mechanisms.

Use case 3.
(who) As a District Water Engineer
(what) I want to assess the reliability of reported problems within my jurisdiction
(why) so that I can exclude unreliable reports from my analysis.

Use case 4.
(who) As a District Water Engineer
(what) I want to identify similar reported problems in a network
(why) so that I can understand common causes.