# mHEALTH-PHC – Application design for rural health care

Pilot experience from one of the rural location in India


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***Abstract*— Reducing Infant Mortality Rate (IMR) and Maternal Mortality Ratio (MMR) is one of the important Millennium Development Goal (MDG) [1] and many countries are working on it. In India, it is being addressed through National Rural Health Mission (NRHM). Though Government is taking huge efforts, considering the vast geographic area and less Doctors: Patient ratio, there is a gap in health-care delivery. To address this challenge, mHEALTH-PHC - mobile based remote health-care delivery platform was developed and piloted. This platform enabled health workers to digitize the patient's data and ask questions to doctors. Doctors could see the questions along with the data and give appropriate answers. This experiment was conducted for more than a year for a set of approximately 300 expecting mothers in one of the most under-developed and remote regions of the state.**

**Since this was one of the early initiatives in rural health-care delivery, it was a very good learning experience. There were excellent interactions and feedback from the ground level health workers. An innovative "Participative Design" approach was used for this purpose.**

**This paper captures the experience of designing a health care application for rural India, the tools and methodologies used, issues faced and how these were resolved. The paper also discusses the strategies used for optimizing the fairly large set of information to suit small form factor of mobile screens without losing data fidelity, categorization and prioritization. The design was then translated to mobile based application. Analysis of usage by the health workers, their experience and impact on overall health delivery process was also studied.**



***Keywords—mHEALTH - PHC; Design; rural and health care; mobile health;***


## I. INTRODUCTION

In India, the Maternal Mortality Ratio (MMR) and Infant Mortality Rate (IMR) are still high and far-fetched from the standards set by NRHM itself. In India, one of the states reported a MMR above 300 [2]. In few other states, IMR are above 50 [3]. For MMR and IMR, rural areas have shown the maximum mortality rates [2][3].

India's population is more than 1.25billion. Out of this around 70% of the population lives in rural India. To address this population, government has setup various health centers at rural areas, like Sub Centers, Primary Health Centers (PHC) and Community Health Centers under a program called as National Rural Health Mission (NRHM).

Each PHC caters for population of 30 K people. PHC is typically manned by a medical officer. Few Para medical workers are also part of PHC. It has small basic pathology lab. Though there is reasonable infrastructure in PHC, problems like lack of transportation, roads, etc. make it difficult for pregnant women or children to get the benefits of health centers [4].

On careful study of these issues, it was felt that ICT based system could bridge this gap in an effective way. Rural health-care mobile based applications are almost non-existent in India. Hardly any research is done in the area of usability, modeling or standards specifically for rural health-care applications. We came up with our own methodology to design and develop such kind of application. It has been a great learning journey for the last couple of years. The experiences are detailed below in subsequent sections.


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## II. BACKGROUND

Though there are a few remote health care applications in India they are primarily for urban profile. A challenge was taken to develop a remote health care application specifically for use of rural health worker and doctors in rural area. Appropriate design was one of the most important factors that could lead to success or failure. Hence, while developing this application we ensured that each aspect of application is carefully designed, keeping rural community in mind. It was a difficult task since there were no benchmarks /standards / recommendations for these types of applications.

For designing the application, mHEALTH- PHC platform was used as a base for customization. mHEALTH-PHC is a mobile based question answering system . It comprises of following building blocks 1, Mobile based application facilitating data digitization, asking question and receiving answer, 2. Radio enabled pathological devices – Battery operated field deployable devices that transfer the pathological test results wirelessly to platform and 3. Doctor's console that enables doctors to look at the questions raised, look at the data and provide the correct answers. Earlier mHEALTH-PHC application was developed for J2ME (Java) based mobiles now it is being ported to Android too considering the widespread availability, technology benefits and low cost.

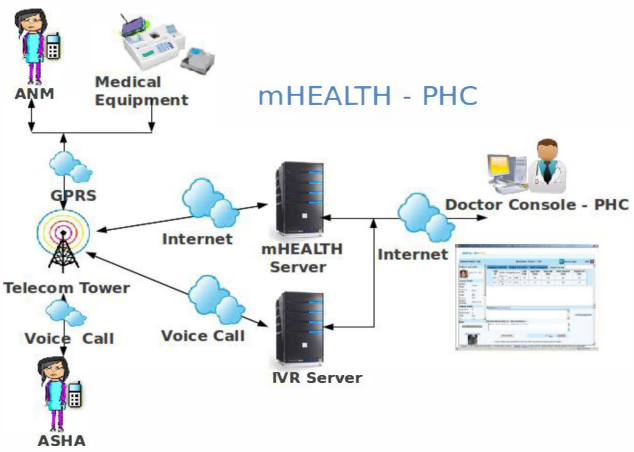


Figure 1. Architecture of mHEALTH-PHC

## III. PROCESS FOR RURAL APPLICATION DESIGN

This application was designed considering the end users, their literacy level, domain knowledge, familiarity with the technology, radio network availability, cost of operations etc. Important steps are detailed below.

**Arriving at right application focus:** Considering the MMR and IMR to be a critical issue, it was learnt that in rural areas, Pre and Post natal care needs special attention of doctors. Hence, it was decided to develop the application that would benefit Pre and Post natal care of mothers and their child's care**.**

**Understanding end user of the application:** ANM [Auxiliary Nurse and Midwife] are the ones who interact with mothers most of the times. They have typically 12 years of formal education and are trained to handle non complicated deliveries. ANM typically works as a bridge between mothers ASHAs [Accredited Social Health Activist] and doctors at PHC. Hence, it was decided that ANMs should use this mobile application since they are trained and can take corrective actions suggested by doctors. The mobile application is purposefully not given to mothers since advice would be left to interpretations by the mothers that sometimes could create issues. For PHC doctors, internet based application was developed. This was done since the PHC typically has an internet enabled multimedia computer.

**Study of existing Pre & Post natal care delivery method:** It was understood how Pre and Post natal care is implemented at health centers. Health centers provide a form named as R15 card for each expecting mother during her first visit. This R15 captures mother's personal profile and detailed medical profile from Pre to Post natal visits, till child vaccinations. Mother has to carry this card along with her for every visit or for checkup. On visiting health centers mother's R15 card is referred and Doctors or ANMs give the mother appropriate medicines, suggestions or advices. R15 card forms the unique and to an extent complete source for mothers medical data. Hence, it was decided to digitize R15 card using mobile based application.

**Digitizing paper based forms and mothers meta data:** R15 card contains around 100 plus fields categorized under various sections. Adding 100 plus fields to a mobile application would have impacted the usability of the application adversely. Joint exercise with doctors was undertaken to identify most critical fields. Along with doctors, the fields were grouped in sections. Ranking of the fields and the sequence of groups was according to flow and importance. The total number of fields was reduced to around 60.

**Right Screen Flow / Call Flow design:** A screen flow simulating application flow was designed and shared with the doctors**.**

**POC creation and deployment:** An application was created with help from the doctors and people from ICT team. Two health centers were selected for launch of pilot. ANMs from both the centers were having around 10 years of experience. The POC was demonstrated to ANMS and training was conducted. The application was handed over to ANMs to familiarize and use. However it was observed that despite the follow up, the application usage was miniscule**.**

**Applying Participative Design technique:** We had two training sessions with these ANMs. Though during training ANMs agreed to understand the need and the usage of the application, but we realized that ANMs had a fear to use the application, since this was something new for them. They were also shy to interact with us since we were from corporate background. Probably there was a social gap. We observed that the inputs from them were not very objective.

It was decided to have one female and local candidate who can work with ANMs to bridge this social gap. Weekly meetings were arranged between ANMs and our team members. In the initial meetings we had casual conversations and lunch or snacks with them. Their general inputs on using the application and also checked for doubts or issues if any. Soon they were comfortable talking with our team members so we could

discuss the possible positive impact of this application on overall social health and show them a bigger picture. As a result of this exercise we started getting mindshare of ANM's for the application. Once the ANMs were comfortable using the application, we, as a team started involving them, in getting their personal views, comments, suggestions and feedback on the application and its usage. Feedback on various aspects of mobile application like choice of fonts, size, background color etc. was also taken. Few experiments were done with a combination of these parameters and optimum parameters were chosen by ANMs. This helped in getting ownership of the ANMs for the application. ANMs suggested modifications in screen flow and actually helped us to optimize screen flows. For a few critical operations, the screen navigations were reduced from 4 – 5 clicks to 1-2 clicks. They also suggested use of local terminologies, rather than technical terminologies. We appreciated their suggestions. With the ANMs inputs and feedback from the doctors, we redesigned the solution, optimized the number of screen flows and brought important services on the main menu of the application itself.

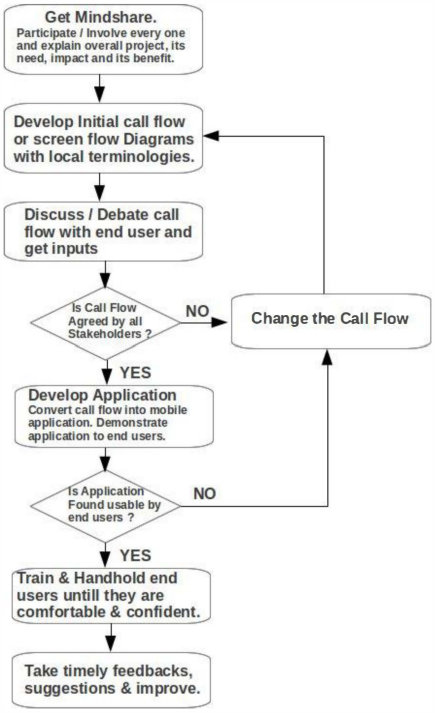


Figure 2. Participative Design.

**Design of Web based console for Doctors:**

Doctor's access web based console using standard web browsers. Upon login, doctors are presented with a list of new questions which look similar to conventional emails in the mail box. Email is a very common and very well understood concept. Hence, a similar view for listing the queries was used. In the single screen of inbox, the queries are marked with priority. High priority queries are specially indicated so that they are taken care on urgent basis. A query is selected and the patient's data is shown to doctor. Each field contains large amount of mother's data. We applied the common concept of reading from left of screen to right. The patient's data is divided into various tabs/sections. Most left tab displays patient's personal profile. This helps doctor to identify mother's age, weight, height, blood group, HIV status, previous child history, locality area (tribal/non-tribal), below poverty line, etc. Then moving towards right of screen, we have arranged mother's data in different tabs. These tabs were arranged as guided by doctors, according to the Importance and priority of the mother's data. Again in each tab, each field that had a low or critical value was highlighted with appropriate indicators. This indicator helps in drawing doctor's attention directly to those points. Doctor's listens to voice based question and check relevant tabs for medical history (factual data) and provides appropriate answer.

**Advice mode for answering:** Following modes were provided for doctors to answer the queries.

**Text based entry:** Typing using the desktop or laptop's keyboard was fast for doctors. We provided our own transliteration tool on the console. Using this tool doctors were able to provide advices in local language. Based on doctor's feedback, typing in local language was time consuming and hence it was taking time to answer queries.

**Electronic pen (Epen) based advice**: Electronic Pen was provided to doctors to give advice. This Epen was connected to desktop or laptop. Using Epen doctors could write on any piece of paper. This writing was captured as a jpeg image in computer by Epen. Doctors used this Epen to write the advice and upload the image as the answer to query. This image based advice was sent to mobiles ANM application. Doctors found Epen very simple to use and time saving.

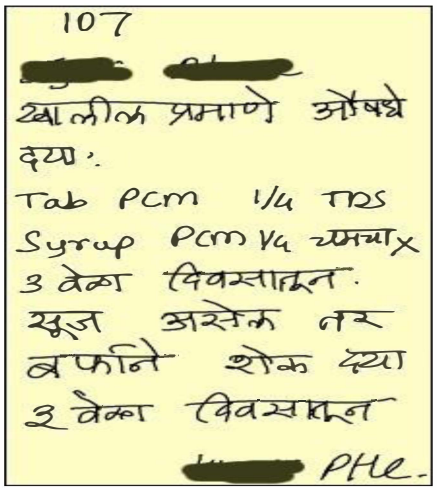


Figure 3. Doctor's advice using Epen.

## IV. IMPORTANT LEARNING DERIVED OUT OF THIS EXERCISE

Participation from end user in design helped a lot in coming up with optimum application design and is well understood by most of the health workers. Local language based interface for application is a must for all rural applications. English is not understood by most of the health workers, especially spoken English. In this case, the local language framework developed previously came handy.

Number of screens in any flow should be less. Screen flow or call flow should be very simple to understand. Any desired

action should work in maximum 3 clicks. Navigation and actions should be clearly indicated. Use of larger size and dark colored fonts and lighter colored background screens helped. This gives good readability in sunlight also.

Form factor plays an important role for usability of the application. Earlier, candy bar type mobile handsets were provided. However there were lots of issues in data entry. Hence large screen mobiles were provided. It was much easy for ANMs to do the data entry using the QWERTY keypad based mobile, rather than using multi tap/multi entry 3x4 keypad. Long battery life of mobile is very critical. Mobile networks are feeble in rural areas. It is a good practice to check the availability of signals, more importantly data connectivity and then go for an operator.

Local language text based entry especially for Indian languages through mobile phones is very complex. Hence the most appropriate medium to ask questions is voice mode. Typically 60 seconds duration is sufficient to describe the problem completely.

Health workers were shy in talking to a machine but this was overcome over a period of time through training.

Use easy or local slangs or conventions in the application interface and avoid major use of technical terminologies.

Provide, drop down boxes or radio buttons where a set of values are already known. Avoid local language and large text entry. Ensure end users are not required to fill in large amount of information. All inputs should be properly validated in mobile application itself, so that incorrect values are not entered against a patient.

Considering that the end users are from rural background, there is a need to provide enough alerts, warning or error pop-ups on screen to guide users to trace the issue and provide solutions to solve the issues [5].

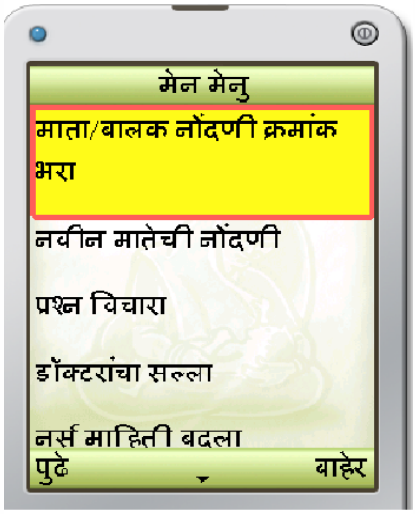


Figure 4. Representative Mobile Screen shot.

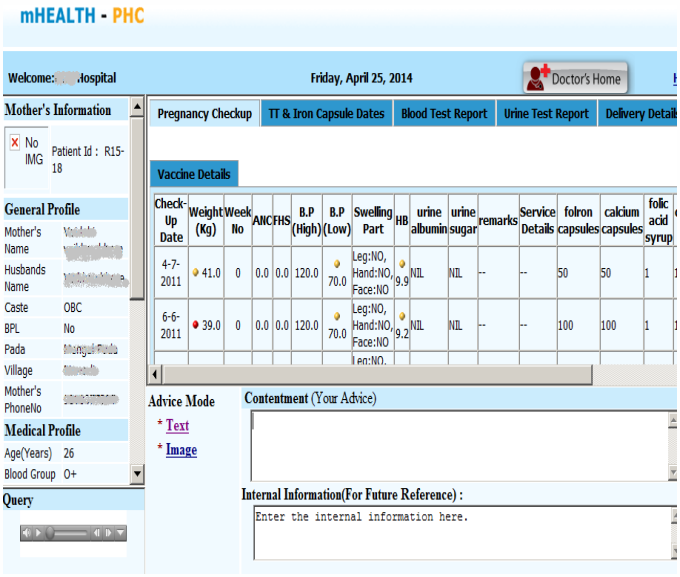


Figure 5. Doctors Web Console Screen shot.

## V. RESULTS

Participative design technique was very effectively used to design, implement and enhance the application especially in rural settings. The ownership and performance of the application increased drastically after this exercise. This platform enabled health workers to digitize the patient's data and ask questions to doctors. Doctors could see the questions along with the data and give appropriate answers. This experiment was conducted for more than a year for a set of approximately 300 expecting mothers in one of the most under-developed and remote regions of the state. The critical factor contributing to such a good use was involvement of all the stake holders right from the beginning and inculcating a sense of ownership. Few queries were really critical and appropriate advices from Doctors led to corrective actions. Upon statistical analysis of data compiled using this application, good insights about not only the health related issues but also social issues were discovered and corrective steps were taken. The platform is slowly emerging out to be a research test bed where new innovations of possible impact on masses' health could be tested. One such innovation for water quality is also being researched and piloted.

## VI. FUTURE WORK

Though the application was found to be very useful and has demonstrated limited positive impact on overall health of mothers in pilot areas, there are few still unresolved issues. Even though data entry in mobile based application was reduced, still the data fields are high in number. This is creating problems especially when radio connectivity is poor. Exercise to further prune the fields for data entry is being undertaken. At times while uploading data or recording a query, ANMs used to face issues in GPRS connectivity. In

such cases ANMs required to re-do the work, when GPRS network was available. To handle such cases, implementation of store and forward methodology is being investigated

Work is being done to come up with standardized set of recommendations, especially for rural health care applications.

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