Experiences with Bulk SMS for Health Financing in Uganda

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Abstract
Short message service (SMS, aka text messaging) is a low-cost and effective means of communication for organizations attempting to maintain contact with many people. In this paper we look at the deployment and of a bulk mobile text-messaging platform (Bulk SMS), conceived and commissioned by a health non-governmental organization (NGO) for use in communicating with the 100+ private health facilities. We show how the platform emerged from existing practices, the features and expectations of the system, and the ways in which it was used. Common failure points include infrastructural limitations, human error, and unexpected use cases. We find that 1) the use of SMS as a media enables new types of communication, and 2) SMS alone is not sufficient for maintaining relationships within the NGO program.

Keywords
Bulksms, mobile phone, SMS, ICTD, health, braided communications.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.
Introduction
Healthcare and communications often go hand in hand as development agencies attempt to deliver effective services to a broad range of people. In Uganda, SMS-based text-messaging offers an effective platform for reaching rural users, in places where e-mail and even voice-based mobile communications can be difficult.

However, as an informal practice, SMS messages can be difficult to organize on mobile phones. As an alternative, organizations use third-party web applications developed by a SMS gateway companies based in Uganda. The reproductive health voucher program (RHVP) regularly used mobile voice and SMS to communicate with their beneficiaries. For donor and liability purposes, the program administrators wanted a way to effectively and efficiently track these communications. They commissioned and deployed a web-based bulk SMS messaging platform (Bulk SMS) with the assistance of a third-party organization. The RHVP project sent out their first message in November 2009, subsequently using the application for tracking payments, confirmation of contract revisions, and handling other types of program communication.

In this paper we chronicle the deployment and actual use of Bulk SMS in the context of this NGO’s management of a health-financing program. In spite of unexpected difficulties, the system met the NGO’s needs successfully. We show the new types of communication enabled by SMS, and the ways in which SMS alone is insufficient for mediating communication between the NGO and their beneficiary Health Service Providers (HSPs).

Background
Financing Healthcare in Uganda
This Reproductive Health Voucher Project (RHVP) began in 2007, using a performance-based finance model. Rather than paying for service provision up front, they paid participating HSPs based on the number of clients they actually saw. Potential patients purchased vouchers for 3000 UGX (~1.50 USD, based on 2009 exchange rates) from authorized pharmacies and community-based distributors, then brought them to a participating HSP. For each visit, the HSP filled out a claim form including the visit findings and signatures of the patient and the clinician. Once or twice a month, the HSP submitted the claim forms in batches to the NGO, who spent the following weeks processing them. Each claim was reviewed and then entered into a database. Information about the claims was then sent to the finance officer (FO) in the Kampala offices (HQ), who made payments directly to the HSPs by electronic funds transfer (EFT). In all, RHVP financed 99,000 treatments in 22 districts of western Uganda.

The NGO was in constant communication with the HSPs. For each payment made, the project coordinator (PC) in Mbarara was required to secure confirmation from each of the HSPs that they successfully received the correct payment in their bank accounts. The project management office (PMO) also coordinated yearly training sessions, handled questions regarding the treatment protocol, and settled disputes regarding unpaid claims. The PMO sales staff traveled to each of the HSPs once or twice a month to deliver blank claims to the HSPs as they ran out, pick up claim submissions, and relay messages from the NGO.
As the project's catchment area expanded from four districts to twelve, it became less feasible for HSPs to visit the PMO in person. Mobile phones started to play a larger role in the communication activities of the NGO in 2008. The use of mobile phones helped them more effectively scale up to a larger geographic coverage area and more participating HSPs. However, voice-based interactions were often subject to the fallibility of memories. As a result, the NGO introduced a policy of maintaining a written record of the outcomes of their discussions with the HSPs. SMS served as a primary written form, since e-mail use was not convenient for many HSPs, and it served as a medium by which both the HSP and the NGO would retain a copy of the message.

At the same time, the informal nature of SMS communication became unmanageable. While saved SMSes now constituted a written record, they were distributed over the many different phones of key staff in the NGO. It was difficult to find important messages on individual phones. Furthermore, if a particular staff member was not available, their records of SMS transactions were not either. In May 2009, the project support manager (PSM) suggested the idea of using a Bulk SMS system. Earlier that year, the NGO had worked with another organization, providing healthcare content for an SMS-enabled health education system. We had also previously had discussions about using a smartphone-based application for sending announcements and verifying payment of claims [8]. The PSM contacted the supporting aid agency to see if implementing the system might be financially feasible. Shortly thereafter, the NGO put out an official request for proposals, and by late July 2009 we were evaluating vendors for a Bulk SMS system, to be paid for by the funding agency that financed the RHVP project.

**SMS at Large**

SMS plays both formal and informal roles in Uganda. Newly engaged couples might send out text messages to all of their friends, asking them to attend wedding meetings. During holidays, especially Christmas, many people will send greetings to all of their contacts, wishing them well. Mobile service providers allow phone users to subscribe to news, sports scores, and other information services. The popularization of SMS for these types of usage and advertising has enabled the birth of an SMS gateway industry, with Ugandan owned-and-operated companies like SMS Media, DMark Mobile, Beyonic and others. [7]

Meanwhile, numerous applications use SMS to address issues around healthcare and public health education. FrontlineSMS is a downloadable open source application, first released in 2005, which can be customized to help any organization use their computer to send individual or mass messages to all of their staff and beneficiaries. TextToChange (TTC) is another NGO in Uganda, specializing in text-message based quizzes intended to educate participants about HIV, malaria, child abuse and other topics [1]. In addition to SMS-based quiz functionality, EpiSurveyor enables mobile-phone-based data collection, allowing synchronization of the data manually, over mobile Internet, or by SMS [22]. Other organizations use SMS to improve patient attendance [3][14][5][13], enable communication with health practitioners during crises [19][6][23], manage patient information [13][4][21], health education [11][18][1][14], data collection [4][21][20] [22]. drug prices [17], tele-consultation [10][12][14][15][5],
health diaries [14], treatment adherence. While many applications use SMS directly [22], others send structured information, using SMS as a transport layer instead of a person-to-person communication medium [21]. These and other systems often entail installing an additional application on a Java-capable or otherwise advanced phone [21][20][22][23]. Some projects explicitly acknowledge the general-purpose aspect of SMS by subsidizing text-messaging costs but not specifying the ways they should be used [5][12][14]. Results from these studies range from no improvement found, to improvements in patient adherence, attendance, or knowledge [9][18]. SMS is often promoted for its accessibility with minimal training, and relatively low cost. However, there are concerns about the literacy of the target population, as well as security and privacy of the data transmitted by SMS.

Like many of the systems identified above, our Bulk SMS platform was adopted by an NGO to improve communications with their clients. The intention was to provide a new mechanism for sending payment confirmations, to help mediate medical consultations, and to send out announcements. However, the platform was introduced more generally, enabling other uses to also emerge as HSPs and the NGO staff familiarized themselves with the system. In this case, literacy was not an issue, since the NGO staff and the health practitioners (the doctors and midwives that ran the private health facilities) were highly skilled and literate by virtue of their position. The users of the system addressed issues of security and privacy on a message-by-message basis.

Methods

Participant Observation (May 2009 – April 2010)
Although the scope of observation for this population as a whole extends from June 2007 onwards, for the paper we present findings primarily from observations occurring during May 2009-April 2010. During the period of January 2009 – April 2010 the researcher was situated as an IT consultant working in the offices of the NGO, where it would be possible to observe the daily workings of the staff, how they used information technology, and how they interacted with participants in the health financing project. In addition, the staff of the NGO would call upon the researcher to evaluate technology project bids, to fix computers, and to advise on technology matters, including the purchase, design, and deployment of a Bulk SMS system.

Just prior to the deployment of the Bulk SMS system, we surveyed the participating HSPs about information technology use, information management practices, and their relationship with the NGO. At the time that the baseline study was conducted (September – November 2009) there were 83 facilities participating in the Uganda OBA project, 37 treating patients for STIs, and 52 overseeing mothers (6 facilities were participants in both reimbursement programs). Out of 83 HSPs, we acquired survey data from 59 facilities.

Analysis of SMS Data (Oct 2009 – June 2010)
We included in the design of this third-party Bulk SMS system the ability to download a history of all the SMS messages sent and received by the system. Each message is accompanied by one or more status codes, indicating to the sender whether and when the Short
Message Service Center (SMSC) and the recipient received the message (See Table 1).

Based on these message codes and the accompanying timestamps, we can derive the ultimate status of each message. Any message with status codes 16 (NonDeliveredToSmSc) or 2 (NonDeliveredToPhone) is considered dropped. Delays can be calculated using the sent time, indicated by 17 (SysAcceptedForDelivery) or 18 (SysQueuedOnBearer) and the delivery time and the timestamps on status code 8 (DeliveredToSmSc), or 1 (DeliveredToPhone) if present. Using phone numbers, status codes, and message content, we are able to analyze adoption and usage patterns over the course of the first eight months of the use of the Bulk SMS system.

Groups and Contacts
The Bulk SMS system enables the NGO to manage mobile contacts and groups of contacts. The program served 83 HSPs at the time of system launch (October 2009), and added an additional 32 HSPs to the MCH program in January 2010. In some cases, HSPs had multiple contact numbers, for different staff members, or additional phones owned by the HSP proprietors. This system provides an easily accessible central repository for this information. In addition, individual contacts can be added to groups (e.g. MCH HSPs and STI HSPs). In practice the NGO includes the project coordinator’s (PC) mobile number in each group. As a result, the PC receives a copy of each message sent.

Message Types
Bulk messages are identical messages sent to groups of numbers, typically an announcement or a request for information. Template messages are similar to bulk messages, where the same message is sent to a group of numbers, but each message is customized for each individual in the group. For example, a payment notification will be customized to include the name of the health facility and the amount paid. Direct messages consist of a single message sent to one number, often in response to a query, always initiated by a staff member at the NGO. HSPs can also contact the NGO by sending a query to the system phone number.

System Design
The Bulk SMS system is based on a third-party vendor’s infrastructure, hosted on their servers and viewable through a customized web application. In this section we describe the features and usage of the system.

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>SysAcceptedForDelivery</td>
</tr>
<tr>
<td></td>
<td>The network has received the message.</td>
</tr>
<tr>
<td>8</td>
<td>DeliveredToSmSc</td>
</tr>
<tr>
<td></td>
<td>The message has been received by the SMSC.</td>
</tr>
<tr>
<td>1</td>
<td>DeliveredToPhone</td>
</tr>
<tr>
<td></td>
<td>The message has been received by the recipient</td>
</tr>
<tr>
<td>16</td>
<td>NonDeliveredToSmSc</td>
</tr>
<tr>
<td></td>
<td>The SMSC did not receive the message.</td>
</tr>
<tr>
<td>2</td>
<td>NonDeliveredToPhone</td>
</tr>
<tr>
<td></td>
<td>The SMSC could not reach the recipient.</td>
</tr>
<tr>
<td>18</td>
<td>SysQueuedOnBearer</td>
</tr>
<tr>
<td></td>
<td>The message could not be delivered</td>
</tr>
<tr>
<td></td>
<td>immediately</td>
</tr>
</tbody>
</table>

Table 1: The Bulk SMS system receives status messages from the network as SMSes are delivered.
addition, there is a page for saving and modifying these messages for reuse.

**Template messages** are a specific type of bulk message, which allow the NGO to personalize each message based on metadata about the contact (Figure X). Square brackets ([ ]) indicate fields that will be replaced by other content. For example, the template message:

Dear [vsp], u’ve been credited with [AMOUNT] submission of [MONTH]. send us your queries and cnfrm rct to mgt on 078******* (sic)1 (Dec. 12, 2009)

might expand to:

Dear **Wellness Clinic**, u’ve been credited with **1041050** submission of **November** send us your queries and cnfrm rct to mgt on 078*******

for a given HSP. The metadata is specified along with phone numbers in a Microsoft Excel spreadsheet. The fields named in the brackets correspond to spreadsheet columns. Using the advanced send feature, the user uploads the spreadsheet and sends the message. The advanced sending feature also allows the user to schedule either a one-time message or repeated messages.

**DIRECT MESSAGES**

The system can also be used to send messages to a single contact. NGO staff use this for two reasons: 1) direct messages are stored in the SMS database, allowing the NGO to retrieve them for later reference and 2) direct messages are charged to the NGO’s account, instead of using the staff member’s personal airtime2.

**QUERIES**

Queries are messages relayed via the system, typically questions sent by HSPs to the NGO about the program. Upon receipt, the system then sends the message to five phone numbers of staff members at the NGO, who can then reply to the query by direct message, or by sending another query. **Query replies** will then be sent via the system to the original sender and also to the rest of the staff, much like a ‘reply all’ feature in an email application.

**Branded Addressing**

Messages sent to and from the system are also branded by the NGO. When using the shortcode, users must also start messages with the NGO’s name (e.g. “8111 ngo my message”). In addition, messages received from the system show up automatically as having originated from “NGO” rather than an anonymous phone number.

**Credit Balance Management**

As part of the initial agreement, the NGO pre-purchased approximately a year’s worth of SMS credits from the vendor. The web interface displays the balance of credits remaining, and the total number of credits used. In addition, the administrator can

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1 The name of the NGO has been replaced by NGO in all example messages for the purposes of this paper. Likewise, phone numbers and names will be replaced or redacted for privacy (indicated with *italics* or asterisks*). Messages are quoted here exactly as they appeared in the system.

2 Most Ugandans use prepaid mobile phone plans. In order to make phone calls they purchase credits, usually in the form of a paper scratch card with a concealed number code. These credits are known as ‘airtime’, since they allow the purchaser to speak on the phone (i.e. air) for a certain amount of time.
allocate credit to individual users. Users can then use this credit to send direct messages or bulk messages through the system. Thus, the NGO can monitor and control use of the system by many users.

**Expectations and Requirements**

*Bid Process*

In this NGO, software adoption occurs through a bid process, in which many potential vendors are invited to submit a proposal and system description in response to a request for proposals. The three bids varied widely in detail, pricing and feature availability. Two primary features emerged from the review process as key choices in the deployment of a Bulk SMS system. Firstly, the deploying agency must choose whether to pay for all of the text messages sent to and from the system, or to expect the users to pay for their own text messages when they reply via the system. Secondly the deploying agency must choose between using a standard telephone number or a short code, a sequence of usually 4-6 numbers that are generally used for value-added text services, such as television voting and charity donations. In Uganda, short code consists of 3-4 digits, significantly easier to read, memorize, and use than the ten-digit numbers used for standard communication. However, securing short codes, especially cross-network short-codes that would work with different mobile carriers, is expensive, potentially increasing the costs of the system by thousands of dollars. One bidder priced short code and non-short code versions of their system at a difference of 6,000 USD.

At the conclusion of the bid process, the NGO balanced budgetary requirements with recommendations about usability. We chose to use a shared short code, piggy-backing on the pre-existing short code of our selected software vendor. Shared short codes pair well-known codes with keywords, such as “8111 NGO my message” vs. “8111 my message”. While dedicated short codes might be easier for the participating HSPs to remember, and less prone to error, the additional expense entailed by this feature exceeded the donor’s budgetary restrictions. Thus we see how a user-centered design decision might be in conflict with financial restrictions. Likewise, the NGO reduced their own risk by outsourcing to the third-party vendor with existing expertise in Bulk SMS systems. In addition to the design of the web interface, these infrastructural decisions factor into the user experiences of the NGO and the HSP staff.

**Anticipated Uses**

The NGO expected to use this system to send out payment notifications (40, 2x/month), make announcements (every other month to 80 HSPs), manage questions (1-2x/month for each HSP), and handle stock requests (50/month). Our expectations were that the NGO would get about 160 messages per

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3 Note that in Ugandan pricing plans mobile users only pay for text messages when they send a text message. Unlike most plans in the United States, they do not pay for text messages when they receive them.
month from the HSPs at a rate of 1-2x per month, and that the total usage would be about 660 messages per month.

System Usage
We have described above the conception and anticipated uses of the system. In the next sections we examine in detail how the NGO and associated stakeholders actually used the system.

Overall Use
Using the reporting feature of the BulkSMS system, we acquired data from its initial launch to June 30, 2010, reflecting approximately 7.5 months of usage. During this period of time, the system sent 4,167 messages, comprising 250 unique messages. Figure 2 provides an illustration of when the messages were sent, divided by message type. This figure reflects numbers of unique messages rather than total numbers of messages sent. Direct messages typically coincide with queries.

System Launch
While the system officially went online on October 23, the NGO eased into its use of the system almost a month later, sending its first payment notification as a direct message to a single HSP:

Dear Facility NGO Mbra has credited yo a/c with 20000 for Oct 1 batch submissions.Plz confirm rcpt on 0772707719.Thx (November 16, 2009)

The next day, the NGO sent a template-based message to 80 recipients:

Dear [FACILITY] NGO would like you to send travel details for the CBDs u r going to send 4 the training to this no. Thanks[-] (November 17, 2009)

The health service providers (HSPs) responded by sending 26 messages with information travel costs and destinations for the community based distributors (CBDs) scheduled to travel to the NGO offices in Mbarara for training the following weekend.

Finally, the NGO made a formal announcement of the system’s availability:

Dear Service Provider, NGO has developed an SMS systm to ease communication back and forth for any query, pse snd your SMS to this no.0785555555. (Dec. 12, 2009)

Starting the following day, HSPs began to send their complaints, medical queries and other greetings via the system. Over the course of the next 6-7 months, the BulkSMS system became a locus of conversation, primarily between the NGO and the HSPs.

Payment Confirmations
The primary motivation for the Bulk SMS deployment was to enable SMS-based the notification and confirmation of payments. We estimated that the NGO would send out approximately two notifications per month to about half of the HSPs each time. This was based on the contractual agreement with the HSPs in which the NGO would accept claims twice monthly (on the 15th and the 1st of the month) and make payments 15 days following.

While payments were made on a timely basis for much of 2009, during early 2010 the NGO was deploying a new claims processing system. As a result, claims processing took longer, and payments were delayed, as can be seen from this template message:

Dear [FACILITY], we exprncd a tchncl prblm wth our claims processing systm thus a delay in pymnts 4 Oct &
While unanticipated, in retrospect, it is almost unsurprising that the first response to the introductory SMS contained a complaint:

that’s o.k but when are you paying me? ur delay has actually paralyzed my work. try 2 be fair. (Dec. 17, 2009)

In fact, out of the seven months of the study, only six out of the expected 14 payments were made (twice monthly).

Between February 1st, 2009 and May 6th, 2009, the backlog was so bad that they decided to make a partial payment, paying all of the HSPs 80% of the total value of their outstanding claims on March 31st, 2009. Three HSPs acknowledged this gesture:

thanks for that good message. wishing u a happy easter. (April 1, 2010)

thanks to msiu. i have withdrawn my first claim at last. (April 19, 2010)

we received a msg early this morning that mane [mane=money] had been deposited bt its nt reflected on the account (April 1, 2010)

24 HSPs over the next month sent query messages complaining about lack of payments, whereas, since only five HSPs had sent complaints by SMS in December, and there had been no queries regarding payments in January and March. Payment complaints take on a number of forms. Some are more neutral:

what about our feb payment?we only received 50percent for both jan n feb/facility hciv (April 28, 2010)

Others claim that non-payment affects the functioning of their facility, or fear from creditors:

hello, i would lyk to enquire whn we shd expect payment coz its over a month now and we ar really counting on you 4 us to be able to clear salaries and procure sme drugs. i will be grateful if we ar considered. thank you (April 28, 2010)

Some just attempt to appeal to a sense of obligation:

facility unpaid medical claims fro ngo now total ugx 20,941,300. other vouchers ready for submission are ugx 6,197,800.p’s act urgently to enable us serve d poor mothers (April 27, 2010)

Note: In 2009, 2100UGX \approx 1USD, therefore values represented here are about 9,972 and 2,951 USD.

Figure 4: Chronicle of Payment SMS events and responses.

We subcategorize communications regarding payments in Figure 3. Complaints dominate (25/35, 71%) the HSP communications. We note also that despite explicit asks for confirmation of deposit, (e.g. “cnfrm rcpt to mgt on 0785555555”) there are only six acknowledgement messages in total. Indeed, after the first three payment confirmations, the NGO no longer includes a request for acknowledgement, perhaps realizing that they will get complaints until the money is deposited. 19 total confirmation messages were sent by the NGO to the HSPs, comprising the six total payments. This occurs because payment confirmations are often sent out in small batches, to a subset of the
HSPs each time. As a result, the NGO does not normally use the “HSP” groups for template messages.

Administrative Communications
The Bulk SMS system is also frequently used for program administration, in coordinating visits, requesting resupply of claim forms or vouchers, and even carrying out contractual agreements. In one instance a newly recruited HSP received a contract and notified the NGO that they had signed it:

health center has signed the contract today 14th dec.o9.thanks. (Dec. 14, 2009)

In response, the NGO sent a direct message:

Dear service provider, thank you for your compliance. Please begin providing voucher services. A team from NGO will come and pick the contract. (Dec. 15, 2009)

The NGO scheduled visits about once or twice a month to the areas near each health facility. When requested, they could arrange a visit and pick up paper documents, like contracts and claim forms. Since the NGO trusted the HSP and the Bulk SMS system as a temporary proxy for the signed contract, the HSP was able to offer the NGO-covered services a few weeks before they would be able to visit the HSP in person.

When the NGO conducted the annual review of drug reimbursement prices, they decided that the Bulk SMS system would be an efficient and effective means of recording acceptance of the new prices. The NGO an email to the affected HSPs, followed up by a bulk SMS message:

NGO has sent you an email on revision of service delivery costs. Please retrieve email and confirm receipt. Thank you (March 16, 2010)

Hello service provider, please check your post office mail for your payment summary reports and review letter from NGO.Confirm receipt. Thx. MGT (March 23, 2010)

This message served two purposes. Firstly, it informed the NGOs that they needed to check their email or post office box for the new service delivery costs. Second, it provided a mechanism by which they could confirm receipt of the email and accept the new prices. Out of the 12/22 recipients responded over the course of the next month with acceptance or conditional acceptance of the prices:

christian greetings. i acknowlfge that i received yo letter dated 9th march 2010 on 30th march 2010 txs 4 yo support n we a ready 2 continue working with you.4rm name,facility h/c 111,village. (March 31, 2010)

At the same time, the remaining HSPs chose not to respond, and required in-person or call-based follow-up. While the system proved useful for some of the HSPs, the NGO had difficulty encouraging widespread use of the system.

Medical/Protocol Consultations
One of the expected uses for the Bulk SMS system was to provide an official channel through which HSPs could ask for advice about the treatment protocols. The medical advisor was expected to answer messages about treatment, and the PC often responds to queries about protocol administration. While many medical queries required immediate attention, responses are often delayed, due to office closures or present availability of the NGO staff:
If a pregnant mother has +mps. what shd I do on rx (Dec. 30, 2009, 1:43 PM)

thnx 4 ur msge. Depending on what trimester she is, consider coartem from a govt facility. NGO doesn't pay for coartem coz funders are d same! 1st trimester Fansidar (Dec. 30, 2009, 5:52 PM)

Hello, in reference to the text you sent to NGO, if a pregnant mother has +mps, please give Fancida. Thank you (Jan. 6, 2010, 8:42 AM)

In this case, the initial query was sent in early afternoon. An initial reply was sent (via the web system) about 4 hours later. A second response is then sent a week later, correcting the course of action suggested in the first message. This has several implications on message characteristics for the HSP: 1) unknown provenance: based on the message alone, it is unclear who has responded and how reliable the answer is, 2) lack of immediacy: the mother in question might need immediate treatment, but solutions are not presented until several hours or several days later, 3) brevity: due to the length constraint on SMS messages, content is abbreviated, which may lead to confusion or insufficient information.

In general, the HSPs chose not to use the Bulk SMS system for medical queries, preferring to call or ask questions in person. Over the course of the seven months covered by the logs, only three messages are recorded involving medical queries. Instead HSPs dropped in, or called, preferring more conversational mediums for sharing this type of knowledge. In addition to wanting to speak to the medical advisor directly, they expressed a need for describing conditions in detail. In many instances, they needed immediate answers for treating a patient with them at the time. These mechanisms are not afforded by length-limited SMS messages.

Misdirected and Dropped Messages

An individual payment notification includes the HSP’s name and the amount for which they were reimbursed. Rarely, phone numbers for HSP were mixed up in the spreadsheet for the template metadata. As a result, one HSP would receive the financial data for another. This misdirected message results in a privacy violation for the HSP named in the message. This is a result of human error; either the data administrator or the finance officer may have included the wrong phone number when assembling the spreadsheet for the template message. Each spreadsheet includes information for 29-118 recipients, sometimes including multiple phone numbers for a single HSP. Despite careful assembly of the spreadsheets, mistakes occurred.

In addition, many HSPs never received messages from the system. One HSP reported that he had received messages in the beginning, but stopped shortly after. It turned out that he had changed phone numbers. Although he had been actively using the new phone number when calling the NGO, the data administrator was never made aware of the change, and failed to update the system. Others reported receiving messages intermittently. If their phones were turned off when the message was delivered, the underlying network would attempt to resend the message. However, many HSPs did not have electricity, resulting in phones would be without power for longer than the resend timeout. In these instances, neither the NGO nor the HSP would know that a message had been dropped.

Table 2 lists the delivery statistics, as derived from the status codes. Unreliable indicates what percentage of messages were not accompanied by sufficient
information to reliably verify whether and when they had been delivered (i.e. received statuses with codes 1:DeliveredToPhone, 2:NonDeliveredToPhone, or 16:NonDeliveredToSmSc). Unknown indicates the percentage of messages for which we have no information about the delivery status and delay of the message. Average delay indicates the average amount of time it took to deliver messages on each network, with Delay > 4h indicating what portion of the messages were delayed by more than four hours. For unreliable messages we calculated delay based on when they were delivered to the SMSC (8:DeliveredToSmSc). As a result calculated results may be lower than the actual delay. Dropped indicates the percentage of messages which we can reliably verify were dropped. Any unreliable messages may have been dropped also. Thus out of all the messages anywhere between 3.1% (dropped) and 28.6% (100-reliable+dropped) of the messages were dropped.

The reliability of status delivery was carrier-dependent. While Warid’s system responded with status codes for 95.1% of messages sent to phones on their network, far fewer messages sent to other networks included delivery-based status codes. Most of the messages (75.5%) were unreliable. We see here that 0.0% of UTL messages were dropped. However 98% of these messages were not accompanied by status codes; it is unknown whether any of the remainder were dropped silently.

This speaks to a critical problem: in most instances neither the HSPs nor the NGO know whether a message has been dropped. We estimate that between 3.1%-28.6% of the messages have been dropped. Since most of the Warid messages are ‘reliable’, we can guess that about 10% of messages sent to mobiles on other networks are also dropped, yet at most 3.1% of those messages are marked as dropped in the system. Even though the Bulk SMS platform provides status codes to the NGO, the status codes do not provide sufficient information for the NGO to know whether their messages have been delivered or not. In the HSP case, they cannot know when they have missed a message, unless they see that neighboring HSPs have received a message. As a result dropped messages are ignored, and HSPs may unknowingly miss vital communications.

We also observe that there were problems with inter-network communications. Based on the available data, messages (from MTN) were delayed by less than an hour on average to MTN, Zain, and Warid numbers, but delayed by an average of two days for recipients on UTL. Likewise, more messages sent to Warid lines were dropped (10.4% vs 3.1% for all messages). In addition, the ‘branding’ of the messages failed for Zain users, with the message arriving from an ‘unknown sender’ instead of the NGO.

As a message delivery system, the Bulk SMS platform has significant flaws. First, it is subject to user error – it implicitly delivers messages where it is asked, which may not match the intention of the user. Second, it is subject to the limitations of the recipient networks (i.e. MTN, Warid, Zain, and UTL). If the service provider fails to provide sufficient status information, there is no way for the platform or the user to know whether messages have been delivered. Message delivery problems are silent failures.

<table>
<thead>
<tr>
<th>Network</th>
<th>MTN</th>
<th>Zain</th>
<th>Warid</th>
<th>UTL</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Delay</td>
<td>0.77 h</td>
<td>0.59 h</td>
<td>0.39 h</td>
<td>46.7 h</td>
<td>4.60 h</td>
</tr>
<tr>
<td>Dropped</td>
<td>3.4%</td>
<td>1.2%</td>
<td>10.4%</td>
<td>0.0%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Delay &gt; 4h</td>
<td>9.9%</td>
<td>3.1%</td>
<td>4.9%</td>
<td>29.1%</td>
<td>10.5%</td>
</tr>
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<td>73.1%</td>
<td>98.6%</td>
<td>4.9%</td>
<td>98.0%</td>
<td>75.5%</td>
</tr>
<tr>
<td>Unknown</td>
<td>6.8%</td>
<td>4.5%</td>
<td>2.5%</td>
<td>7.1%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Messages</td>
<td>3181</td>
<td>487</td>
<td>163</td>
<td>354</td>
<td>4185</td>
</tr>
</tbody>
</table>

Table 2: Message delivery statistics


Other Technical Difficulties

In addition to delivery problems, the NGO endured other technical difficulties. NGO staff could not send new messages unless they had an Internet connection. Often the project coordinator and the medical advisor were in the field visiting HSPs. If they received a message on their personal phones, they could normally use the Bulk SMS system to send a ‘direct message’ in response. However, if they were in the field, they were unable to shift the conversation to the system. In addition, it was impossible to send bulk or template messages without an Internet connection.

Analysis

System Limitations vs. Design Flaws

The usability and the reliability of this Bulk SMS system is ultimately subject to limits imposed by the mode of use. SMS message delivery can be delayed and is not guaranteed because 1) the networks do not guarantee quality of service for SMS messages and 2) messages cannot be delivered when the recipient phone is out of network range or out of power. The system is unsuitable for messages requiring immediate attention; often the NGO will send a response hours and sometimes days later (immediacy). As a short message service, messages are limited in length – messages are abbreviated and contain less information that may be gained in a phone call (brevity). In addition, all messages sent by various NGO staff using the system are anonymized as coming from the NGO and not individuals, leading to potential misunderstandings regarding the reliability of responses to medical queries (provenance). We also see that user error could lead to incorrect information being sent, or misdirected messages.

While these problems may be a function of the SMS channel, many of issues could be addressed through changes in design. Longer messages were sent by sending multiple messages, broken up with continuation markers (e.g. ‘msg cont.’). The system could cross reference phone numbers and HSP facility names with its internal contact database prior to sending template messages, thus reducing the potential for misdirected messages. Messages sent through the Bulk SMS platform might be appended with the name of the user logged into the system, as appropriate. The system might send warnings or highlight messages that are known to be dropped or significantly delayed, enabling at least some means for the NGO to address known message delivery failures. In addition, the vendor might negotiate with the networks to enable more status information. The vendors might enable sending of messages via the system from the field by accepting the recipient number as a keyword from certain senders (e.g. “8111 ngo send +2567** message”). However, since none of these features were requested in the initial specifications (the need had not been anticipated), they were not a part of the system.

At the same time, changes in design cannot address all of the limitations. A message split across multiple SMSs is still a short message. As an asynchronous medium, it is natural for responses to be at least somewhat delayed. It is important to understand the difference between limitations inherent to SMS-based systems and limitations that are imposed by design flaws.
"I hate sending messages they are time consuming I prefer making audible calls and then having audible communications." – an HSP

In addition to the NGO’s issues with using the system, we also observed that the HSPs were reluctant to send SMS messages through the system. Figure 8 shows the results of a survey question asking how they preferred to receive payment confirmations prior to the system deployment. While 19/53 (35.8%) were happy to receive these confirmations by SMS message, 25/53 (47.2%) of the HSPs preferred to receive payments confirmations over a phone call instead.

Despite this, the NGO went forward with SMS-based payment notifications. Preferences aside, it was better to ensure that each HSP received regular notifications. Prior to the Bulk SMS deployment, 6/58 (10.3%) HSPs reported not receiving notifications when they should have. We also observed that many HSPs were not receiving notifications on a regular basis. When taking preferences into account, the use of SMS did not preclude any other type of payment confirmation, except for paper receipts delivered to the facility, which was discontinued. The trade-off between HSP preferences and NGO convenience greatly favored the use of SMS.

However, we also observed that HSPs chose not to send messages using the Bulk SMS system. Figure 7 shows the cumulative adoption of the query feature, as compared to the total number of HSPs participating in the NGO program. At any given time, less than half of the HSPs have sent even one message. Indeed, by the end of this dataset, 65/106 (61.3%) of HSPs had sent only one message, with only 25/63 (39.7%) users having sent more than one query (See Figure 6).

When adoption did occur, it was often in response to NGO-initiated events, such as a specific bulk messages requesting information to the Bulk SMS phone number (Nov. 18, 2009) or confirmation of contract revisions (March 23, 2010). Messages specifically asking for responses via the Bulk SMS system increased adoption, and awareness of the system. However, each on their own does not guarantee responses. The NGO gave up requesting acknowledgements of payments. Ultimately, Bulk SMS does not stand alone as an effective communications medium.

**Braided communications**
For each mode of communication, the NGO must weigh the cost of information delivery against the amount of content and immediacy of the information. SMS is low cost, and relatively immediate, but only enables short communications. For critical, formal or long communications, the NGO can have their drivers personally deliver messages. For less critical communications, email and postal service suffices. One-on-one conversations may occur at the health facility, in the NGO offices, or over the phone.

SMS can augment the usability of email and postal messages. When the NGO sends documents to the HSPs, they can ‘signal’ to them that they should expect an email or letter. This signal also enables the NGO to notify the NGO if they do not find the expected letter:
Am still waiting and up [to] now have not received any letter from the your office via my box number address. But I wish to use my email address address@yahoo.com. It’s – post office people are not efficient. But I will agree with your new terms.

The short message entailed by the Bulk SMS system (i.e. its capability) cannot carry large amounts of information, email may only be checked on demand, and postal service is unreliable. Together, however, the capabilities of each can combine into a reliable channel for large amounts of information.

**Perception: Successful Enough**

In spite of flaws and the slow adoption on the part of the HSPs, the NGO, and many HSPs deemed the Bulk SMS system successful. First, technical difficulties were invisible to the users. HSPs were unaware when messages addressed to them were dropped, and the NGO had no reliable means of knowing what messages were successfully delivered. At the same time, *enough* messages were delivered, and *enough* HSPs used the system to give the NGO a perception of having achieved their goal. Second, HSPs relayed appreciation for the new system, both in interviews and in queries. While this type of positive feedback should be taken with a grain of salt [1], the system was an improvement over when HSPs did not get payment notifications. The centralized and written nature of the system also enabled a new mechanism for collecting information from the HSPs and effecting contract revision confirmations.

We consider the tradeoffs entailed in the original design: HSPs paid SMS rates for their queries, sending messages to long phone number instead of the shortcode. Template messages could be more prone to user error than a “send payment notification” button but were flexible and powerful enough to accommodate unanticipated uses. The design of a system and its ultimate usability is subject to both budget and functionality requirements. However, in the absence of clear cost-benefit calculations, its success is derived from both a need to be successful [16] and perceived benefit.

**Conclusion**

This Bulk SMS system exists in a rich ecosystem of interactions between the HSPs and the NGO. In addition, it co-exists with many other communications technologies. These technologies, independently and together help the NGO improve communications with the HSPs, and thus also improving the RHVP program management. Although HSPs often used SMS to complain about delayed payments, providing a channel for the complaints helped them to feel more engaged with the program. Likewise, the NGO was able to communicate more frequently and casually with all of the HSPs. Finally we observe that in spite of the idiosyncrasies of the Bulk SMS platform, both the NGO and the HSPs found this system to be beneficial.

Bulk SMS systems are technically simple – many companies provide this service, with minor variations on interface and reliability. However, in this paper we see how the usability of these systems is subject to infrastructural limitations as well as 1) changing and 2) unspoken needs of the NGO. In addition, we found that the utility of SMS messages depended on NGO and HSP needs around the 1) immediacy, 2) brevity, and 3) provenance of the messages. While the HSPs did not use the system extensively, we suggest that addressing the above three features may increase usage. When appropriate, the NGO can encourage use and visibility

<table>
<thead>
<tr>
<th></th>
<th>Immediacy</th>
<th>Content</th>
<th>NGO Cost</th>
<th>HSP Cost</th>
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<tbody>
<tr>
<td>SMS</td>
<td>High</td>
<td>Short, Informal</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Trucks</td>
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<td>High travel cost</td>
<td>Low</td>
</tr>
<tr>
<td>Postal</td>
<td>Low</td>
<td>Long, Formal</td>
<td>Med</td>
<td>Low</td>
</tr>
<tr>
<td>Phone Call</td>
<td>High</td>
<td>Long, Informal</td>
<td>Med</td>
<td>Med</td>
</tr>
<tr>
<td>Email</td>
<td>Medium Access entails travel</td>
<td>Long, Informal</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 3: The affordances of different communication mechanisms.
of the system by sending specific requests for information, to be sent via the system.

ACKNOWLEDGMENTS
We especially thank the NGO staff for their patience and help in providing the data and the venue for this research. This research has been funded by the Blum Center for Developing Economies.

References