Claim Mobile: Engaging Conflicting Stakeholder Requirements in Healthcare in Uganda

Melissa R. Ho, Emmanuel K. Owusu, and Paul M. Aoki

***Abstract*—Claim Mobile is a platform designed to support a project that subsidizes healthcare by reimbursing health service providers in Uganda for treatment of patients with sexually transmitted infections. As with many development projects, the Uganda Output-Based Aid (OBA) project involves a number of stakeholders: the service providers, the project implementers, the financiers, and the Ugandan government. Design of an appropriate solution requires meeting the various and conflicting requirements of all of these stakeholders. In this paper we detail the rapid design and testing of a pilot implementation of a mobile and web-based system for processing claims forms, based on two prior field visits to Uganda. Based on a comparative device study, semi-structured interviews, health clinic surveys, and a brief deployment, we affirm the selection of the mobile phone as a platform from the health clinic perspective, and further suggest that effective design for development requires more than addressing requirements of the the "users" of the mobile phones but also all the other stakeholders involved, who may have conflicting requirements.**

***Index Terms*—mobile phone, ICTD, health, participatory design, Africa, HCI**

I. Introduction

Mobile phones are frequently touted as being **the** appropriate and sustainable platform for rural healthcare in Africa. They are relatively cheap, durable, consume less power than laptops and desktops, and incorporate a battery that makes them more amenable to use in places with intermittent or no power. Commonly proposed uses are for data collection [1], [2] and decision support for rural health workers [3], [4]. Some projects also use mobile devices as a platform for information dissemation as well as data gathering [5]. However, these are all generally "closed loop" systems in which researchers are able to control all aspects of the system design and operation, focusing their research primarily on the rural health workers that will be using the mobile phones.

Other applications have even more potential for large-scale impact. In the agricultural sector, we have observed how the introduction of transparent market prices and subsequent hiring of "middlemen" to purchase from farmers has reduced fraud and transformed supply-chain management for the E-choupal project [6]. While health information is critical to the improvement of healthcare in developing regions, *financing* healthcare also remains a significant unsolved problem. Can we take lessons from e-Choupal and apply them in the healthcare sector? The design of usable, reliable, and fraud-resistant tools for management of these aid flows is an area with potential for very significant impact.

However, in the case of healthcare, the financial models are very different from commercial markets – financing of healthcare typically comes through transnational aid agencies like the World Bank and International Monetary Fund (IMF), and is implemented by non-governmental organizations (NGOs) and the local government. Since the NGOs are typically experts in health, not technology, data processing is often outsourced to third-party information technology (IT) vendors. Relationships between the vendors, the NGOs, the local governments, and the transnational aid agencies are not always smooth - and limitations in communications infrastructure means that the information flows between them are scattered at best.

In this paper we suggest that the "closed loop model" generally used by researchers in deployments of mobile health applications does not map onto the financial and political realities of the mainstream of healthcare provision in Africa, and limits the ability of pilot programs to increase their scale and impact. We describe an innovative, IT-based, NGO-run healthcare access program in Uganda, and our experiences designing and deploying Claim Mobile, a mobile-phone based system intended to address inefficiencies and help the program scale to additional districts. We argue that in addition to addressing the needs of the primary users in the system, the health workers, our design must consider the requirements, motivations and concerns of the other stakeholders: the IT vendors, the NGOs, the government, and the aid agencies. Our designs must consider the larger order ramifications of how we may positively and negatively impact both the "users" who will be generating the data, and the entities that will be engaged in managing and using the information in the resulting database. Just as the e-Choupal project assimilated the middlemen by hiring them as kiosk operators, we propose that we can design applications structured to accommodate conflicting stakeholder requirements, while also alleviating information inequalities resulting from limitations in the system prior to the introduction of the information technology.

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Melissa R. Ho is with the School of Information at the University of California, Berkeley, 94720, USA. (phone: +256 777 723 786; email: mho@ischool.berkeley.edu).

Emmanuel K. Owusu is with the Computer Engineering Department at Iowa State University, 50011, USA. (email: kwame@iastate.edu).

Paul M. Aoki is with Intel Research, Berkeley, CA, 94704, USA (email: aoki@acm.org)

Fig. 1. A HealthyLife voucher. The 'M' in the top left is a note written by the health service provider to indicate that the first client voucher on the left was given to a male client, and that therefore the partner vouchers on the right should be given to a female client.

Mbarara, Uganda
• HIV prevalence: *10% of adult population (15-49 years)*
• Syphilis prevalence: *about 5-7% of adult population*
• *1 in 4 households had at least one phone.*
• *39% reported STI symptoms*
• *only 1/3 sought care*
• *54% of respondents who sought any STI treatment reported using private clinics.*

TABLE I
SOME BACKGROUND STI STATISTICS ABOUT MBARARA, UGANDA [7].

II. BACKGROUND

Providing effective health care in poor countries is an essential component to economic development and poverty reduction. Unfortunately donors supporting this endeavor often find that resources given are not matched by desired gains. The output-based aid (OBA) model of financing seeks to address this by paying healthcare providers directly for services rendered instead of paying for the service provision up front. However, OBA program management is information intensive, necessitating much paperwork to track and reimburse payment claims. Smartphones (mobile phones with advanced features such as the ability to run third-party software) have the potential to alleviate this burden. In collaboration with a local NGO and their partnering IT vendor, we have proposed to deploy a number of smartphones for use in an OBA project based in Western Uganda, with dual goals of reducing claim processing time and improving communication between the health care providers and the OBA management agency.

The project is managed by the local branch of a multinational NGO and a for-profit health insurance company, in collaboration with the Ugandan Ministry of Health (MoH) and Ministry of Finance (MoF). The project is primarily funded by an aid agency based in Europe, with additional funding for the expansion coming from a separate transnational funding agency. Together, they run a voucher program called HealthyLife, which treats sexually transmitted infections (STIs), reimbursing providers for the diagnosis and full course of treatment only after the patient is seen. This program was implemented in response to the high burden of sexually transmitted infections in Uganda, and began in July 2006 in four districts of southwestern Uganda: Mbarara, Ibanda, Kirihura and Isingiro (See Table I).

Patients buy treatment vouchers in pairs, one for the client and a second one for the client's sexual partner (See Figure 1). Each voucher is good for one consultation (generally including a lab test to diagnose the STI) and three follow-up visits. During the consultation, the provider completes a claim form recording the client's demographics, the examination and laboratory results, a diagnosis and details of the course of treatment prescribed (See Figure 5). Completed claims forms are sent to the voucher management office in the city of Mbarara, the main urban center of Western Uganda. Forms can take two weeks or more to move from the provider's office to the management agency. The current data management system requires all claims to be submitted on paper forms to the management agency. At least another two to four weeks are spent reviewing each claim, cleaning data from improperly-completed forms, and verifying that the service took place among suspect claims. Two months or more can go by before the provider is reimbursed for service provision. In Uganda, private providers traditionally operate on a fee-for-service model, receive prompt payment, and do not have a large operating margin. In many cases, payment is provided prior to service. Delays in payment result in delays in procurement of replacement prescriptions and medical supplies, often leading to a temporary hiatus in service. Encouraging provider involvement in the OBA program requires a great deal of confidence on the part of the providers to participate. If a system to shorten claims processing could be devised, more providers could join the scheme and more patients could be provided the life-saving STI treatment voucher subsidy.

The remainder of this paper details the system we are currently piloting, in which claims are submitted via Internet from a mobile phone directly to all the parties in the management agency. In addition to describing our user studies and how this has informed the design of the system, we discuss the problem of negotiating conflicting stakeholder requirements. We find that in projects with multiple stakeholders, the introduction of a system may disrupt balances of power, particularly around the flow of information and money. As a result, the design of this system, in order to secure positive support from all parties involved, must carefully balance stakeholder incentives.

III. METHODS

The research described here involved an iterative process of field research and prototyping. The fieldwork and deployments have been done over the course of three visits to Uganda: an initial two-week visit in Summer 2007 to establish a relationship with the project, in which we also conducted a survey of the clinics in the program; a followup visit for three weeks in November 2007; and a five-week pre-pilot deployment in August-September 2008. During all three visits we conducted semi-structured interviews with the various stakeholders, and directly observed claims form entry and processing. When given permission, we did audio and video recording of interviews and user study activities. In all, we

have approximately 30 hours of audio, and have done detailed interviews in seven of the 12 participating clinics (in addition to the initial survey of all of the clinics), as well as intensive observation in two clinics, a rural, high-claim-volume clinic with very little exposure to computers, and an urban low-claim-volume clinic with its own computers. The last visit entailed a comparative user study as well as deployment of the mobile phones in the latter two clinics.

A. Clinic Surveys

The clinic survey was conducted in conjunction with a larger survey of available infrastructure at contracted clinics. We asked 14 questions, assessing familiarity with computers and mobile phones, but primarily gathering feedback from the health clinics on the claims process (e.g., how long it takes them to fill out the paper forms, and what their priorities might be for improvement of the process). We also collected various documents from the management agencies regarding the performance of each clinic, including all available financial reports on processed claims, and in November, we returned to seven of the clinics to do in-depth surveys and to follow-up on the survey findings.

B. Rapid Development and Pre-pilot Deployment

Initial prototyping occurred in early 2008, and we returned to Uganda in Summer 2008 to do a three-stage pilot deployment, first testing the functionality of our software, second reviewing the proposed claims process with the management agencies, and finally taking the phones to the health clinics to test the mobile phone interface in the field. During this time we also conducted another round of semi-structured interviews to gather information on changes in the claims submission process (for example, claims processing had moved from Mbarara to the national capital, Kampala). We did iterative development based on feedback from the various stakeholders, trying out features as they were suggested, and developing new tools as seemed merited by findings in our interviews. To gain a more in-depth understanding of health clinic life, we stayed overnight for three days in the rural health clinic, thereby supplementing the the semi-structured interviews with direct observation of actual practice.

The primary purpose of this last field visit was to conduct a pre-pilot demonstration, using the mobile phones to submit actual claim data to the management agency, have it reviewed, and have the management agency provide feedback to the health clinics via the mobile phones. We simulated the proposed process, physically following the claims forms from the time the patient comes into the health clinic, through the preparation of the claims summary forms, physically transporting the forms to the management agency where we observed the claims approval, and data entry into the existing database. We simultaneously had the service providers submit the claims form via Claim Mobile, enabling the management agency to provide feedback to the service providers through the system. The pre-pilot is still operational, with mobile phones remaining in the two clinics, and the full pilot will be conducted in May 2009, with mobile phone-based claims processing expanded to 8-10 additional clinics.

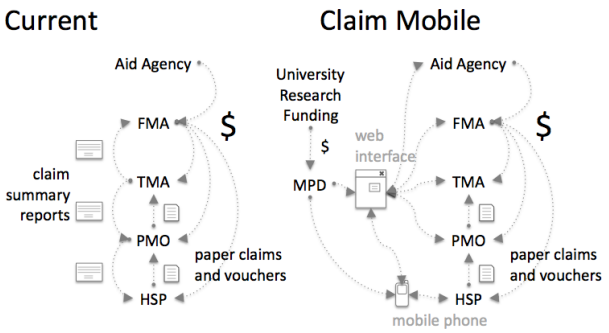

Fig. 2. This diagram illustrates the flow of money and information between selected stakeholders in the OBA project, both currently, and how it will be once the Claim Mobile system is fully deployed.

IV. Stakeholders

In this section we describe the funding, management and service provider organizations to which we alluded in Section II. Fundamentally, all stakeholders want to improve STI treatment and reduce the prevalence of STIs. Each stakeholder also has a financial interest in the success of the overall project - staying afloat for the health service providers, and staying within the aid agencies' target budgets for the management agency partners. The discussion highlights the ways in which the various stakeholders have competing as well as common interests. While we will detail several stakeholders in this section, there are six key stakeholders: the aid agencies who fund the OBA project, the financial management agency (FMA) which receives the funds from the government and disburses them, their program management office (PMO) in Mbarara which runs the program and interacts directly with the health service providers, the technical management agency (TMA) that manages the claims processing, the health service providers (HSPs), and us, the mobile platform developers (MPDs). Figure 2 illustrates some of the relationships between these entities which we will describe in detail in the remainder of this section, based on qualitative fieldwork and document analysis.

A. Aid Agencies

As the funder of the HealthyLife STI treatment program, the involvement of the European aid agency is more than apparent. Their role in the management of the program is more supervisory – a consultant goes to Uganda at irregular intervals to help with planning of the program, and they do some monitoring. They also have commissioned another non-profit, affiliated with a North American university, to conduct an evaluation of the program. Ultimately, however, they control the flow of money to the financial management agency, which then pays the IT vendor to handle the technical aspects of the operation.

In the past year, the European aid agency has worked with an additional transnational aid agency to fund the expansion

of the project into additional districts. While they may not have a direct impact on the information processes in the project itself, the funders' internal actions have direct impact on the project as a whole. In one example, a delay in payment to the European aid agency resulted in a delay in payment to the two management agencies. As a result the IT vendor ceased processing of claim forms until payments were received. However, not only did the voucher program grind to a halt, but reimbursement to the participating providers for patients already seen was delayed as well; the management agencies ended up with a backlog of claims forms to process, exacerbating the length of time it takes to process claims and further delaying payment for services.

B. Financial Management Agency (FMA)

The local NGO partner that acts as the financial management agency (FMA) is the Uganda office of a multinational non-profit sexual and reproductive health organization with a goal of reducing unintended pregnancies and unwanted births through family planning and other methods. Their role in this project is to receive the funds from the aid agencies via the Ugandan government, using these funds to pay the health clinics and to pay for other program costs, including the database software development and management. The main office in Kampala runs this program (as well as others) and manages several clinics throughout Uganda, one of which was a participating clinic in the HealthyLife program until Summer 2008. In addition, they have a program management office (PMO) in Mbarara which is directly in charge of coordinating the the OBA project. In the claims process, the FMA disburses payments to each of the service providers, based on claim reports from the technical management agency (TMA).

C. Program Management Office (PMO)

The HealthyLife PMO in Mbarara has five full-time staff, in addition to two people that help with cleaning and cooking, and the FMA staff that come in and out of Kampala for related programs. There are two computers in the office, one in the project coordinator's office, and another in the finance office, shared by the Behavior Change Campaign (BCC) coordinators who go out into the field to run community radio advertising programs and to distribute vouchers. Their Internet connection was down when we arrived, but was repaired the same day and largely functional for the remainder of our four weeks there. They share a 56kbps dial-up connection over a local area network.

It became clear through our interviews in this office that, while the PMO is the nominal clearinghouse for information between the TMA and the health clinics and is primarily responsible for communication with the health clinics, they actually have the least information of all of the stakeholders in the OBA program. At the point in which the database processing moved from Mbarara to Kampala, all of the claims information moved there as well. They have been able to change the claims process such that the health clinics submit two copies of each claim to the management agencies, one for the PMO, and one for the TMA. However, the copy that remains in the PMO does not have the voucher number, a critical piece of information, and with stacks of hundreds of claims per month, the information is not in a format actually accessible to the program office until the TMA sends back claims summaries. However, even this is stripped-down and only includes the value of the claims, without any patient or diagnostic information from the claims.

This poses a problem for the PMO staff's interaction with the health clinics. They lack sufficient information to effectively counsel and train the clinics, and often feel like they do not know what is going on with the program because they do not have access to the claim data for the long claims processing cycles.

In the version of Claim Mobile developed in early 2008, we intended to make the claims process more efficient by enabling the mobile phones to submit claims directly to the database (originally co-located in the PMO, now located in Kampala). In the Summer 2008 interviews it became clear that having the claims data bypass the PMO staff would deny them even more of the information they need in their interactions with the clinics. Based on this realization, we discussed the possibility of an intermediary application, a website in which the project coordinator in the PMO would be able to view claims as they are submitted, as well as any status updates. Furthermore, Claim Mobile could facilitate another of the project coordinator's key roles in the OBA ecosystem: as the primary interface between the health service providers, the project coordinator would also be able to send messages to the service providers through Claim Mobile, either as individual messages, or broadcast announcements.

D. Technical Management Agency (TMA)

The TMA is a for-profit health insurance agency based in Kampala, providing conventional employer-based health insurance for the formal private sector as well as conducting non-profit health management for targeted low-income informal sector populations. That is, their work for the HealthyLife program is in addition to their private health insurance program, and is part of a company effort to help deliver quality affordable healthcare to the poor. Their business is highly technical, and they have a wholly owned software company based in Chennai, India. As the IT vendor, the TMA's responsibility in the program is to provide the claims forms, and the Voucher Management Unit System (VMUS), the database implemented by their software company to cross-check the claims and to generate reports. The TMA also prints (through another agency) the glossy color vouchers that the patients purchase in exchange for subsidized care.

Although the data entry clerks and the database engineer were initially located in the FMA's PMO in Mbarara, they are actually employees of the TMA, and moved when the TMA shifted claims operations to their offices in Kampala in March 2008. They carefully enter each claim into the database, later updating its status with information from the clinical officer

From : 29/Aug/2008 **To :** 29/Aug/2008

FORM DETAILS				ACCEPTED CLAIMS				REJECTED CLAIMS			QUARANTINED CLAIMS		
CLAIM DATE	SL. NO	FORM NO	EXPECTED AMT.	FULLY PAID AMT.	ADJUSTED AMT.	VARIANCE	REASON	REASON	AMOUNT	VARIANCE	REASON	AMOUNT	VARIANCE
Second Half of August 2008													
29/Aug/2008	1	10786	6,920	6,920									
29/Aug/2008	14	10800	9,400		4,400	5,000	11						
29/Aug/2008	15	19101	19,200	19,200									
29/Aug/2008	16	19102	8,000	8,000									
29/Aug/2008	17	19103	13,700				11				NO PREVIOUS FOLLOW UP	8,700	5,000
29/Aug/2008	18	19105	19,200	19,200									
No. of Claims Submitted :		**18**	**251,320**	**214,520**	**13,100**	**10,000**				**0**		**8,700**	**5,000**

Fig. 3. This is a sample summary sheet prepared for one health clinic, showing a partially paid claim (QC11=Wrong consultation fees), and another claim quarantined for having the wrong voucher. While these summary reports can be informative, most clinics are not familiar with the quarantine codes, and they often don't reach the health clinic for several months after the original claim has been submitted, often too late for the clinic to rectify any errors indicated on the report.

(a doctor) who "vets" the paper claims[1]. They then produce two reports: a summary report for all clinics, and an itemized report (see Figure 3) for each clinic detailing the status of each claim, as well as any quarantine codes (Table II) or rejection reasons for any partially paid or rejected claims.

In addition, when required, the TMA produces reports (based on the information in the database) for the FMA, the European aid agency, and the aid agency's evaluating partners. Although these reports were not part of the original specified mandates for the operation, they have proved necessary for the program's external evaluation, and there has been much friction over the work involved in the creation of reports.

The relationship between the TMA and the FMA in this program is highly contentious. While initially they were equal partners in the program, both reporting directly to the European aid agency, changes in funding have led to a situation in which the TMA reports to and is paid by the FMA. On top of this, the funding for the expansion of the program has been delayed a number of times, from October 2007 to April 2008, and again to September 2008. While the TMA has received some payment, both the TMA and FMA have been operating without pay (but with promise of pay) since April 2008, just to keep the program running while the aid agencies work out the details of the new grant and the expanded program. This is part of the reality of dealing with aid-funded projects – unexpected delays in funding are common, and projects are subject to the vagaries of arbitrary rebudgeting. While the FMA is often powerless to address the issue, in this case, the TMA often chooses to respond by cutting off program access to the database, ceasing claims processing and refusing requests for reports, until their problems have been resolved.

Perhaps in response to these database shutdowns, but officially as part of the aid agency's project policy and the Ugandan government's policy on software developed for government-funded projects, there is an expectation that the TMA's VMUS software should be turned over to the project. However, since the TMA outsources development of this software to its partner company in India, this IT vendor considers its software to be part of its key assets, and sees its role in the project as a software licensor and service provider, not a software vendor. Again, while this situation is being resolved, the TMA asserts its control over the project by processing the claims, but refusing to pass on the summary reports to the FMA. While the project continues running, and the service providers continue to see patients, this introduces additional delays into the claims process, and frustrates the health clinics, whose payments are delayed without explanation.

[1]The clinical officer is employed by the FMA, and was terminated in March 2008 due to temporary lack of funds.

E. Service Providers: Health Clinics/Hospitals

Service Providers are selected on the basis of a number of factors (e.g., services offered, capacity, personnel, geographical location). In one respect, they are the origin of the primary information in the claims management process, producing the claims records, which are then used to determine reimbursement. At the same time, as is perhaps typical, they are information-poor, because they are not given tools to use this information effectively. At the point of claims submission, they are no longer agents in the process, and must wait passively for both payments and any feedback reports produced from the information in their claims.

Code	Description
QC01	No indication of date of treatment
QC02	No indication of time of treatment
QC03	Wrong visit type: Consultation or follow-up, etc
QC04	Wrong demographic information: no age and name of client
QC05	Wrong/No syndrome, no diagnosis
QC06	Wrong Clinical examination / not applicable to OBA
QC07	Wrong/Poor diagnosis
QC08	Wrong investigation/poor lab reporting
QC09	Wrong drugs prescribed/invalid treatment
QC10	Over prescription: more than enough
QC11	Wrong consultation fees
QC12	Wrong patient status: cured or not cured
QC13	Next date of visit: wrong or not filled in
QC14	Wrong voucher attachment/interchanged vouchers on followup visits
QC15	Unclear claim/uncharged claim and treatment contradicts other visits
QC16	Partner treated on client form
QC17	Exceeded VMUS ceiling limit
QC18	Treated syndromically and asymptomatically
QC19	Unclear/wornout/blank attached vouchers
QC20	Claim without patient thumbprint
QC21	No voucher attachment
QC22	No doctor's signature
QC23	Diagnosis contradicts clinical examination
QC24	Used drugs not on OBA list
QC25	Undercharged/overcharged drugs, double lab charged
QC26	Patient free/normal from STI or cured not allowed for next visit
QC27	Diagnosis not catered for by project
QC28	Follow-up contradicts previous visits

TABLE II
CODES USED BY THE MANAGEMENT AGENCY TO INDICATE REASONS FOR PARTIAL PAYMENTS.

Providers are expected to follow a rigorous course of diagnosis and treatment — they must select a lab test based on symptoms presented, and prescribe particular medications

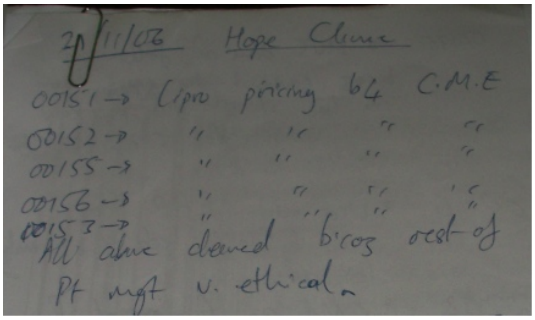

Fig. 4. "All above denied b'cos rest of P[atien]t mgt n[ot]. ethical": this is a sample medical advisor review of a claims summary, occurring often well after the original mistake has been made several times, before it could be caught and corrective measures could be made, as noted in the first line: "Cipro pricing b4 C[ontinuing] M[edical] E[ducation]"

on the basis of the results of the test. Any deviations from this treatment are penalized; the service providers are not paid for medications given that are not prescribed by the program. This is reasonable by public health and insurance standards, and necessary for the cost-effectiveness of the program. However, despite educational illustrative posters, training sessions, and on-site continuing education provided by the PMO's clinical officer and project coordinator, the learning curve on the exact protocol to be used is high, and the subsequent errors are costly for the service provider. Figure 4 illustrates a particular problem in which costly errors are caught well after their first occurrence, often after the provider's staff has have made the same mistake for a month.

A few months into the program, there had been so many quarantined claims (claims that had been held for review due to discrepancies from the treatment protocol) that the management agencies and the service providers were required to do a financial settlement, in which the service providers were paid some percentage of the value of the disputed claims. Subsequently, the approval process was modified such that deviations from the protocol were partially paid (e.g., minus the cost of the incorrectly prescribed drug), and could be disputed in later reviews with the PMO's clinical officer. Here are some figures on the value of the disputed claims for one of the rural service providers for a randomly selected month of the program:

Claims submitted: 294
Approved: 259 (88%), $1379
Approved, but adjusted: 27 (9%), $149
Quarantined: none
Rejected: 8 (3%), $51
Total Requested: $1642
Total Paid: $1526 (difference: $114)

Thus the claims submission process, while nominally a simple information flow between cooperating organizations, becomes a site of financial contention. Claims are disapproved for a number of reasons (see Table II), which could be disputed but in practice are not. However, due to the change in policy, many claims are approved with incomplete data (e.g., missing demographic information for the patient). In any event, the claim form and its contents are the object of much dispute between the service providers and the management agency. Often, the service providers (especially more distant providers) feel disempowered to address this dispute and choose to accept the given variance in payment as the cost of participation in the program.

The health clinic survey we conducted in July 2007 explains some of their extreme disengagement from the OBA program. Out of the twelve clinics surveyed, three said they had not gotten feedback from the OBA program at the time of the survey (July 2007), and 4 said they *did not know* how many claims had been rejected. While they were receiving payments on a regular basis (albeit late - 9/12 clinics defined "timely processing" as less than 15 days, half of the current processing time of 30 days), there was no mapping between the claims they submitted and the payments they received.

> *I don't know. I don't know how we are performing. I don't know how we are faring. And of course my staffs are also complaining. They are overworked, they don't get any benefit from the project, and of course it takes a lot of time... They need to be motivated as individuals. All that will depend on – are we making any profits?*

This has deeper ramifications than inability to follow up on quarantined, partially paid, and rejected claims. This communications gap between the health clinics and the OBA program leads to continued errors in adherence to treatment protocol, a feeling of lack of control over health clinic finances, and discouragement on behalf of the participating service providers.

At the time of the second field visit in November 2007, we were able to follow up with the PMO and the health clinics, and noted that this situation had improved. The then-informal practice of passing on copies of the itemized clinics reports to the service providers was formalized, and clinics are receiving more feedback on their claims. However, there are physical limits to a paper and in-person based communication system, and it remains to be seen how this practice will scale as more clinics join the program.

It should also be noted that the service providers differ greatly, in number of clients, setting, and availability of resources. While some clinics have computers and use them regularly, in one clinic, our smartphones were greeted with enthusiasm because they were the "first computers we have seen."

F. Patients

Patients are the real target beneficiaries of the HealthyLife program. They purchase vouchers from distributors (at a heavily-subsidized price) and then go to the service provider for diagnosis and treatment. After an initial consultation with the health worker, they are directed to the lab technician, who performs the requisite test and sends them back to the health worker with a slip of paper indicating the lab result. The health worker then fills out the remainder of the form, writes a prescription, affixes the appropriate stub from the

voucher, and has the patient sign and fingerprint the form, at which point their participation in the claims form process is complete, until they return for a follow-up consultation. For the follow-up, the service provider checks recovery progress and prescribes additional medication if necessary. In some clinics, patients are given a copy of the claim form, which they are directed to keep and bring back for the follow-up. However, most clinics do not depend on the patient copy of the claim form, and just go back through their time-ordered record book, finding the prior consultation manually. Sometimes patients either accidentally swap vouchers with those of their sexual partners, fraudulently give their own voucher or the partner's voucher to someone else, or simply choose to go to a different clinic for follow-up. Claims are quarantined or rejected if any of these potential errors are detected, but not until the claim has been processed by the TMA, and the fraudulent patient has already been treated. Since the original voucher is attached to the submitted claim, the clinics do not always have a way of verifying these external aspects of voucher validity. Although their direct involvement in the claims process is minimal, it is their identity that is often contested in the vetting process.

G. Mobile Platform Developer (researchers)

As ICTD researchers, we are of course also stakeholders the claims management process – initially as outside observers, later as designers interested in using technology to measurably improve the process, and finally as researchers interested in watching the mechanisms by which the process changes over the course of the project. From an outside perspective, our role is most allied with TMA, the technical partner in the project; however, since the aid agencies and FMA are interested in replicating the mobile device system in other OBA projects, there is a vested interest in the new technology from other stakeholders as well.

V. Design

Claim Mobile is a two-part system, including a web-based PHP/MySQL application and a Java-based mobile application running on Palm (GarnetOS) phones. For the pilot program, the web-based application has a single level for all users, but the final implementation will be tiered, having appropriate access levels for service providers, management agency users, medical advisors, etc. Both the web and the phone applications require user login to protect patient data.

The two applications are paired, designed such that the phone-based application uploads claims to the web site, and downloads configuration information (drug lists, status feedback, claim form backups) from the web site. Eventually, the web application will also connect to the TMA database, sharing the cross-checked and validated claims form data directly so the TMA's staff do not have to do redundant data entry.

To facilitate end-user training, both of the applications are based on the original claim form and largely retain the same structure, titles, and information. Figure 5 illustrates some of the mappings between the phone-based user interface and a revised version of the claim form. In addition, all of the codes and tables in the web application database also include mappings to their equivalents in the TMA database, so the information can easily be transferred between the two databases.

A. Claim Mobile

The web application is designed primarily with three functions in mind: claims submission, feedback/communications process, and in-clinic claims management.

Claims Submission: This is the bulk of where the service providers will spend their time. In this case, we adopt common design strategies such as (1) using pre-filled checkboxes to reduce the amount of required text entry, (2) limiting answers to valid options to reduce coding errors (see QC01,02, 04-09, 27 in Table II), (3) downloading logistical data such as drug prices into the application to eliminate pricing errors, and (4) calculating dependent values such as expected claim amount to eliminate arithmetic errors and save time. However, we must counter-balance potential fraud by also introducing cross-checks that are not clarified explicitly. That is, to encourage accurate clinical reporting (as opposed to clinical reporting that has been "fiddled" to make electronic claim submission more convenient or favorable), providers are allowed to submit inconsistent claims but are *warned* that they should clarify any discrepancies from normal OBA treatment protocol.

Closing the Feedback Loop: Based on our primary finding from the clinic surveys and follow-up interviews, we have also included the ability for the clinics to send queries to the management agencies about particular claims and to receive live updates on the a claim's status (e.g., whether it has been approved, the amount for which a claim has been approved, and explanations why the full amount may not have been approved – see Figure 6). Any changes to a claim's status are included in this annotation audit trail, and anyone with access to the claim can respond to and receive queries.

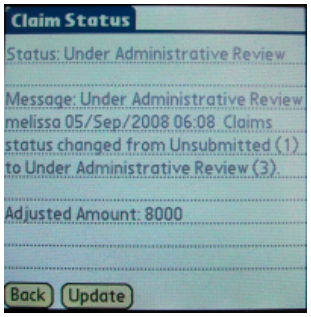

Fig. 6. On this screen the service provider can view the current status of their claim, as well as any annotations or feedback from the management agency made in response to their queries.

In-Clinic Claims Management: In the phone application, the service providers can also link between consultations and follow-up visits, as well as between client and partner visits, so they can easily check to see if the valid voucher is being

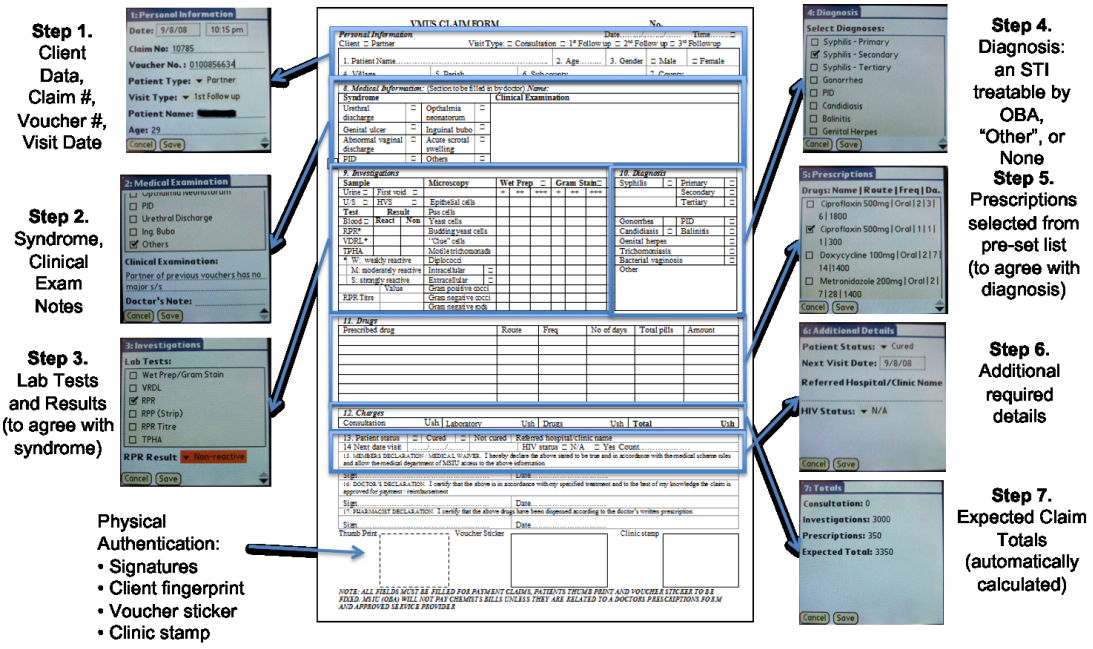

Fig. 5. From paper form to mobile phone: a mapping of the mobile phone interface equivalents for each section of the claim form.

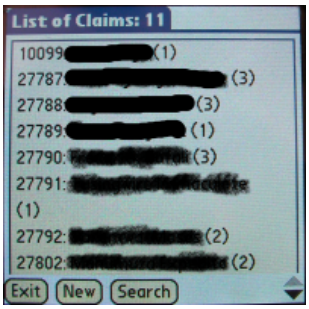

Fig. 7. This is the list of claims currently entered or downloaded to the mobile phone. The first number is the claim form number, followed by the patient name, and then a number indicating the current status of the claim. (1-unsubmitted, 2/3-under review, 4-preliminary approval, 5-quarantined, 6-approved, 7-rejected)

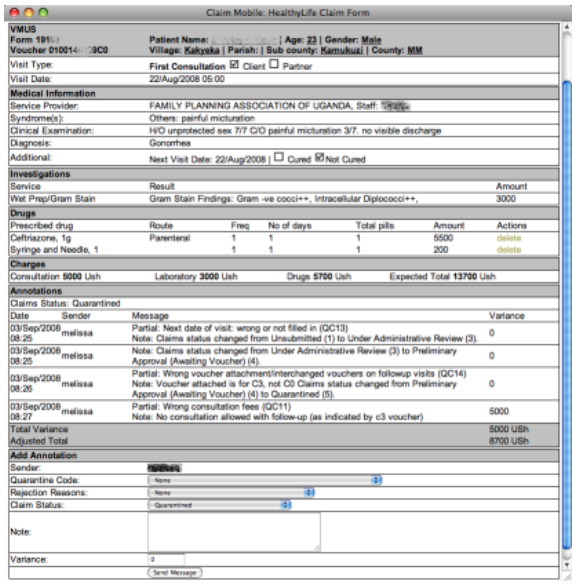

Fig. 8. Claim Mobile Web: the web-based view of the submitted claim forms is also based largely on the original claim form, split into several sections, and ending with annotations for the claim, and a form for adding additional annotations.

used by a returning patient, and that treatment of a partner or during a follow-up matches the medical history. For new phone installations, or if the claims data is lost, the mobile application will automatically download all prior claims data from the web application. Future versions of the application will also include financial summaries, outpatient statistics, and other reports that may be useful to the clinics.

B. Claim Mobile Web

The web application, having been commissioned in the middle of the fieldwork in response to program office findings (see Section IV.C) has two main functions: receiving claims and displaying them for review.

Much of the claims receipt is invisible to the web application user, and written as a backend for the mobile phone application. The login user for the mobile application and the web application is the same – and the login information given to the mobile application is used to authenticate with the application when submitting claims and annotation data.

There are three primary views in the web application. The claims list can be filtered by service provider and is modeled on the claim summary report (Figure 3). From each claim in the claim list, the user can either (1) click on the claim number to access the individual claim (and annotation/status update functions, see Figure 8) or (2) click on a patient name to view all consultations and follow-ups for the both the client and

partner associated with that particular voucher. This allows the viewer to correlate treatments, lab tests, and diagnoses across visits.

C. The Modified Claims Process

In the modified claims process, the service providers continue to complete and submit the claim forms. However, in order to receive faster payment, as well as the immediate cross-checked feedback from the phones on claims completion, they also enter the data on the mobile phones, submitting each claim to the web application as it is completed. Prior to claims submission the status of the claim is "Unsubmitted (1)," after which it can progress through a number of stages. The service provider can verify that a claim has been successfully received if the claim status has been updated to "Under Medical Review (2)" or "Under Administrative Review (3)" for medical advisor review or database cross-checking (validation of voucher) respectively. If a digital claim has been verified, the TMA will set its status to "Preliminary Approval (4)" until the paper form with the voucher has been received. Once preliminary approval has been received, the clinic can be paid. If no voucher is received, or the wrong voucher is attached to the form, then the preliminary payment is subtracted from the next month's payment until the error is resolved. In the meantime, the service provider can view status updates as they are made to the web application and sent to the mobile phones, and can send annotations on each claim, which then appear in the web application and in the status update window (Figure 6) when they are received.

VI. Pre-Pilot Results

Having detailed the claims submission process, our findings with respect to the various stakeholders in the OBA project, and the design of the Claim Mobile system, we now discuss some specific results from our user studies.

The pre-pilot demonstration was designed to last one claims cycle, following one week's worth of claims (submitted in parallel through Claim Mobile and on paper) for two clinics through the claims submission process. A total of 35 claims were submitted to the web application, including the full complement of 18 claims from the urban clinic, 12 out of the 86 paper claims from the rural clinic, and 5 additional claims from the urban clinic following the pre-pilot study.

The claims from the rural clinic spanned August 9, 2008 to August 27, 2008. We observed three patient consultations during our two visits to this clinic, as well as the preparation of the summary sheets for the 86 claims, taking careful note of what the service provider verified on each form. Notably, although "syndrome" is a required field (see QC05 in Table II), it was left blank in almost all of the claim forms. In one case, the drug was entered correctly, but with the wrong reimbursement value, and in another case, a drug was entered, but no reimbursement was claimed either in the subtotal or the total. At the time of the claim approval process, they were not reimbursed for the drug, because it had not been claimed in the amount, although it had been listed. Another inconsistency is in lab reporting – some lab tests require a value to indicate the result, and where not included, the data entry clerk just changes the lab test in the database to one which does not require a result. This is an error, which never gets communicated back to the service providers because only errors which accompany a payment change are reported in the claim summary sheet.

The 18 claims from the urban clinic spanned dates from February 16, 2008 through August 25, 2008. During the process of simultaneously entering some of the claims into Claim Mobile with the service provider, we were able to identify some problems: missing personal information, missing next visit date, and wrong consultation fees. However, not all claims were entered into and reviewed via Claim Mobile, and, as can be seen from Figure 3, three paper claims were submitted with wrong consultation fees, an error that would not have occurred with an electronic submission. In addition, a fourth claim was submitted with the wrong voucher. We were able to catch this while entering the claim into the mobile phone, noting that the voucher number did not match the consultation type, but too late to change the submission and retrieve the correct voucher. As a result, the claim has been quarantined until the correct voucher is given to the program office in Mbarara.

Fig. 9. Rural clinic staff entering data from claim forms into two of the phones.

With regard to the digitally-submitted claims, we spent about a day training the staff in the rural clinic on how to submit the claims, and returned later to spend another day in training. They were very enthusiastic, and although only one person was actually responsible for submitting claims, they were all training each other (Figure 9). However after the the researchers' departure they have still not submitted any claims. It is unclear whether this is from technical difficulties or lack of time to enter the claims into the phone. The urban clinic has continued to submit claims, with five new claims arriving in the two weeks since the pre-pilot study.

An interesting outcome from our observation of the claims review process is that there are many errors that are made that affect the quality of the data, but are never communicated to the service provider, in part because they have no attached financial consequences. The annotation feature (see Section V.A) enables attachment of quarantine codes to any claims that were in error without affecting the payment of the claim, providing feedback to the service providers on how to better complete the claims in the future.

One concern that emerged from this proof-of-concept study, however, was with the reliability and the speed of Internet access in the TMA office where the claims processing was occurring. Accessing individual claims took a long time, and the online database was completely inaccessible when the Internet connection was down, which occurred infrequently but noticeably often. It may not be desirable for the claims submission process to introduce a dependency on Internet connectivity where it is unreliable.

Unfortunately, the financial and claim review aspect of the pre-pilot was halted early due to administrative and political reasons, the result of which is that payments in the OBA program as a whole have been halted; so, while the technical feasibility of the system has been demonstrated, the logistical details are still in process. We found that while the TMA's database entry staff were enthusiastic at the prospect of spending more time reviewing claims and less time doing just data entry, their participation in the pre-pilot was limited by two factors: the press of other claims that still needed to be processed, and pressure from the TMA to be secretive about the data being processed until certain political issues had been sorted out.

VII. Discussion

A. Understanding Delays in the System

Delays can occur in a number of places in the claims process, not all of which can be accounted for by the introduction of mobile phones. However, there are three key bottlenecks: 1) the delay in the health clinic between when the health clinic sees the patient and when the claim is submitted, 2) the time it takes to process the claims, entering each on into the database, and 3) administration of feedback to the health clinics, especially in case of errors.

Claim Mobile is able to address all three of these cases by 1) encouraging providers to submit claims as they see patients, 2) reducing the data entry burden through the use of digital claims, and 3) eliminating the possibility of a number of errors, and providing a digital feedback mechanism to supplement the infrequent in-person feedback.

However, another source of delay is the administrative and political dynamics by which program administration halts, although health distributors continue to sell vouchers, and health clinics continue to see patients. During these times payments are delayed unexpectedly for undetermined lengths of time, as can be observed from the early termination of our pre-pilot study. Understanding this particular delay is key: the TMA halts the program by withholding information, specifically claim reports, from other stakeholders in the system. This is possible because the database is owned and controlled entirely by the TMA. What happens when another outside database is introduced, with independent control? In this case, the data was not so much the key as the data entry staff that were responsible for approving the claims and validating the vouchers. At the same time, it is unclear where Claim Mobile Web fits in with the political strategy of the TMA.

B. Information Poverty

In addition to trying to address delays, we have also tried to address information asymmetry and information poverty within the system, identifying where stakeholders are disadvantaged by lack of information, or lack of tools with which to use the information.

This past year's move of the data processing from Mbarara to Kampala especially has further exacerbated the gap between the people that have the information and the people that can make use of it. While limited remedies have been made to rectify the situation, with a paper-based process, these remedies have been ineffectual, leaving the PMO without access to necessary claims data, including voucher numbers.

Through extensive stakeholder interviews, in particular with the program office in Mbarara, we have identified the need for a transparently accessible database, with the ability to generate reports based on the submitted claims data. While control over access to the database is a key means by which the TMA asserts itself in the OBA project, this practice is highly disruptive to the OBA program, causing deep difficulties for the health clinics and the program office, rather than affecting the financiers or the FMA.

The initial design of Claim Mobile, reflected the paper-based process, and directly submitted claims from the mobile phones in the health clinics to the TMA, bypassing the PMO entirely. In response to our findings, we developed Claim Mobile Web as a means of re-engaging the staff of the PMO in the mobile claims process. The integration of the new web application database is specifically meant facilitate resolution of information gaps, not only sharing the information with the people that can make use of it, but also giving them the tools they need to make sense of the information.

Likewise, for the mobile-phone application, we also specifically do not design one-way system in which claims data is going out and only money returns. Instead, the claims data created in the clinic is also used within the clinic to help them improve patient care, as well as the accuracy of future claims.

C. Related Work

There have been a number of recent technical projects on the use of ICTs for healthcare in Africa [8], [9], [10], [5], and specifically on mobile devices for healthcare in Africa [3], [11], [12]. However, many of these projects are design-focused and technology-driven, reflecting on designing a working technological solution to complete a particular task, rather than reflecting on the role of the technology in the system and how various solutions or approaches might affect social processes within the system.

Braa describes two action research projects to deploy the Health Information System Program (HISP) in Cuba [13] and in South Africa [8], using Actor Network Theory (ANT) to think about how human and non-human (e.g. documents, events, software, standards) interact. He specifically addresses the challenges of designing for the multiple levels of entities involved in district health information systems, able to compare deployments across Mozambique, India, South Africa,

and Cuba. However, these entirely government-based contexts are much more hierarchical than the highly disparate multi-organizational context described here.

VIII. Conclusions and Future Work

There is clearly much additional work to be done, in which the lessons learned from this pre-pilot study will be applied in the development of a new version of Claim Mobile for a full pilot in Spring 2009.

The outcomes from this study were three-fold. Firstly, the choice of the mobile phone as a platform was affirmed by the health clinics, for reasons of battery life, design for readability, portability (susceptibility to theft), and ease of data entry. Where we were concerned about introducing "qwerty" keyboards to novice users, our fears were alleviated, and all of our users assured us that "we can learn," which they did, quickly. Secondly, the mobile platform is not a sufficient solution for this program, and alone has the potential to exacerbate information asymmetries between the stakeholders. To address this issue, we complement the mobile phone platform with a web application. However, Internet accessibility issues may require further development to enable local hosting and synchronization of the web application [10], [14]. Our final point is related – we consider the plethora of stakeholders in this project, and note that as technology providers we are not coming in as naturally neutral players. Our projects are necessarily disruptive, and equally potentially disrupted by other dynamics within the program as a whole. As a result it is necessary for us as researchers to position ourselves and our designs carefully, making sure to take into account the needs of all of the stakeholders, and not just our primary users.

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