Tangaza: Frugal Group Messaging through Speech and Text

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ABSTRACT

We describe the design, implementation, and evaluation of Tangaza, a mobile phone-based group messaging system targeted at moderately low-income users in developing regions. We focus on the design decisions that make Tangaza inexpensive and usable with even the most basic GSM mobile phone, and examine the resulting usability trade-offs. We also describe how we worked with a subset of our target population to gather design feedback that we were able to immediately build into our prototype implementation. We provide quantitative and qualitative analysis of a three month trial covering one hundred people, drawn from two distinct user populations, with a particular focus on the relationship between the in-person physical social groups that users already had and the virtual groups they formed using Tangaza.

Categories and Subject Descriptors

C.2.4 [**Computer Communication Networks**]: Distributed Systems—*Distributed Applications*; H.5.2 [**User Interfaces**]: Voice I/O User Interfaces

General Terms

Experimentation, Human Factors, Measurement

Keywords

Speech Interfaces, Usability Testing and Evaluation, User Interface Design

1. INTRODUCTION

Through his study on the impact of expanding mobile phone coverage in southern India, Jensen portrayed how simple person-to-person calling and text messaging can have a positive net economic effect [9]. Inspired by this study and the success of group communication tools from USENET [3] to Twitter [22], our research group designed and implemented a group messaging system for low-income users in developing regions. We call our system Tangaza, which means "announce" in Swahili.

While others have developed messaging systems through on-device applications [8], we have intentionally constrained our design to standard GSM features available on every cell phone and attempted to limit user and provider costs wherever possible. Through the use of missed calls, a basic SMS command set, and a concise touch-tone menu, Tangaza is designed to enable cheap, primarily spoken communication among flexible groups of users. In contrast to earlier information dissemination systems, such as HealthLine [21], content in Tangaza is exclusively user created: end-users create groups, invite others, and then may send spoken messages, texts, and responses to those in their groups. We envision larger groups consisting of people with a shared occupation, such as taxi drivers and farmers, and smaller groups, drawn from families, classes, workplaces, churches, and *chamas* (self-help groups). Instead of relegating this class of users into their own separate set of social networks, Tangaza is intended to complement more sophisticated group communication tools that could run on more advanced phones and the Web.

We analyze quantitative and qualitative results from a hundred person, three month pilot in Nairobi, Kenya. The pilot consisted of two groups, a smaller, low income group from a slum, and a larger, middle-and-upper income group from a university.

In summary, the paper makes the following contributions:

- Design and implementation of a cost-effective, server-based group message system, *Tangaza*, which is built for low-income, cost-conscious, basic cell phone users;

- Quantitative and qualitative analysis of how Tangaza was used by two distinct user populations – middle-and-upper income and low income groups – in urban Kenya;

- Findings suggesting that successful social networks will draw from pre-existing personal groups, that privacy and trust concerns can be particularly acute in this target demographic, and that significant demand for

Figure 1: Tangazo and Text Example

Create	A send:	`create testgroup 2`
	A recv:	`OK. Created the public group testgroup, assigned key 2.`
Join	A send:	`invite testgroup 0722981234 0719115678`
	B,C recv:	`A invited you to the testgroup group. Reply: join testgroup.`
	B,C send:	`join testgroup`
	A recv:	`A new user B<0722981234> has joined testgroup`
Text	A send:	`@testgroup Meeting is at 6pm tomorrow`
	B,C recv:	`Meeting is at 6pm tomorrow A@testgroup`
Tangazo	B calls:	*Selects key 2, Records* "Poa, was great to see you both!"
	A,C alerted via flash:	*Each observes existence of new tangazo*
	A,C call:	*Each listens to B's message*

group communication tools, such as Tangaza, exists in developing regions.

In the next section, we provide a high-level overview of how Tangaza functions from a user's perspective. We review related work in Section 2. In Section 3, we cover our design goals and how we actively involved users in the design process. We describe our implementation in Section 4. In Section 5, we examine how Tangaza was used by two user groups through qualitative surveys and quantitative log analysis. In Section 6, we describe future work and conclude in Section 7.

1.1 System Overview

Tangaza is a social networking service that makes use of SMS and voice to enable low-cost group communication. Users can create and manage their groups and invite others to join. After a group is formed, members can then text and send spoken updates to each other. Through sets of SMS-based commands users can create both public and private groups, giving them the flexibility to decide who can or cannot be members. After a message is sent, the members of the group are notified about the existence of a new message via a "flash," i.e. missed call, or a text.

To better understand Tangaza's design and implementation, we first give an overview of how users create and join groups and send each other spoken and text messages with only a basic mobile phone as a requirement. Figure 1 shows the process of a person A creating a group and then inviting two other people B and C. After they accept the invitation, A sends the group a text message, which is delivered to both B and C. Illustrating a common use of Tangaza, the message sets up a meeting time for group members. After the meeting, person B sends a spoken message, or *tangazo*, to the group. Tangaza flashes A and C, notifying them of the new tangazo, which they call in and listen to.

While the example shows the people as having called Tan-

gaza directly – bearing the expense themselves – Tangaza limits end-user costs and increases usage by allowing users to flash it, which results in a call-back from the interactive voice response system (IVR). This mimics a common mechanism in developing regions in which people regularly communicate through missed calls [7]. We use only the most common meaning of a missed call, or "flash": call me back.

As the example shows, Tangaza is used exclusively through texting and calling: *no* software is installed on the user's phone. We discuss how we came to this decision, its advantages, and other design choices in Section 3.

2. RELATED WORK

The design of Tangaza can be considered in juxtaposition to several messaging alternatives.

2.1 mPhone

mPhone, from Heimerl et al., makes a compelling economic argument for sending spoken messages when network utilization is low, e.g. at night, and, therefore, cheap [8]. Their asynchronous messages mask network outages, unlike Tangaza, which requires a working network connection. mPhone requires messaging software to be installed on mobile devices, which limits its ease of distribution. In addition, several participants in our study commented positively on the immediacy of Tangaza's notifications (others did not like *continued* notifications). As we discuss below, Tangaza could complement on-device messaging tools, including mPhone.

2.2 BubbleTalk

BubbleTalk is a commercial server-based spoken messaging service that is popular in India [2]. Through mobile operator integration, users record messages and text notifications for free, but must pay to listen to messages. Unlike Tangaza, BubbleTalk only allows one-to-one or one-to-many messages; there is no group communication facility. Instead of flashing users when they have a new voice message, BubbleTalk sends them a text message. As we discuss in Section 5.5.1, this provides more information at an increase in cost, which is either borne by the system operator or passed on to users.

2.3 Semeni

Semeni is a mobile operator-run group text-message service in Kenya [20]. It uses USSD to manage and send messages, which are then received via SMS. This is simpler than Tangaza, because users do not need to remember a group number. While operating USSD services are subject to high fees, they may provide a preferable, more interactive, user experience for group management. Similar to how our users allocated their groups, Semeni divides groups into friends, family, church, *chama*, and work.

2.4 Voicemail

Mobile network operators often provide voicemail as part of a calling plan. Voicemail allows messages to be stored for later retrieval in case the recipient cannot or does not answer a call. Users typically navigate voicemail menus through a touch-tone-based interface. Despite the existence of voicemail in Kenya, mailboxes are not active by default and, based on anedotal reports, few people switch them on.

We are not aware of surveys on voicemail usage in other African countries. If Tangaza were deployed in countries where operator-provided voicemail was widely deployed and understood, it would be possible to inject tangazos into the existing voicemail delivery system. While replying and forwarding would generally be new concepts, using existing voicemail systems would likely alleviate some user interface issues, as users would already be familiar with much of the interface.

3. DESIGN

The primary driver for design decisions we made about Tangaza was cost to the end-user. Low income users in developing regions – our target population – are extremely price sensitive and make savvy choices to keep their own costs low when using any service. Of course, Tangaza cannot be a giveaway – this would not be sustainable. We describe how a provider's costs are kept low as well.

We describe the main environmental factors that guided and constrained our design (§ 3.1), how we involved users in the design process (§ 3.2), and the main features of the current prototype (§ 3.3).

3.1 Design Considerations

While media reports play up mobile phone penetration in many developing regions, the vast majority of legacy phones only have the most basic GSM functionality – calling, SMS, and USSD – a trend that is likely to continue. For example, currently in Kenya, while 54% of people own a mobile phone and many more have access to one, only 6% have a 3G "smart" phone [17]. Forecasts suggest these percentages will remain fairly static through at least 2013, with 2.5G only becoming a majority in 2014 [17]. With more than 30% of phones remaining basic GSM phones by the end of this time frame, it makes sense to design services that incorporate these users from the beginning and to consider how any service might work with both these users and ones with fancier phones.

Given this technical constraint and given our desire to make a broadly usable service, we focused our design space on what our target users' devices could actually do. We would not argue that a more graphical or tactile or speech recognition-based interface would provide an equivalent experience – in fact, these would most likely be superior – but that, to make group communication truly broadly available, using only these basic GSM capabilities is a requirement. But selecting these lowest-common-denominator channels should not preclude development of alternative, more advanced group communication tools. On the contrary, we see Tangaza as a stripped-down social networking tool that would explicitly interconnect with iconographic or, perhaps, web-based clients, running on more advanced phones.

Constraining the design to SMS, standard voice calls, and other GSM technologies has many advantages, including:

- Users are already familiar with these technologies, including keyword-based SMS services [11].

- Users do not need to buy a new phone.

- Users are already familiar with their local mobile cost structure and plans: every user in the low-income group knew exactly how much mobile credit he or she had when we asked at the beginning of the trial.

- Because of the broad access to basic phones, the system is easy to deploy widely and could enjoy network effects, where it becomes more useful the more users it has.

- More pragmatically, the design integrates with any mobile operator and would arguably increase usage and their key financial metric: average revenue per user.

- Selecting these technologies enables a server-side design, which simplifies improvements and upgrades: e.g. adding prompts in new languages becomes trivial.

However, negatives clearly exist if only using these capabilities. Medhi et al. showed improved completion rates with a spoken user interface and, in particular, with a graphical UI [12]. Other drawbacks include the lack of exposure to newer technologies, exemplified by visual and web tools, and costs that are at the whim of the mobile operator. Integrating Tangaza's users and groups with a more feature-rich tool designed for advanced phones and networks might also be challenging. However, we believe that the potential exists for economic benefit from group communication, but only if this capability is widely available.

3.2 Design Process

Our internal design and prototyping of Tangaza involved several iterations. In particular, our initial, internal designs did not use text messages at all. Instead, both group management and tangazos were conducted through an IVR; some initial designs used speech recognition, some keypad-based input, and some a combination. For example, a user could pre-record a name for a group and then look up this name during a later call. This combination, however, had complicated menus and proved cumbersome and error-prone. As a result, the system was split into SMS and IVR components, with group management tasks ("control" tasks) shifting to SMS and with listening and sending of spoken updates as the sole tasks for the IVR. We also removed speech recognition entirely from the IVR because, as others have shown, the resulting ambiguities and mistakes tended to frustrate users, particularly in noisy environments [5, 15]. Individual group naming was also confusing because people often supplied different names for the same group.

After releasing Tangaza externally to our test users, we continued to refine the user interface based on their active feedback, relying on Participatory Design techniques [4]. Through videotaped interviews with groups of participants early in trials and through on-going contact with the groups [19], we learned about several aspects that users found confusing and about their privacy concerns. We also received active confirmation that a primarily spoken-message group communication mechanism like Tangaza would be useful to them socially and commercially. Several members of our group speak Swahili and Sheng, a local English and Swahili patois; we communicated in these languages during the feedback process.

We drew early feedback mainly from technologically-savvy "key informants" from both our poor and moderate-income populations [13]. In response, we refined the invite/join protocol to be more informative at the expense of more messages (and therefore less frugal). In our original version, no message was sent to the inviter when the invitee accepted an invitation. Users told us that they assumed they would
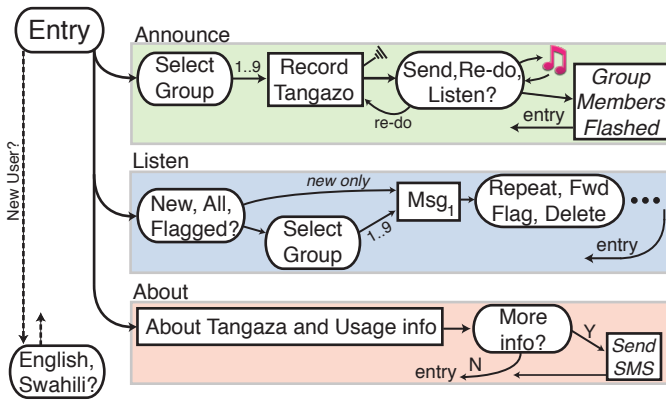
Figure 2: Tangaza IVR. After new users select the language in which they would prefer the prompts, they can select to create a new tangazo for any of their groups, listen to tangazos, or hear more about the system.

Figure 3: Common Tangaza commands

Group creation:	`create testgroup 2`
Group deletion:	`delete testgroup`
Add group administrators:	`addadmin 0711999555 0711999666`
Delete group administrators:	`deleteadmin 0711999555`
User Invitation:	`invite testgroup 0722981234 0719115678`
Joining group:	`join testgroup`
Remove users from group:	`remove 0711999111 0711999222`
Leaving group:	`leave testgroup`
Group messaging:	`@testgroup Meeting is at 6pm tomorrow`
Disable group notifications:	`quiet testgroup`
Enable group notifications:	`listen testgroup`
Set nickname:	`name Pau`

be notified and, when they were not, they assumed a system or network error. We changed this so that the inviter was notified by SMS whenever the invitee confirmed joining the group. In addition, we added the ability for users to give themselves a pseudonym instead of having their phone number displayed on each message. As we discuss later, this only partially ameliorated security and privacy concerns.

3.3   Features

We focus on Tangaza's limited, keypad-based (i.e. dual-tone multi-frequency signaling, or DTMF) interactive voice response system, its controls for group administration via SMS, and its privacy and access control features.

3.3.1   Simple IVR

As noted above, early implementations of Tangaza included group administration commands within the IVR. Removing these greatly simplified the user interface, leaving tangazo creation and listening as the primary tasks.

Figure 2 illustrates the IVR in its entirety. In addition to allowing short-cutting of menus at any point, the design of the IVR makes two main attempts to lower end-user costs. The first is the ability to hang up immediately after recording the tangazo and having this act as the confirmation that it should be sent. This would allow, for example, a person to record a twenty second tangazo in under approximately 22 seconds, assuming it took one second to select *announce* and one to select the target group. The second is the ability to flag messages as important, as one might flag or give a level of importance to an email. This allows users to segment off important messages they want to listen to again for faster access. In addition, users can skim through lists of tangazos, using skip, repeat, delete (from their perspective), and forward. The forwarding feature allows users to prefix their own new message on to the front of an existing tangazo.

We attempted to bootstrap users into groups in an intuitive manner, given the limited tools. For example, if a user attempted to create a tangazo but was not a member of any group, he or she would automatically receive a text containing instructions on how to create and join a group.

The IVR also includes one additional top-level option: to learn more about Tangaza. We included this so that (a) low-literate users could listen to the service description and (b) any user could choose to receive an SMS with a basic list of commands. Because the introduction SMS message also includes the service's phone number, a novice user could successfully begin using the system knowing either the text number (a short code) or the phone number (In countries where short phone numbers are available, this process could be simplified).

3.3.2   SMS Command Set

We attempted to limit the number of SMS commands that a typical user would need to use. We assumed that slightly advanced users would create groups, and only very advanced users would manage large groups, where banning, sharing administration, and removal would be required. This complements previous work on intermediated access [18], where the advanced users are bearing a greater load in understanding the technology. We assume that most users would use the `join` and `send` (`@groupname`) SMS commands shown in the tangazo and text overview example in Figure 1. Alternatively, an intermediary user might complete the invite and join steps and a user with low technical literacy might only use `send` or, perhaps, use the IVR exclusively.

Figure 3 lists the common SMS commands, which fall into three categories:

- Group administration: creating and deleting groups; removing users from groups; adding and removing group administrators;

- Configuring personal preferences: silencing, joining and leaving groups;

- Sending group texts.

The commands for group administration and personal preferences formed the basis for a user's ability to send and receive messages. When a user created or joined a group, they

could either choose a number to be assigned to the group or have the system do it automatically. This number mapped onto a number on the mobile phone's keypad; for example, group 1 mapped onto key number 1 on the keypad, and group 2 onto key number 2. This meant that a user was allowed only up to nine groups. Each group also had a unique name, which the user specified when creating the group. One exception was the default group, named "mine," which was always automatically created and assigned to the key number 1 as soon as the user joined Tangaza. To the user, the group was seen as "mine," to their friends the group's name was the user's phone number or nickname. When users were invited to a group, they were automatically assigned the key of the inviter if this was unused. The purpose of this was to improve intermediated use: the two users would tend to have the same key assigned to the same group, easing an explanation of the IVR, if required. Synonyms in local non-English languages and abbreviations for the commands are also accepted.

3.3.3 Privacy and Access Restrictions

Mirroring our application use cases (§ 1), each group was categorized as public, private, or personal by its administrator. Public groups allow any member to invite anyone else; private groups only allow administrators to invite new members. For these two group types, any member can send a message; we rely on social controls (and optional banning) to limit spam. Public groups target sharing information across medium-to-large classes of people with a common interest, such as taxi drivers, farmers from a particular region, and fishermen. Private groups are meant for friends, workmates, and shared projects, for example. Although adding other group types such as "public broadcast" – where only select members can send to the group and all others are recipients – would be trivial, we favored simplicity over this level of granularity. The third type of group was the personal "mine" group: this provided a personal broadcast channel to be used among a group of friends, for example. While these access restrictions were a somewhat complex feature for many of our users, most understood their purpose because they directly mapped on to existing physical social relationships. Because trial participants concurred with the mapping of these access restrictions on to the scenarios we described, we did not change them as a result of user feedback.

In response to a feature request, we added the ability to hide one's own phone number and display a nickname instead. With many reported cases of mobile phone-based extortion schemes in Kenya, some users were concerned that their phone numbers would be used by people outside their control to target them.

4. IMPLEMENTATION

Tangaza is composed of two main subsystems, one to process incoming and outgoing SMS messages, and the other to handle the DTMF-based IVR. We describe our current implementation in this section and outline an alternative, more portable one, in Section 6. Figure 4 illustrates these subsystems, their external connections to a mobile operator and an SMS provider, and internal connections to a database.
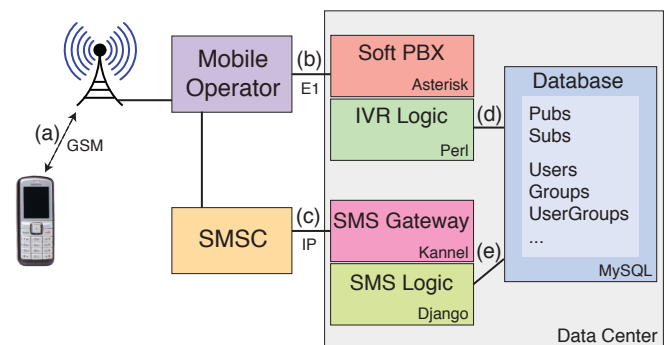

Figure 4: Key Implementation Components. (a) Users interact with Tangaza's server-side implementation via a mobile operator. (b) Voice calls connect directly to a programmable PBX, an Asterisk server, over an E1 line. (c) SMS commands are sent through a third-party that runs an SMS center, which forwards them to an SMS gateway over HTTP. (d) The IVR logic processes user's calls. It primarily navigates over the *pubs*, i.e. sent tangazos, and *subs*, i.e. received tangazos, tables. (e) The SMS logic mainly alters the group administration tables, controlling future pubs and subs entries.

4.1 SMS Processing

Users sent and received SMS through a four-digit shortcode. When a user sent an SMS to this shortcode, it was routed by the service provider via a Kannel SMS gateway [10] which then filtered and routed the messages to processing scripts written in Django [6]. The SMS processing unit is approximately 2500 lines of Kannel configuration and Django code. [1]

Since the SMS shortcode number was not a toll-free number, users were sent an automatic reimbursement after each set of five SMS they sent to eliminate user costs during the trial.

4.2 Handling Voice and DTMF

The IVR was connected to the Public Switched Telephone Network through an E1 line that routed the calls to an Asterisk PBX [1]. An E1 line supports up to thirty simultaneous calls. Since the phone number used was not a toll-free number, a user had two options: either call-through at their own cost or flash the number and have the IVR call them back. Asterisk scripts presented the user with prompts that allowed them to navigate the system using DTMF input. The IVR logic is approximately 6500 lines of Perl code and a small Asterisk configuration.

The flash/call-back mechanism provided unlimited free use of the system, although we explicitly asked users not to abuse this. To prevent unintentional abuse, calls had a maximum time limit of ten minutes (this limit was not triggered during our trial). In addition, we instituted other limits, e.g. on the number of call-backs per day, to prevent misuse. A Tangaza operator could translate these limits into promotions to expand use of the service: for example,

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[1]The SMS and IVR code are available at `http://projects. forum.nokia.com` under the Affero GPL.

Table 1: Population Demographics

	Strathmore	Slumcode
Income	medium - high	low
Participants	87	13
Age	20 - 26	18 - 40
Sample occupations	students	caterer, social worker, unemployed, artist
Education	University	High school, College
Min/Call	5	2
Calls/Day	3	3
Texts/Day	5	3
Budget/Day	137.5 Ksh	58.5 Ksh

offering x "free" (called-back) talk minutes and y reimbursed SMS. As the perception of value in the service changed, an operator could alter this cost structure easily because the units of mobile credit are well-understood.

We made two notable parameter choices in our implementations. First, because we were primarily interested in enabling quick, concise communication, we limited tangazo length to twenty seconds. Second, to remind users of unheard tangazos, they were flashed twice per day in addition to the initial notification.

5. EVALUATION

In order to learn about how different groups of people in a developing country would understand and use Tangaza, we deployed it in Nairobi, Kenya. We recruited two different user populations to try it, invite their friends and family, and give us feedback. We used this qualitative feedback along with quantitative data from logs to examine: how the two populations differed in their perception and use (§ 5.3), how groups formed over time (§ 5.4), and how they perceived the user interface (§ 5.5). We discuss the findings in § 5.6.

5.1 Two Pilots

We deployed two separate pilots of Tangaza from February to April 2010 in: (a) Huruma Slum and (b) Strathmore University. Table 1 summarizes the demographic differences between the pilots' populations. [2]

5.1.1 Slumcode (Huruma Slum)

Our user population representing low-income users in a developing country came from a youth group called Slumcode. Slumcode focuses on personal development, primarily through community-based activities and technology education, and consists of twenty young people. The group is based in the Huruma Slum, a dense, low income settlement in Nairobi. Slumcode was selected because of its previous work with our organization; all members were invited to join, and thirteen people became active Tangaza users. Slumcode members have varying degrees of technological exposure and many have extended rural family members who have limited exposure and low literacy levels. In addition to free use of the service, the group was paid for its participation in the trial.

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[2] Phone data are per-person medians of previous day's reported usage; budget estimate assumes in-network calls and SMS with a prepaid account.
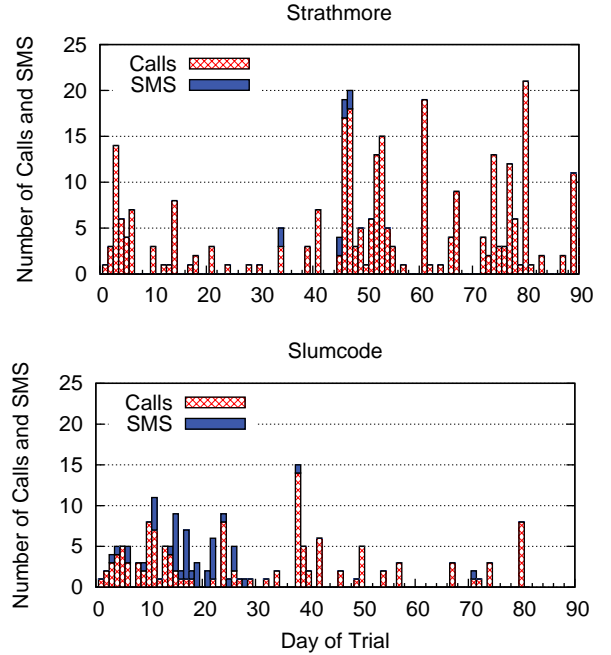
Figure 5: Aggregate Calls and SMS during trial

5.1.2 Strathmore University

Our second user population came from Strathmore University, a business and IT-focused college in Nairobi. Strathmore students primarily come from middle and upper income levels; they are technologically adept, and active, but not always-connected, Internet users [26]. Out of similar university settings, we selected Strathmore because a member of our research team was a recent alumnus and able to orchestrate a high level of interest from students and faculty. While over 440 people from Strathmore have used Tangaza, we focus on 87 active users during the pilot period. While their use of Tangaza was reimbursed, the participants themselves were volunteers.

5.2 Methodology

We isolated the log records of active Tangaza participants during the trial period and asked them to complete an evaluation and impact assessment survey. Eleven Slumcode participants and nineteen Strathmore participants completed the survey. Because the Strathmore students were on holiday, they were given the option to complete the survey online. Participants were paid a small amount for completing the survey.

The survey examined comprehension, usage, likes, dislikes, preferences, impact on communication, ease of use, related costs, and comparison to other communication systems. In addition to the survey, the system logs showed how, when, and how often participants used Tangaza. By examining a subset of the texts and tangazos, we also gained some insight into the purpose of different messages and groups.

5.3 Comparing User Populations

The two pilot groups used Tangaza in ways that primarily reflected differing levels of cost consciousness.
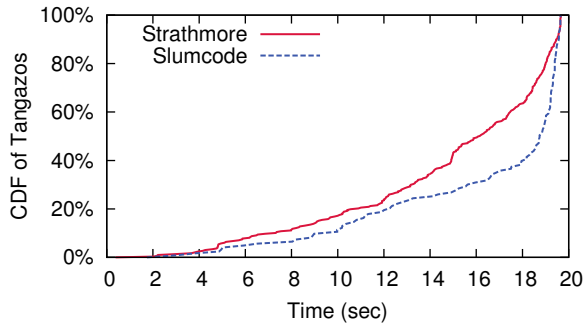
Figure 6: Length of tangazos exemplify the greater cost consciousness of Slumcode participants.

Figure 8: Distribution of number of groups each person joined. Users did not appear to be limited by the ten groups threshold.

5.3.1 Aggregate Usage Patterns

We first examine aggregate usage of the pilots, as shown in Figure 5. From the data, we can make three observations. First, the Slumcode users texted far more often than Strathmore ones. This reflected a commonly stated preference among Strathmore users for tangazos over texts. For Slumcode users, this appeared to be an unconscious continuation of their standard behavior: because texting is a significantly cheaper method of communication outside of Tangaza, these users continued to text. Outside of Tangaza, Slumcode users allocate 50% more of their phone budget to texts than Strathmore users, at 18% vs. 12%, respectively (they text less overall because their total budgets are less than half of Strathmore users). Slumcode users also expressed how tangazos could be difficult to send or receive in noisy environments, such as buses, which are more common for this group.

Second, the per-person usage of Tangaza was significantly greater for the Slumcode group. While Strathmore had more calls in total due to their larger population, Slumcode had on average 65% more calls and 80% more texts per person per day. While this is due in part to a more focused pilot, it also reflects a stronger relevance of the service, as compared to other social networks that the Strathmore group had easy access to. Note that the SMS data only include sent group texts, not commands (e.g. `join`).

Third, Slumcode use diminished during the second half of the pilot. This occurred because a service provider did not have automatic reimbursements properly implemented at the beginning of the trial and, later, failed to note when the reimbursements did not succeed. Among this group of users – who knew their exact mobile credit – this led to significant frustration. While some users resumed using Tangaza, many remained distrustful, with some calling the service "very expensive."

5.3.2 Cost Sensitivity

The population demographic data in Table 1 showed that Slumcode users tended to have short, frequent calls. Because mobile billing is per-second in Kenya, low income people have even evolved a short-hand speaking notation to save money: calls tend to be short and to the point; this is in addition to using missed calls to transfer or eliminate calling expense.

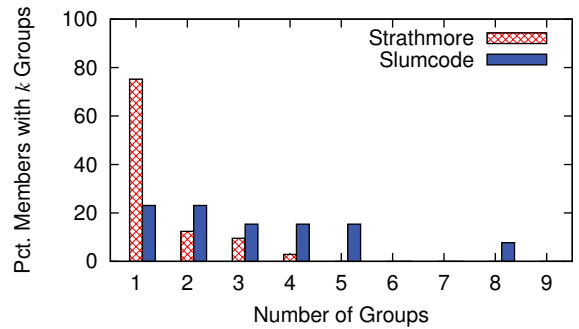We found this maximization of resources extended into their use of the Tangaza pilot, even though the pilot was free. Figure 6 illustrates this pattern in comparison to the Strathmore participants, who do not appear to be as cost-conscious. Slumcode users consistently used almost all of their allotted twenty seconds per tangazo. In discussing this limit, two Slumcode users expressed a desire to leave multi-minute tangazos, but most appreciated the known cost that short tangazos would bring for both senders and receivers.

While Slumcode users are more cost-conscious, both groups wished to limit expenses: 87% of all participants said they would prefer a prepaid tangazo/text allocation plan, which would prevent unforeseen high costs.

5.4 Group Formation and Evolution

Growth and usage during the Tangaza pilots mirrored typical social participation rates, such as the Pareto contribution rates in Wikipedia [25].

5.4.1 Why some groups grew

The most successful groups were based on pre-existing, non-virtual connections. For example, the "slumcode" group was active, as were several class, homework, and club groups within Strathmore. Slumcode also included groups that were used for church and family activities. Active groups tended to have a small subset of active members; for example, while everyone in the Slumcode pilot was a member of the group "slumcode," there were only four highly active members.

Many people initially stated that the nine group ceiling was too low. While 45% were members of only one group, many of the Slumcode participants, in particular, were members of two and often three groups. One person was a member of eight groups. Figure 8 illustrates this distribution. An alternative, more flexible, design could number groups as short codes: having an e.g. four-digit code per group would be familiar, alleviate the nine group ceiling, and ensure that everyone used the same "key" for a given group.

Figure 7 shows the change in group membership over the trial period for both pilots. It illustrates how the Slumcode participants, in particular, created many groups which often went unused; they did have three active groups, and one small group with an external member (10). Strathmore users tended to form larger groups based on class and club memberships. Several smaller groups were used for homework and socializing. Within groups, texts were primarily used casually and for greeting, while tangazos were for more
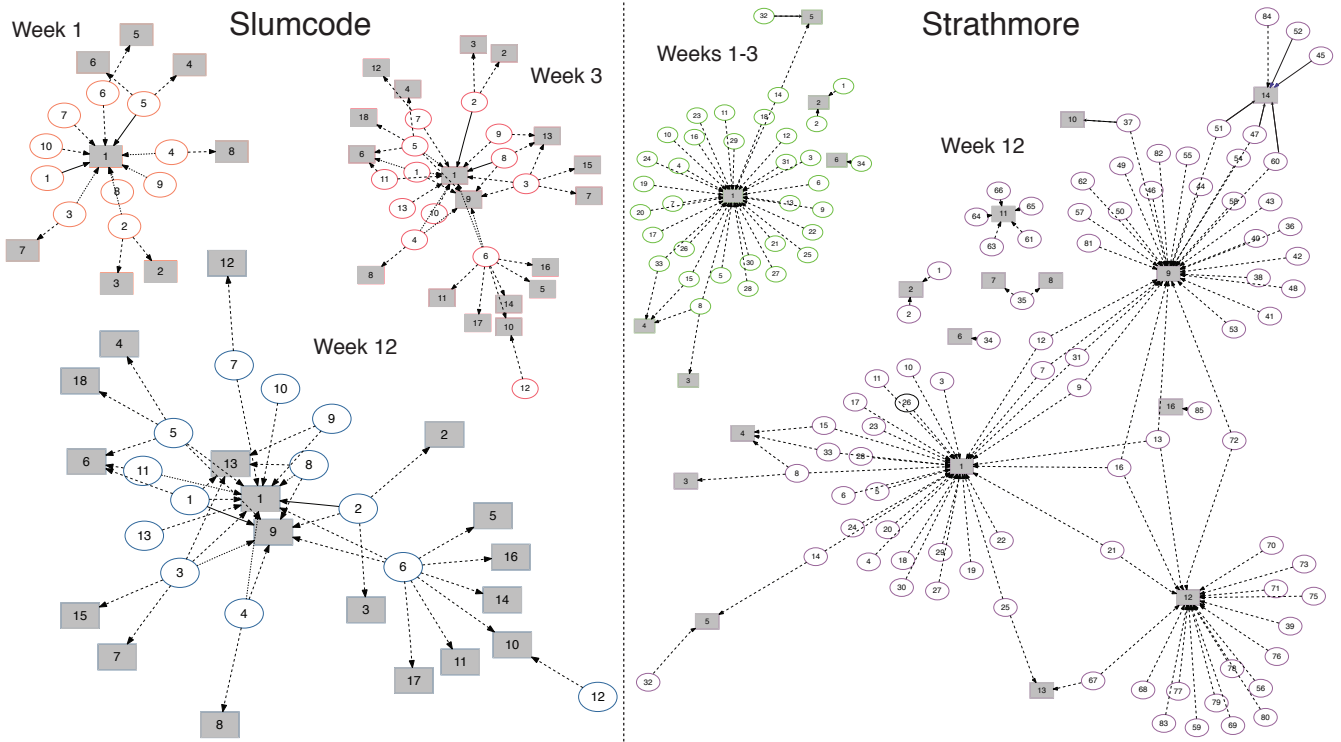
Figure 7: Change in group structure over trial period. Each box represents a group; each circle represents a person. Less active group membership is shown with dashed lines; solid lines show active membership. For example, in Strathmore Week 12, group 14 had five active users: 45, 47, 51, 52, 60 (upper right).

serious notifications such as changes in meeting schedule, homework discussions, and coordinating events.

5.4.2 Why others did not

While the more active groups were based on pre-existing local networks, some groups became dormant, mainly because the scale of the Tangaza pilot did not match the ubiquity of other online social networks. This was particularly true for the Strathmore group. Strathmore users said Tangaza was "not widely used yet," that "more people need to know of its existence," and "other people stopped *tangazaring* so I also followed suit."

5.5   User Interface

Our design attempted to make creating and listening to new tangazos fast and, therefore, cheap. While most people said Tangaza was "somewhat easy" to use, some tasks were harder than others. People from both groups felt that sending a message was particularly easy, but creating groups and inviting people to them was particularly difficult. Many people wanted to use invalid characters (punctuation and spaces) in group names – e.g. "Deno R.I.P.," "odhoji's" – and were frustrated when these were rejected. Perhaps not surprisingly, some people expressed that there was a disconnect between which key needed to be pressed to select a group and the group itself. Users also wanted reinforcement that they had selected the correct group when using the IVR; we had not provided this to speed up the interaction. Instead, announcing the name of the selected group, as recorded by the group creator, could provide this feed-back. Another option would be to use speech recognition for group selection, where either the user or the administrator would have supplied the matching utterance; recognition and feedback in low-resource languages can be particularly tricky, however [16, 24].

5.5.1   Notifications

We received conflicting feedback on the new tangazo notification mechanism. Several users from both groups referred to the on-going notifications as "spam" and wished to "to avoid the buzzing and call backs;" another said "the system can at times be irritable by flashing you at odd times." Others liked being reminded that they had forgotten to dial in and listen to new tangazos, and liked that notifications occurred in a "flash of time." While the commands exist to silence notifications, people did not use these options.

One interesting trade-off that would become relevant in a large deployment is the Tangaza operator's decision on whether to alert users of new tangazos either by flashing or by SMS. In our pilots, users were given a missed call when they had a new tangazo. Instead of the single bit of information that a flash provides – "you have a new tangazo" – in many cases, users would have preferred to know the group name and the sender. In feedback, some users also mentioned ascribing priorities, which could then determine the notification mechanism; we left this out so as not to add another option to the IVR. For a Tangaza operator focusing on a small number of groups or on keeping costs to a minimum, flashing may be the right choice. But for a larger deployment where many users are part of many groups, switching

to SMS as the notification mechanism is most likely preferable, as long as there is a financial mechanism to support it.

5.5.2 Privacy and Access Restrictions

Several Slumcode participants and one from Strathmore used the nickname feature to hide their identities. Many in Slumcode, in particular, continued to find privacy a concern, stating that "it shares the number with all the numbers in the group." This was due to not knowing about the feature rather than a problem with the feature itself: fewer than half of the Slumcode participants remembered about nicknames whereas 2/3 of Strathmore knew about this feature.

All groups used the default "public" level of access. Because participants knew each other, it is unclear if our proposed access controls would, in fact, map well on to larger groups, which would presumably be more of a management challenge.

5.6 Discussion

When we asked participants to describe in their own words what Tangaza is about, almost all mentioned its focus on spoken messages, one calling it simply: "audio twitter." As previous work found [8], most of our participants preferred spoken messages over texts: according to a Strathmore participant, "Text does not work...voice you get to capture people's emotions in their voices." Thus, while texting is cheap, there appears to be significant demand for spoken messaging among both income groups.

Other examples of this demand were a willingness to pay and a desire to expand the service to rural relatives. When asked what pre-paid package of Tangaza phone minutes and SMS they would prefer, users in both groups selected plans that cost a little more than one USD per week, saying they were "affordable;" they also marked as affordable plans where little or none of the cost was covered by the operator, showing the service could be self-sustaining or moderately subsidized. In addition, Slumcode participants asked for a "grandmother mode" that would provide their non-technically savvy relatives with a reduced, simpler interface; it would, for example, play new tangazos immediately, without any IVR selection.

6. FUTURE WORK

Tangaza "in a suitcase." While we have focused on single-country, long-term deployments of Tangaza, there are cases where a group would want to install it quickly in a new location. For example, Ushahidi, which aggregates and relays crisis information from many on-the-ground sources using their mobile phones, is currently SMS-based [23]. In order to deploy a spoken hybrid of Tangaza and Ushahidi, where sources can send spoken as well as text reports, Tangaza would need to become portable: because crises can occur anywhere, this Tangaza "in a suitcase" would need to be deployed in days, not months.

This appears feasible with three changes to our current implementation. First, our E1 and SMS lines can be replaced with a GSM modem bank. To contact the system and leave a new spoken message, users would flash a well-known phone number – advertised on the radio, for example – and a different phone from the bank would call back, freeing up the well-known number. Second, much as Ushahidi is customized for each deployment now, the Tangaza/Ushahidi

operator would first customize the series of IVR prompts. In addition, the initial set of groups for each user could be preset, hastening group growth at the expense of some flexibility. Third, to protect reporter privacy, we would require each user mask their phone number with a nickname. We plan to pursue these changes to Tangaza in collaboration with Ushahidi in the near future.

Community education. Many NGOs and government institutions focus on mass education of issues such as family planning, farming, and health. Agencies often only have the capacity to organize brief events where pamphlets are distributed; there is no forum to express problems and ask questions. Like Avaaj Otalo [14], Tangaza could be used as a platform for community education. Several NGOs, including LifeBloom in Naivasha, Kenya, have expressed interest in using Tangaza for this purpose.

7. CONCLUSION

Tangaza provides a low-cost group communication tool that can be used with basic cell phones with no installed software. It aims to enable primarily low-income users to form groups and send and respond to spoken messages and SMS texts within these groups. Through a simplified command interface that is accessed mainly through SMS, Tangaza intends to complement and connect to more robust group messaging systems that may be deployed to other users' more advanced mobile phones.

We described the design and implementation of Tangaza, and showed how two pilot groups, containing middle-and-upper and low-income participants, respectively, used it during a three month trial. We found that many previous mobile usage patterns were continued in Tangaza, particularly for the low-income group, and that pre-existing social networks tended to thrive, whereas other groups did not. We also found significant privacy concerns regarding users' phone numbers and a long-term loss of trust among some participants when reimbursements were slower than anticipated.

With improvements to the user interface and with more stable and fluid mobile credit transfers, our prototype of Tangaza depicts a demand for speech-focused group communication tools. These tools may, in turn, continue to alter the economics of developing regions beyond what the mobile phone has already achieved.

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