An Empirical Comparison of Technologically Mediated Advertising in Under-connected Populations

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ABSTRACT

Information and Communication Technology interventions have the potential to improve outcomes in health and other development sectors in low-income settings. Large-scale impact, however, remains the central challenge for the HCI4D community as significant and diverse resources are typically required to scale such interventions beyond the pilot stage. In contrast, voice-based entertainment services accessible over simple phones, designed for similarly low-income, low-literate populations manage to scale 'virally' to tens of thousands of users with little to no advertising cost. Our study compares the outcomes of using voice-based entertainment to spread a maternal-health hotline against conventional advertisement channels including paper flyers, posters, radio, TV, social media and robocalls. Through an 11-week deployment in Pakistan where the hotline reached 21,770 users over 32,625 calls, we find that the entertainment service outperformed other channels on all popular user acquisition metrics, with the exception of robocalls, which lead in terms of spread.

Author Keywords

HCI4D; ICT4D; advertisement; under-connected; Interactive Voice Response; IVR; Pakistan; low-literate; mobile phone; flyers; banners; TV; television; radio; social media; robocalls.

CCS Concepts

•**Human-centered computing** → **Human computer interaction (HCI);** *Sound-based input / output; Empirical studies in HCI;*

INTRODUCTION

In low and middle income countries, Information and Communication Technology for Development (ICT4D) interventions have been used to improve outcomes in sectors such as health [12, 49], agriculture [16, 32], and education [33, 21]. Several such interventions are designed using the modality of voice over simple mobile phones (aka Interactive Voice Response or IVR). This is done to ensure more inclusion towards people who do not have access to any other forms of technology beyond simple mobile phones and who are not literate enough to consume and produce textual forms of information. Regardless of the modality, to scale beyond the pilot stage, ICT4D interventions typically require significant capital and human resources to acquire and train large numbers of users [16, 32, 28]. Furthermore, the human resources used to recruit and mobilize users to the platform sometimes end up changing the intended purpose of the platform, or fail to reach vulnerable populations such as women, and other marginalized populations [28] . Scalable development impact is a central challenge in the ICT4D and HCI4D communities, and lack of scale is often cited as one of the main reasons for little impact in the face of big challenges [45]. In contrast, certain IVR services designed around the theme of entertainment and social-networking for similarly low-income, low-literate audiences [39, 38, 52] have scaled to tens of thousands of users with little to no advertisement cost for user acquisition. Such services can be leveraged to advertise and spread core development-related services as shown by Raza et al [39]. In this paper, we compare the effectiveness of leveraging an IVR entertainment service as a user acquisition strategy for a large-scale development service against conventional advertisement channels. For the purposes of this paper, we define *development* service as any technological intervention that aims to improve outcomes listed in the United Nation's Sustainable Development Goals (SDGs).[1]

Super Abbu (Super Dad), is an IVR-based development service that allows expectant fathers to ask questions and get answers from doctors, listen to publicly-posted questions and (doctors') answers, and share relevant personal stories with peers. Super Abbu is specifically targeted towards low-literate expectant fathers as pregnancy and childbirth remain taboo topics among men in Pakistan where maternal and child health indicators remain exceptionally poor [43, 20]. Traditional maternal health information services for mothers often fail to achieve desired outcomes as women are not the primary decision makers in most Pakistani households [30].

As part of a country-wide roll out of Super Abbu in Pakistan, we needed to reach a large number of users who would find the service relevant. Acquiring (and training) users is a significant

CHI '20, April 25–30, 2020, Honolulu, HI, USA.

ACM ISBN 978-1-4503-6708-0/20/04 ...$15.00.
http://dx.doi.org/10.1145/3313831.3376683

[1] https://sustainabledevelopment.un.org/sdgs.

challenge for any development service, particularly among under-connected populations. Moreover, the ability to effectively advertise to a large number of people directly impacts the scalability of the service. While traditional media such as paper flyers, public posters, television and radio advertisements have been used to market to low income users [26, 11, 7], over the past decade with the rapid proliferation of mobile phones [1], mobile marketing mechanisms such as robocalls[2] have become more common [2]. More recently, low-cost Android phones and subsidized access to mobile Internet [42] have made digital marketing through sponsored ads on online social networks a possibility [9].

This paper presents results from an 11 week campaign where we acquired users for Super Abbu through seven different advertising channels: (1) paper flyers [3], (2) banners displayed at the back of auto rickshaws, (3) cable TV ads, (4) radio ads, (5) robocalls, (6) sponsored Facebook ads, and (7) an IVR-based entertainment service. Across these channels we eventually reached 21,770 users who engaged in 32,625 interactions on Super Abbu. To assess the efficacy of the channels, we considered three main user acquisition metrics: conversion rate, cost of user acquisition, and retention rate. Furthermore, to understand whether the IVR users interact with Super Abbu differently from users acquired through other channels, we compared users in terms of their activity, engagement, and IVR use sophistication. Overall, our results show that the IVR-based entertainment service outperformed other advertising channels on all considered user acquisition metrics with the exception of robocalls, which lead in terms of spread.

Our paper contributes to the domain of HCI4D by building upon previous HCI literature which shows that voice-based entertainment services accessible over simple mobile phones can be used as vehicles for spreading development services [39]. However, the literature does not show how well such entertainment-driven proliferation performs in comparison with traditional advertisement channels in terms of cost, extent of spread, and quality of user-engagement. Our work aims to fill this gap by comparing various advertisement channels side-by-side as they attempt to scale the same development service – a maternal health hotline. We also show how users acquired through various channels fare in terms of overall activity, engagement, seriousness of purpose and IVR sophistication. While our project scaled a voice-based maternal-health hotline using an IVR-based entertainment platform, our results demonstrate more generally that compared to traditional channels of spread, entertainment has a great potential to be leveraged for acquiring users for development services and may even help resolve the critical bottleneck of large-scale impact in HCI4D interventions.

BACKGROUND

Super Abbu

Super Abbu, the development service we aim to scale, is a hotline designed to promote maternal-health awareness among low-literate men in Pakistan. Super Abbu was developed with the aim of driving down adverse birth outcomes by spreading reliable maternal health information in Pakistan – a patriarchal context, where men are the main decision-makers in their families and also have more access to technology [31]. Women only have limited and often monitored access to cellphones [41]. Therefore, Super Abbu was designed to target expectant fathers as the target audience. Modeling our approach on the framework put forward by Sultana et al. [45], Super Abbu was designed to circumnavigate the existing constraints and structures that bind women, and empower them from within despite these constraints. With an understanding of the local context and with the aim to *design beyond the user* [45], Super Abbu targets a father with essential information about the health and well-being of his wife (and child) with the expectation of benefiting the wife as the ultimate beneficiary. Further studies are required (and are underway) to investigate whether designing beyond the user in the current context actually leads to a trickle-down effect where women's health is impacted significantly.

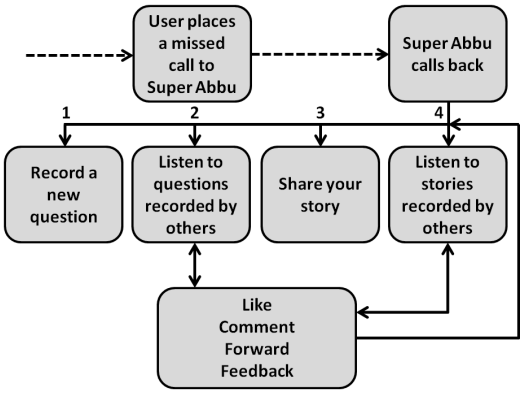

Figure 1. Super Abbu user interface flowchart

As shown in Figure 1, to interact with Super Abbu, users place a missed call and the service calls them back. Super Abbu is a public service, and does not require users to login or register. The service allows users to: (1) ask a doctor a question, (2) listen to publicly posted questions from other users and doctors' responses to those questions, (3) share their own stories, and (4) hear other users' stories related to pregnancy and childbirth. For option (1), users can choose to ask a private question (where the question is shared with the doctor and the doctors' response is only shared with them), or a public question, where their question and doctors' response forms part of option (2). Once users hear a story or question, they are able to share it, tag it as useful, and comment on it.

All user-generated questions and stories are moderated by the hotline staff before making them public. This prevents the spread of inaccurate, irrelevant and inappropriate information, and maintains the decorum of the voice community. Moderators listen to user-posted questions and only forward relevant ones to the doctors. Our volunteer doctors are recruited from local public and private hospitals. They listen and respond to user-questions via a smartphone app by recording an audio or a text message. All responses are re-recorded by a female

[2] An automated telephone call which delivers a recorded message.

[3] A handout or leaflet distributed among individuals in a public place.

speech artist as "Dr. Saba" – a female doctor's persona created for Super Abbu. Users receive these responses in their next interaction with the service. Questions marked public by the users are posted publicly along with Dr. Saba's responses.

Following a successful pilot deployment, it was decided in consultation with the funders of Super Abbu to scale the service to 20,000 users. The primary target audience was low-income and low-literate men of reproductive age. We explored all available options for reaching the desired number of users belonging to the target demographic. Being constrained by both budget and time, it was important for us that the advertising channels should be able to reach a large number of people rapidly, and at a low cost per user. Based on literature and our knowledge of the local culture, we identified seven channels as having the potential for maximum reach among the target audience: flyers, banners displayed at the back of auto rickshaws, video ads on local cable TV, targeted video ads on Facebook, audio ads on local radio, robocalls placed to people of target demographics, and audio ads on a popular entertainment driven IVR service, Polly [37].

Polly

Polly, one of the advertisement services that we used to spread and scale Super Abbu, is an IVR-based entertainment service designed to reach low-literate, low-income populations via a simple voice-based game. Polly was launched in 2011 by introducing its phone number to five low-literate members of the service staff at a local university in Pakistan. Within three weeks it had amassed over 2,000 users and 10,000 calls [37]. Over a year, Polly reached more than 165,000 users over 636,000 calls [39]. Polly's virality was achieved by design. When users call Polly, they are able to record and send voice messages to their friends in morphed, funny voices, making Polly playful while also providing a utility of being able to send free voice messages. This allows users to (1) be introduced to Polly through a referral from a friend whom they trust, and (2) immediately identify the playful aspect of Polly after answering the call. In 2012, Raza et al. launched a development service on top of Polly [39]. They scanned the classified section of Pakistani newspapers for job ads appropriate for low-literate workers, audio-recorded them in the local language, and made them available for audio-browsing on Polly. These ads were listened to more than 386,000 times within a year and demonstrated that Polly could be used to draw users to a development service. Our work tries to replicate Polly's success to promote a different development service, compare Polly to traditional and upcoming advertisement channels in terms of its ability to efficiently acquire users, and investigate whether users acquired through Polly behave any differently from users recruited through other means.

RELATED WORK

User Acquisition in Development Interventions

In 2009, Ho et al. [19] defined the scope for HCI for Development (HCI4D) as "any HCI research that addresses the needs or aspirations of people in developing regions, or that addresses specific social, cultural, and/or infrastructural challenges of developing regions". In a subsequent review of HCI4D research, Dell and Kumar identified scaling of projects to have the desired development impact as one of the benchmarks for success [13]. Scaling to a large number of people is also often a key requirement for donor agencies, or other investors, that fund development projects [28]. However, despite scale being a critical metric for success, only a small handful of HCI4D projects have managed to actually achieve large scale, with only a few notable exceptions [16, 39, 29].

Many HCI4D pilot studies recruit on the order of tens of users [35, 47, 40, 50, 34]. Lack of resources has been cited as a reason for why HCI4D projects fail to achieve large scale [6]. More specifically, since the technology service itself is often already challenging to design, implement, and deploy in a constrained development setting, very few resources remain to scale and sustain projects [10]. While a small number of users may be sufficient for pilots or projects with narrowly defined research goals [19], scale ultimately determines the social impact of development services.

HCI4D projects generally recruit users through personal contacts, word of mouth, or NGOs and other public institutions [34, 12, 35]. These approaches are often not scalable because the cost per user is high and recruiting additional users requires a proportional increase in resources. One particular community mobilization and user recruitment strategy that has been able to scale after multiple rounds of iteration, is the "federated model of smaller democratic volunteer groups, that are incentivized through monetary, social, purposive, and solidarity incentives" [28]. This strategy requires hiring a number of community managers, who recruit and train volunteers, and finally monitor and incentivize their performance. The smaller volunteer groups not only recruit potential users, but also garner hyper-local content for the platform, further changing the structure and content available to users of the platform. Moitra et al [28]. found that this particular community mobilization strategy also requires the right balance between standardization and flexibility, and between centralized organizational control and decentralized democratic setups. Consequently, bigger projects in ICT4D typically rely on advertising to recruit users more cheaply at large scale [32]. Marketing of health interventions, especially technology-based health promotion services, remains a challenge. Levine et al. [24] spent $15,000 on marketing and evaluation of a sexual health text messaging service that cost $20,000 to build and $1,500 to maintain. Our work builds on the strategies for social marketing in health promotion provided in Hastings and Haywood's article [18], and we find that the medium of communication can have an impact on the conversion and retention of users for health promotion applications.

Advertising

When the world wide web was taking off in northern America and western Europe in the late nineties, a few empirical studies compared the effectiveness of interactive advertising on the new medium with traditional media sources such as television and radio [5]. Since then, multiple waves of digital advertising have come to the fore, including mobile advertising (via apps), social media advertising, targeted advertising based on online behavior. As brands have shifted advertising budgets towards

digital ads to increase reach at lower costs, research has been conducted related to privacy and intrusion around location based advertising [25], how multitasking while using computers changes the effectiveness of traditional advertising such as radio [53], and how increased advertisement online effects brand equity [4]. However, a vast majority of this research has been conducted with literate and tech savvy users in Europe and North America.

In countries like Pakistan, where 42% of the population cannot read and write [22], yet more than 50 million users are online, it is worthwhile to explore the effectiveness of advertisement over new media technologies such as SMS, robocalls, and Facebook, compared to traditional media outlets such as radio, television and flyers. Sultan et al. [44] performed a comparative study between the US and Pakistan to test for consumer acceptance of mobile marketing. Little work is available comparing new advertising channels within low and middle income countries. Generally, research shows that robocalls are marginally effective [23], universally disliked [48], and their efficacy goes down as the number of robocalls from the same campaign increase [56]. Among college students in Turkey, Aydin et al. [7] found that attitudes towards both SMS and mobile app-based advertisement were negative, and that SMS ads are less credible than mobile app ads.

Voice-based Development Services

A significant majority of modern information and communication technologies rely on textual interfaces to communicate information over digital channels, which do not work well for non-tech savvy, low-literate, low-income, and visually impaired populations [14, 8]. For low-literate populations, even graphical interfaces can be a barrier to entry [27]. Interactive Voice Response (IVR) systems thus provide an opportunity to reach wider audiences because they only require the ability to make or receive a phone call using a basic phone.

A number of IVR services have been used to deliver development outcomes in low-income settings. Patel et al. [32] found that for farmers in Gujrat, India, task completion rates were significantly higher for touch-tone input compared to speech input, especially where farmers were less than 30 years old, or had less than eighth grade education. While designing an interface for school children in South Africa to provide feedback on school meals, Grover et al. [17] found a strong preference for speech as an input modality. White et al. [55] designed a voice-based employment exchange in rural India, and reported that respondents across various educational backgrounds found the service useful for getting job-related information.

With low barriers to entry, voice-based technologies have also been demonstrated to scale more organically and without extensive external inputs. For example, Vashistha et al. [51] found that low-income visually impaired people in rural and peri-urban communities of India had established informal networks of peer-produced audio content shared via Bluetooth, memory cards, and CDs. CGNet Swara, an IVR forum for citizens to discuss local issues, logged 70,000 phone calls and 1,100 messages within the first 21 months of launch [29]. Baang, a voice based social platform in Pakistan, received 269,468 posts from 10,721 users (69% of whom were blind) within the first 7 months of its launch [38]. Unlike robocalls, voice-based platforms are also attractive because they can be designed to provide a variety of interactive features that promote engagement. Baang, for example, allows users to submit audio posts, upvote and downvote on other people's content, comment on previously recorded content, and forward such content to others. Our work compares the efficacy of an IVR-based entertainment service against conventional advertising channels for scaling a development service.

METHODOLOGY

Our research goal is to compare the efficacy of different advertising mediums to spread awareness about a development service to hard-to-reach, low-literate, low-income users. We measure the success of these channels in terms of their ability to recruit callers to Super Abbu who actually use the service for its intended purpose. We primarily focused our recruitment efforts in Lahore, the capital of Punjab province, because of the high population density and relatively good infrastructure.

We hired a creative advertisement agency to help design the ads for all channels and recruited a famous Pakistani cricketer to appear in our ads and endorse Super Abbu. To maintain a reasonable comparison, we employed the same ad agency and celebrity across channels. We also tried to keep the recruitment material design, information content and even verbiage as similar across channels as permitted by the specific design guidelines of each medium [5]. Certain mediums impose design constraints e.g. for the robocall, we needed to grab the attention of the users so that they do not hang up. So we created five curated questions and placed them before the standard boilerplate ad language. The Polly ad was brief as users tend to skip lengthy ads, and in the same voice as rest of Polly's prompts. We also tried to keep the production quality as high as we could afford for each channel (professionally recorded audio and video, glossy paper for the flyers).

We began advertising on all mediums around the same time and spent an initial $100 - $300 on each medium to see how well they performed. After an initial period (reported below), due to budgetary restrictions, we stopped funding the mediums that did not perform well (rickshaw, cable TV, radio). We spent the remaining amount of funds on the four channels (Polly, robocall, Facebook ads, and flyers) that performed better in terms of bringing a large number of users to the service.

We used unique call-in numbers for the Super Abbu service for each of the seven channels to differentiate users recruited through them. After the campaign period, we analyzed our detailed call logs as well as the actual user-recordings. We compared the channels in terms of the number of users acquired, cost of acquisition, and retention rate. We also compared the users in terms of activity on the Super Abbu service, relevance of contributed content, and the use of relatively complex IVR functionality. Finally, we conducted a post-study telephone survey to obtain demographic information about our users.

Institutional Review Board (IRB) approval was obtained from the three universities of the authors before the start of the project. Disclaimer messages were added to the Super Abbu service to let the users know that their interactions were being

recorded for research and quality improvement purposes, and also to warn them to hang up in case of emergency and call the local emergency numbers instead. The users who received robocalls had submitted their cell phone numbers as part of a prior government intervention in health and agriculture sectors, and had agreed to be contacted about other relevant services. While robocalls can be a nuisance, users could hang up at any point during the call. Users who actively disconnected robocalls were never called again as part of the recruitment process. It was determined that the potential benefit of finding out about a public health service outweighed the risk of annoyance as part of a robocall, and every possible effort was made to minimize such risks.

Recruitment strategy

This section describes the recruitment strategy for each of the channels. We have made all of the described material available in the supplementary material section.

Polly: We placed a 28-second audio banner ad at the start of the interaction. Users could press a key to transfer to Super Abbu anytime during and just after the ad that was played each time a user contacted Polly. An option to switch to Super Abbu was also augmented to the main menu of Polly (as option 5). The ad was recorded by the same voice artist who had recorded other prompts for Polly. 3,046 users ended up listening to the ad, costing us a total of $969. The script of the ad is as follows:

> Guarantee your family's health! Super Abbu helpline, now allows you to hear expert doctors' opinions around pregnancy and childbirth. To avail Super Abbu's services, press 1 on your phone now, or place a missed call to 042-3890 0808 at any time. The system will call you back in a short while, and you can enjoy all of Super Abbu's services for free, from the comfort of your home.

Robocalls: In order to acquire phone numbers of potential users from our target demographics, we partnered with a government agency responsible for running public services in healthcare and agricultural domain. We were given a data set of 100,000 phone numbers without any personally identifiable information. These users had volunteered their cell numbers while accessing public services, and were not denied access in case they refused to give their numbers. We placed 35 second long robocalls between 9 am and 10 pm. The robocalls were retried up to three times with a gap of 8 hours if the phone number was busy, powered off, or out-of-cell-coverage. Robocalls were not retried if users canceled the calls, either before or after answering. 75,994 recipients answered our calls, costing us $2,894. Each robocall contained an audio endorsement by the cricketer at the start of the recording, followed by one of five curated messages that contained a question around maternal and child health. Here is an example robocall script:

> Assalam O Alaikum! (Hello!) Do you know what it means if a child doesn't cry immediately after birth? You can find answers to such questions without leaving the comfort of your home. Call Super Abbu's free hotline, and ask qualified doctors questions about pregnancy and child birth. You can also listen to other parents' experiences. To go to Super Abbu now, press 1. Or, at any time, place a missed call to the number from which you have received this call to get a call-back from Super Abbu.

Figure 2. Printed flyers distributed in hospitals and at bus stops

Flyers: We distributed 30,000 flyers (Figure 2) outside five large public hospitals and at bus stops in Lahore. In hospitals, the flyers were distributed among men at the gates and those waiting outside maternal and child wards. The flyer distribution was done in 2-3 day drives over 3-4 weeks through a distribution company that charged 1 cent (US) per flyer. The overall cost of printing and distribution of the flyers was $682.

Sponsored Facebook Post: We created a 60-second sponsored video ad using Facebook's boost-post feature. It was watched by 102,935 users over 3 weeks. The target audience was specified as men of ages 18-45 years and living within and on the outskirts of large urban cities in Punjab: Faisalabad, Gujranwala, Lahore, Multan, Rawalpindi, and Sialkot. The amount of money spent on advertisement on Facebook ($95) was roughly half the amount spent on radio and cable TV ads, but given the low conversion rates, we chose not to spend more money on sponsored Facebook ads.

Auto Rickshaw Banner: We commissioned 100 auto rickshaws to display a banner attached at their back for a month (total cost: $301). We calculated the expected reach of this medium with the help of two local advertising agencies which came out to 4,752,000 views (6 average daily active hrs * 264 views/hr * 100 rickshaws * 30 days (duration of campaign))[4].

Audio Radio Ad: We created a short 25-second audio ad and a longer 60-second ad and aired them on two local FM radio stations of Rajanpur and Jhang districts of Punjab, having a total population of 4.7 million in 2017. The short ad was

[4]These estimates are based on internal industry surveys that are not publicly accessible.

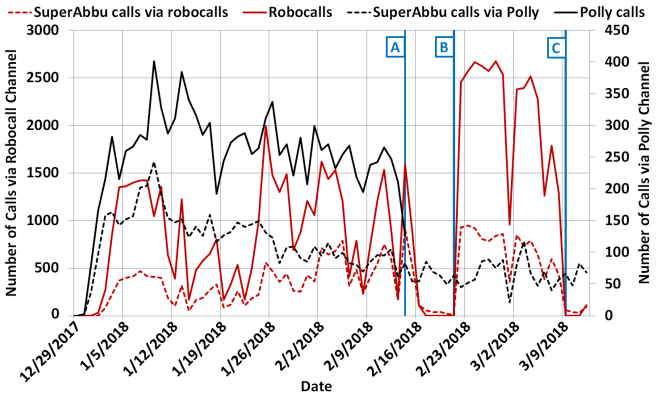

Figure 3. Number of users acquired via Polly and robocall channels

played 12 times and the longer one 5 times in each peak slot (7am – 10am and 5pm – 10pm) over four days (total cost: $198). As the radio stations did not have listenership estimates we calculated the expected reach with the help of our partner advertising agencies to be 38,000 impressions (peak time usage (# radio listeners (11% in Jhang (2,743,416), 9% in Rajanpur (1,995,958)) * fraction of FM 104/5 listeners (6% and 9%))[4]. The short ad script is as follows:

> Now you can listen to the advice of expert doctors around pregnancy and childbirth for free without leaving the comfort of your home, using the Super Abbu helpline. Place a missed-call to 042-3890 0808 right now and Super Abbu will call you back soon. All of its services are available to you for free.

Cable TV Ad: The Facebook video ad was also played on local cable TV. Lahore is serviced by eight cable providers that do not compete in terms of geographic coverage. We chose two that mainly service low income areas. The ad was played between movies on three movie channels operated by each cable operator for a week (total cost: $172). Super Abbu's number was also occasionally displayed on a ticker at the bottom of the screen during movies. As the cable operators did not have viewership estimates, we estimated the reach with the help of our ad agencies to be 31,000 views (12,000 and 19,600 subscribers for the two cable companies * household size (6.6) * 15% normalization for the number of channels)[4].

RESULTS

Overall, our advertising campaign was able to reach 21,770 users through the seven advertisement channels. The total amount of money spent on advertisement was approximately $5,500 (USD). Our primary objective was to study whether an existing IVR entertainment service (Polly) can be leveraged to attract users onto a new development service (Super Abbu), and if so, how does it compare to other promising advertising channels (1) flyers distributed at hospitals and bus stops, (2) automated robocalls to a curated list of phone numbers, (3) sponsored Facebook video ads, (4) banner ads placed on auto rickshaws, (5) audio ads on local radio channels, and (6) video ads on cable TV.

We present our results using standard user acquisition metrics (a) conversion rate, (b) cost of user acquisition, and (c) user retention rate, because our primary research question was focused on achieving scale for HCI4D interventions in a "sustainable" (i.e. without costly external inputs) manner. These metrics, while not comprehensive, are common standard advertising metrics that capture the first-order measures of interest for our research question. As suggested in the literature [38, 54], we also use (i) user activity (on the target platform) (ii) level of engagement, and (iii) level of IVR sophistication to measure the relevance and the quality of the usage of the development service by users attracted through the various advertisement platforms. Detailed qualitative analysis of the usage data from the Super Abbu pilot is beyond the scope of this paper.

User Acquisition

We use the following metrics to assess user acquisition:

- *Conversion rate* - The fraction of people reached through an advertisement channel who end up calling Super Abbu.
- *Acquisition cost* - Cost of acquiring a new user of Super Abbu.
- *Retention rate* - The fraction of users who keep calling Super Abbu k days after their initial use.

Conversion Rate

Table 1 summarizes the conversion rate for each of the channels. We find that Polly was very successful in attracting users to Super Abbu, much more so than any of the other six channels. Approximately 50% of the 3,046 users reached through Polly opted to become users of Super Abbu, while the second highest conversion rate (robocalls) was roughly half of that of Polly (25% of 75,994 users approached). All other channels had conversion rates of less than 0.1%.

Figure 3 compares Polly and robocalls, the channels with the highest conversion rates, in terms of number of interactions with these channels and with Super Abbu over the entire length of the deployment. The activity of users acquired via robocalls with Super Abbu sharply rises and remains high while the robocalls are active (flag B in the figure when we started calling a large group). It plummets as soon as we stop making robocalls (flags A and C). On the other hand, users acquired through Polly continue to call Super Abbu for several weeks even after we turned Polly off (flag A). This brings up a possibility that robocall users only end up having a handful of interactions with Super Abbu and churn at a high rate. In the following sections, we see that this indeed is the case.

Channel	#People Approached	#People converted	Conversion Rate	Cost (USD)	Cost per user
Polly	3,046	1,539	50%	$969	$0.63
Robocall	75,994	19,688	25.9%	$2,894	$0.15
Facebook	102,935	91	<0.01%	$95	$1.05
Flyer	30,000	197	<0.1%	$682	$3.46
Rickshaw	4,752,000	132	<0.01%	$301	$2.28
Cable TV	31,000	87	<0.01%	$172	$1.98
Radio	38,000	36	<0.01%	$198	$5.5

Table 1. Conversion rate and user acquisition cost for different channels.

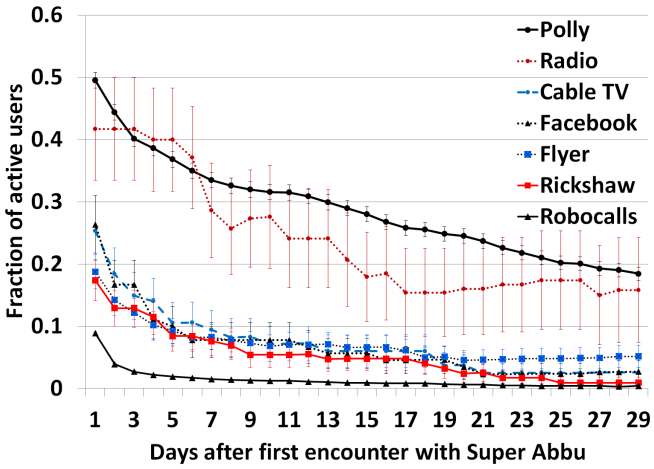

Figure 4. Retention of users from different channels

Acquisition Cost

Robocalls were the most cost effective way to get users onto the platform (Table 1). It costs $0.15 to recruit each user via robocalls, compared to $0.63 to recruit each user from Polly – approximately 4 times as costly. While Polly's conversion rate is a lot higher, it is also more costly to advertise on Polly compared to placing robocalls in Pakistan. Still compared to other channels of spread, both Polly and robocalls turned out to be the most cost effective choices.

It should be noted that we have calculated the cost of advertisement on Polly by measuring the number of minutes that the ad was played on Polly, and not the overall cost to run Polly. We used Polly as an existing service for hosting our ad campaign. Researchers and practitioners who wish to replicate this model may need to account for a profit margin on top or plan to host Polly. Polly's actual running expense varies a lot based on several factors. It is low in regions covered by cloud platforms like Exotel, Plivo, Twilio. Otherwise, there is a cost of hosting servers and telephony gateways. It also depends on the airtime and hosting rates negotiated with the local TELCOs. Finally, there is a lot of cost variability around the extent of virality [36]. The total cost in Table 1 also does not include the creative cost of design of the advertisement or the cost of production for any of the channels. These costs come to $1200 that the advertising agency charged us lump sum. The level of effort, however, was not uniform across mediums and it took more time and effort to shoot the video and design the flyer and poster compared to the scripts for audio ads, robocalls, and Polly.

Retention Rate

Next we compare user retention among the four channels that performed the best in terms of user acquisition (Polly, robocalls, Facebook ad, flyers). Figure 4 depicts the comparison of retention. Each graph shows the fraction of users acquired through a particular channel, who remain active on Super Abbu, k days after their initial interaction (where k = 1, 2, 3, ..., 29). For each k we only consider the set of users in the denominator for whom we had a chance to observe at least k days of activity. Error bars show standard error. The retention curves for rickshaw, cable TV, radio, and Facebook are not as smooth since there were fewer users from these channels.

As shown in Figure 4, users acquired through Polly had the highest user retention with 50% of users returning one day after their initial interaction, 33% returning a week later and 18.5% still calling a month later. Polly offered the lowest cost per retained user. Radio had the second highest retention. However, as only 36 users were recruited through the radio channel, these estimates are prone to more noise. All of the other services performed poorly. Robocalls, which performed very well in terms of user acquisition, had very low user retention. Only 8.9% of users called a day after their initial interaction and the numbers fell to less than 2% within a week. In fact, 70% of all users who were acquired through robocalls only had a single interaction with Super Abbu. Similarly, 58.8% and 58.4% of all users acquired through Facebook ad and flyers engaged in just a single call with Super Abbu. In comparison, 60% of all users acquired through Polly called more than once and 14% called more than 5 times.

User Interaction

We also wanted to assess whether users from the entertainment service interacted with *Super Abbu* differently compared to users from other channels. We were particularly interested in exploring whether (a) prior experience using speech-based services (familiarity with Polly) helps in the adoption of *Super Abbu*, and (b) prior exposure to an entertainment service makes users less likely to take the development service seriously. We measure interaction in terms of the following metrics:

- *Activity on the platform*: The average number of calls and time spent by each user during their first week on the development service.
- *Engagement*: The quantity and quality of questions and stories recorded by users from different channels.
- *IVR Sophistication*: The average number of button presses and 'barge-ins' performed by users of different channels[5].

Activity on the Platform

We found that users acquired through Polly were much more active compared to their counterparts who were recruited through other channels. Table 2 compares the activity of users who were acquired through various channels over their initial seven (consecutive) days of use. The restriction on number of days was imposed to normalize across channels. Users acquired through Polly spent an average of 27.77 minutes on Super Abbu, compared to robocall users who spent an average of 6.38 minutes. Users recruited through Facebook ad (12.33 minutes), auto rickshaw ads (11.49 minutes), radio (12 minutes), and cable TV ads (17.07 minutes) spent more time on average than robocall users. Users that came in through Polly also ended up calling more frequently compared to users from all other channels.

Feature Engagement and Quality of Usage

We find that users from Polly performed better across engagement with all interface features. Figure 5 summarizes the

[5]A *barge-in* is the selection of a menu item while the instructions are still being played.

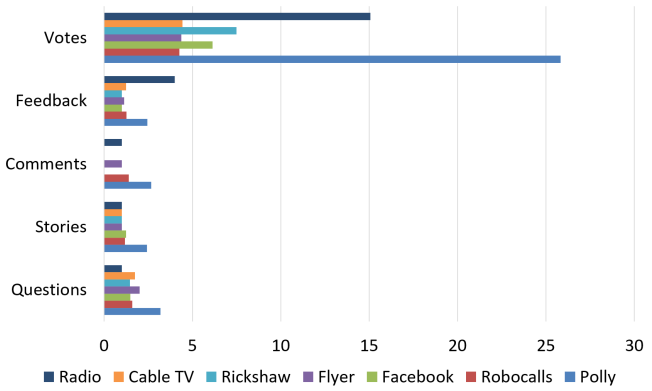

Figure 5. Average usage of features per user

average number of interactions for users from each advertisement channel with various interface features of Super Abbu (voting, feedback, comments, stories and questions recorded). It can be observed that users acquired through Polly expressed their opinions via higher number of votes and comments and also contributed more content in the form of stories and questions. To investigate further, we consider the quality of content contributed by users from these channels.

Table 3 shows a comparison of the quality of questions recorded by the users. All contributed questions were tagged as being "relevant", "silent/noisy" or "irrelevant/inappropriate" by our moderators and only questions marked as "relevant" were forwarded to the doctors. We find that Polly and Robocalls drastically lead in terms of number of questions posted by users and that the fraction of relevant questions contributed by users from Polly (27.7%) is nearly three times that of robocall users (10.9%). Interestingly however, this percentage is lower compared to the remaining channels (39.7% - 44.9%). A possible explanation is that users acquired through an entertainment service may not take the advertised development service seriously. Also, 82% of all questions contributed by robocall users were empty. These users may have ended up in the recording menu by mistake or were just exploring the interface (e.g. by randomly pressing keys) and did not know what to do once there.

IVR Sophistication

In this section we compare users acquired through the four most prolific channels in terms of the sophistication of their IVR usage. We have used a subset of features: button presses, barge-ins and forwarding of posts, that are suggested by Wang et. al [54] as indicators of more sophisticated IVR functionality. For button presses we count all key presses in Super Abbu,

Channel	#Calls	#Users	Airtime (mins)	Avg #calls per user	Avg airtime per user (mins)
Polly	5,224.00	1,491.00	41,407.00	3.50	27.77
Robocall	26,420.00	18,873.00	120,418.00	1.40	6.38
Facebook	165.00	90.00	1,110.00	1.83	12.33
Flyer	377.00	195.00	1,498.00	1.93	7.68
Rickshaw	222.00	131.00	1,505.00	1.69	11.49
Cable TV ad	158.00	58.00	990.00	2.72	17.07
Radio	59.00	35.00	420.00	1.69	12.00

Table 2. Activity of Super Abbu users acquired through all channels over initial seven days of use

Channel	Relevant questions	Silence/ Noise etc.	Irrelevant/ Inappropriate
Polly	452 (27.7%)	1011 (62.1%)	166 (10.2%)
Robocall	491 (10.9%)	3692 (82%)	322 (7.1%)
Facebook	22 (44.9%)	25 (51%)	2 (4.1%)
Flyer	161 (47.5%)	167 (49.3%)	11 (3.2%)
Rickshaw	25 (39.7%)	37 (58.7%)	1 (1.6%)
CableTV	26 (40%)	35 (53.8%)	4 (6.2%)
Radio	2 (40%)	3 (60%)	0 (0%)

Table 3. Quality of user-recorded questions

a barge-in occurs when a user presses a key to make a selection before the audio prompt is finished and for forwarding we consider sharing of both questions and stories. Table 4 compares usage in terms of these behaviors averaged over number of users from each channel.

We find that the differences between channels are not significant in case of button presses. Users from Polly lead in terms of barge-ins (77.99%), though users from Facebook, cable TV and radio all used barge-ins nearly as frequently (68.97% - 72.50%). In terms of the forwarding function, users from Polly forwarded many more stories and questions than users from other channels (20%). We suspect that this is likely because Polly users are already familiar with the forwarding feature and the involved dynamics from prior experience.

Comparing Polly and robocalls, we see that although robocalls lead in terms of the magnitude of *primary spread* (19,688 vs. 3,046 users brought by robocalls and Polly, Table 1), Polly clearly outperforms in terms of viral spread (20.66% of Polly users forwarded content vs. 1.04% of robocall users). Primary spread measures the #users acquired directly through the ad. Secondary (viral) spread measures the #users acquired through the primary users as they forward stories and questions to friends or engage in offline discussions. Table 4 shows the fraction of users who engaged in the secondary spread. As a result of these forwarded messages and offline communication, 1.57% of all robocall users and 27.55% of all Polly users were acquired through the secondary spread.

User Surveys and Demographic Details

We conducted a phone survey of 216 users, selecting most active (119) and least active (97) users. The questions were arranged in increasing order of sensitivity so that we could obtain at least partial information in most instances. The surveyors introduced themselves as individuals conducting surveys on behalf of Super Abbu. After introducing themselves, reminding the user of Super Abbu and collecting informed consent, the surveyors asked demographic questions such as age, education, and occupation. The survey then moved on to technology use, and asked about the type of cell phone, monthly cell phone expenditure, and Internet usage.

Only 55% of the 216 users selected for the surveys, picked up our calls and consented to the survey. Among them, only 29 had heard about Super Abbu or remembered using it. Since the overall number of active users in our pool from other channels was small, this initial survey group was heavily dominated by Polly (21) and robocall users (7). To get demographic

information for all other channels, we conducted another round of surveys with 140 users, with 20 randomly selected users for each of the seven channels. From this second round of phone surveys, only 14 of the 140 respondents picked up the call, consented to the phone survey, and remembered using Super Abbu. Given that we were only able to collect demographic data of 43 users from the two phone surveys, we present our findings as a comparison between the users of Polly (22 respondents) and the users of all six of the other channels combined (21 respondents).

Based on our surveys, the vast majority of Super Abbu users recruited through Polly were male (95%); spent $2.58/month on mobile expenses and had an average of 7.2 years of education. Similarly, for all other channels, a vast majority of the users were male (94.7%), spent $3.88/month on cell phone use, and had 9.33 years of education on average. If we consider money spent on cell phone expenses as a loose proxy for income, our data shows that on average, we were able to recruit low literate (despite 7.2 years of education [46]), low-income men to the Super Abbu service. Compared to users from the other channels, Polly users were less educated, spent less money on cell phone usage, and a greater fraction were feature phone users (63.6% compared to 38.1%). These broad demographic trends corroborate with prior studies that have found Polly users to be mostly low-income, low-literate young men [37].

Phone surveys are essentially cold-calls conducted without prior appointments or notice to the users. A few of respondents said that they were *busy at the office* or *driving*. Other users said they *did not want anything from Super Abbu* (presumably thinking we were telemarketers). Some users disconnected the call as the surveyor was introducing themselves, while others asked the surveyor to call back from the official number used for Super Abbu, as they did not trust a call from a random number claiming to be from Super Abbu.[6] Given these numerous issues with phone surveys it was unsurprising that a large number of respondents refused to consent to the survey, or hung up when questions such as years of education or money spent on phone usage were asked.

DISCUSSION

In this paper, we have reported a comparison of seven advertising channels to scale up a maternal health hotline in Pakistan and acquire users for it. We have presented a detailed comparison of all the channels in terms of indicators that are important for a development-related information service: spread of the service and cost of user acquisition, user engagement with features of the interface, user retention, quality and relevance of the user-contributed content, and sophistication of interface use. Out of the seven channels, only robocalls, Facebook, and the IVR entertainment service were able to acquire users at relatively low cost per user (around $1 or less). Polly offered the lowest cost per retained users of Super Abbu and most users outside of Polly did not end up becoming long-term users of the service. Thus, Polly clearly performed the best in terms of user acquisition and retention. Users recruited through Polly also demonstrated markedly higher activity, tendency to spread the service to others and feature engagement than users from other channels.

One of our key findings is the surprisingly high conversion rates for Polly (50%) and robocalls (25%) compared to other channels (less than 0.1%). The latter statistics are not surprising, as the industry standard for advertisement channels is also 0.1% [15]. While our data does not establish the causal reasons for the high conversion rates of Polly and robocalls, we can hypothesize several explanations. The high conversion rate of Polly might be due to its entertainment value that lowers the barrier for the users to press a button and explore the advertised service. Also, both robocalls and Polly employ the same modality (IVR) as the development service. This allows a relatively smooth transition between the advertisement channel and the advertised service compared to other channels where people need to memorize the advertised phone numbers and dial them later. This means a higher cognitive load and persistent motivation compared to simply pressing a key immediately on Polly and robocalls. The IVR advertisement services also offer a smoother transition in terms of pre-training or at least priming the users to navigate speech interfaces before transitioning to the development service. Previous work by Wang et al. [54] supports this hypothesis as it has been shown that speech-based entertainment services implicitly train users to better handle speech interfaces. Yet another reason for the high conversion rate of robocalls could be that these calls were made to users of government-run information services (health and agriculture), so they may be primed and pre-selected to be more open to such services given that they had volunteered their phone numbers. However, additional studies are required to generalize and verify these explanations.

Some of the most promising advertisement channels performed surprisingly low in terms of conversion rates. While we were able to reach 102,935 views for the Facebook ad among the demographics of interest, and at a very reasonable cost, the response in terms of conversion rate was negligible. Only a tiny fraction (less than 0.01%) of the Facebook users who were reached through the advertisement ended up calling Super Abbu. However, the users acquired via Facebook asked more relevant questions (44.9%, N=49) compared to Polly (27.7%, N=1,629) and Robocalls (10.9%, N=4,505).

Our finding regarding lack of user retention and engagement resulting from robocalls is consistent with the literature. We were fortunate to have access to a huge database of phone num-

[6]There have recently been widely reported phone survey scams in Pakistan, including one where the caller claimed to be calling from the army to verify census data and asked for sensitive personal details [3].

Channel	% of users who ever pressed a button	% of users who ever used a barge-in	% of users who ever forwarded a story or question
Polly	98.77	77.99	20.66
Robocall	97.05	38.89	1.04
Facebook	97.57	71.96	5.49
Flyer	95.79	34.74	3.55
Rickshaw	96.86	56.7	2.27
Cable TV	100	72.50	5.75
Radio	89.66	68.97	25

Table 4. Engagement with sophisticated interface features

ber acquired through government interventions around health and agriculture. Despite that, our findings are very similar to prior attempts to acquire users via robocalls in India [36]. This is unsurprising since robocalls by definition are "cold-calls" where the recipient does not know the caller and is not expecting a call. As a result these calls either catch the recipients at a bad time or fail to orient and engage them quickly enough so that they would want to engage in a lengthy, involved call. As these calls originate from unknown phone numbers, users exhibit mistrust and suspect scams. In contrast, Facebook does not reach populations that do not own a smartphone, and the other advertisement mechanisms are costly and lead to poor conversion rates. HCI4D interventions continue to look for a solution that can help scale the intervention and increase the resultant impact. We demonstrate that entertainment services such as Polly, that go viral by design, while simultaneously build trust by forwarding voice messages to friends and playing the sender's name to the recipient as soon as they answer, could be one viable way to acquire and train users to scale HCI4D projects. Our results show that despite coming via an entertainment service, Polly users still converted to the development service in large numbers.

Although IVRs are more interactive than robocalls, usability of the IVR interface is still a potential barrier in development services. As reported previously, Polly implicitly trains its users to become better skilled at using IVR interfaces [54]. Thus, we were not surprised that users from Polly are on the more sophisticated end of the usage spectrum, and also end up becoming longer term users of the service. While robocalls turned out to be the cheapest channel of spread, users recruited through robocalls have very low retention. Facebook users ask more relevant questions, but are more expensive than Polly users. The only weakness of recruiting users through Polly appears to be the lower fraction of relevant questions. This, is unsurprising given that Polly is originally an entertainment platform. We do not think this is a serious limitation of entertainment services since users will likely self-select into the development service based on its relevance to their interests and eventually only the more serious users will be retained.

Limitations and Future Directions

Super Abbu was designed to target fathers in the hope that the information will lead to better health outcomes for expectant women [45]. However, a service designed exclusively for fathers does present a potential risk of excluding women and reinforcing their existing marginalization. We are investigating this further in our current research in Pakistan where we are also trying to measure the impact of the delivered information on the health of the expectant women.

Our study uncovers interesting questions about the extent to which quality of ad content may impact user acquisition rate, and the correlation between various features of content quality (e.g. paper quality, size, choice of words, graphical vs. textual, colored vs. grey scale, etc. in case of flyers) and high user acquisition. These questions are beyond the scope of the reported study and we plan to investigate them in our current and future research. The extent to which user acquisition and retention are linked to the modality being common between the advertisement channel and the advertised service, also needs further investigation.

Our demographic surveys were only able to obtain data from a handful of users from all channels except for Polly. Due to the cold-call nature of the survey, it was difficult to find users who were willing to respond to our questions, especially those who had never really engaged with Super Abbu. Therefore, we were unable to concretely determine the demographics of users from various channels. Also, our surveyors noted down their own assessment of participant's gender (using binary gender assignment) based on their vocal characteristics. It is considered impolite to ask someone's gender in the local context.

Finally, in case of Polly, rickshaw, radio, and cable TV, we had no strict control over the geographical location and demographics of the people reached. With the exception of Polly and Facebook, the remaining channels use unconstrained broadcast mechanisms that reach people of various demographics. In case of Polly, we only have control over the initial "seed" users of the service, but there is no control or limitation over its organic spread. Finally, we did not pre-screen any of our acquired users to predispose them towards health services (with the exception of flyer recipients in hospitals), and we cannot objectively claim whether or not any bias of this type exists in case of users acquired through any channel.

CONCLUSION

In developing regions, technology-based interventions typically require significant resources to achieve scale beyond the pilot stage. Spreading awareness, acquiring users, and retaining them over time are all significant barriers to scale. In this paper, we compared seven different advertisement channels in their ability to cheaply and effectively acquire users for a maternal health hotline, Super Abbu, in Pakistan. We presented a detailed comparison in terms of indicators that are important for a development-related information service. Our findings point to IVR platforms (robocalls and Polly in our study) performing better than other platforms (Facebook, flyers, radio, cable TV and rickshaw ads) in terms of user acquisition. Users acquired through the IVR entertainment service (Polly) performed better than other channels in all interface-related measures (activity, feature engagement, use of sophisticated interface features, and retention). Only robocalls, Facebook, and the entertainment service were able to acquire users at relatively low cost per user (around $1 or less). In contrast, most users acquired from outside of the entertainment service did not end up becoming long-term users of the development service. Our findings also show the comparatively lower performance of increasingly popular social media advertisement platforms (Facebook) to recruit low-income users (91 out of 102,935 people reached).

ACKNOWLEDGEMENTS

This project was supported by the UNICEF Innovation Fund. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the sponsoring institution or any other entity.

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