

Exploring the potential and challenges of using mobile based technology in strengthening health information systems: Experiences from a pilot study

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ABSTRACT

This paper empirically examines the challenges of introducing a mobile based reporting system (called SCDRT) within the public health system in India to strengthen the health information systems, and also discusses the approaches to address these challenges. Taking an “infrastructure” perspective, various socio-technical challenges relating to technology, operator and usage are discussed. Scaling, in geographical and functional terms, is discussed with a focus on aspects of “attractors” and “motivation.”

Keywords

mHealth, mobile phones, health information systems, infrastructure, scaling, attractors, motivation.

INTRODUCTION

Within the context of public health in developing countries, there is a mounting interest in the field of mHealth — the provision of health-related information services via mobile communications. This surge in interest can be traced to the evolution of several interrelated trends (UN Foundation, 2009). As governments (Indian in this case, where the study is based) seek to make health services more “patient centric”, there is increasing demand for the health service provider (called Auxiliary Nurse Midwife (ANM) in India) to be more mobile to cover the catchment population in her jurisdiction (typically 5-7 villages or population about 5000) in providing health services. Further, as health information systems strengthening including their decentralization become a central feature in health sector reforms of governments, there are attempts to explore the use of innovations in technologies such as mobiles. The explosive growth of mobile communications over the past decade (TRAI, 1997-2007), including in rural villages, provides a promising potential to strengthen health information systems, something which earlier experiments with PDAs and low cost laptops have failed to deliver (Raghavendra and Sahay, 2005). As demand for server based health information systems outstrips the speed at which the internet is physically becoming available in rural setting, mobile phone based technologies because of being reliable, cheap, easy-to-use and already domesticated in the everyday lives of even the rural population, provides interesting possibilities to becoming an integral part of the “health information infrastructure” in the future. However, this possibility needs to be empirically established and is the focus of this paper.

Mobile technology offers a unique potential to address various challenges currently faced by health information systems, and also allow for new ways of communication or co-ordination which would provide value additions to healthcare delivery. Some of these potentials derive from:

1. Improved timeliness of reporting because of allowing data to be transmitted from a distance
2. Strengthening data quality and data coverage, by getting data from the lowest levels of the system and thus furthering the agenda of decentralization which is key to the process of health sector reform.
3. Help to transcend the internet related challenges in accessing server based applications.
4. Enabling integration of health information systems supporting various vertically existing health programs, another

key agenda item of the reform process, because the ANM is primary source of information for all these health programs.

5. Empower the health service providers who hitherto have been over burdened and neglected.

Arguably, many attempts at introducing technological solutions in the context of health information systems have not delivered their potential as they tend to be treated as standalone systems and not integrated with the “installed base” of existing systems, including technological and institutional. Information systems research have acknowledged this lacunae and now promote an “infrastructure” rather than a “systems” approach (Hanseth, 2003) which moves away from focusing on standalone systems and focuses attention to how new components supporting the information flow be integrated with what already exists. This makes it crucial to treat the mobile phone and the associated practices around its use (such as the mobility of the health worker) as a component of a larger health information infrastructure that includes amongst other things the paper forms, the desktop based health information systems applications, the networks, and the processes by which the data flows from the community to the national level through the various intermediate steps of the sub district, district and state. History has shown us that such integration is a non-trivial challenge, more so in the domain of work practices and institutional arrangements as compared to the technology itself.

With this background, a pilot project on mHealth application was initiated in India through Ministry of Health & Family Welfare (under National Rural Health Mission (NRHM)) by the National Health Systems Resource Centre (NHSRC - a technical advisory resource centre to the NRHM) in technical partnership with the Society for Health Information Systems Programmes (HISP India) to empirically evaluate the potential of mobile technologies in strengthening routine health information systems and develop strategies to scale and make them sustainable.

MOBILE-SCDRT – PILOT PROJECT’S CONTEXT & CONCEPT

In response to the urgent need to reform the state of public health affairs including its supporting health information systems, the NRHM was launched in India in 2005, with the explicit aim of bringing about architectural corrections within the health systems framework in order to make health care, especially to the marginalized poor, more equitable, affordable and accountable. Implications for reform of the Health Management Information Systems (HMIS) were to make them more integrated, decentralized and user-focused. The integration agenda included developing a common platform for the supporting information systems of existing national health programs (including Reproductive Child Health, Tuberculosis, Malaria, Blindness Control etc). The decentralization agenda focuses around building infrastructure and capacity at the district and sub district levels to enable the staff there to be able to use the HMIS generated information for supporting local evidence based action. This use would lead to strengthen the entire process of sub-district, district and state planning processes.

With this as the starting point, a Mobile Phone Based Sub Centre Data Registration and Transmission (SCDRT) application was designed and developed to capture data from the sub-centre (the lowest reporting unit in the system) through mobile phone. Based on directions from the Ministry, HISP India initiated the design and development of the application in early February 2009, and an initial prototype was rapidly developed (on free and open source software) which enabled the ANM to register data for the monthly sub-centre data set on mobile phone, send the report in form of SMS to next level where the data was imported into the database of the existing HMIS application. Useful feedback from the Ministry on the prototype contributed to the incorporation of additional functionalities such as validation checks on data completeness, sending the SMS to multiple levels (sub district, district and state) rather than only one level and the saving of the previous month’s data. The Ministry then in consultation with states agreed on piloting the application in 5 blocks (sub district units) in 5 different states. Site selection was based on the willingness of the states to participate and to pilot the phone in diverse settings with respect to infrastructure, terrain and local language use. The pilot (named SCDRT) was initiated with the following aims and expected outcomes:

1. To develop a very simple form-like data collection tool on mobile phones.
2. Efficient transmission through SMS of the data from the Sub Centre to the next level(s) (sub-district, district and state).
3. Establish a basis for improved data quality and validation by bringing in improvements and checks right at the point of first line data registration – the sub centre.
4. Explore the potential of other value added mobile phone based applications, such as:
 1. Providing feedback to the ANM on activity scheduling.
 2. Strengthening processes of communication of the ANM with other functionaries (such as the medical doctor).
 3. As a training tool, such as to help orient the ANM on new data elements.

- Integrating the SCDRT information with the mainstream district based health information systems. In this case, it was the software application called DHIS2 used in the pilot sites.

Empirically, the pilot sought to:

- Establish the technical feasibility of mobile phones to report sub-centre data.
- Test the application in field situation and scope for scale – geographically and functionally.
- Understand the response of ANMs towards mobile phone reporting and to this application.
- Empirically determine the volume of data that can be reported through SMS and mobile phones.
- Determine the quality of services from the service provider to support large scale use.
- Understand the emergent uses of the application, other than the intended sub centre reporting.

SCDRT Concept & Technology

SCDRT enables the ANM to send monthly report via an SMS through the mobile phone to the next level(s). SCDRT was designed not as a stand-alone application for sending the report, but integrated with the mainstream district health information system for national level reporting. By design SCDRT was envisaged to be similar to the paper formats to maintain the familiarity and identification of the ANMs to the application. The figure below describes the SCDRT infrastructure and flow.

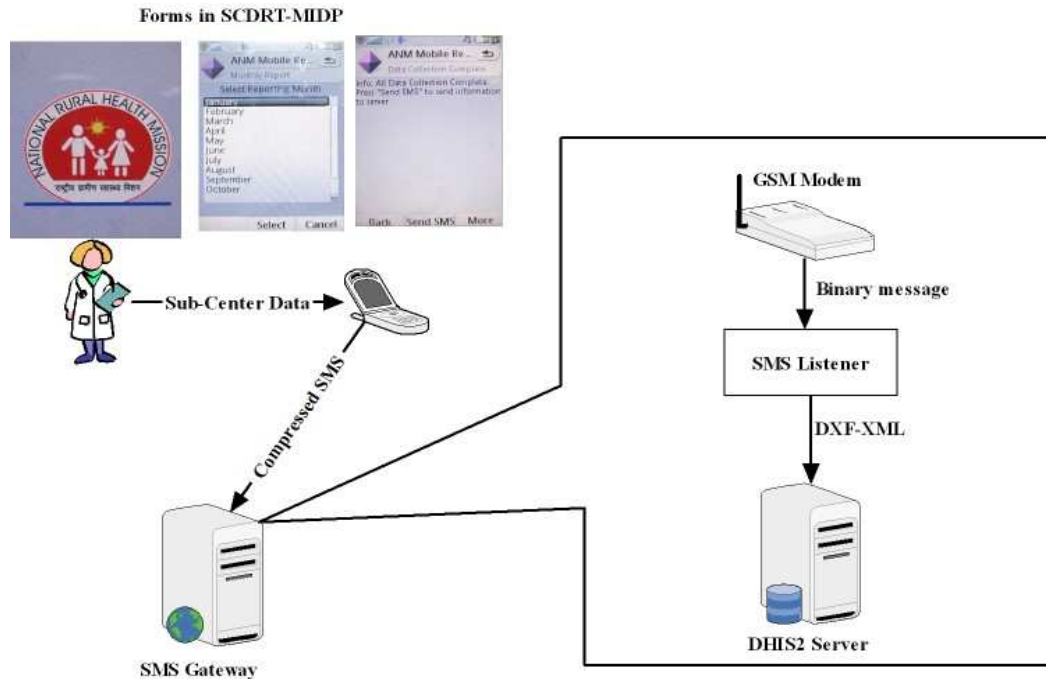


Figure 1: SCDRT: Infrastructure and flow

The flow is summarized:

- SCDRT allows the ANM to fill the Sub-Centre Monthly Dataset (monthly reporting form) on the mobile phones.
- On filling the Sub-Centre Monthly Dataset, the report is sent as a text message (SMS) to desired phone numbers, which are located at the PHC/Block/District.
- The SMS sent is compressed as a binary message. The compression is about 70%, resulting in more data being reported with lesser number of SMS messages.
- These messages are received at the PHC/Block/District into the GSM Gateway Cards using a software application called SMSListener, and messages are integrated into the organization's existing systems for immediate analysis i.e. the state HMIS application (which is on DHIS2 software).
- SMS Listener in context of DHIS2 is a utility application developed and configured to listen/receive SMS on any

stand alone system. User can send their encrypted data through Mobile-SCDRT application at one end, and on another end it gets received by SMS Listener. When SMS Listener receive the encrypted data, it first decrypts it and writes complete information on xml files which then is easily imported on DHIS2 application using mobile-import.

6. The staff at PHC/Block/ District can data quality check in built into the system, including validation queries which are part of the DHIS2 application.
7. The sub-centre report in DHIS2 can be taken into an excel-sheet output.

SCDRT Technology Requirements

1. Mobile Phones: Any Java-enabled phone. One for each ANM representing a sub-centre.
2. GSM Modems: Each PHC/Block/District installation will receive SMS using these into DHIS2.
3. Software: Free & Open-source applications Mobile-SCDRT, SMSListener and DHIS2.
4. SIM cards: Every mobile phone and GSM modem requires a SIM card with a phone number.

THE IMPLEMENTATION PROCESS

A key component of the process was to understand the need for capacity building and strategies to deliver it on the mobile based reporting. An attempt was made to adopt a uniform training methodology across the pilot sites, including the use of a detailed training manual. The focus of training varied with levels of use from the state to the peripheral levels. The table below summarizes this different focus.

Level	Capacity Building
State Level	<ul style="list-style-type: none"> • SCDRT application – working and integration with main HMIS • Strengthening institutional support mechanisms
District Level	<ul style="list-style-type: none"> • SCDRT application – installation, working, troubleshooting, providing technical support
Block Level	<ul style="list-style-type: none"> • SCDRT application – installation, importing sub-centre reports/SMS into state application at block level, troubleshooting, providing technical support • Sub-centre Datasets, information flow
Sub-Centre Level / ANM	<ul style="list-style-type: none"> • Mobile Phone – using mobile phone & features (camera, phone calls, etc) • SCDRT application – filling sub-centre report, sending report through SMS • Sub-centre datasets, information flow

Table 1: Different levels of trainings and content

Selection of pilot sites

Selection of sites for pilot testing the SCDRT application was another crucial factor – as the efficacy of the application had to be tested across factors of geography, accessibility, infrastructure, human resource availability, integration with main state HMIS application and capacity building. The following were the pilot sites, and numbers of staff trained at each level.

State	District	Block	State-level officers	District-level officers	Block-level officers	ANMs *
Nagaland	Peren	Jalukie	4	5	3	15
Gujarat	Navsari	Chikhali	3	4	4	99
Rajasthan	Jaipur	Govindgarh	3	4	3	36
Kerala	Trivandrum	Vizjinham	4	4	2	26
Himachal Pradesh	Hamirpur	Sujanpur	2	3	3	31

Table 2: Trainings attended at different levels for SCDRT

* In some states the male health worker (called MPHWH) also joined the training along with the ANMs, but were not given mobile phones

Methodology followed in the pilot sites

1. Orientation of State Teams on the SCDRT application and establishing the institutional support required, including providing orienting information, finalizing training schedules, and the nomination of nodal officers to guide the pilot.
2. Most crucial for mobile based reporting is mobile service provider. In each state a feasibility study was done to check the best possible connectivity option. In case the states already had CUG subscriptions to CUGs (Closed User Group), the same was used, in other states pre-paid connections were subscribed to.

State	Mobile Operator
Nagaland	Aircel
Gujarat	Vodafone (CUG)
Rajasthan	Vodafone (CUG)
Kerala	BSNL – prepaid
Himachal Pradesh	BSNL – prepaid

Table 3: Different Mobile Operators & Plans for the Pilot

3. The ANM in each pilot sub-centre was given Nokia 3110 handset which had SCDRT application installed and phone numbers issued to block and district where the SMS had to be sent.
4. Specification of computers at block and district had to be checked to install SCDRT application and also to check compatibility with GSM card.
5. With the required hardware in place, training of ANMs on sub-centre dataset and SCDRT was initiated at the Block headquarters:
 - a) Part one of the training emphasized on orientation on the revised sub-centre dataset which was included in the application.
 - b) ANMs were introduced to the handset Nokia 3100, and its features of menu options, camera, radio, hands-free.
 - c) Training included – locating the application, opening it, selecting month and filling the report, sending the report through the SMS.
 - d) Confirming the sent report.
 - e) Re-sending the same report after making changes when required.

EVALUATING THE PILOT

The feedback on SCDRT was observed at two levels – one during the process of pilot implementation and second post three months of implementation in order to understand how the phone usage has changed (or not) over time. In level one – each training session was followed with a feedback session with the participants after the ANMs had sent at least three reports through SCDRT and the respective block and district teams had imported these reports into the HMIS application.

Both, informal and formal methods of feedback were adopted – informal through discussions and formal through the use of a structured feedback questionnaire/form. Also some focused group discussions were held with the participants to build a comprehensive understanding of the overall project and their respective roles. Building this understanding was crucial in order to develop a strategy for the institutionalization of the mHealth application as a part of the overall HMIS infrastructure. Level two of feedback and evaluation was undertaken post three month of the pilot implementation through structured questionnaires, discussions, and examining the data status in the database. The results are summarized.

Monthly reporting observations

The feedback identified that all the ANMs (207 in the pilots), including 97% of them independently, had used the SCDRT application in sending at least five monthly reports; and about 98% of them had found the application easy to use. On an average it took the ANMs (including first time users) about 12 minutes to register the data and send the SMS, and this reduced to about 3 to 5 minutes after first time use. With respect to usability and benefits, the ANMs said that in the past they spent a significant amount of time around reporting including for travel, filling forms and their compilation, and sending on an average least four reports each month. In conditions of hilly terrains (such as in Nagaland and Himachal Pradesh), hot summer conditions (like in the desert of Rajasthan), and inadequate public transport (in all locations) travel was arduous and

time taking (often even 2 days), making the use of the SCDRT for reporting a much more attractive option than the existing system.

Eighty nine percent of ANMs felt that after sending the report, they needed to confirm with the PHC or Block staff regarding receipt of the report, and requested for “some kind of auto-generated” SMS confirmation. On other (than reporting) uses, 92% ANMs said they regularly called other ANMs on work related issues, while 88% said they had called the other health officer and PHC staff in case of help; and 85% said they had contacted doctors or staff nurse at PHC/CHC for medical help in case of emergency, which otherwise is hard to access. Strengthening processes of communication and collaboration is an untapped potential of the mobile phone which future efforts should necessarily focus on.

Emergent uses of application

ANMs in Himachal Pradesh said that they widely publicized the phone number as the —sub-centre number which helped in people calling the sub-centre for services and information. This helped them in better scheduling of outreach services, as they now could prioritize village visit schedules based on number of patients/persons identified to be waiting for services. Also this helped them in giving solutions on the phone itself, if someone was unable to travel up to the sub-centre.

While in Nagaland, ANMs used the additional feature of the mobile handset – the camera – for taking pictures of events such as the Village Health Nutrition Day and immunization days in villages, and use them in their reports to the senior. Some ANMs reported to have taken pictures of some peculiar cases such as abscess, allergy etc. which they showed and discussed with the doctor when they subsequently visited their parent CHC or PHC. In Kerala, some ANMs also used text messages to the implementing staff to request for technical support for their computers or their software application.

Other than the ANMs, the PHC and block staff also expressed that getting reports through SMS which were directly received in electronic form in computer (HMIS application) was much easier, as it saved their time of again digitizing all these reports when received in paper form. Also they felt that it was easier for them to check the data status (how many sub-centre submitted the report) and quality of data received, which helped to provide constructive feedback to the ANMs. Since the data had already been transmitted to the level above, the ANMs felt that their monthly review meetings with the doctors could become more productive and be used for discussing action needs rather than on the routines of completing the monthly report. Overall, the users felt that use of mobile phones did facilitate in enhancing the efficacy and efficiency of the reporting work, and added value in communication within the health system and also externally with the community. The evaluation helped us not only to evaluate the potential and challenges of the application for reporting, but also for strengthening other process of communication and collaboration.

CHALLENGES AND SUGGESTED APPROACHES

The SCRDT pilot helped us to identify various socio-technical challenges and also learnings of approaches to address them, which we summarize below.

1. **Technical Challenges** – Though the technical efficacy of the application was established i.e. sub-centre monthly report sent through SMS from mobile phone can be imported into DHIS2 (state application) without data transmission loss, the following challenges were faced:
 - (a) Application Deletion –SCRDT application was installed in the mobile phone using Blue-Tooth or Data cable, which then is saved in the phone memory. But it was observed that while selecting the SCDRT application through the main menu, if the user mistakenly selects deletion option, the application gets deleted and is removed from the memory permanently, requiring reinstallation. In such cases, the ANM feels that all her data and reports have been lost.
 - A solution to this problem is by burning the application into the ROM of the mobile handset. But this has to be done by the OEM or part of the mobile phone's firmware
 - (b) Mobile Handset – one of pre-requisite of mobile phone to be used for SCDRT application is that it has to be Java-enabled, should support local languages (Unicode fonts or bitmap fonts), support for WMA (JSR205) API – the handset used for the pilot had all these features with a cost of about USD 100 per handset, which becomes expensive while scaling to a large number of users.
 - The application has now been tested on cheaper handsets starting from USD 55.

- (c) GSM modems – during the field test it was also noticed that the GSM card used at the server end for receiving the SMSs into the SMS listener showed poor connectivity and reception, which led to jamming of SMSs, which led to loss of data at times. There was about a 10% failure of these modems requiring replacement at additional costs.

→ This issue was addressed by wider testing and exploring of other lower cost options and other models have now been identified.

2. Operator-Related challenges

- (a) Pre-paid connections vs. CUG – pre-paid SIM cards were used in three states while CUG connections in other two states. It was noticed that ANMs using pre-paid connection had a little restricted usage as there was lack of clarity on re-charge of the connections and allowed usage. CUG connection users felt more confident and consistent usage patterns, as there was clarity on “allowed usage” and “bill payments” as well as cheaper call rates.

→ States planning to scale up the application are being recommended to adopt CUG connections.

- (b) Service messages sent by the operator to bulk users become a concern, as when they reached the SIM card used in the GSM modem they were not in the format understood by the SMSListener and could not be imported, which resulted in error messages.

→ This issue was dealt with an update to the application to ignore such messages. Further, the operator can also be requested not to send these messages to the designated phone numbers.

- (c) SIM cards suspension – during the pilot it was also noticed at a few places that whenever the SIM card was inserted/used in GSM modem was not used for making any calls or sending any messages – the number was suspended by the service provider for non-usage.

→ This could be addressed by either using the SIM card for making calls once in a while or giving specific instructions to mobile operator.

- (d) SMS jamming – in a few places (especially smaller places) it was noticed that sometimes when excess messages are pending with the operator, it clears only a limited messages (about 25) and rest are kept in the queue. In this case if the message passes the expiry date the while in the queue and the data is lost.

WAY FORWARD: SCALING

Pilots in the context of technology for development projects are notorious, because they remain that – a pilot – and the benefits and memory of the same slowly dissipate over time. For projects to live on and provide larger benefits, they must be scaled – both geographically and functionally – and be institutionalized in the use setting. We discuss in this section two dimensions of scaling – strategies and motivators. Learnings from the pilot have shown that two important factors guide the scaling of such projects – attractors for scaling and inherent motivation of the user.

As an implementer, there needs to be constant “attractors” for scaling, such as through “functional scaling” of mobile based reporting. This includes taking mobile reporting from mere sending of one monthly sub-centre report to the broader dimension of “upward reporting” across facilities and programs. Scaling discussions with states have shown that, states initiating facility based electronic HMIS reporting are willing to use mobile based reporting across all facilities which do not have computers, i.e. all PHCs and Sub-Centres. Alongside expanding the reporting scope to facilities, there has been a demand for reporting across health programs such as RCH (Reproductive Child Health Program), IDSP (Integrated Diseases Surveillance Program), TB and various financial reports. Another opportunity that has emerged during the course of this pilot is the national mandate to all states to implement a community focused name-based tracking and reporting system for pregnancies and immunization. Mobile reporting can potentially support the information flow of this tracking system because of the mobility inherent in providing these tracking services. As a result, the mobile phone has become an “attractor” and a reason to be adopted by the states and scale it across the state.

Second identified dimension for scaling of such projects has been “motivation of the user” in implementing such projects. Different states have varying motivations to scale as seen in our pilot project. For Nagaland overcoming physically inaccessibility has been major motivator in using mobile technology for all facilities and making it the “official” tool for

reporting in the state across all programs. Himachal Pradesh views the “mobile phone” as sign of empowerment and recognition for all health workers. State feels that ANMs has been the most “neglected lot” in the entire health system, and unless she is recognised and her services valued, it will not be possible to bring in the “quality” approach in the services. The mobile phone is viewed within this context of strengthening the condition of the ANM. Another state, Punjab has opted for implementing mobile based reporting for 5000 ANMs (urban and rural) across the state as a strong “communication” tool, and a mechanism to bring all health workers on the “same platform” and under one “common user group”

We close by arguing that strategies for scaling should be a natural outcome of any such pilot project. And strategies depend on two key dimensions. One, is the inherent capacity of the pilot and the technology used to become an attractor to support other processes that can support its institutionalization. Two, the users must have their motivation to take up the ownership of the project and put it to larger use. We see some evidence of that emerging, and future efforts would need to focus on how this scaling potential is further realized.

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LIST OF ACRONYMS USED

1. ANM – Auxillary Nurse Midwife
2. ASHA - Accredited Social Health Activist
3. CHC – Community Health Center
4. CUG – Closed User Group
5. DHIS 2 – District Health Information Software v2
6. GSM - Global System for Mobile Communications
7. HISP India – Society for Health Information Systems Programme, India
8. HMIS – Health Management Information System
9. NHSRC – National Health Systems Resource Center
10. NRHM – National Rural Health Mission
11. PDA – Personal Digital Assistant
12. PHC – Primary Health Center
13. ROM – Read-Only Memory
14. SCDRT – Sub-Center Data Reporting & Transmission
15. SMS – Short Message Service
16. TRAI – Telecom Regulatory Authority of India

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