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THE LAND SECTOR HAS AN APP FOR THAT: THE EVOLUTION OF MOBILE USE IN INTERNATIONAL DEVELOPMENT

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Abstract

This paper is a literature review of primary and secondary sources that seeks to chart the non-linear evolution of mobile use in development, from early efforts in the health sector to current land sector interventions. The objective of the paper is to identify three things: how mobile technologies and solutions have already been implemented by international development organizations in order to reduce duplication of efforts through information sharing; major obstacles to future interventions; and how innovations in the land sector, which include mobile broadband applications ("apps") that record land information, assist in land registration, and share land management best practices, may lead to overcoming the obstacles. The obstacles, notably developing mobile solutions that take into account local contexts and scaling interventions, are intersectional in nature and therefore solutions are relevant more broadly to international development efforts beyond the land sector.

Key Words: Education, Health, Learning, Mobile Applications, Mobile Money, Programmatic Evolution, Information Communication Technologies (ICT)

Background and Summary

As mobile technology has advanced in leaps and bounds since the turn of the millennium, so too has the use of mobile phones radically evolved in international development. The "first handportable cellular phone, the Motorola 8000" was developed and sold in the United States in 1984 and within twelve years, 103 countries had cellular networks (Agar 2003). At the turn of the millennium, the majority of these were European and other developed countries. With little to no coverage in developing countries, options for mobile interventions were limited. However, less than two decades later, mobile phones have "reached more people in many developing countries than power grids, road systems, water works, or fiber optic networks" (Qiang et al. 2012). As a result, international development organizations are implementing mobile phone-based development projects in many sectors, "including agriculture, health, education, emergency response, and governance" (Aker and Mbiti 2010). Yet, the developing countries in which these projects are being implemented are quickly becoming "more mobile" than the developed countries and the implementers themselves, introducing innovations such as "multi-SIM card phones, low-cost recharges, and mobile payments" (World Bank 2012). In this landscape, development organizations need to be not only on the cutting edge of mobile technology, but incredibly flexible as well, with current mobile interventions ranging from SMS alerts to mobile surveys to broadband "apps," sometimes all three within a single country due to varying levels of cellular coverage.

This paper seeks to facilitate a discussion of productive paths forward for applying mobile solutions to development problems while acknowledging the complexity of the landscape, which includes an ever-increasing range of options for mobile solutions and an equally diverse array of issues that development organizations are addressing. To point out paths forward, as a field, international development must first pinpoint where it is now by identifying the current landscape as well as the route that brought it to this point. Accordingly, this paper charts the non-linear evolution of mobile use in development, from early efforts in the health sector to current land sector interventions. Even though this paper is primarily concerned with the mobile interventions implemented by development organizations, it is necessary to note that this is just the beginning of a larger conversation and that mobile innovation is being advanced throughout the developing world by public and private sector actors alike. By charting the evolution of mobile solutions, this paper also identifies two major obstacles in any path forward—developing solutions that can be scaled up as well as solutions that fit local contexts—and how the land sector is addressing both. Since these challenges are intersectional in nature, approaches to overcoming either in the land sector are relevant more broadly to international development efforts across sectors. Finally, this paper provides suggestions for how development organizations and mobile technology developers may pave the path forward, making it smoother and allowing all of organizations to move a

little more quickly. These recommendations for a path forward include: maintaining a dialogue around mobile solutions through additional research, the development of databases cataloguing mobile efforts to reduce duplication of effort and make progress bolstered by previous efforts, develop and adapt existing solutions when applicable, and make use of the mobile innovations and services that are continually being developed already by and within the developing world.

Methodology and Limitations

A literature review of secondary sources was conducted to identify past and present mobile-technology based development efforts. For the purposes of this paper, mobile technology-based interventions are narrowly defined as efforts which depend on the use of handheld devices (cellular phones or tablets) by implementers, beneficiaries, or both and are partially or completely funded by international development organizations through ongoing programs. In general, interventions that affect mobile users but could still be implemented without the use of handheld devices, such as hotlines or websites are not included.

The intent of this paper is to spark a conversation and as such is not exhaustive: there remain many topics to continue talking about. For example, one-off challenges and funds were not included because they merit an entire paper to themselves, such as Making All Voices Count, a collaborative fund between the United Kingdom's Department for International Development (DfID), United States Agency for International Development (USAID), Swedish International Development Cooperation Agency (Sida) and the Omidyar Network or the Google Impact Award, which has supported the development of an SMS land titling system built on FrontlineSMS (McDonald 2013). As noted by the World Bank, the developing world is embracing mobile technology to an astonishing degree and multiple papers could be devoted to the private sector's participation in mobile innovation. This paper is not a complete review of the public and private mobile landscape but simply the start of a dialogue.

New Developments

While the development of mobile technology may be considered relatively linear, the rapid pace at which it has developed, as well as variances in adoption of mobile technology, has resulted in a non-linear evolution of use globally, which is mirrored in mobile development interventions. Globally, mobile technology is considered to have reached a fourth generation (4G), with previous generations introducing standardized analog networks, digital networks (including the Short Message Service, or SMS), and mobile broadband (Brookes 2012). Accordingly, a linear evolution of mobile solutions in international

Box 1. Mobile Phones and Applications

Many mobile handsets, particularly in the developing world are so-called basic phones, based on the second-generation (2G) GSM (Global System for Mobile communications) standard, first introduced in 1991. GSM offers a number of different services embedded in the standard and therefore available on all GSM compatible devices, however basic. These include short message service (SMS) text messages of up to 160 characters, and instant messaging using the USSD (Unstructured Supplementary Service Data) protocol. Many of the older "mobile applications," particularly in the developing world, are based on SMS or USSD, because they do not require additional data services or user downloads and are available on virtually any device. Strictly speaking, however, these should be considered network services rather than applications [and are accordingly referred to as "basic apps" in this paper]. Internet-enabled handsets, or feature phones, were introduced with the launching of data services over mobile networks in the early 2000s. These phones supported transmission of picture messages and the downloading of music and often included a built-in camera. Smartphones appeared in the late 2000s. They typically feature graphical interfaces and touchscreen capability, built-in Wi-Fi, and GPS (global positioning system) capability. Smartphones with expanded memory and internet access are also able to download applications, or "apps," pieces of software that sit on the phone's memory and carry out specific functions, like accessing websites or reporting the phone's location and status.

Source: Adapted from Maximizing Mobile, World Bank 2012

development could be expected to generally progress from interventions that use analog services (voice calls), to SMS-based interventions, and ultimately smartphone apps that require mobile broadband. However, developing nations have proved to be more mobile-friendly and are "leapfrogging" typical infrastructure, including wired telephone services in some cases, and governments and donors are striving to mirror the jump by developing programs that go "beyond basic voice calls and text messaging" (Aker and Mbiti 2010). The box above provides additional context for mobile phone capabilities and Table 1 at the end of the paper lists technological functions found in mobile devices by increasing level of sophistication. It is important to note that sophistication of technology does not by itself make a function more or less desirable, but the addition of functions and handset capabilities is important to understand in relation to the evolution of mobile solutions in international development. Like a Rube Goldberg machine, a more complex solution to a problem is not necessarily better.

The astonishing growth of mobile technology use in international development is mirrored by the rapid growth of international development itself as a field. Global development efforts, like the World Bank Group and the Food and Agriculture Organization of the United Nations (FAO) were only established after World War II. In the United States, the first group of Peace Corps Volunteers left for Ghana and Tanzania in 1961 and later that year USAID was established. It wasn't until the 1970s, though, until USAID had shifted to an approach that would be familiar to us today, focusing on "basic human needs," including food and nutrition, health, and education (USAID 2015). Similarly, in the United Kingdom, the Ministry of Overseas Development, which would ultimately become DfID, was established

as an autonomous ministry in 1974. International development is a field that has barely finished celebrating semi-centennial anniversaries.

Peace Corps as a Primary Focusing Lens

To look at the evolution of mobile solutions implemented by international development agencies *en masse*, one may begin by looking at the micro-evolution of solutions implemented by the United States' Peace Corps in particular. Due to a rule that obligates staff to rotate out of the Peace Corps after no more than five years of service and twenty-seven month contracts for Volunteers in the field, the relatively quick rotation of the workforce has resulted in an organization that can nimbly respond to a variety of situations in the field and quickly incorporate new advancements in the field of international development. The rapid spread of mobile phone use by Volunteers in the field illustrates this. The first group of Peace Corps Volunteers arrived in Mongolia in 1990, six years before the country's first cellular network, MobiCom, was established. Little more than a decade after MobiCom began operating, Volunteers in every post in Mongolia had traded radios for mobile phones to communicate with Peace Corps staff. The rapid rotation of Volunteers and the gear they take to their posts, contributed to Peace Corps Mongolia being able to adopt basic mobile phones as a primary method of communicating with rural posts almost as quickly as mobile operators provided coverage. This is not uniform across Peace Corps countries, though, as some countries, such as the Comoros have progressed beyond basic phones to smartphones, while the most recent handbook welcoming Volunteers to Guyana still references satellite phones and landlines (Peace Corps 2015). Due in part to its policies, Peace Corps can respond to the specific situation and needs in each country instead of forcing mobile solutions that may not fit the local context. However, the same policies also exacerbate the international development pitfall of duplicating efforts.

A review of publicly available information on Peace Corps' mobile solutions (Table 2) shows an evolution of projects that ultimately become more sophisticated over time while responding to both local and organizational needs but occasionally "reinvent the wheel." Multiple Peace Corps projects established SMS information hotlines as early as 2008. By 2013, projects incorporate mobile apps, the most interesting of which may be MedLink—a multi-platform solution that includes a smart phone app to assist clinicians tracking medical supply inventories and the ability for patients to query inventories or submit supply requests via text messages (Peace Corps 2013). Originally implemented in South Africa, MedLink was ultimately adopted for use by Peace Corps' own medical staff (Hessler-Radelet and Forde 2014). This is an example of how developing countries can be "more mobile" than donor countries, and emphasizes how a flexible development organization can directly benefit from its own mobile solutions.

A closer inspection of earlier Peace Corps projects that only included SMS functionality highlights the importance of knowledge management. In 2008, Sex-Ed by Text (SET), an automated HIV/AIDS information text hotline in the Philippines, led to the development of a similar hotline in Namibia after Volunteers shared their experience. However, another automated SMS project does not appear to be implemented until 2013. In the five intervening years, at least one SMS information hotline is implemented, which even provides HIV/AIDS information, but it is not automated and requires volunteers from the local Red Cross to answer texts (Peace Corps 2011). Alone, either the gap between projects or varying levels of technological sophistication may be individual projects responding to local contexts, but taken together they indicate a possible issue with knowledge management. This indication is supported by the fact that the next time an automated SMS hotline appears to be implemented by Peace Corps Volunteers, Chat Salud, it is built on FrontlineSMS and modeled on the USAID-funded Mobile for Reproductive Health (M4RH) project (Spigel and Kishore 2013). The influence of an earlier USAID project on the development of a Peace Corps project is a positive example of how sharing successful solutions between international development organizations is beneficial. However, the three Peace Corps projects that do not reference previous Peace Corps mobile projects highlights just how much more work needs to be done managing and sharing knowledge between and even within agencies.

Early Adoption in Public Health – mHealth

Whether or not health is "the foundation on which development rests" (World Bank 2012), mHealth programs are a cornerstone of mobile interventions. In fact, many of the earliest mobile solutions implemented by international development agencies are in the health sector. Years before USAID's M4RH project would inspire Chat Salud, the U.S. Centers for Disease Control and Prevention (CDC) implemented TRACnet, an HIV/AIDS project in Rwanda that enabled patient data to be entered "through the Internet, via voice, or using forms on mobile devices" (DeRenzi et al 2007). Additionally, since 2005, "organizations like the World Bank, the World Health Organization and USAid [sic] have used a program called Magpi [formerly EpiSurveyor] to collect information on diverse subjects, everything from water quality to anti-malarial bednet distribution" (McKenzie 2013).

Many early mHealth programs used mobile devices for data collection, through a variety of methods, including voice calls, SMS, and featurephone applications (see Table 3). The variety of technological sophistication in early mHealth solutions is notable; even though they share a common purpose, to record and store data, some implementations of EpiSurveyor use functions not found on basic phones, such as Bluetooth (Frost et al 2009), while other solutions such as mTrac, built on RapidSMS, collect data primarily through SMS and USSD (Blaschke and Alinaitwe 2015), functions found even on

Box 1. RapidPro: From Projects to Platform

UNICEF has been working with SMS systems since 2007, when it created an open source platform called RapidSMS with its partners to support ongoing data collection efforts and youth engagement activities. RapidSMS is a free and open source framework designed to send and receive data using basic mobile phones, manage complex workflows, automate analysis and present data in real-time. In Zambia, for example, RapidSMS was used to facilitate communication between clinics and community health workers to significantly reduce the amount of time between collecting blood samples for early infant diagnosis for HIV and the return of test results to the originating health facility.

Inspired by RapidSMS, Rwandan software engineering firm Nyaruka built their own SMS service called TextIt - a commercial hosted service that combined the advantages of RapidSMS while addressing many of the limitations. UNICEF partnered with Nyaruka to open source and expand the functions of TextIt, giving birth to RapidPro in 2014.

From youth engagement programs like U-Report to education monitoring systems like EduTrac, RapidPro has become UNICEF's common platform for developing and sharing mobile services that can be adapted for different contexts and sectors.

Source: Adapted from UNICEF's RapidPro About Page

basic mobile phones. It is also important to note that data collection is not limited to the health sector and some of these solutions have been used successfully in programs tackling other development issues. EpiSurveyor/Magpi has been "used by the health, agriculture, education, conservation, and commerce sectors" (McQueen et al 2012) and Open Data Kit has a similar range of possible uses (Hartung et al 2010), including data collection for impact evaluations of projects in the land sector (Persha 2015). When developing new programs, organizations can benefit from knowing the full range of earlier efforts, and cross-sector applicability of solutions is not limited to mHealth.

While mHealth interventions have progressed and come to span a number of programmatic areas, including behavior change communication, data collection, finance, logistics, and service delivery (Levine et al 2015), Table 3 shows a trend towards less technologically sophisticated solutions. This is likely the result of an increase in mobile interventions pushing further and further towards underserved, rural communities. SMS is "widely available, inexpensive, and instant" (Cole-Lewis and Kershaw 2010) and has the potential to reach rural communities ahead of even an electrical grid. Likewise, the shift from SMS to interactive voice response (IVR) is a way reach out even further to illiterate populations (World Bank 2012). A mobile solution is not better because it uses more technologically sophisticated functions, but because it is a fit-for-purpose intervention for the problem it is intended to solve.

The Mobile Alliance for Maternal Action (MAMA) program implemented in 2011 illustrates the effectiveness of mHealth programs that incorporate basic functions, providing voice or text messages to thousands of pregnant women and mothers (Lipowicz 2011) as well as a new trend towards mobile

money. The MAMA program has been implemented in multiple countries, including Bangladesh, where it is known as Aponjon and began using mobile money to pay community agents in the field (Dnet 2014). Since 2011, more and more mHealth solutions have begun to incorporate mobile financial services, specifically mobile money, into their programs as way to make payments that are easier and safer. The next section examines this further.

Economic Growth for the Unbanked – Mobile Money

While mobile money is often used interchangeably with the term mobile financial services (MFS), it may be more accurately viewed as one of multiple services under the umbrella term MFS. This paper uses the definition of mobile money programs as ones that use a mobile phone "to transfer money and make payments," offer at least one of the following: "domestic or international transfer, mobile payments including bill payment, bulk disbursement, and merchant payment;" and usually rely on an existing service provider with "a network of transactional points outside bank branches and ATMs" (Scharwatt et al 2014). Of all the solutions included in this paper, mobile money solutions are unique in that most take advantage of services that are being adopted in the developing world independently of the projects that use them. They are also particular to the developing world—the majority of mobile money solutions use basic mobile functions such as SMS and practically do not exist in developed countries. Instances of mobile money that use mobile apps and near field communications (NFC) such as Google Wallet and Apple Pay exist but have had low rates of adoption, making them unlikely to be part of a mobile money solution in the near future. One possible explanation for the different rates of adoption are that the problems mobile money solves in the developing world—access to bank accounts and difficulties traveling with cash—are not pressing issues in developed countries, which underlines the importance for interventions to effectively identify a problem before implementing a solution.

Perhaps one of the most well-known examples of services used by early mobile money solutions is M-PESA, which is also an example of how a service or a solution can scale successfully across a country but encounter issues accounting for different local contexts beyond its initial borders. M-PESA is a mobile money system developed by Vodafone and launched by its Kenyan affiliate Safaricom with seed funding from DfID (Mas and Radcliffe 2010). The system allows users to use SMS to send money to other users, pay bills, and buy mobile credit. With 7 million registered users in Kenya, which includes 40% of all adults in the country (Camner et al 2009), it would be hard to argue that M-PESA is not an example of a successfully scaled solution in Kenya. However, adoption rates were significantly lower when it launched in Tanzania the following year. Fourteen months after launching in June 2009, "M-PESA in Tanzania had 280,000 users and 1,000 agents" compared to the "2.7 million users and almost

Box 2. M-PESA: Mobile Payments Go Viral

M-PESA is a small-value electronic payment and store of value system that is accessible from ordinary mobile phones. It has seen exceptional growth since its introduction by mobile phone operator Safaricom in Kenya in March 2007: it has already been adopted by 9 million customers (corresponding to 40% of Kenya's adult population) and processes more transactions domestically than Western Union does globally. M-PESA's market success can be interpreted as the interplay of three sets of factors: (i) pre-existing country conditions that made Kenya a conducive environment for a successful mobile money deployment; (ii) a clever service design that facilitated rapid adoption and early capturing of network effects; and (iii) a business execution strategy that helped M-PESA rapidly reach a critical mass of customers, thereby avoiding the adverse chicken-and-egg (two-sided market) problems that afflict new payment systems.

Source: Mas and Radcliffe 2010

3,000 agents" M-PESA had fourteen months after launching in Kenya (Camner et al 2009). Additional details on M-PESA and the obstacles it encountered can be found in Box 2, but the review of learnings from M-PESA in Kenya and Tanzania conducted by the Groupe Speciale Mobile Association (GSMA) concludes with the observations that "one of the greatest challenges is the new relationships that have to be established" and that the "review demonstrated the importance of the country context" (Camner et al 2009). Both observations are reinforced by the way mobile money solutions in international development have evolved to leverage existing relationships and use similar approaches but different services, sometimes even in the same country.

One way that mobile money solutions have mitigated the challenge of establishing new relationships is by being added on to established projects, thus leveraging the projects' existing relationships and providing a benefit by solving one or more financial issues for the project. Table 4 lists projects with mobile money solutions, and many also include interventions for other sectors, including mHealth and mLand solutions. USAID's mSTAR program in Bangladesh exemplifies this approach as it seeks to help "USAID implementing partners engaged in agriculture, health and education programs integrate mobile payments and electronic payments into their program operations" (Islam 2015). The MAMA program, mentioned in the mHealth section, received support in Bangladesh from mSTAR to pay community agents through bKash, a local mobile money service provider, reducing the payment process from 41 to 11 days and increasing security (Islam 2015). Other USAID projects that have begun implementing mobile money solutions with some level of mSTAR assistance include: an Agriculture Extension project, Aquaculture for Income and Nutrition (AIN), Marketing Innovations for Health (MIH), Mayer Hashi II, SHOUHARDO II, and SIAPS: Systems for Improved Access to Pharmaceuticals and Services (Islam 2015).

While mobile money solutions can enhance existing projects that are implementing mobile solutions of varying levels of technological sophistication, or standalone as the only mobile aspect of a project, the mobile money solutions that are used by development organizations have not evolved beyond SMS functions—differing mainly by which company provides the service and whether USSD or SIM cards provide menu functionality. However, the fact that numerous mobile money service providers exist, sometimes in the same country, and projects use different ones is important. For example, in Bangladesh, where multiple USAID mobile money solutions are being implemented, some (including MAMA/Aponjon) use bKash, while others, such as TB CARE II, use Dutch-Bangla Bank (DBBL) services. While it is tempting to conjecture at the reasons for this, the lesson is clear, that mobile solutions need to be driven by both what a community needs and already has. Identifying an issue to solve is only a first step and the next challenge is accounting for the local context.

Global Classrooms in Palms and Pockets – mLearning

Similar to the way mobile money has connected people to financial services that they may not have had access to before due to physical distance from banks or limited resources, mLearning (also referred to as mEducation) has increased educational opportunities for people who do not have access to traditional classrooms. Unlike mobile money, though, many mLearning solutions are implemented among populations that may not even have mobile devices, as evidenced by the number of programs in Table 5 that provide tablets and phones as part of the intervention. There is a clear evolution in mLearning-related programs donating technology from desktop computer labs to the UN backing the One Laptop Per Child initiative in 2006 to Voluntary Service Overseas (VSO) supplying tablets in 2013, with programs involving assorted levels of mobile phones in between.

Due in part to programs supplying the hardware, mLearning shows the most linear evolution of solutions that become progressively more advanced with time and the availability of new technologies. Initially launched in 2003 as “Text2Teach” in the Philippines, BridgeIT has expanded over a decade to at least ten countries and through its own development exemplifies the larger, mostly linear evolution of mLearning. An initial phase relied primarily on the SMS function of mobile phones to let teachers choose educational videos that would then be downloaded onto a separate system via satellite. Later phases included phones pre-loaded with videos and then the Nokia Educational Delivery software with the ability to download videos using mobile web functions over 3G (Cole-Lewis and Kershaw 2010). The phases of BridgeIT clearly demonstrate the linear evolution of mLearning solutions as available technologies and mobile functions become increasingly sophisticated.

While the fact that many programs supply the mobile devices that are used may explain how mLearning solutions have steadily progressed to use more and more technologically sophisticated features, it does not explain why. Assuming the availability of funds, any sector could provide smartphones and deploy mobile solutions that use the latest features if the return on investment was great enough to make it worthwhile. What makes mLearning different from other sectors is that it can take advantage of advanced features to provide additional value. A landscape research review of mobiles for reading (M4R), a subset of mLearning solutions, observed that "substantial opportunities" would arise from new, more powerful innovations (Wagner et al 2014). Greater technological sophistication of mLearning solutions have the potential to directly benefit a project's primary goal of enhancing learning in contrast to a mobile money solution that may actually be less useful, for example, transitioning from SMS to an app that requires 3G connectivity or NFC, not only because it requires someone who may already have a basic phone to invest in a smartphone, but may not directly benefit the primary goal of the solution, to transfer money more conveniently. An analysis of the use of mobile phones to improve educational outcomes in Asia found that "the quality of the software and hardware is instrumental to the success of mLearning modalities" (Valk et al 2010). Another benefit that new technologies offer is simply making learning more fun. An English language learning project in Mongolia included in the aforementioned analysis reported that participants found that including a text messaging component to tests made it more interesting than paper-based tests. By making learning fun and exciting, mLearning solutions using the latest technologies offer opportunities to engage students better than traditional methods and improve outcomes, which in turn may shed light on the unusually linear evolution of mLearning solutions from SMS tests to Massive Open Online Course (MOOC) apps.

Finding A Path Forward – mLand

This paper defines mLand as mobile solutions concerned with land use and management, from agricultural to tenure interventions. When examining the evolution of mLand solutions (Table 6), similarities to the other sectors examined in this paper become apparent, consistent with the view of land as cross-sectoral and "fundamental to a wide variety of development outcomes," (USAID 2013) including food security, economic growth, and broadening access to resources for vulnerable populations. Early efforts included broadcast SMS services, similar to mHealth. Where early mHealth solutions connected rural health practitioners and patients to clinics or provide health advice, mLand solutions connected buyers and sellers of agricultural commodities or provided market and climate updates to subscribers. The opportunity to connect mobile money was also realized relatively early on by projects that provided mobile money services to farmers and agricultural day laborers (included in Table 5). And similar to

mLearning, recent projects in the land sector have benefited from more technologically sophisticated mobile functions, including apps, as donors often provide the hardware used in projects, especially mapping and registration solutions. With major points in common, mLand must also confront the major obstacles that lie across paths forward for all sectors.

The two major challenges facing mobile technology-based interventions identified in this paper, designing for scale and accounting for local contexts, may at first appear to be mutually exclusive when in practice they are not. The observation that a trend has emerged for mobile solutions that "are not built for scale but rather for small pilots" (Qiang et al 2012) implies a false dichotomy. A pilot, by definition, is a small scale experiment testing a solution for a larger problem. The gap between small and scaled solutions is more likely to be a knowledge gap than a result of pilot design, as demonstrated by the example of Peace Corps reinventing SMS solutions, but learning from USAID solutions. Along these lines, USAID's Mobiles for Development (M4D) Handbook notes that "the often siloed nature of our development programs mean that mHealth, mAgriculture, mFinance and other 'm-' efforts are not built to support each other and, in some cases, are working at cross-purposes" (Woodard et al 2014). With sufficient knowledge management processes in place, the land sector may be uniquely positioned and serve as an example for the international development community of a possible path forward for scaling mobile solutions that account for local contexts.

The path forward that can address both issues of scaling and local context requires robust knowledge management processes or entities to balance current solutions and momentum with lessons learned from earlier efforts across sectors. Databases of existing solutions can begin to address knowledge management issues, and the land sector has multiple notable examples, including USAID's land tenure portal and the Global Donor Working Group on Land's land governance programme map, both of which are actively maintained and facilitate knowledge management by cataloguing current and past projects, including some of the mLand solutions in Table 6. Either developing an existing database or a new repository specifically for mobile solutions that includes information from existing databases would facilitate the sharing of lessons learned across sectors and could prevent reinventing solutions. Ideally, a database would be cross-sectoral and reference the technical functions of solutions, similar to the tables included in this paper, as well as include contact information for developers and implementers to encourage follow-up regardless of agency or sector. Such a database would be valuable to donors and developers alike. For international development organizations, a repository of cross-sector mobile solutions would reduce the need for costly landscape reviews, provide lessons learned from previous successes while reducing the risk the repetition of failures, and could enable one or more donors to scale the successful pilots of another donor when funds and programmatic directions shift, thus amplifying

donor impact through coordination. For developers and implementers, the database would increase opportunities to be contacted and for solutions to continue to be used or adapted after a program ends. Additionally, it could encourage organizations to collaborate and continue to improve successful solutions independently, instead of developing a new but not novel solution for every program.

The land sector also demonstrates how programs can adapt existing solutions successfully instead of reinventing them. Two solutions, Open Data Kit (ODK) and FrontlineSMS that had previously been used by mHealth solutions, were successfully adapted for use in mLand solutions as well. Not every solution can be this flexible, but knowing that a mobile solution can be successfully adapted should inform the design process. Approaching the design of mobile solutions as building a base for additional, future solutions instead of a final, immutable solution is one way to address concerns of scalability. Two current fit-for-purpose mobile solutions unique to mLand, Open Tenure and the Mobile Application to Secure Tenure (MAST)[1], highlight how the land sector is positioned to go beyond adapting existing solutions to provide new, flexible foundations for adaptation by future solutions. In order to address spatial, identification, and even infrastructure issues, both mobile applications include GPS, camera and offline functionality. Solutions developed by the land sector require a variety of sophisticated technological functionality, and can be adapted for use beyond the original context.

The way that the land sector has embraced newer mobile technologies, similar to mLearning, serves as a useful reminder that the path forward needs to include learning about and incorporating technological improvements. Solution design must be driven by identifying an existing problem and identifying existing solutions is secondary to this. A solution that is "tried and true" may not necessarily be the best fit and failure to innovate will doom any sector to stagnation. The Land-Potential Knowledge System (LandPKS) is an mLand solution that provides an example for other sectors to follow. LandPKS is being developed as a platform to allow others to use it as the foundation for creating and sharing apps to address more specific information needs. Currently hosting two smartphone apps developed by USAID and USDA, LandPKS has the potential to host a variety of solutions developed by other agencies and actors in the developing world that address issues not yet identified and incorporate smartphone innovations not yet envisioned.

[1] The MAST project referenced is a pilot implemented by The Cloudburst Group in Tanzania with USAID funding to test Robin McLaren's hypothesis that tenure rights could be crowd sourced. The USAID E3/Land Office has since adopted MAST as a general term for all mobile applications it financed in the land sector.

Recommendations

After reviewing the evolution of mobile solutions in international development, this paper offers four recommendations for a path forward:

1. First and foremost, the discussion would be enhanced by further research. This study has not included innovation challenges and awards that provide seed funding to mobile solutions, though these may have important lessons for the use of mobile solutions. In addition, it would be helpful to review the evolution of mobile solutions pioneered by non-governmental organizations and the private sector and bring this learning to the donor agencies and the broader development community.
2. Secondly, systems for knowledge management and sharing of solutions need to be developed further. As it currently stands, the risk of "reinventing the wheel" is real because there is no central repository of information on mobile solutions to development challenges. This can contribute to waste of limited development resources, excessive search and development costs, and lost opportunities to innovate around existing solutions.
3. Thirdly, the land sector should take an approach the builds on and adapts existing solutions when reasonable and when developing mobile solutions, keep in mind how these solutions may be built upon and adapted by other sectors. In other words, the land sector should more actively educate itself about what has already been developed and think creatively about how to adopt existing solutions.
4. Finally, all sectors can bear in mind the rapid innovation that is occurring even without direct donor intervention in the developing world, and embrace these innovations in their own programming.

Tables

Table 1. Types and Availability of Mobile Technologies

Technology	Description	Availability
Voice	The most basic channel; avoids most literacy or linguistic barriers	Basic phones
Interactive Voice Response (IVR)	Computer programs that respond to the voice input of callers. The programs are hosted by the service provider, not the mobile phone – any phone can use IVR	Basic phones
Short Message Service (SMS)	Ubiquitous text-based messaging limited to 160 characters	Basic phones
Unstructured Supplementary Service Data (USSD)	A protocol used by Global Service for Mobile Communications (GSM) phones to communicate with the mobile network	Basic phones
General Packet Radio Service (GPRS)	Low bandwidth data service	Midrange phones
Featurephone App (e.g. Java)	Software of limited sophistication, typically pre-installed on a SIM card	Midrange phones
Mobile Wireless Application Protocol (WAP)	A limited manner of browsing the internet	Midrange phones
Multimedia Messaging Service (MMS)	SMS-based technology to transmit multimedia (including images and video)	Midrange phones
Camera	For capturing still or moving images	Midrange phones
Bluetooth	Protocol for transmitting data over short distances	Midrange phones
Mobile App (e.g. iOS or Android)	Preinstalled or downloaded software developed for smartphones	Midrange phones
Mobile Web	Full-fledged web access	Smart phones
Global Positioning System (GPS)	Technology allowing for location-based information	Smart phones
Near Field Communications (NFC)	Protocol for transmitting data over even shorter distances than Bluetooth	Smart phones

Adapted from Box 3.3 in the ICT in Agriculture e-Sourcebook (World Bank 2011)

Table 2. Peace Corps Mobile Solutions

Year	System	Mobile Function(s)	Details
2008	Sex-Ed by Text (SET)	SMS	Volunteers in the Philippines worked with a local NGO to establish an SMS service to access an HIV/AIDS information hotline with automated responses (source & archived site). After exchanging information, Volunteers in Namibia set up a similar service to help individuals find the nearest Anti-Retroviral Therapy (ART) facilities (p. 4 Peace Corps ICT).
2011	SMS Information Hotline	SMS	Peace Corps Volunteers in Armenia Use Text Messaging for HIV/AIDS Education and Prevention: a simple text hotline is set up for awareness raising, staffed by Armenian Red Cross Society volunteers (based on earlier hotlines)
2013	ChatSalud (FrontlineSMS)	SMS	ChatSalud Aims to Empower Rural Nicaraguans to Advocate for their Sexual and Reproductive Health & Reach for Your Pocket: Nicaraguans Turn to their Phones for Reproductive Health: text hotline with automatic responses, going beyond HIV/AIDS to cover five topics "reproductive health, safer sex, HIV/AIDS, STIs and domestic violence" (implemented around August) Based on earlier USAID/FHI360 programs in Kenya and Tanzania: Mobile for Reproductive Health (M4RH)
2013	Bantu Babel	App	Peace Corps Volunteers Create Mobile Language Application: Translation app for seven languages in Zambia Peace Corps Volunteers in Zambia worked with local software developers to create Bantu Babel, a mobile app on the Android platform that acts as both a dictionary for seven less commonly-spoken Bantu languages in Zambia while also providing a basic phrasebook for those languages. This project was developed through an Innovation Challenge Hackathon sponsored by Peace Corps Headquarters in Washington (source)
2013	MedLink	SMS / App	Peace Corps Volunteers Launch Development of Innovative Application that Links Rural Communities with Life-Saving Medical Information: SMS + mobile app hybrid allows rural communities to text clinics to check medical supply inventories, and clinicians use the app to track the inventory. Note that the app is for use in the clinics, less rural areas.
2014	PC MedLink	SMS / App	Keeping Peace Corps Volunteers Healthy, One Text at a Time: the SMS + app hybrid being used in the field comes to Peace Corps volunteers to be used with their own medical offices.

Table 3. mHealth Solutions

Year	Project or Service Name / Agency	Mobile Function(s)	Details
2004	TRACnet / CDC	SMS, Internet, Voice	TRACnet is a dynamic information technology system designed to collect, store, retrieve, display and disseminate critical program information, as well as to manage drug distribution and patient information related to the care and treatment of HIV/AIDS. This system enables practitioners involved in anti-retroviral (ARV) treatment programs to submit reports electronically and have timely access to vital information. By dialling 3456, a toll free number, or logging onto a bilingual website (English and French), health centre staffers can submit or receive programme results on HIV/AIDS patients as soon as they are processed. (source) The system sends SMS reminders for due and overdue reports (source) Patient level data is entered into the system through the Internet, via voice, or using forms on mobile devices. Answers to questions in Epihandy and TRACnet are sent if there is connectivity or are cached until the device has a connection to the Internet and can synchronize with a server (source)
2005	EpiSurveyor (Magpi) / Multiple	Initially: Featurephone App, Internet Later: SMS, Mobile App, GPS, Bluetooth	Since 2005, organizations like the World Bank, the World Health Organization and USAid have used a program called Magpi to collect information on diverse subjects, everything from water quality to anti-malarial bednet distribution to the health of endangered species (source). Magpi delivers a configurable, cloud-based application that enable users in the field to quickly and easily collect data via SMS or Web entry and create broadcast messaging campaigns (source). In the write-up section, may be interesting to note the possible use by Returned Peace Corps Volunteers (source) USAID details in 2009 (source) and (source)
2007	RapidSMS / UNICEF	SMS, USSD, Internet	RapidSMS uses text messaging to create and maintain dynamic databases. One example of many is UNICEF's birth registration system in Uganda, which uses RapidSMS to maintain a central electronic database of new births, updated using information transmitted via SMS (source). Notable projects connected to RapidSMS include mTrac, Ureport, and RapidPro http://www.unicefstories.org/2015/06/01/ugandas-ict-innovations-are-now-replicable/
2009	Open Data Kit (ODK)	App	ODK consists of four tools: Collect, Aggregate, Voice, and Build (source) Earliest record of use by USAID is 2009 (source) and additional details in AMPATH paper (source)

2010	Mobile for Reproductive Health (M4RH) / USAID	SMS	Automated text message hotline set up in Kenya and Tanzania, being worked on in Rwanda as well (source). Kenya-specific report & M4RH pilot results. Includes "Text to Change"
2010	TB CARE I / USAID	SMS	SMS system developed to enable laboratory technicians in Cambodia to transmit TB test results immediately instead of waiting for health center staff located in more peripheral locations to come and collect it on a weekly basis.
2010	mUbuzima	IVR	In Rwanda, mUbuzima, uses interactive voice response (IVR) technology to enable CHW team leaders in each village to submit data on a monthly basis relating to indicators for case management of sick children, nutritional status, vaccinations, supervision, maternal health and deaths at home. Used in conjunction with RapidSMS (source)
2011	mHealth for Safer Deliveries / Bill & Melinda Gates Foundation	App, SMS, Voice	CHWs trained to use a phone with a decision support application to develop a birth plan with expectant mothers, provide health behavior counseling, use mobile banking use mobile banking instead of cash to pay for transportation to the health facility when the woman is in labor or in case of complications, and use text or voice communication to notify a health facility that a woman is in transit to ensure the facility is prepared (USAID 2015).
2011	CAP-Malaria / USAID	IVR	In Cambodia, CAP-M has a radio program with interactive voice response (IVR) that listeners can call to access additional information and to leave questions or comments for the call-in program.
2011	Mobile Alliance for Maternal Action (MAMA) program / USAID, United Nations Foundation	SMS, Voice	Pregnant women and mothers receive voice or text messages about pregnancy care, warning signs, family planning and infant care to thousands of registered users. Similar to Text4Baby, launched in the U.S. in 2010 (source). Some local implementations of the project have different names, such as Aponjon in Bangladesh, which began using mobile money to pay community agents in the field (source).

For a more extensive list, please see Table 5.2 "Mobile Applications for the Health Sector" (World Bank 2012) and the mHealth Compendium Volume 1 (USAID 2012) to Volume 5 (USAID 2015)

Table 4. Mobile Money Solutions

Year	Project or Service Name / Agency	Mobile Function(s) / Cross-sector(s)	Details
2009	Text to Treatment / UNFPA	SMS, Voice / mHealth	Program "ambassadors" (health workers and volunteers) identify women with fistula and arrange a referral. Once they have confirmed the diagnosis, funds are sent via M-PESA to the ambassador to purchase a bus ticket for the woman's transportation to the hospital. The ambassadors also receive incentive payments through M-PESA. (source: HFG)
2012	mHMtaani / USAID	SMS, App / mHealth	The mHMtaani project (Swahili for "Mobile Health for my Community"), funded by USAID's APHIAplus Nairobi-Coast Program, includes CommCare, a mobile phone application used by Community Health Workers (CHWs) as a "decision and counseling support tool" to register clients and upload patient data. CHWs are paid to use the mobile app through M-PESA (source: HFG)
2012	Agri-Fin Mobile / SDC	SMS, App / mLand	This project uses a suite of apps and services to provide "bundled" support for smallholder farmers. The LISA platform uses SMS and an app to provide weather forecasts, agricultural information, and answer questions submitted to a team of experts. Andara Link adds the ability to pay electricity and phone bills through a mobile app (source) (LISA info).
2013	Program for Strengthening Household Access to Resources (PROSHAR) / USAID	SMS / mLand	Day laborers in the agricultural sector are paid with mobile money through bKash accounts connected to individual SIM cards (source).
2013	mSTAR / Bangladesh	SMS, USSD / multiple	Worked with multiple projects in Bangladesh to scale up mobile payments, including Aquaculture for Income and Nutrition (AIN); Agriculture Extension Project; Blue Star, PCHP; Strengthening Partnerships, Results and Innovations in Nutrition Globally (SPRING); Agro Inputs Project (AIP); and SHOUDARDO II (source?) (baseline report with full list of projects)
2013	Scaling Innovations in Mobile Money (SIMM) Project	SMS	SIMM aims to increase uptake and usage of m-money services by working with local and national government units to promote the adoption of m-money in government financial transactions. SIMM will encourage adoption of mobile money payments for business transaction with special focus on SMEs. The project will also train people on the uses of m-money and for improved household financial management, facilitate new savings account openings via m-banking, establish additional cash-in/cash-out merchant partners in rural areas, increase e-payroll implementation and adoption by businesses, and increase volume of m-money transactions. Led to E-PESO, which is not included because it's a

			general e-payment project, not strictly mobile. Built on previous m-money efforts. Note the cross-sector, finance for governance here, emergency response interventions that are mHealth and vice versa (source). Through GCash, taxpayers in the Philippines can pay real estate taxes via text, in addition to the more typical mobile money options of paying bills and loading airtime (source).
2014	TB CARE II / USAID	SMS, USSD / mHealth	Accepts mobile payments, contacted by mSTAR
2014	Financial Access for Investing in the Development of Afghanistan (FAIDA) / USAID	SMS	Afghans can load their 'mobile wallet' with cash. The cash can be used to send money to a far-flung relative, or, in some cases, to pay electricity bills or receive government salaries (source). In some cases, both bills and payment are sent via SMS (source). Purchase airtime directly from their handsets, send money from their mobile phones to family and friends, pay their bills via their mobile phones, purchase goods and services from shops and or retail outlets and deposit or withdraw cash from Etisalat authorised mHawala distributors or Etisalat partner banks (source)

For a more extensive list, please see the "Mobile Money Activity Examples" provided by USAID's Health Finance and Governance (HFG) project: https://www.hfgproject.org/resources/hfg-mobile-money-activity/mobile-money-examples/

Table 5. mLearning Solutions

Year	Project or Service Name / Agency	Mobile Function(s)	Details
2003	BridgeIT / Multiple	SMS, Internet, Feature Phone App	Initially launched in the Philippines as "Text2Teach," BridgeIT let teachers choose from 120+ educational videos using a text message, which were then downloaded onto a separate system via satellite. Later phases included phones pre-loaded with videos and then the Nokia Educational Delivery software with the ability to download videos over 3G. Teachers could also use the mobile phone to access the Text2Teach helpdesk or to communicate with other teachers, for example in order to compare experiences or notes via SMS or exchange via Facebook groups' information on updates, events or post pictures. (Lautz-Cauzanet 2013)
2009	BBC Janala / DFID	IVR, SMS	English language learning mobile service launched in Bangladesh as part of the English in Action (EIA) initiative. The mobile service includes a complete course on a mobile IVR platform which incorporates three-minute pre-recorded bilingual audio lessons with self-evaluation IVR quizzes and SMS summaries (Cotter & Ashraf 2012)

2009	Bunyad Mobile Based Post-Literacy Program / UNESCO	SMS	Mobile phones are provided free of charge to program participants (contingent upon completion of the six-month program). Text messages containing literacy materials are sent via SMS to these mobile phones 6-8 times a day and program participants are instructed to read the messages, practice writing them in their workbooks, and answer questions (UNESCO 2012).
2009	Jokko Initiative / UNICEF	SMS	Jokko uses RapidSMS to allow users to send SMS text messages to a "magic number" that then forwards the message to all phone numbers belonging to the network, creating a mobile-based community forum.
2010	PAJE Nièta (Support to Youth Entrepreneurs Project) / USAID	Feature Phone App	Mobile content development platform created by EDC called "Stepping Stone," which allows a teacher or curriculum developer to create a series of slides viewable on a (Java-enabled) mobile phone by dragging and dropping components into place; this multimedia can be loaded onto phones and played back as lessons.
2011	Using Mobile Phones to Accelerate Literacy Education and Empower Afghan Women / Multiple	SMS	Teachers sent daily SMS messages to the students, who read the incoming message and responded via return text message to demonstrate reading comprehension and writing skills.
2012	Ustad Mobile Literacy / USAID	Feature Phone App, Bluetooth	Ustad app runs offline on the simple feature phones available in small mobile shops and can be installed as a dictionary or any other simple app on any phone with a memory card. It takes users from the first letter of the alphabet through grade 3 literacy and numeracy and includes hours of narrated instruction, reading comprehension exercise, quizzes, educational games, and video clips for visual learners in both of the Afghan national languages, Dari and Pashto. The application contains built-in metrics, which enable a user's learning time and quiz scores to be reported over Bluetooth to his or her teacher's phone.
2013	Unlocking Talent / VSO International	Apps	Tablets distributed with local language apps developed in line with Malawi's national curriculum for math, reading, and basic English lessons.

For a list of additional mLearning projects, please see Annex A of the "Mobiles for Reading Landscape Review" (USAID 2014) & Annex B of the "Landscape Review Mobile Education for Numeracy" (GIZ 2014)

Table 6. mLand Solutions

Year	Project or Service Name / Agency	Mobile Function(s)	Details
2005	Trade and Investment Program for a Competitive Export Economy (TIPCEE) / USAID	SMS	An SMS system was piloted to connect maize farmers and buyers. Interesting to note that for targeted crops, TIPCEE provided Global Information System (GIS) maps of all farms that produced the crops, some produced by handheld GPS devices, but not mobile devices as defined by this paper (ones connected to a cellular network).
2006	Smallholder Enterprise and Marketing Programme (SHEMP) / IFAD	SMS, Voice	Farmers send an SMS message with part of a commodity's name to a text hotline and receive best prices for the commodity by buyer. Farmers can follow-up with a buyer's code and receive a contact name and phone number to reach out and set up a transaction.
2010	Gombe-Masito-Ugalla (GMU) REDD Project / USAID	App, GPS	Forest monitors used GPS-enabled Android smartphones and tablets to monitor illegal activities in village forests as well as Open Data Kit (ODK) to manage data collection and aggregation.
2010	Swaziland Entrepreneurship and Enterprise Development Program (SWEEP) / USAID	SMS	Used FrontlineSMS to build an automated text hotline providing information weekly to cotton farmers in Swaziland. From information on rainfall to notifications on pest outbreaks, farmers could receive up to date advice on managing their crop. Ultimately made sustainable by moving from donors to the private sector (cotton ginnery).
2012	Solutions for Open Land Administration (SOLA) / FAO	Apps, GPS, Camera, Internet	The SOLA project developed an open source computerized cadastre and registration system, also named SOLA, and ended in December 2012. After its conclusion, Open Tenure mobile apps for Android and iOS were developed based on SOLA's software. The apps can capture data regarding land tenure claims (text, images, and GPS) and upload data over mobile web connections.
2013	Land-Potential Knowledge System (LandPKS) / USAID & USDA	Apps, GPS, Camera, Internet	LandPKS is being developed as a platform to allow others to use it as the foundation for developing apps to address more specific information needs. Currently, it hosts two apps, LandCover and LandInfo, which allow users to collect data on land use, soil, and vegetation, which can be uploaded to the cloud, shared and examined by other users.
2014	Mobile Application to Secure Tenure / USAID	App, GPS, Camera, Internet	The MAST project developed a mobile app with the same name that enables users to collect data on land rights (text, images, and GPS) and upload data over mobile web connections.

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