Social Computing for Social Good in Low-Resource Environments

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Cornell University
Social Computing Revolution

Discussion Forums, Social Media Platforms, Crowdsourcing Marketplaces, Blogs, Wikis...

Literacy, Language, Socioeconomic, & Connectivity Barriers

- 781 Million illiterate
- 2.5 Billion speak low-resource languages
- 736 Million live on < $2/day
- 3.6 Billion w/o connectivity
Great First Steps…

Facebook Aquila

Google Loon

Not Enough!

Microsoft Airband

Connectivity

- Sociocultural norms
- Geopolitical environment
- Literacy and language

Devices

- Energy and power
- Transport
Very Difficult to Connect People in Low-Resource Environments

Sociocultural norms
- 43%
- 13%

Connectivity

Devices
- 36%
- 64%

Geopolitical environment

Literacy and language

26% people illiterate

122 major languages but no models and data

No fonts for several languages

100+ proprietary OS
Goal: How to bring the benefits of social computing to billions of people who face literacy, language, socioeconomic, and connectivity barriers?

Voice-based Social Computing Services Using IVR

To record an audio message, press 1. To listen to others’ messages press 2.

Overcoming Barriers
Chhattisgarh, India
CGNet Swara
A Voice Portal for Citizen Reporting

600,000 phone calls, 6,500 reports
Other Early Deployments

**Avaaj Otalo** in India
Peer sharing of agricultural information

**Mobile Vaani** in India
Enabling people to record and listen to stories from others

**Ila Dhageyso** in Somaliland
Connecting rural people and government officials
Voice-based Social Computing Services for Global Development

**Health**
- Empowering Health Workers
  - Yadav et al. WWW 17

**Agriculture**
- Agriculture Discussion Forum
  - Patel et al. CHI 10

**Civic Engagement**
- Citizen News Journalism
  - Mudliar et al. ICTD 12

**Employment**
- Job Ads by Entertainment
  - Raza et al. CHI 2013

**Social Computing**
- Agarwal et al. ICTD 09
- Koradia et al. ICTD 12
- Vashistha et al. CHI 15
  - Raza et al. CHI 18
  - Vashistha et al. CHI 19

**MISC**
- Feedback on School Meals
  - Grover et al. DEV 12

**Millions of Calls and Voice Messages in Local Languages from Marginalized People**

- Realtime Health Radio Show
  - Razakos, CHI 14

- Treatment of People with AIDS
  - Joshi et al. CHI 14

- Community Price System
  - Bawa et al. CHI 12

- Civic Engagement Portal
  - Gulaid and Vashistha, ICTD 13

- Charabot et al. ICTD 15
Small-group Activity 1

Discuss and Identify five challenges that these voice-based services experience.

Then, pick any one challenge and discuss ways to overcome it.
Challenges of Voice-based Social Computing Services

Adoption

- Training users
- Spread
- Retaining users
Challenges of Voice-based Social Computing Services

**Adoption**
- Training users
- Spread
- Retaining users

**Scale**
- Content Moderation
- Financial Sustainability
- Misinformation
### Challenges of Voice-based Social Computing Services

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How to create *scalable, sustainable, replicable, and impactful* voice-based social computing systems that can grow at the scale of large Internet websites?
### Challenges of Voice-based Social Computing Services

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Adoption Hurdles

User Interface hurdle: How to train low-literate, non-tech-savvy people to use speech interfaces?

Motivation and trust hurdle: How to motivate and incentivize target populations to change their ways and practices?

Uptake and spread hurdle: How to spread the services to poorly connected masses?

Our strategy is ENTERTAINMENT
For Entertainment:

• Users overcome interface hurdles (Smyth et al. 2010)

• Users do not need any convincing

• Users spread the services to others
Our Strategy:

Use **Viral Entertainment** as a vehicle to disseminate **Development** related information
Polly (میال منجو)

Polly is a telephone-based, voice-based service which allows users to make a short recording of their voice, modify it and send the modified version to friends.
Job Audio-Browser

1. Scan Pakistani newspapers for jobs for low-skilled workers

2. Record these ads

3. Invite Polly’s users to audio-browse them
Deployment in Lahore

Seeded with 5 users

• Within a year
  • 636,000 calls
  • 165,000 users
  • Reached a rate of spread of 1,000 new people per day

• 34,000 people used the job search service
• listened 386,199 times to 728 job ads
• and 19,000 users forwarded them to their friends.

Raza et al. 2013, CHI, best paper award
User Demographics

Determined by listening to a sample of recordings:

- **Gender**
  - Male: 87%
  - Female: 11%
  - Unclear: 2%

- **Languages**
  - Punjabi: 64%
  - Urdu: 21%
  - Pashto: 13%
  - Others/Mixed: 2%

Used mostly by Punjabi speaking men...
User Demographics
Estimated from 207 survey calls

Socio-Economic Status

- Low SES (No Education): 24%
- Low-mid SES (up to 10 years of Education): 33%
- Mid SES (up to 12 years of Education): 13%
- High SES (up to 16 years of Education): 9%
- Low SES (up to 5 years of Education): 21%

Primarily used by low-educated, low-income people.
Geographical Spread

- Seeded in Lahore and Okara
- Reached all parts of Pakistan.
- And also a handful of calls from:
  - India
  - Belgium
  - Oman
  - Saudi Arabia
  - UAE
User Retention

Enthusiasm is Lost Quickly

A few people continue long term

Fraction of users still active (dashes)

Days post first encounter with Polly
How can we increase user retention?
Challenges of Voice-based Social Computing Services

**Adoption**
- Training users
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**Broader Impact**
- Measurement
- Replicability
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Content Moderation Challenge

ReddIt

Categorize
Review quality
Decide playback order
Managing User-Generated Content in Local Languages

10-15 Moderators

Generate meta tags

Review them

How to reach the scale of large Internet websites?
Key Idea: Enable Scaling through Community Moderation

RQ: Can marginalized users of these services moderate and categorize voice messages?

Novice users
Sangeet Swara
A Community-Moderated Voice-Based Social Media Service

[Vashistha et al. CHI 15, Best Paper Award]
Sangeet Swara
A Community-Moderated Voice-Based Social Media Service

[Vashistha et al. CHI 15, Best Paper Award]

1800-102-3690

1. Access Analytics on Users' Messages
2. Record New Message
3. Listen to & Vote on Messages

To share this message with friends, Press 4.
Community Moderation Algorithm for Voice Interfaces

How to decide the playback order?
- Balance of novelty & popularity

How to decide the quality of messages?
- High score for messages with high ratio of upvotes to downvotes
- High confidence in judgement
Deployment of Sangeet Swara in Rural India

Spread virally from 73 people to 1500+ by word of mouth

Traffic in 11 weeks
- 25,000 calls
- 5,400 messages
- 140,000 votes
- 200,000 playbacks
- Avg. call: 5 mins

50% rural residents
94% men
26%+ blind people
Did Users Value the Community?

- Generic Content: 36%
- Songs: 21%
- Poems: 16%
- Pre-recorded Content: 6%
- Introductions: 6%
- General Info: 5%
- Instruments: 4%
- Jokes: 3%
- Blank Messages: 3%
Did Users Value the Community?

Impassioned Usage by Blind People

Do they derive same benefits from using mainstream social media platforms?

More barriers beyond the basic hurdles of literacy, language, poverty, and connectivity

No training

Problems with Screen Reader Software

[Vashistha et al. ASSETS 15, Best Student Paper Award]
Did Users Value the Community?

User’s valued their interactions with the community members!
Community Moderation Evaluations and Results

3,700 tasks
93% response rate
98% accuracy

Categorization tasks

Distinction b/w high & low ranked messages

Comparison with experts

Top-ranked vs. Bottom-ranked → 90% agreement

Understanding users’ perceptions

Understood ✔
Satisfied ✔

<table>
<thead>
<tr>
<th></th>
<th>Song</th>
<th>Joke</th>
<th>Poem</th>
<th>Misc</th>
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<tbody>
<tr>
<td>Top 50</td>
<td>16</td>
<td>7</td>
<td>23</td>
<td>4</td>
</tr>
<tr>
<td>Bottom 50</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>38</td>
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Two Significant Contributions

1. Built the first community-moderated voice-based social media service that connected people, gave them information, and provided them digital equity.

2. Demonstrated that low-income low-literate people, rural residents, and blind people can moderate their digital community without any outside support.

Baang service in Pakistan
Quarter million calls, messages, and votes
# Challenges of Voice-based Social Computing Services

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Small-group Activity 2

Discuss ways to address the financial sustainability challenge of voice forums. In other words, how can you reduce the cost of voice calls?
Strategies to Manage the Cost of Voice Calls

Use advertisements
ONLINE ADVERTISING
KKT service by HUL in India
($4.8B revenue conglomerate)

Partner with MNOs and govts
3-2-1 service in Africa

Grant Funding
CGNet Swara service in India

Infeasible, Unpredictable, Unsustainable
Can incentives prompt people to pay for voice call costs?
Can we use data channel instead of voice channel?

Only a few users of these services own a smartphone and use the Internet

[D’Silva et al. DEV 14]
Key Idea: Using Profits from Crowd Work to Address the Financial Sustainability Challenge

RQ: Can users complete useful work on their mobile phones to get free airtime to use these services?
7 Million Workers in $5 Billion Gig Economy

Inappropriate for people who are illiterate or who do not have connectivity

Ambitious Goal

How can I provide earning opportunities to illiterate people and basic mobile phone users?

New Crowdsourcing Marketplace
What is a compelling problem that can be divided into voice-based microtasks and generate $$$?
मेरे प्यारे भाइयो-बहनो
इस बार जब मैं मन की बात को लेकर आप लोगों के सुझाव देख रहा था तो मुझे पांडिचेरी से ...........

Speech Transcription
More than $60 Billion Industry

Hindi Speech

Hindi Text

Poor accuracy or high cost for audio files containing local languages and accents
Key Idea: Using Profits from Crowd Work to Address the Financial Sustainability Challenge

Research Goals

1. Design a voice-based and basic-phone-based crowdsourcing marketplace

2. Facilitate transcription of low-resource languages and accents

3. Generate profits to provide earnings and free airtime to users
Respeak System
Combining Benefits of Human Intelligence and ASR Systems

Key Idea

Text obtained from ASR engine
Respeak System

- Engine
- User App
  - Respeak: Smartphone app for low-income students
    - [Vashistha et al. CHI 17]
    - 🎖️ Best Paper Honorable Mention
  - BSpeak: Accessible app for blind people
    - [Vashistha et al. CHI 18]
  - ReCall: IVR app for rural residents
    - [Vashistha et al. CHI 19]
Respeak’s Design – The Engine

Step 1: Segmentation

They changed their minds because they observed how the Olympic Games were working in Rio. We had security for people in the Olympic Park....we had efficient public transportation.

Step 2: Distribution to App users

- They changed their minds because they
- observed how the Olympic Games were working in Rio
- We had security for people in the Olympic Park

Large audio file

Short audio segments
Respeak’s Design – the Smartphone and Basic Phone App

Step 3: User perform tasks

1. Listen to segment
2. Remember the content
3. Repeat content into ASR
4. Verify transcript
Respeak’s Design – the Smartphone and Basic Phone App

Step 3: User perform tasks

A blind user using the smartphone app

Women using the IVR app
Respeak’s Design – The Engine

Transcripts generated by re-speaking the segment

Step 4: Merging using multiple string alignment and majority voting

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<thead>
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<td>The changed their blinds they</td>
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<td>They changed their minds because</td>
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Best estimation transcript for the segment

They changed their minds because they
Expected Improvement in Accuracy from Majority Voting

![Graph showing the expected improvement in accuracy from majority voting. The graph compares the accuracy of aligned words for different numbers of speakers: 1, 3, 5, and 7. The accuracy increases as the individual accuracy increases.](image-url)
Respeak’s Design – The Engine

Step 5: Final merging

Best estimation transcripts for different segments

- They changed their minds because they
- Observed how the Olympic Games were working in Rio
- We had security for people in the Olympic Park

Final transcript

They changed their minds because they observed how the Olympic Games were working in Rio. We had security for people in the Olympic Park... we had efficient public transportation.
Cognitive Experiments, Usability Studies, Experimental Evaluations
with 67 low-income students, blind people, & rural residents

Listening
smart or basic phone?
data or voice?

Remembering
segment length?
sequential or random?

Re-speaking
speaking or typing?
phone type? data or voice?

Verifying Transcript
reading or listening?

Accessibility & Usability Comparison

Usability & Performance Comparison

First time on respeak?

Enter Your Phone Number
Log In
Sign Up
respeak
10:46
Field Deployments with 73 Low-Income Indian People

Five hours of Hindi content ➔ 4,124 micro tasks

- **Respeak**
  - 25 students
  - 1 month

- **BSpeak**
  - 24 blind people
  - 2 weeks

- **ReCall**
  - 24 rural residents
  - 2 weeks

Users completed 50,000 micro-tasks and earned ₹31,000 ($470)

- **ASR Accuracy**: 71%
- **Transcription Accuracy**: 92%
- **Transcription Cost**: $1.30 per minute
- **User Earnings**: ₹50 per hour

1 USD = ₹66
Benefits of Re-speaking and Multiple String Alignment

Graph for a challenging audio segment containing speech

Accuracy (%)

K=1  K=3  K=5  K=7  K=9
Number of Transcripts used in Multiple String Alignment (MSA)

Systematic Errors
Compared to sighted users, blind users...

- completed 3x more tasks
- earned 2.5x more money
- with 14% less accuracy
- at 1.5x cost

"I am grateful to you for creating the app. I earned money for the first time and learned the value of each rupee."

Lower language skills
Tasks sent to more people because of poor accuracy
Compared to urban users, rural users…

completed **5x** more tasks

earned **7x** more money

with **3%** less accuracy

at **2.2x** cost

“Laborers work 9 hours a day to earn ₹2,500 per month. They can use ReCall for just 2 hours daily to earn the same amount”

“ReCall improved my pronunciation as I was speaking words carefully to get them recognized”

Earnings + Cost of calls to use the ReCall IVR app
Can Profits from Crowd Work Address the Financial Sustainability Challenge?

Users’ Earnings

₹36 per hour

Free Airtime

8 hours

all profits → ₹111 per hour

Integrated ReCall with Sangeet Swara!
Three Significant Contributions

1. Built the first voice-based crowdsourcing marketplace for illiterate people and basic mobile phone users.

2. Demonstrated that low-income students, blind people, and rural residents can vocally transcribe audio files.

3. Showed that the profits from crowd work can provide earnings as well as airtime to users, thereby addressing the financial sustainability challenge.

Strong Commercialization Interest by Social Enterprises
# Challenges of Voice-based Social Computing Services

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  • Misinformation | • Measurement  
  • Replicability  
  • Inclusivity |
Key Idea: A Toolkit to Create Replicable and Connected Voice-based Social Computing Services

1. Easier to build and maintain
2. Connect unheard voices to global social media platforms
3. Distributed architecture

[Vashistha et al. NSDR 12]
More than 110,000 Phone Calls from 25,000 Users

Government of Somaliland

Connecting rural people and government officials

[Urltaid and Vashishta ICTD 13]

Voice of America in Mali

Distributing and gathering news in low-resource regions

Women’s rights activists in India

Giving voice and digital identity to protestors

Picture credit: Fiona Graham

Picture credit: Reuters
Challenges of Voice-based Social Computing Services

- **Adoption**
  - Training users
  - Spread
  - Retaining users

- **Scale**
  - Content Moderation
  - Financial Sustainability
  - Misinformation

- **Broader Impact**
  - Measurement
  - Replicability
  - Inclusivity
Low Participation of Women on Voice-based Services

Why the participation of women is almost non-existent on these voice-based social computing services?

- Polly in Pakistan: Women: 11%
- Ila Dhageysso in Somaliland: Women: 15%
- CGNet Swara in India: Women: 10%
- Baang in Pakistan: Women: 12%
- Sangeet Swara in India: Women: 6%
Why the participation of women so low in Swara & Baang?

**Mixed-methods Approach**

Content Analysis: 10,361 audio messages (~140 hours)
— content type, gender, targeting women, abusive?

Usage Analysis: 857 users
— what users liked, disliked, shared, and reported

Surveys and Interviews: 50 users
— user experience, perceptions, as well as benefits and limitations of these services
Swar in India  5% messages
Baang in Pakistan  6% messages

Number of Posts

Top 25 Users

Men  Women
Low Participation of Women on Social Computing Services

Flirts

Patriarchy-driven systemic marginalization

Poor Agency

Threats

Blackmail

Abuses

Posts directed at women
98% of flirty
62% of threatening
46% of abusive messages

[Vashistha et al. CHI19]
Implications

Need to go **beyond access and connectivity** when thinking of solutions in low-resource environments

Marginalities **within** marginalities
Small-group Activity 3

Discuss how can you make voice forums like Sangeet Swara more welcoming and safe for women?
Combating Harassment and Misinformation on Social Computing Systems

Information Retrieval

Machine Learning

Public Policy

RQ: How to address situations where the collective ignorance of community members eclipse their collective intelligence?