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Digital Technology for Health Sector Governance

Key findings from a scoping review

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About This Report

This report summarizes the key findings of a study conducted by a team of researchers at Medic Mobile, the University of Cambridge and the University of Edinburgh and commissioned by the Leadership, Management and Governance (LMG) Project. Funded by the US Agency for International Development, the LMG Project (2011-2016) collaborates with health leaders at all levels to improve leadership, management and governance practices to strengthen health systems and improve health for all, including vulnerable populations worldwide. Medic Mobile, a member of the LMG consortium, equips health workers with mobile and web tools to provide better care and reach more people.

The initial remit of the study was to capture and synthesize published research demonstrating the actual and potential impacts of mobile phone technology usage on health sector leadership, management and governance in lower income countries. As part of the iterative research process, the focus was sharpened to emphasize good governance concerns such as transparency, accountability, and public participation, rather than management or leadership activities. Although the study pays particular attention to mobile health (mHealth), our analysis draws on other global development sectors with potential for transferrable learning and the scope was extended to encompass other Information and Communications Technology (ICT), reflecting the wider eHealth ecosystem in which these innovations exist. The methods were adapted to combine a semi-systematic search for peer-reviewed articles with a landscape scan of innovative practice (as summarized in technical reports, project websites and blog posts), supplemented by interviews with expert practitioners and researchers in the field.

This report highlights the ways in which mobile phones and other ICTs are being used, or soon could be, to encourage good governance of the health sector through greater accountability, transparency and public participation, and identifies research and development priorities for scholars and innovators aiming to contribute to this nascent field. This version was prepared for internal circulation, pending publication of full study results in a peer-reviewed journal.

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Executive Summary

Problem: Poor health sector governance is a major barrier to the cost-effective provision of equitable healthcare in many lower-income countries. Since poor governance stems from a complex blend of organizational, political and socio-cultural factors, many in the global health community have regarded the problem as endemic and intractable. However, interventions aimed at promoting transparency, accountability and participatory governance have yielded encouraging results in recent projects. In an increasing number of these cases, mobile phones and other information and communications technologies (ICTs) have played a significant role, often building on lessons learned in other sectors.

Aims: This scoping study set out to identify, synthesize and analyze existing case studies and research reports concerning the use of mobile phones and other digital ICTs for improving the governance of healthcare systems in lower-income countries. Rather than drawing conclusions concerning evidence of impact, this study sought to map the landscape and highlight future research and development priorities.

Methods: We conducted a quasi-systematic scoping review of published peer-reviewed research and a landscape scan of grey literature, guided by a keyword search and an emergent theoretical framework. We used online social networks to seek additional case studies and publications for inclusion. Finally, we interviewed selected experts in the field to test and verify the interpretive framework and to identify additional projects and research reports pertinent to the aims of the study.

Results: After clarifying the diverse ways in which the term 'governance' is used in the global health community, this report highlights particular opportunities for digital interventions to promote transparency, accountability, and public participation. We emphasize interventions that address specific and local concerns with government performance, with the long-term aim of enabling people to improve their own lives in concrete ways. Many of these projects are civil society or community-driven, while other projects have been initiated by healthcare organizations, governments or public-private partnerships.

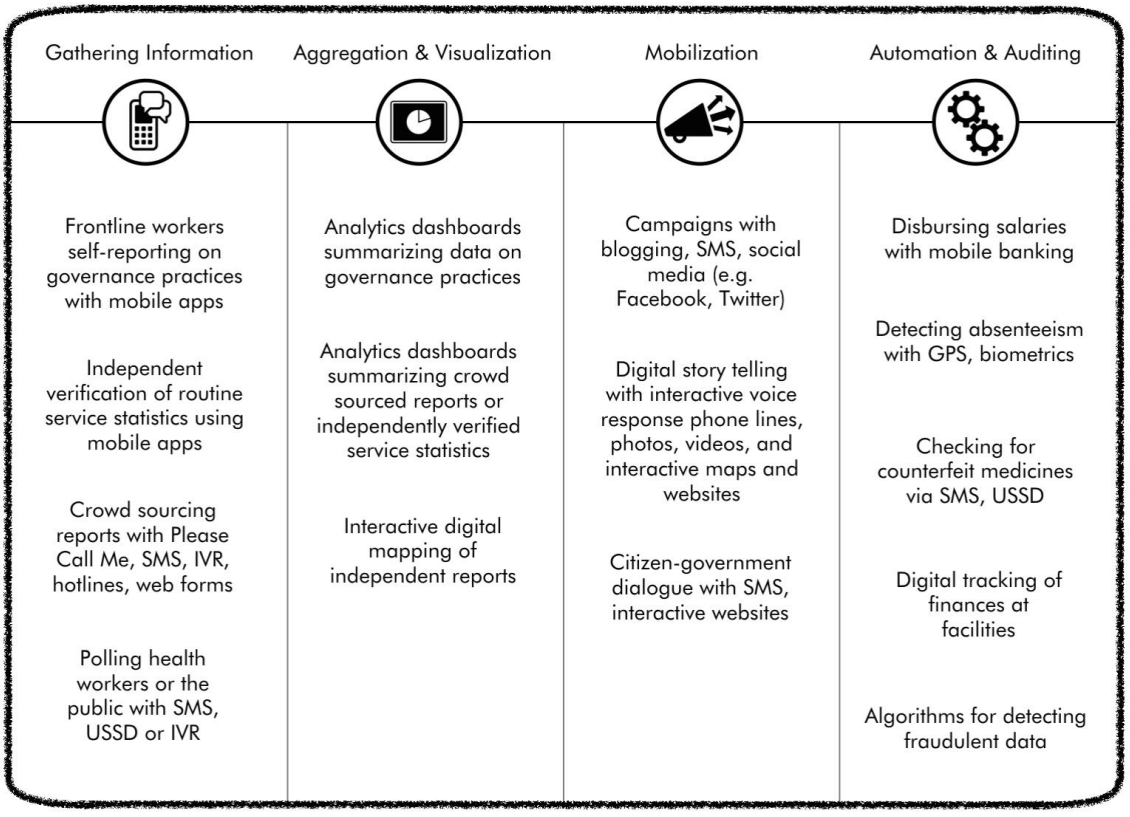
Organizing the review by technology use cases, we discuss the use of digital tools for gathering information, aggregating and visualizing data, mobilizing communities to foster accountability, and managing fraud by auditing or automating service delivery (see Figure 1, following page). Numerous case reports and anecdotal accounts attest to the actual or potential value of ICT for improving the transparency, accountability and equity of health services in lower income countries. However, there is little published, peer-reviewed evidence to substantiate these claims, and the relevant evidence base from other sectors and non-digital interventions is decidedly mixed.

The role of digital technology as an enabler of good governance is not straightforward; for example, transparency itself may not trigger change without effective mechanisms of

accountability and oversight, supported by a culture of participative and responsive government. The contexts for which these interventions are intended, and in which they are delivered, can also be sociotechnically complex, calling for nuanced approaches using adaptive and human centered design.

Conclusions: A number of ICT interventions show great promise for improving transparency, accountability, public participation and ultimately equity in healthcare services. This is an active and growing area of investment by governments, healthcare organizations and donors. However, the evidence base is mixed and successes appear highly context-dependent. To address this concern, human centered and participatory approaches to intervention design merit greater attention. Furthermore, robust studies are needed to clarify the pathways through which such interventions lead to improvements, as well as to document impacts and unintended consequences.

Figure 1: Components of ICT for Health Governance Interventions



See page 16 for the full-size version of this figure.

Introduction

From misplaced priorities and negligent performance to absenteeism and outright fraud, the costs of poor health sector governance are staggeringly high. Best estimates suggest that 10%-25% of all money spent on health care is lost to corruption alone [1]. When compared with discrete medical technologies such as immunizations or insecticide-treated bed nets, the problems of poor governance are deeply complex and can seem intractable, or at least relatively inaccessible to concrete and replicable intervention. Nonetheless, efforts to address such concerns have yielded remarkable results in a growing number of recent projects. Pragmatic good governance interventions are feasible on a local scale, and increasingly they are being evaluated experimentally.

In 2004, a good governance intervention in Uganda improved health care delivery so dramatically that mortality in children under the age of five had fallen 33% within a year, in comparison with communities in the randomized control group. Provider absenteeism and wait times fell substantially, while utilization of outpatient services rose 20%. Costing just $3 per household, the surprisingly simple intervention revolved around “community score cards” (CSCs) with information about the quality of health care in each community, as compared to other communities and national benchmarks. With this information, community members were able to identify concrete problems in health services and work with care providers to address them [2]. Another project in Kenya focused on hospital staff stealing user fee revenue. Through more attentive management, separating the tasks of billing and fee collection, and implementing digital cash registers to streamline financial data collection and analysis, the hospital was able to increase user fee revenue by 47% in just three months, with no effect on service utilization. Within three years, better revenue controls and one modest price increase had afforded a 400% increase in annual collections, according to a report by the U4 Anti-Corruption Resource Center [3].

The Kenya project is part of a growing trend towards melding analog good governance interventions with innovative uses of digital technology. Such approaches are becoming well established if not yet widespread among global health practitioners. To give but one example, the U-Report initiative, backed by UNICEF, provides a social messaging platform through which individuals and communities can engage in surveys, report issues and influence change, and now has over 1.7 million registered users in 15 countries [4]. Among researchers, however, less attention has been devoted to digital good governance interventions. For example, one wide-reaching literature review of eHealth in developing countries revealed that the most substantive areas of research concern were interventions for improving communication, eliminating accidental errors, monitoring patients who might abandon care or improving data quality and timeliness; good governance interventions received no mention [5]. Academic reviews of mobile health (mHealth) interventions have often revolved around applying behavior change theories [6], or addressing specific disease verticals such as HIV [7] or maternal and child health [8,9]. Reviews that address mHealth and health systems strengthening in developing countries have

mentioned the importance of transparency, particularly with respect to medical supply chains, but otherwise have devoted more attention to routine management of clinical care and public health interventions than to governance challenges [10,11].

On balance, a considerable body of research has addressed the use of technology for improving efficient health service delivery and routine management, but the literature concerning ICTs and health sector governance challenges in lower income countries remains relatively sparse. To our knowledge, there have been no scoping reviews to map this terrain, to assess the nature and quality of existing evaluations and to highlight priorities for research and development. In the following section we clarify the conceptual terrain for ICT for health sector governance interventions, before discussing the methods and then findings of our scoping review.

Three Global Health & Governance 'Conversations'

The term 'governance' has been used in a variety of ways within different bodies of literature and professional practice, which presents a challenge for reviewing the role of ICTs in good governance interventions. In order to clarify this report's focus, we must first distinguish it from two relatively distinct 'conversations' concerning governance and global health. Perhaps the oldest of these, though it is not the primary focus of this report, we might refer to as the *Global Governance and Health* literature. This literature takes a macro perspective in studying worldwide governance of contemporary health issues. For example, a WHO working paper entitled 'Global Health Governance' focuses on issues around the globalization of health and healthcare, and aligns the concept of governance with WHO's role in assisting countries to manage cross-border risks to public health security and support improvement of health outcomes. It goes on to discuss four related elements of governance: 1) transcending territorial boundaries, 2) the need for cross-sectorial perspective on the determinants of health, 3) the need to involve, both formally and informally, a broad range of actors and interests, and 4) the need for governance institutions and rules to enable participation by a broadly defined "global" constituency. More recent work in this global governance vein has addressed the challenge of achieving the goal of "health for all by the year 2000" in a free market economy [12], the proliferation of global health NGOs and the potential of the WHO as a coordinating and governing body [13], and structural governance challenges related to national sovereignty or the accountability of non-state actors [14].

A very different set of concerns appears in the body of literature we might call the *Governance of eHealth* and the related area of *Health Information Governance.* This topic has its origins in the large-scale implementation of information systems in healthcare and has recently extended to the use of mHealth and personal digital health devices. The storage, use and sharing of personal data in these new environments raises risks for information security and privacy, which have technological, legal/regulatory and ethical/societal implications. The word governance is often used to describe the policies and processes of oversight required to ensure the security and trustworthiness of such systems. It may also be used to refer to the management structures involved in collective oversight of eHealth initiatives. Governance of health systems through information is another theme in this literature, concerning the best use of data for supporting

strategic planning, healthcare coordination, quality improvement and evaluation, in common with the 'Learning Health Systems' concept [15].

Within this literature, governance or regulation is often treated as an 'input' that influences (for better or worse) the 'output' of eHealth initiatives, or as an instrument with which to leverage access to data or to gain a mandate for new digitally-enabled ways of working. To be sure, such work also has philosophical and socio-political dimensions, with respect to rights to data privacy and concepts of ownership and choice, which call for direct engagement with citizens and policymakers. These are reflected in participatory approaches to designing or evaluating eHealth programs. For example, the Health Information System Programme—an international research, development and action network aimed at supporting eHealth in the Global South—is an excellent example of designing and studying health information systems with the substantive participation of diverse stakeholders [16]. Nevertheless, we would still refer to such work as part of the Governance of eHealth conversation insofar as it tends to treat broader participation as an input and eHealth initiatives as outputs, rather than the reverse approach of using technology to foster broader participation or other governance reform throughout the health sector.

In contrast, the projects in Uganda and Kenya mentioned earlier were more broadly concerned with reforming health sector underperformance and corruption. These projects have more in common with what Kosack and Fung [17] call the Transparency and Accountability Movement (T/A movement). This loose coalition of actors consists of grassroots activists and their allies in government, international development organizations and academia who aim to improve public services through the effective use of information about service quality, frontline worker performance, absenteeism, corruption, funding allocations or citizens' rights [18,19,20]. Producing actionable transparency information for the purpose of mobilizing governments and communities to address specified accountability concerns distinguishes the contemporary T/A movement from an earlier era of 'right to information' initiatives in which transparency was less connected to particular mechanisms of accountability [17]. As with the use of participatory approaches in the eHealth literature mentioned earlier, the T/A movement has strong links with the broader participatory development community [see e.g. 21,22,23]. T/A initiatives often involve advocacy campaigns in cases where government actors were unresponsive or uncooperative, but they also may involve proactive collaboration among community members, civil society and government staff at local and/or national levels. While the T/A movement has strong grassroots or 'bottom-up' origins, eGovernance initiatives tend to be more 'top-down,' typically initiated by government institutions and concerning their internal operation [24]. *ICT enabled good governance interventions*, as we use the term here, address matters of accountability, fraud or underperformance in the internal operation of government institutions, and may be bottom-up, top-down, or include elements of both through public private partnerships. While eGovernment initiatives are in some respects related, this term is more often used to refer to the use of digital technologies to deliver government services to external constituencies and stakeholders [25], and may emphasize efficiency rather than good

governance themes such as transparency, accountability, participation or equity in the performance of government institutions.

To summarize, three important and somewhat distinct conversations about global health and governance appear in the literature, which can be summarised as ‘global governance and health’ (international standards and oversight) the ‘governance of eHealth’ (data protection and standards) and ‘ICT enabled good governance interventions’ (as in our focus on trustworthy and responsible health systems). Any search for literature addressing matters of ICTs *and* governance *and* health in lower income countries will reveal a preponderance of articles in the former two categories, but this report focuses on the latter, aiming to identify and understand digitally-enabled good governance interventions. This recognises the critical importance of strengthening institutional integrity through the elimination of corruption and theft, as recognised in UN MDG 16, for the benefit of society, particularly in lower income country settings. Contemporary 'good governance' interventions typically address practical, specific and local concerns with government performance, with the long-term aim of enabling people to improve their own lives in concrete ways. These good governance interventions may be initiated by governments (as part of an eGovernment agenda), driven by civil society actors (eg. as tools of democracy) [26] or enabled by public-private partnerships (combining government and business). While the interventions themselves are often complex and situational, some are simple enough, or have been sufficiently well-specified, to allow them to be rigorously evaluated, whilst many encompass transferable principles or reusable components that may be useful in other contexts. For this reason funders, donors and practitioners have become increasingly interested in sponsoring research and development in this area and a number of evaluation studies have been published or are underway [17,18, 25]. Development economists and political scientists have undertaken much of this research, with interventions targeting education or basic infrastructure as often as health care. This growing evidence base also includes projects in healthcare that meld traditional good governance interventions with innovative technologies, indicating a growing appreciation of the need to customise projects to suit their settings.

Methodology

The initial scope of this project was to review the literature concerning innovative uses of mobile technology to strengthen leadership, management and governance in the health sectors of low- and middle-income settings. Given the breadth of this agenda and the nascent state of research in this domain, we opted for scoping rather than systematic reviewing methods. Standard systematic reviewing methods afford a very high standard of rigor, but they are less suited to mapping the extent, range and nature of activity in fields where it is unclear what material is available. In contrast, a Cochrane Public Health Group Update [27] notes that scoping review methods are more suited to mapping the landscape of evidence and promising practice in less well-established fields of research (see Table 1).

While systematic reviews typically focus on a narrowly defined body of peer-reviewed literature, scoping reviews often complement a nascent or broadly scattered evidence base with expert interviews or a landscape scan of grey literature and existing projects.

Table 1, based on Armstrong et al. 2011

Systematic review	Scoping review
Focused research question with narrow parameters	Research question(s) often broad
Inclusion/exclusion defined at outset	Inclusion/exclusion developed post hoc
Study quality filters applied	Quality not an initial priority
Detailed data extraction	May or may not involve data extraction
Quantitative synthesis often performed	Synthesis more likely to be qualitative
Formally assess the quality of studies and generate a conclusion relating to focused research question	Used to map the landscape of peer-reviewed research and grey literature reports, identify gaps and opportunities

To ensure rigor for such a flexible research strategy, this study design builds on the widely cited scoping methods framework by Arksey and O'Malley [28] and incorporates more recent developments [29]. Our scoping review method consists of six parts:

1. Refining the research question
2. A landscape scan of key actors, project reports and grey literature involving digital (especially mobile) technology and some aspect of governance
3. Based on 1 and 2, defining a search strategy and using this to interrogate databases of published, peer-reviewed research in order to identify relevant articles.
4. Study selection based on agreed inclusion and exclusion criteria (as above)
5. Charting and analysis of the data
6. Consultation with key experts

Refining the Research Question Through a Landscape Scan of Literature Reviews

At this stage we focused on existing reviews (rather than evaluations of specific interventions), and confirmed our initial impression that considerably more has been published relating to mHealth and management or leadership than to mHealth and governance. While most mHealth projects that generate data for improved decision-making are in some sense relevant to leaders and managers, we identified an important gap in the literature concerning digital technology and governance for health.

Landscape Scan of Practice

Our initial impression, based on our own work in the mHealth/eHealth research and practice arena, was that that a considerable number of technology projects had addressed the themes of digital innovation and governance. That said such work seemed under-represented in the peer-reviewed medical literature and to our knowledge there are no major systematic or academic reviews that focus specifically on the health sector. For this reason, we sought to develop a framework that was grounded in the aspirations and key terms of practitioner projects, rather than beginning with academic literature. We collected a snowball sample of case reports that began with projects we were familiar with and expanded through web links, tracing the work of key organizations and funding streams, and keyword searches in Google and Google Scholar. The list of case reports includes 'grey literature' such as project reports, compendia of mHealth/eHealth initiatives, websites and blog posts. Searches at this stage were conducted in English, Spanish and Portuguese. An initially larger list was narrowed down to 22 entries to reflect this review's iteratively refined focus on governance, rather than management or leadership. A complementary list of key actors includes funders (e.g. US government, Swedish government), research organizations (e.g. the Anti Corruption Resource Center) and technology organizations (e.g. Ushahidi) that surfaced repeatedly in case reports. In a spreadsheet we summarized each case report's use case and key themes. Based on this spreadsheet we continued to iteratively refine our search terms and initiate the search for peer-reviewed literature. The approach for this landscape scan reflects similar landscape scans undertaken as part of other scoping review exercises [29,30].

Identifying Relevant Studies

Refining search terms was a forward looking and highly iterative process that evolved as the landscape analysis progressed. Given time constraints, we decided to limit these searches articles published in English and indexed in PubMed for medical literature or Web of Science for a more interdisciplinary database including more social science. Searches included combinations of the following terms: "governance," "transparency," "accountability," "participation," "participatory," "stakeholder engagement," "corruption," "absenteeism," "mHealth," "eHealth," and "digital." Complete search strategies are available from the authors on request. Further articles were identified by examining reference lists and through key informant interviews. We

identified a total of 1,492 documents through these various searches, of which the preponderance fell within one of the exclusion criteria.

Study Selection

All identified references and abstracts were imported into the reference management software Zotero before being sorted by two authors. Articles with abstracts referencing governance and health were excluded if they did not address digital technology, as were articles that mentioned only governance and technology but not health, or technology and health without addressing any of the governance themes related to the keywords above. Additional articles were excluded from the main body of literature under review if they focused exclusively on the governance of mHealth or eHealth initiatives, rather than the use of such technologies to improve governance of the whole health sector. While these are not unrelated, the latter emerged as a trend in the case reports we identified and an important research opportunity for this review. Given the nascent state of research in this domain, some articles that were excluded according to these criteria were nonetheless referenced in developing the framework we present below.

Charting and Analyzing The Data

Due to resource constraints, articles that could not be accessed through the University of Cambridge or University of Edinburgh e-libraries were excluded. The remaining articles were downloaded for full review. In keeping with standard scoping review frameworks, we charted these studies according to key themes rather than performing full data extraction. We also followed Levac et al.'s [29] recommendation to make charting an iterative process by continually updating the data-charting spreadsheet to fit the study data being extracted. The themes used for data compilation and analysis were as follows:

1. Author(s), year of publication, study location
2. Study type/methodology
3. Problem(s) the program aimed to address
4. Technology used
5. Intervention use cases (e.g. data collection with mobile apps, interactive digital mapping) and categories (e.g. information gathering, mobilization).

Our framing of the broad categories and particular intervention use cases or components of point 5 above evolved as we reviewed more literature, and eventually formed the basis of the findings we summarize in Figure 1. Our analysis proceeded through comparison of peer-reviewed literature, grey literature and project examples, mind-mapping exercises involving all three authors, and consultation with key experts in this field.

Consultation with Expert Practitioners and Researchers

To validate and develop our emerging insights, we posted questions to relevant ICT and global health-oriented email lists and online forums, including GHDonline, the mHealth Working Group listserv, and several LinkedIn groups. Through these posts we identified a number of additional

grey literature reports and peer-reviewed articles. For more in-depth feedback, we conducted a total of ten expert interviews, ranging from 45 to 90 minutes, with respondents to these forum posts and members of the authors' own networks (see the acknowledgements section of this report for a complete list of interviewee names and affiliations). These interviews were conducted with a purposive sample of practitioners and researchers affiliated with important global health institutions (e.g. USAID), and organizations or technologies that emerged repeatedly in our search (e.g. Ushahidi). Participants included a roughly balanced group of men and women who could speak to experiences in Africa, Asia and Latin America, as well as each of the categories of ICT for health governance interventions we identified. Through these interviews we discovered a number of additional projects and use cases that have not yet been reported in the literature, and received feedback on an earlier version of Figure 1. This feedback enabled us to make a number of iterative improvements to our analysis and presentation of the review's findings, as well as to situate these findings in light of a number of implementation and contextual challenges that we consider in the discussion section of this report.

Results

Quantity, Type and Focus of Articles and Reports

Our search for peer-reviewed articles in PubMed and Web of Science yielded 1,492 results. Once we combined the results and removed duplicates, 563 articles remained. We then screened the articles on the basis of title and abstract, excluding a total of 529 articles for the following reasons: the article was irrelevant (n=294); the article focused on information or data governance (n=158); the article focused on participatory design or evaluation of eHealth projects (n=30); the article focused on *global* governance (n=4); the article focused on good governance and health but not technology (n=8); the article focused on good governance and technology but not health (n=3); the empirical case was in a high-income country (n=28); and/or the article was theoretically but not empirically relevant (ex. Focused on corruption in the education sector) (n=4). After these exclusions, the 34 remaining articles met all inclusion criteria based on analysis of article titles and abstracts.

The next stage of the review entailed downloading all articles, reading full manuscripts and applying inclusion criteria. We excluded a total of 25 articles on the basis of the following criteria: the article focused on a high-income country (n=10); the article focused on a low-income population within a high-income country (n=5); the article was not a peer-reviewed publication (n=2); and the paper was not accessible for downloading in either the University of Cambridge or University of Edinburgh digital libraries (n=8). Following this round of exclusions based on analysis of complete manuscripts, nine articles remained.

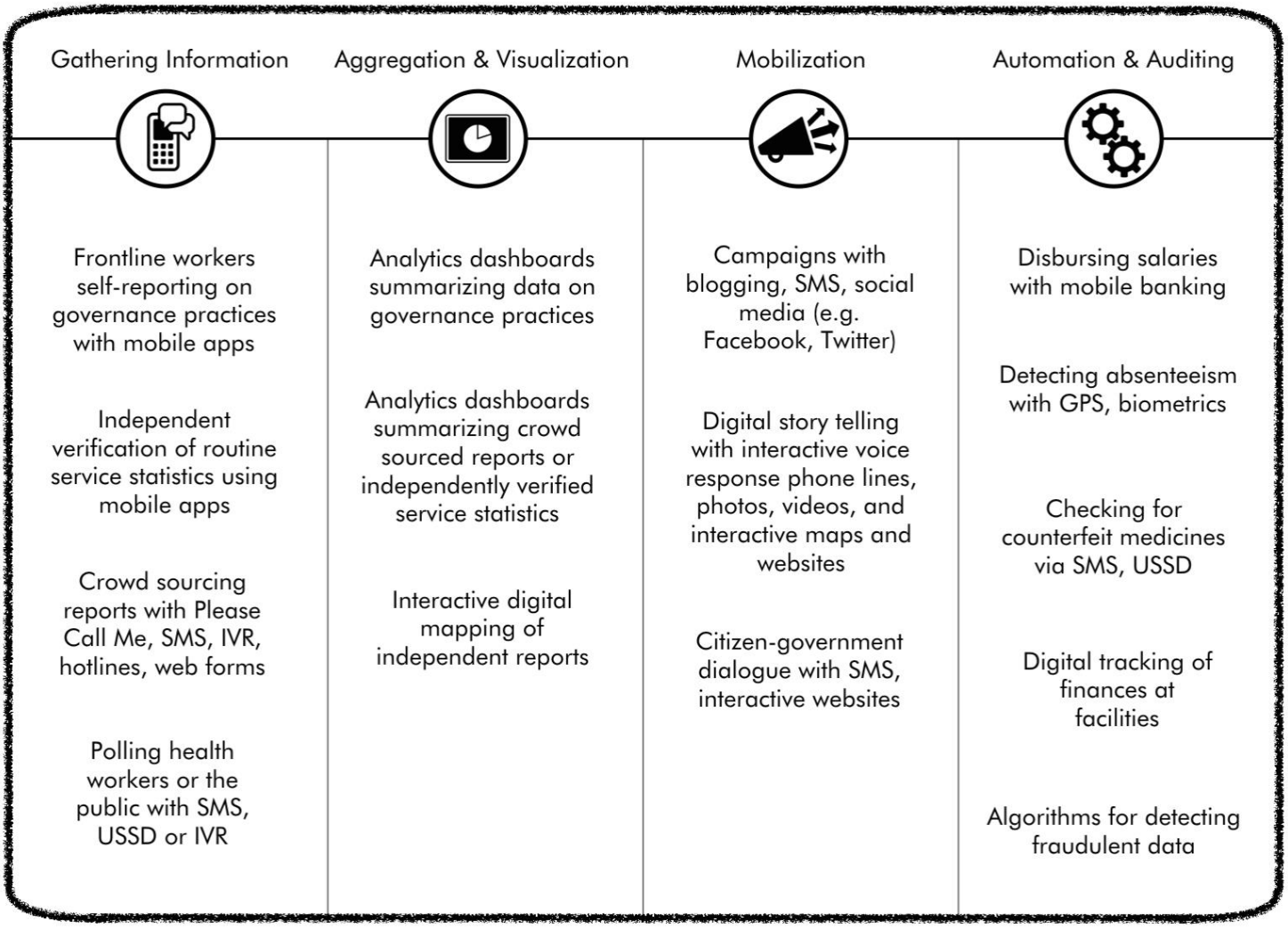
We then conducted an additional unstructured search that yielded eight additional peer-reviewed papers, as well as seventeen technical reports and white papers. We were pointed to this literature by expert interviews, Google searches, and by using a 'snowballing' method whereby reports were identified in the bibliographies or reference lists of peer-reviewed articles. The complete list of peer-reviewed studies and grey literature articles included in this review is available in the appendix.

The relatively high proportion of articles identified through unstructured searching relative to structured searching of academic databases reflects the fact that studies did not use a common vocabulary or set of key terms to identify their work. These articles were published for disparate academic communities in political science, sociology or medicine, and generally paid little attention to at least one of the central themes of this report (technology, health, governance and lower income settings). Not all potentially relevant bodies of research were represented; for example we did not identify any articles in the corporate governance literature that met all of our inclusion criteria. In other words, research in this topic area is nascent and relatively scattered. This finding underscores the appropriateness of this study's iterative, semi-systematic scoping review method rather than a fully systematic review.

Common Components of ICT Enabled Good Governance Interventions for the Health Sector

Our analysis of the relevant research and numerous grey literature reports of innovative practice revealed a number of recurring uses of ICTs in projects addressing health sector governance challenges. We classified these in terms of 'use cases,' mindful of the diverse ways in which this term has been applied in the design and engineering communities. We use it here to refer to the actions (behaviors and processes) through which various actors interact with systems to achieve particular goals. Some digital technology for good governance initiatives are comprised of a single use case, however, we will discuss below the tendency to pair two or more use cases as components of an integrated intervention. Moreover, a single use case (e.g. crowd sourcing reports) might be supported by multiple technologies (e.g. SMS and web forms). We chose to organize our analysis according to use case, rather than by technology, because this approach enabled us to draw on the conceptual underpinnings of good governance interventions that employ similar use cases without making use of ICTs. Additionally, articulating the use case can help to clarify how a technology-mediated intervention achieves its intended influence. Use cases can be organized into general classes, depending on the activity, users and desired outcome. Attending to mechanisms of action enabled us to distinguish uses of technology (e.g. online dashboards) in a particular health domain (e.g. supply chain) that target an important problem (such as rate of stock outs) either by addressing a governance challenge (e.g. using external sources to verify potentially fraudulent self-reporting of data by health workers) or not (e.g. focusing on inefficient communication alone). While ICT enabled interventions that address governance challenges and those that do not are often integrated in practice, in our analysis they are conceptually distinct simply for the sake of clarity. Figure 1 portrays these recurring use cases, organized into four categories: gathering information on healthcare services, data aggregation and visualization, mobilizing to foster accountability, and automation and auditing to address fraud among government employees.

Figure 1: Components of ICT for Health Governance Interventions



Gathering Information

The first category, gathering information, refers to uses of digital technology to generate data that is intended for transparency purposes. Routine data collection is one of the more widely discussed use cases in the mHealth literature; it is well established that using mobile devices can improve data timeliness and quality [5]. Some governance initiatives have used the same or similar technologies to collect data for transparency or governance purposes. Some of these initiatives involve members of civil society or independent government offices collecting routine data on health service quality or access, rather than focusing specifically on a governance challenge such as corruption. Independent verification of routine health service statistics may enable external accountability in ways that are not possible for the numerous mHealth initiatives that rely on health providers self-reporting. For example, the PMA2020 initiative equipped over one hundred data gatherers in each of four African countries with the Open Data Kit software to collect health data. The initiative was then able to produce independent reports on the quality, demand for and utilization of family planning services.

Other projects rely on self-assessments by frontline health workers rather than on independent data gatherers, but focus data collection on key governance indicators. For example, the GovScore tool[1] uses a mobile app to administer surveys on key governance practices related to engaging local stakeholders or stewarding resources responsibly [31]. Such an approach may foster important opportunities for governance capacity building, though it is not intended as a means of verifying whether health workers intentionally report fraudulent data.

Another use case in the information-gathering category involves crowdsourcing information about diverse health systems performance issues such as stock outs, health worker absenteeism, bribery or corruption. Crowdsourcing entails using digital technology to foster the collaborative contributions of large groups of people, driven by a philosophy that links the open-source software movement with basic democratic principles [32]. Rather than providing equipment (e.g. smartphones) to a relatively small group of data gatherers, projects that solicit the participation of large groups of people are more likely to rely on technologies that people can access via the Internet or, particularly in low-income settings, via the least expensive and most widely available mobile phones. These technologies include SMS, USSD, free 'Please Call Me' messages, Interactive Voice Response services or ordinary telephone hotlines. As we will discuss below, differential access to technology has the potential to skew data generated in this manner. Nonetheless, relying only on phones that people already have in their hands, whether they are health workers or members of the general public, can dramatically expand the potential reach of crowdsourcing initiatives.

1. The GovScore tool is in ongoing design and development by Management Sciences for Health and Medic Mobile, as part of the same USAID-funded Leadership, Management and Governance project that commissioned this research.

In this vein, the Open Health Networks project, initiated by Guatemalan civil society and Parsons New School of Design, used the Ushahidi crowdsourcing software and enlisted members of the public to submit SMS reports of drug stock outs, health worker discrimination against indigenous patients and other issues [33]. According to a press release by the Canadian Government's International Development Research Centre, this data and subsequent community meetings resulted in seven municipalities increasing the amount of funding allotted to keep medicines in stock or provide fuel for ambulances [34]. One of the larger crowdsourcing for global health initiatives is U-Report, which was started by UNICEF in Uganda and now operates in several countries, with over one million registered users in Nigeria alone [4]. The toll-free SMS hotline invites users to register by answering several simple questions via their mobile phones. Amassing a large database of registered users has enabled U-Report administrators to conduct massive polls, simply by sending SMS questions to registered users. For example, in one instance data from 16,117 U-Report respondents was used to compliment more traditional survey methods in a report concerning client satisfaction with services in Uganda's public health facilities [35].

Project Spotlight: PMA2020

The Performance Monitoring and Accountability 2020 (PMA2020) project uses smartphones to transform traditional pencil-and-paper methods of health data collection, making information electronically and rapidly accessible to stakeholders and decision makers. With a focus on family planning, water and sanitation, PMA2020 gathers data around access, quality, equity and utilization. Current countries include Ghana, the Democratic Republic of Congo, Ethiopia, Burkina Faso, Kenya, Niger, Nigeria, Uganda and Indonesia.

PMA2020 is implemented by local universities and research organizations in participating countries, who work with national partners to build a network of data collectors, called 'Research Enumerators' (REs). The all-female REs are generally over the age of 21, come from or near the district of intervention, and are familiar with mobile phones. Within their respective districts, REs use smartphones and other mobile devices to conduct surveys at households and facilities including health clinics, pharmacies and other providers of family planning services throughout the country. REs enter survey information into the mobile device and the data uploads via the mobile network to a central server. At this stage, the data is validated, aggregated and translated into user-friendly graphs and tables.

Many ministries of health in lower-income countries rely primarily on frontline health workers to report data concerning the performance of the facilities where they work, and thus the data are subject to the vested interests of those workers. Importantly, paid health workers are not eligible to simultaneously serve as REs in the PMA2020 initiative. By building the capacity of local research organizations and REs to independently verify data gathered by ministries of health, the PMA2020 initiative enables people within government and civil society to hold government service providers to account.

This project is collaboratively directed by the Bill and Melinda Gates Institute for Population and Reproductive Health at the Johns Hopkins Bloomberg School of Public Health and national partners in participating countries. Learn more at www.pma2020.org/about-pma2020

Data Aggregation and Visualization

While data gathered digitally may simply be summarized in written reports and discussed in face-to-face meetings, we identified a second category of use cases related to *data aggregation and visualization*. Projects in this category often, but do not always go hand-in-hand with digital approaches to gathering information. For example, the open source Ushahidi platform enables crowds to submit data via SMS, a smartphone app, email, twitter or online forms. The platform then enables registered users (who may or may not be comprised of large crowds of volunteers) to process reports by category and by placing them on a digital map, which can be viewed online. These maps group categories of reports by color and also show larger or smaller circles of color to indicate the number of reports linked to particular locations. Ushahidi is a Swahili word for 'testimony' and the platform was originally developed to map reports of post-election violence in Kenya in 2008. The platform is now in use globally, and while only a fraction of these projects are focused on improving health sector governance, with over ninety thousand deployments and a total of over 6.5 million reports [36], Ushahidi is probably the most widely used technology associated with this use case. Other organizations, such as Elva [37] and Spatial Collective [38], have supported a number of similar geographic information system initiatives in partnership with major global health and development institutions. While we identified no formal studies evaluating the impacts of interactive digital mapping for health sector governance, numerous journal articles mention or describe such initiatives [e.g. 39].

Another related use case involves online data mapping tools or dashboards that enable large amounts of data to be summarized, analyzed and presented online. For example, the GovScore tool mentioned earlier enlists health sector staff to self-report on key governance indicators using mobile phones, and the data is automatically presented in online data visualizations such as charts and graphs. In a related but distinct approach, the PMA2020 initiative [40] has amassed large amounts of independently verified routine health service statistics, and is currently working to integrate this data with national health information management systems that make use of digital analytics. Thus the use of analytics for governance data might involve civil society actors, government offices, or both.

To be clear, most healthcare analytics dashboards are used for routine management but do not address governance challenges, because they neither involve governance-specific data (e.g. reports of absenteeism) nor independently verified data that could identify cases of fraudulent reporting. It nonetheless bears mentioning that digital analytics technologies such as the DHIS 2.0 software are relatively mature, having been implemented at a regional or national scale in dozens of low-income countries [41]. While most current implementations of DHIS 2.0 and similar software do not incorporate independently verified health statistics or data that specifically pertains to governance, this is an important area for future research and development. In many cases routine health service statistics are recorded on paper and later digitized by data-entry personnel, rather than being collected via mobile phones as discussed previously. Even without the aid of digital data collection, digitization can accelerate data cleaning and aggregation, facilitate analysis and thereby make health data more actionable,

particularly when datasets are extremely large or information management teams are understaffed. Dashboard technology is particularly relevant to governance in part because community scorecards, the intervention evaluated in the Uganda case with which we opened this report, are among the more extensively studied and effective types of transparency and accountability interventions. Digitizing community scorecards holds promise, particularly as pilot-stage community scorecard initiatives are scaled up to regional or national levels.

Project Spotlight: Open Health Networks

In Guatemala, healthcare is public and universal. However, many citizens do not have access to medical treatment and care. For indigenous communities in particular, rural isolation, discrimination against indigenous peoples and other factors combine to create a situation marked by government neglect. The Guatemalan Centre for Studies for Equity and Governance in Health Systems (CEGSS) is working to change this situation through a project called Open Health Networks (OHN). Originally, CEGSS used paper-based forms to report to the government on stock-outs of essential medicines in indigenous communities. This method of reporting was time-intensive and allowed only for reports to be filed four times a year, and government responses in meeting community needs were slow.

Starting in 2012, CEGSS and partners at the Open Society Foundations and Parsons the New School for Design embarked on a design process driven by field research in local communities. The final product was a plugin for the open source Ushahidi platform and a CEGSS reporting booklet. OHN now works through the following steps: First, a trained community leader is equipped with a mobile phone, instruction manual and the reporting booklet. The community leader visits her local health centre, where she interviews staff to gather information on medical equipment and inventory. She enters the report information into the mobile phone using codes correspondent to stock levels, which go to the Ushahidi server. At this point, CEGSS is notified of the new report, and the Ushahidi platform automatically adds the new information to a publically accessible online map of reported stock-outs and clinic closures. Later, the community leader meets with others like her in the area to discuss the reports and file a collective summary to the Ministry of Health, which is able to respond to the reports more quickly and update the inventory. According to a press release by the Canadian Government's International Development Research Centre, this data and subsequent community meetings resulted in seven municipalities increasing the amount of funding allotted to keep medicines in stock or provide fuel for ambulances.

Learn more at http://cegss.osf.parsons.edu/#deliverables

Mobilization

While the first two use case categories revolve around the objective of transparency, one of the central tenets of the contemporary transparency and accountability movement is that it should not be taken for granted that greater transparency inevitably leads to greater accountability or improved government performance. Accordingly, many of the papers and interventions we identified involved a *mobilization* component. Mobilization in this context has often entailed face-to-face meetings among community members, civil society organizations, health workers and other government staff. For example, the Stop Stock Outs campaign crowd sources reports of medicine stock outs in South Africa. The campaign is backed by several HIV/AIDS and Tuberculosis civil society organizations, and according to their website, "all reports will be escalated through the supply chain and resolution sought through the direct engagement of civil society with accountable government individuals and entities." In recent years, a growing number of projects are complimenting these offline mobilization efforts with innovative uses of digital media to change public attitudes about corruption and generate political pressure for change. The 'I Paid a Bribe' campaign is a notable example, with over 120,000 Facebook fans and an active blog that claims to be nearing one million visitors [42].

Project Spotlight: The Quipu Project

In the 1990s, over 300,000 indigenous Peruvian women and 20,000 indigenous men underwent coercive, aggressively promoted and/or forced sterilization through a government reproductive health and poverty reduction campaign which was funded by international donors and initially supported by women's rights organizations. In collaboration with human rights groups, the victims have appealed to the state for justice, which to date remains elusive as the state denies that the sterilizations were non-consensual. In order to raise awareness about the sterilizations and mobilize national and international support, an initiative called Quipu Project uses mobile phones, radio, and an interactive documentary communicating testimonies of those affected by the harmful health policy. A specially-developed phone line using voice over internet protocol (VOIP) technology allows callers to listen and respond to other women and men's stories, thus fostering a sense of solidarity and transparency across geographically dispersed communities. Once recorded, the testimonies are translated and made available in Quechua, Spanish and English.

According to one of the lead researchers, Dr. Matthew Brown, Quipu Project's capacity to mobilize is driven by its participatory element: "I've come across lots of anthropological and ethnological studies where collected testimonies don't even make it into the appendix of publications…We don't want everything mediated through the researcher. We want the words spoken to be available. We may have sub-titles, but it is so important to have these particular voices" (Iain Aitch of The New Statesman 24 November 2014). 'Quipu' is the Quechua (indigenous Peruvian language) word for an ancient Inca communications system made of threads and knots used to record oral information.

Learn more at http://quipu-project.com

Digital story telling through photos, videos and interactive websites is an important variant of digital mobilization. Our literature search revealed a number of health-related photo voice projects, in which people who experience a health issue are given cameras and invited to document the issue from their own perspective [43,44]. Through this participatory approach, photo voice projects attempt to cast a different, and perhaps more democratic light on longstanding health issues. Apart from their participatory approach, most of the photo voice literature we identified did not focus on corruption or other health sector governance challenges, however, a remarkable project in Peru has recently broken new ground in this arena. In the 1990s, over 300,000 indigenous Peruvian women and 20,000 indigenous men underwent forced sterilization through a state government "poverty reduction" campaign funded by international donors and initially supported by women's rights organizations. The *Quipu Project* uses mobile phones, radio, and an interactive documentary communicating testimonies of those affected by the harmful health policy.

Digital campaigns and story telling often are initiated by civil society organizations with the aim of pressuring uncooperative government officials to pursue reform, however, some mobilization efforts are characterized by far more collaboration among civil society and government actors. The use case that we call citizen-government dialogue is similar to and often paired with issue reporting by the public. For example, SMS Voices trained citizen volunteers in Sierra Leone to send SMS reports regarding access to services and other issues relating to education, gender, violence, and governance. The information is collected in a website through which local government councilors can respond directly to each report with information on how the issue is to be resolved. In some citizen-government dialogue projects, community members can "vote up" issues flagged by others [45]. Dialogue in this sense can serve as a form of collective mobilization of civil society and government actors.

Addressing Fraud Through Automation and Auditing

While the first three categories of use cases all have counterparts in offline transparency and accountability interventions, some aspects of service automation are distinctively digital. An important family of use cases in this category involves automating discretionary activities with potential for abuse among public officials or frontline health workers through automation. For example, several reports describe using mobile money to deliver salaries directly to frontline workers, one in the health sector in Kenya [46] and one among police in Afghanistan [47]. Other projects use biometric technology to prevent forgeries and address issues such as absenteeism. For example, an ongoing randomized trial of a home-based tuberculosis treatment program in India requires community health workers to take a digital scan of the patient's fingerprint—which cannot be forged—during each home visit [48]. By removing intermediaries and reducing space for corruption or negligent performance, such approaches to digital automation have the potential to simultaneously achieve both transparency and accountability.

A related collection of use cases involves catching instances of fraud among frontline health workers or government bureaucrats by using digital technology to create a comprehensive,

auditable log of transactions. For example, the hospital governance reform project in Kenya discussed in this report's introduction made use of digital cash registers, alongside changes in management oversight and billing practices, to address the problem of staff stealing user fee revenue [3]. We also identified several projects that address the widespread problem of counterfeit, ineffective medicines. While these projects vary in important details, they typically involve labeling all packets of medicines and enabling purchasers to query, via mobile phone, whether the serial number on their packet of medicines is registered [e.g. 49,50]. Such projects do not eliminate the existence of counterfeit medicines or theft of user fees, but through auditing, they have the potential to reduce harm and facilitate reform. What is more, the flexibility inherent in auditing is important in many processes for which some discretion is legitimate and necessary. Returning to the case of digital cash registers, not all instances of unpaid user fees are attributable to theft among staff. Many patients in low-income settings genuinely have no ability to pay, and thus auditing may be more suited to this situation than automation. While automation and auditing may be conceptually distinct, many e-government initiatives incorporate elements of both, as is the case for many digital procurement systems such as Chile Compra [51].

Project Spotlight: mPedigree Goldkeys

Counterfeit medicines are a global problem, yet particularly salient in low- and middle-income countries. In 2007 the mPedigree Network developed the Goldkeys app and portal to 'clean up' the supply chain in partnership with governments and companies. Pharmaceuticals purchased under the Goldkeys scheme come with a scratch-off panel. The consumer removes the panel to reveal a PIN code. Using a mobile phone, the consumer sends the PIN code via SMS to a four-digit phone number (or enters it on the web-based platform). Goldkeys then responds, verifying or denying the validity of the medication. If the medication is counterfeit, the consumer has the option of calling a hotline. In addition to benefiting from lower levels of dangerous counterfeiting, consumers play an important role in generating data about fake drugs. Goldkeys has been implemented in Ghana, Nigeria, Kenya, India and most recently in Rwanda.

Learn more at http://goldkeys.org

Discussion

From Components to Integrated Interventions

While we summarized our findings through a collection of relatively generic components or ICT use cases, designing a technology-enabled good governance intervention entails determining which combination of technologies and use cases to embrace. Regardless of which offline and digital approaches are utilized, an important feature of the contemporary transparency for accountability movement is the emphasis placed on linking particular forms of transparency to particular mechanisms of accountability or performance improvement in well-integrated interventions. In a helpful review of experimental evaluations of (non-digital) transparency and accountability interventions, Kosack and Fung [17] make this point by discussing the importance of completing an "action cycle." After gathering information about service provision, completing the action cycle entails demonstrating the information's value and salience to intervention participants (e.g. community members), participants taking action to foster accountability, care providers being concerned with or sensitive to participant actions, and providers responding constructively. Shortcomings at any one of these steps can render an intervention ineffective or counter-productive, even if the technologies that support any particular step are functioning as expected. By eliminating particular forms of provider discretion, some cases of digital automation may circumvent some of these steps. It was more common, however, for the interventions we reviewed to integrate information gathering and data visualization and mobilization components in order to complete the action cycle.

To complete the action cycle, interventions tended to mix and match more than one of the digital components outlined in Figure 1. For example, the My Voice project involved citizens reporting on health and other public services via SMS, with reports aggregated and presented to government workers in an analytics dashboard [52]. In contrast, other projects paired citizen reports with an interactive digital map (as with many Ushahidi projects), or the use of analytics with data that salaried workers collect using mobile apps. It also bears mentioning that for many projects, addressing transparency, accountability or other governance concerns is just one aspect of a broader digital health agenda. For example in the ongoing study mentioned earlier involving the use of biometric fingerprint scanners in a home-based Tuberculosis treatment program [46], verifying that community health workers do indeed visit the homes of patients with Tuberculosis is one among numerous objectives, others of which have more to do with the efficiency or quality of care than with negligent or corrupt activities. Integrating good governance interventions within broader digital health initiatives may help address implementation challenges among groups that are skeptical of increased transparency. As one expert informant explained, emphasizing efficiency, quality of care or improving the health worker experience may help to secure broad enough support for activities that could simultaneously address governance concerns.

Practitioners also face important questions with respect to which aspects of a governance intervention to digitize and which aspects to leave offline. In the interventions we reviewed,

there was a trend towards using technologies for gathering and/or aggregating and visualizing information, and subsequently relying on face-to-face interaction to mobilize for change. Nonetheless, to date there are too few rigorous evaluations to provide reliable evidence concerning which components of ICT for good governance interventions are most effective, or to guide decisions about which are best digitized and which may be more effectively pursued offline in particular situations. Calling attention to governance shortcomings is an inherently political undertaking and, as we will discuss below, both digital and face-to-face activities may be more necessary and effective in some contexts than in others. While there is good reason to prioritize completing the action cycle, planning to do so by no means guarantees that an intervention will have the desired effects, or that it will not have unintended consequences.

Mixed Evidence and Key Contextual Variables

While a growing body of anecdotal reports suggests that digital interventions for good health sector governance hold promise, the relevant evidence base is undeniably mixed. Explaining why the evidence is mixed necessarily entails analyzing the relatively small number of studies included in our review in light of the larger and more rigorous body of research concerning interventions that are theoretically relevant, if not in precisely the same empirical domain. Non-digital interventions are relevant here, as other researchers have observed, "technology provides tools to enable a greater number of citizens to access a large amount of information, but the pivotal drivers of success in these initiatives are broadly the same as for any other transparency policy" [53]. These fully offline interventions are also relevant because, as mentioned earlier, most ICT-enabled governance interventions are integrated with offline activities. Randomized trials of non-digital interventions for transparency and accountability have yielded very compelling results in recent years. Yet for every success, there have been outright failures and even some results that seem counter-productive.

To some extent this variability in outcomes might be attributed to the implementation or delivery challenges that face other complex interventions in mobile health [54] or global health more broadly [55]. As Walshe [56] observed, variability in intervention content, contexts, delivery processes and outcomes is the hallmark of complex interventions. While addressing these myriad delivery challenges is beyond the scope of this review, our analysis of the literature and expert interviews drew attention to a few contextual drivers of ICT for health governance interventions that merit particular attention.

One influence is the extent to which government workers are committed to addressing governance concerns, and the resulting collaborative or confrontational dynamics with community members and non-governmental organizations. For example, the World Development Report [20] discussed how cooperative dynamics with government workers can drive civil society actors to pursue either the 'short route' or the 'long route' to accountability. In the short route, community members and frontline providers work together to address particular governance challenges, while in the long route, frontline workers are uncooperative and communities or civil society must engage higher-level government officials. Kosack and Fung [17] develop this framework further in light of evidence from recent field experiments, and

argue that cooperative and collaborative dynamics among community members, civil society, frontline workers and policy makers strongly influence which types of interventions are most likely to be effective.

While their rough rubric (summarized in Table 2) may help implementers clarify the roles to be played by key actors and technologies in particular information gathering, visualization, mobilization or auditing activities, it should not be taken as a means of predicting what will work and where. One of its limitations is the premise that good governance interventions will be driven by civil society and that government actors will respond in ways that are either supportive or not. In practice, support from government actors may be highly heterogeneous; some particular individuals within government are better positioned than others to effect change [57], and relationships between government and civil society actors are likely to change over time. As one expert interviewee put it, “we are constantly refactoring how we think of the government and how to frame ourselves [a non-profit organization] to them in order to maintain an effective public private partnership." Indeed, effective public private partnerships often hinge on the understanding that shared advances are neither entirely bottom-up nor top-down, and that agenda setting is ideally a collaborative undertaking rather than being directed by government or civil society alone.

In addition to the contextual challenges faced by all good governance interventions, ICT initiatives must address particular concerns with respect to the distribution and accessibility of technology. Phone ownership is often lower among vulnerable groups, and in some regions women are far less likely to own phones than are men [52,58]. Literacy rates also vary across demographics, for example young residents of urban areas may participate in SMS polls at greater rates than those who are older or live in rural areas [35,59]. Projects that rely on members of the public using even ordinary mobile phones, not to mention smart phones or the internet, could further marginalize people who are already less likely to have a voice in matters of health sector governance. Local patterns of technology ownership and use are likely to have different ramifications for crowd sourcing or mobilization of the general public than they might for projects that equip staff with technology for information gathering or to automate or audit key services. For this reason, making sense of local patterns of technology use should be central to the process of determining which components of good governance interventions are to be digitized.

We would also note that this body of literature is new enough that additional variables may be identified in future research. The absence of discussion about corporate governance in the sources identified by the review is noteworthy, and arguably reflects the dominance of the public health system and a more widespread concern with corruption in frontline services in these regions, as well as the dearth of literature on corporate governance in healthcare Worldwide [60]. As developing economies grow and the private healthcare industry begins to flourish it is likely that demand for digital good-governance interventions focused on corporate/business practices will also increase.

Table 2 based on Kosack and Fung, 2014

Service Context	Role of Info	Path to Accountability	Example Interventions
Providers compete	Inform individuals	Short route	Comparative provider performance rankings
Providers willing to reform	Collaborative problem solving	Short route, collaboration	Citizen report cards/community score cards followed by community meetings
Providers unwilling to reform, community pressures them	Increase pressure and accountability on service providers	Short route, confrontation	Social audits followed by naming and shaming, protest
Providers unwilling, policy makers willing to reform	Enable policy makers to enact top-down reform	Long route, collaboration	Social audits, absenteeism studies, public expenditure tracking followed by top-down accountability and/or community advocacy
Providers and policy makers unwilling	Build countervailing power to increase accountability	Short and long routes, confrontation	Social audits, public expenditure tracking followed by community mobilization

Participatory, Human Centered Intervention Design

While local patterns of technology use and collaborative or confrontational dynamics among civil society and government workers are undoubtedly important variables, numerous reports and expert interviews underscored that ICT for health governance interventions also hinge on a host of more nuanced, often unique situational challenges. These socio-technical concerns include accommodating existing work processes, cultural and political dynamics, partnerships to address financing and interoperability concerns and identifying which specific actors within government and civil society are well placed to influence target outcomes. There is growing consensus in the ICT for development community that effectively addressing such complex challenges involves more than simply using the most rigorous scientific methodologies. It also requires iteratively improving designs in light of nuanced situational insights obtained through observation, interviewing and prototyping in context. As is recognized by a number of ICT for good governance projects [31,33,52], this entails complimenting the science of hard evidence with situational judgment and expertise in the art of practicing design.

The Principles for Digital Development consensus statement, which has been embraced by a wide array of authoritative global health institutions, calls particular attention to co-designing with all user groups through an iterative and incremental planning, development and implementation process [61]. Key practices of such an approach include cultivating empathy by interviewing and spending time in the circumstances of people who will experience the intervention, making technical plans concrete and accessible to feedback through the use of prototypes, and hosting co-design workshops in which end users can play with and influence the adaptation of prototypes. Today there are numerous resources available for practitioners wishing to pursue such work, from books [e.g. 62,63] to hands-on guides and toolkits [e.g. 64,65].

Designing interventions that are “human centered” in this sense entails more than simply “considering the user” in technology development. Rather, it means placing people and their concerns and insights at the center of activity, with substantive participation in shaping plans, technologies and intervention activities. It bears mentioning that in recent years, much of the rhetoric around human-centeredness, empathy and optimism in technology design has come from the private sector [e.g. 66,67]. Many practitioners in the design for social innovation community acknowledge this recent private-sector heritage [e.g. 68,69]. However, it is striking how this trend was foreshadowed by academic participatory design projects that began in the 1970s and 1980s, as other design researchers have observed [70].

It is no coincidence that participatory design emerged out of Scandinavia's workplace democracy movement, as an approach to technology design that was both pragmatic (designing more usable and effective technologies) and political (the democratic view that workers should have a say)[71]. Increasing the substantive participation of community members in the co-design of good governance interventions will not guarantee their effectiveness or constitute broader governance reform in its own right. But given the growing consensus that human centered design principles and practices have important practical value, in addition to important historical and conceptual links with the broader participatory democracy and development community, it is surely a promising area of focus for practitioners, researchers and the funders of ICT for health governance interventions. Practically speaking, this might entail documenting design activities in detail and in real-time, rather than through post-hoc recollection. Much as documenting impact monitoring or evaluation activities is now common, documenting how design activities were planned and how they actually unfolded in practice could contribute to the rigor and replicability of complex ICT for health governance interventions. In particular, reporting on how particular projects have attended to the priorities outlined in the Principles for Digital Development consensus statement may become an increasingly standard expectation in the years to come.

Conclusion

Recent years have seen rapid growth in the number and scale of ICT for health governance projects in lower income countries. This trend is likely to continue with advances in digital infrastructure and the establishment of the post-2015 Sustainable Development Goals, with goal 16 drawing attention to strong governance institutions, public participation and combatting corruption [72]. Our scoping review revealed a number of recurring ICT use cases related to gathering information, aggregating and visualizing data, mobilizing for change, and addressing fraud through automation and auditing. While some of these use cases have been implemented at considerable scale and show great promise, they should not necessarily be taken as standalone interventions. Rather, the projects we identified tended to mix and match multiple ICT use cases with offline components into integrated good governance interventions. What is more, these interventions tend to be highly complex and context-dependent.

Our reading of the literature and expert consultation indicate that cooperative dynamics among government and civil society actors, as well as distribution and accessibility of technology are key variables to consider in the design of ICT enabled good governance interventions. More important still are efforts to understand the causes and mechanisms of specific instances of poor governance in particular locales, so that interventions can be designed or adapted to address them. Human centered and participatory approaches to intervention design merit greater attention, in part as a pragmatic means of addressing nuanced and contextually unique design challenges. The value of human-centered design in addressing such complexities is increasingly recognized in reports on ICT for health governance [31,33,59] as well as broader consensus statements, such as the widely ratified Principles for Digital Development [61]. Additionally, there are important conceptual and historical links among contemporary approaches to human centered design and good governance interventions, with the former bearing the influence of Scandinavia's participatory design community, and the latter closely connected to the broader participatory global development community.

Despite promising advances in the content of ICT for good health sector governance interventions, as well as the processes by which they are implemented, the evidence base remains mixed and quite sparse. To our knowledge this is the first scoping review of ICT enabled good governance interventions that focuses specifically on the health sector in lower income countries. The framework presented here may help to guide future research and development efforts, however, more robust operational research and evaluative studies are needed to clarify the pathways through which such interventions lead to improvements, as well as to document impacts and unintended consequences.

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Appendix A: Peer Reviewed Research

The following list includes 17 peer-reviewed articles that met this review's inclusion criteria, discovered in databases of academic research, through reference lists, and through consultation with industry experts and online communities.

Birnbaum, B. et al. (2012). Automated quality control for mobile data collection. In Proceedings of the 2nd ACM Symposium on Computing for Development. ACM, pp. 1–10.

Birnbaum, B., Borriello, G., Flaxman, A. D., DeRenzi, B., & Karlin, A. R. (2013). Using behavioral data to identify interviewer fabrication in surveys. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 2911-2920). ACM.

Boss, S. (2015). Getting Creative About Corruption. Stanford Social Innovation Review. Summer, 8-12.

Bott, M., Young, G. (2012). The Role of Crowdsourcing for Better Governance in International Development. Praxis: The Fletcher Journal of Human Security, 27 (1), 47-70.

de Lange, N. and Mitchell, C. (2012). Community Health Workers Working the Digital Archive: A Case for Looking at Participatory Archiving in Studying Stigma in the Context of HIV and AIDS. Sociological Research Online, 17 (1), 7.

Erikson, Susan L. (2012). Global Health Business: The Production and Performativity of Statistics in Sierra Leone and Germany. Medical Anthropology: Cross-Cultural Studies in Health and Illness, 31:4, 367-384.

Estuar, M. R., Batangan, D., Coronel, A., Amarra, A. C., & Castro, F. (2013). Bottom Up Approach and Devolved Design of a Health Information System: eHealth TABLET. In Brain and Health Informatics (pp. 210-217). Springer International Publishing.

Green, E., & Kloos, B. (2009). Facilitating youth participation in a context of forced migration: a Photovoice project in northern Uganda. Journal of Refugee Studies, 22(4), 460-482.

Islam, M. S. (2015). The Impact of Transparency on Quality of Health Service Delivery in Bangladesh: Findings of a Field Survey of Rural and Urban Health Service Organisations. Journal of Nursing and Health Care (JNHC), 2(1).

Islam, M. S. (2015). Introducing modern technology to promote transparency in health services. International journal of health care quality assurance, 28(6), 611-620.

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Weimann, E., & Stuttaford, M. C. (2014). Consumers' perspectives on National Health Insurance in South Africa: using a mobile health approach. JMIR mHealth and uHealth, 2(4).

Wójcik, O. P., Brownstein, J. S., Chunara, R., & Johansson, M. A. (2014). Public health for the people: participatory infectious disease surveillance in the digital age. Emerging themes in epidemiology, 11(1), 7.

Appendix B: Reports and Other Grey Literature

This list includes the 17 published reports that met all of this study's inclusion criteria, discovered through reference lists, Google searches and through consultation with industry experts and online communities.

Blaschke, S. and Grépin, K. (2014). Strengthening accountability chains for maternal, newborn and child health in Uganda – UNICEF's mTrac", World Health Organization.

Croke K, Dabalen A, Demombynes G, Giugale M, Hoogeveen J. Collecting High-Frequency Data Using Mobile Phones: Do Timely Data Lead to Accountability?.

Fahmy, A., Abdelmonem, A., Hamdy, E., Badr, A. (2014). Sexual Harassment in Greater Cairo: Effectiveness of Crowdsourced Data. HarassMap in collaboration with Youth and Development Consultancy Institute (Etijah).

Gichangi, P. (2015). Detailed Indicator Report: Kenya 2014. Performance Monitoring and Accountability 2020 (PMA2020). Baltimore, MD.

Higenya, E., Ekwaro, G., Seru, M. (2014). Client Satisfaction with Services in Uganda's Public Health Facilities. Medicines Transparency Alliance of Uganda.

Kahane, M., Prachanronarong, P. Open Health Networks Implementation Guide V.1 [Internet]. Open Health Networks; 2015 [cited 2016 March 10]. Available from: http://cegss.osf.parsons.edu/#deliverables.

Kickbush, I., Gleicher, D. (2012). Governance for Health in the 21st Century. World Health Organization.

Otupiri, E., 2013. Detailed Indicator Report: Ghana. Performance Monitoring and Accountability 2020 (PMA2020). Baltimore, MD.

Leah, F., Boots, M. Barries and Solutions in using M4D: Connecting Directly to Citizens for Scalable Impact. Kumasi, Ghana: Voto Mobile; 2013.

Makumbi, F. and Kibira, SP. (2015). Detailed Indicator Report: Uganda 2014. Performance Monitoring and Accountability 2020 (PMA2020). Baltimore, MD.

Rice, James A., Shukla, Mahesh, Johnson Lassner, Karen et al. (2015). Leaders Who Govern. Management Sciences for Health. Arlington, VA.

Renata, Avila, Feigenblatt, Hazel, Heacock, Rebekah, Heller, Nathaniel (2010). Global mapping of technology for transparency and accountability. Open Society Foundation. London, UK.

Reboot (2015). "Enabling citizen-driven improvement of public services: Leveraging technology to strengthen accountability in Nigerian healthcare" Reboot and World Bank

Shiferaw, S. and Seme, A. (2014). Detailed Indicator Report: Ethiopia. Performance Monitoring and Accountability 2020 (PMA2020). Baltimore, MD.

Tucker, K. and Brown, M. (2014) The Quipu project: Participatory story-telling can help rebuild community in post-authoritarian societies.

Voices for good governance [Internet]. Place unknown: ENCISS: For Rights and Voice; 2014 [cited 2016 March 10]. Available from: http://www.enciss-sl.org/node/537

Wangui, A., Macharia, M. Medic Mobile Field Research on Leadership, Management and Governance Feedback and Collection Tools. Nairobi: iHub UX Lab; 2015.

Appendix C: Illustrative Cases

This list of illustrative cases of ICT for health sector governance interventions includes projects for which only blog posts, websites or other such materials were available.

Action for Transparency. Uganda, Zambia. http://actionfortransparency.se/

Citizen-monitored Health. Egypt. http://16iacc.org/game-changers/social-entrepreneurs/mena-competition/citizen-monitored-health/

Community Health Information Tracking System (CHITS). Philippines. https://chits.ph/@10/

Disclosure Today. Trinidad and Tobago. https://www.disclosure.today/learn-more

Early Warning System (EWS). Ghana. http://solutionscenter.nethope.org/case_studies/view/supply-chain-early-warning-system-for-commodities-using-mobile-phone-techno

Govern4Health. https://www.msh.org/resources/govern4health-app

GovScore. http://govscoreapp.net/

I Paid a Bribe. India. http://www.ipaidabribe.com

Mobile Technology for Citizens' Vigilance "Vigilancia y Salud". Guatemala. http://cegss.org.gt/

mPedigree Goldkeys. Ghana, Nigeria, Kenya, Rwanda, Zambia, Tanzania, Sierra Leone. http://goldkeys.org/

mTrac. Uganda. http://www.mtrac.ug/

My Voice. Nigeria. http://reboot.org/case-studies/ict-for-accountable-public-service-delivery-nigeria/

Phones for Health. Kenya, Tanzania. http://www.cdcfoundation.org/PEPFAR

SMS for Life. Tanzania. http://malaria.novartis.com/innovation/sms-for-life/index.shtml

SMS Voices. Sierra Leone. http://www.enciss-sl.org/

Sproxil Mobile Product Identification. Tanzania. http://sproxil.com/sms-verification.html

Stop Stock Outs Project (SSP). South Africa. http://stockouts.org/

U-report. Uganda. http://www.ureport.ug/

Women of Uganda Network (WOUGNET). Uganda. http://www.wougnet.org/ushahidi/index.php/

Quipu Project. Peru. http://www.quipu-project.com/

Appendix D: Key Organizations

The following organizations and initiatives surfaced repeatedly in our review. This should be taken as a starting point for future research rather than as a comprehensive list.

Democracy, Human Rights & Governance, USAID https://www.usaid.gov/what-we-do/democracy-human-rights-and-governance

Governance & Public Sector Management, The World Bank http://bit.ly/1LzfaDP

Leadership Management & Governance Project http://www.lmgforhealth.org

Open Government Partnership http://www.opengovpartnership.org

Reboot http://reboot.org

Swedish Program for ICT in Developing Regions http://spidercenter.org

Transparency & Accountability Initiative at the Open Society Foundation http://transparency-initiative.org

Transparency International https://www.transparency.org

The U4 Anti-Corruption Resource Centre http://www.u4.no

U-Report http://ureport.in

Ushahidi http://ushahidi.com

Voto Mobile https://www.votomobile.org