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# **A MOBILE PHONE-BASED ICT SOLUTION FOR REPORTING AND TRACKING UNREPORTED REPRODUCTIVE HEALTH PROBLEMS IN THE OUTLIER COMMUNITIES OF KERALA, INDIA.**

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## **Abstract**

*Many global, national, and regional initiatives are in place to improve the health system and health status of people living in rural areas. The goal of providing universal, equitable and affordable health care has a profound place in the national agenda of many developing countries. With an increasing percentage of populace in the developing countries now relying on mobile phone for managing the activities of their daily lives, there are great potentials in relying on this technology to monitor the health issues among the under-served population. In this research, we describe a health information system, KHID that is developed to facilitate the reporting of reproductive health issues among the women living in outlier communities in the State of Kerala, India. The Information Communication and Technology (ICT) solution proposed in this research aims to mitigate the gaps in symptom reporting and tracking, a major deficient that constraints the reach of health care to those living in the low-income low-resource communities in developing countries.*

*Keywords: Tracking reproductive health symptoms, Mobile phone solution, ICT, Least privileged communities.*

# 1 Introduction

Women's health has long been a concern of nations and policy makers. Their biological functions endanger their health in much more complex ways than in men. The health care delivered to them right from childhood, thus has to be nodes in a continuum. Demographic, epidemiological, social, cultural, environmental and economic factors have a great impact on the quality of life of women, especially those who live in the very low-income societies of the world (WHO, 2009). Social gradient in health is evident in such communities. Inequality in capabilities and opportunities that affect this stratum of the society is invariably reflected in the quality of health. The health-transition of societies (which stems from changes in three inter-related and mutually reinforcing elements - demographic structure, patterns of disease and risk factors) takes a direct toll in the health of women and children in their early stages (WHO, 2009). Gender differences are observed with women reporting significantly lower levels of morbidity than men. This variance is attributable to under-reporting of ailments as opposed to lower health issues among the women (Sen and Iyer, 2000).

In India, women-specific health care services are addressed via various national programs such as the Family Planning Programme, the Reproductive and Child Health Programme, the Mother and Child Tracking System, and the National Rural Health Mission. The services delivered in this particular domain tend to manifest a strong gender bias, a women-centric approach, whereby regulating and controlling reproductive health becomes exclusively the responsibility of the women. This is evident from the commonalities that characterize these programs such as:

- Shift the burden of fertility control on to women
- Focus on women's biological function of 'reproduction'

The different kinds of health issues that fall outside the purview of this biological function had so far been neglected (Gangoli et al., 2005). Women are unable to seek care for problems that are not related to pregnancy and other gynecological complications, as they are not directly addressed by any existing national programme. Since 2005, an improvement can be noticed following the introduction of the second phase of Reproductive and Child Health programme which gave due importance to addressing issues like Reproductive Tract Infections (RTI), Sexually Transmitted Infections (STI) and AIDS.

Electronic Health Record is a relatively new concept in India. The information filing system was a manual process till recently. Since 2008, electronic data compilation is undertaken through the Health Management Information Systems (HMIS, 2011) portal developed by the National Rural Health Mission (NHRM, 2011). The HMIS seeks to monitor the quality of health care and health services among the rural population of India. The portal facilitates public health management and service delivery pertaining to maternal health (registration of pregnancy, receiving ANC, hospital delivery details, information on safe delivery, post partum care, management of STIs, and RTIs, etc.), child health (breast feeding practices and newborn weighing trends), immunisation (tracking drop out rate between BCG and Measles vaccination), family planning, and service delivery (immunisation sessions, referral transport, etc.) The web portal also includes the Financial Monitoring Report (FMR) capabilities, which allow the districts and states to enter their reports on a quarterly basis.

A close analysis of the HMIS reveals multiple weaknesses. First and foremost, the health issues are addressed as national sponsored programmes, the scope of which is so far reaching that it fails to precipitate to the short-term basic needs of the most under-served communities. Second, a review of the system documentation, user manuals and training guides reveal numerous shortcomings in the capabilities of the system in its current form. For example, although the reproductive health services in India acknowledge woman as the 'mother', the multitude of problems that she faces, other than due to pregnancy and delivery, do not come under the consideration of these programmes. Unsurprisingly, these issues form a considerable portion of the unreported health issues among the women in rural areas of

India. Semi-structured interviews with the various Junior Public Health Nurses (JPHN) and the members of the State Poverty Eradication Mission operating at the base level units known as Kudumbashree unit, (shortened and referred hereupon as k-unit) show that the system is severely limited in its ability to collect information on certain crucial, but neglected and disabling morbidities that affect women. No functionality exists to consolidate data for detailed analysis at a later time. Furthermore, the rise in health care costs combined with capability factors (such as physical accessibility to health care clinics and economic constraints) and cultural factors (such as issues of social stigma around discussing RTI and STI symptoms, traditions, and prevalence of non-scientific treatment methods) have resulted in a lower levels of utilization of health care services and under-reporting of illnesses (Dilip, 2002).

Information on the prevalence of morbidity and the pattern of morbidity is crucial from a health policy perspective. To mitigate the social gradient in the health of women, particularly in addressing under-reported incidents of RTIs and STIs, the public health planning has to be as scientific and realistic as possible. This can only be accomplished with the aid of precise and accurate data. The situation described above raise the following research questions:

- What is the nature and type of information (we limit our focus to RTI and STI) that should be collected and filed?
- Can an Information System (IS) be developed that the hugely popular and organized strength of grass root level workers (for e.g., JPHN and k-unit members) use for collection and filing patient symptoms?
- What role can Information Communication and Technology (ICT) play to improve the reporting of unreported problem among the lower socio-economic group?
- Can ICT play an effective role to mitigate the constraints that characterize the health reporting capabilities of women living in the outlier communities?

To address these research questions and to evaluate the current status of the RTI/STI information reporting, we undertook an exploratory study in three outlier communities in the State of Kerala in South India.

## **2 Background**

Several theoretical propositions and empirical studies have appeared in the domain of public health that focuses on STI/RTI prevention (Quadeer, 1988, Jejeebhoy et al., 2006). Literature review identifies various technological solutions that have been built to report and share public health information. There are also ample examples of solutions that rely on cellular phones to collect health data from the field. Mobile phone based technology has been successfully used for literary and community empowerment in Senegal and Kenya (Zelezny-Green, 2010). Community health workers in Zambia and Uganda use them to monitor the health of Millennium villages (Asiimwe et al., 2011). An increasing percentage of populace in these communities now rely on mobile phone for managing the activities of their daily lives, With the substantial presence of cellular phones even among the lowest strata of the society, there exists the potential to develop an ICT solution that can take advantage of the relative simple and easy to use communication device.

The Health Belief Model (HBM) is a psychological model that attempts to explain and predict health behaviour by focusing on the beliefs and attitudes of individuals (Hayden, 2008, Janz and Becker, 1984). Using a phenomenological orientation, it assumes that the subjective world of the perceiver determines the behaviour rather than the objective environment (Mikhail, 1981). It is one of the most widely accepted theories used to explain health related behaviour. (Strecher and Rosenstock,1997, Brewer and Rimer, 2008, Urrutia, 2009). The model is designed to predict a person's health behaviour, including the use of

health services, and to determine interventions to alter maladaptive health behaviour. Originally proposed in 1966, the HBM initially comprised of four main constructs - perception of susceptibility to a disease or condition, perceived severity, perceived benefits of care and barriers to preventive behaviour (Figure 1). Susceptibility refers to one's subjective perception of the risk of contracting a health condition. Severity relates to the idea of an individual regarding the serious consequences of contracting an illness or of leaving it untreated. Susceptibility and severity are often combined and identified as the single force of 'threat'. Benefits correspond to the beliefs regarding the effectiveness of the various available actions in reducing the threat (Strecher et al., 1997, Lefebvre, 2000, Rosenstock, 1966, Urrutia, 2009). Barriers are the individual's own evaluation of the obstacles in the way of adopting a new behaviour. (Hayden, 2008). The model suggests that the susceptibility and severity can provide the necessary impetus to realize the net effect of benefits and barriers, which are instrumental in leading to a preferred path of action (Strecher et. al, 1997).

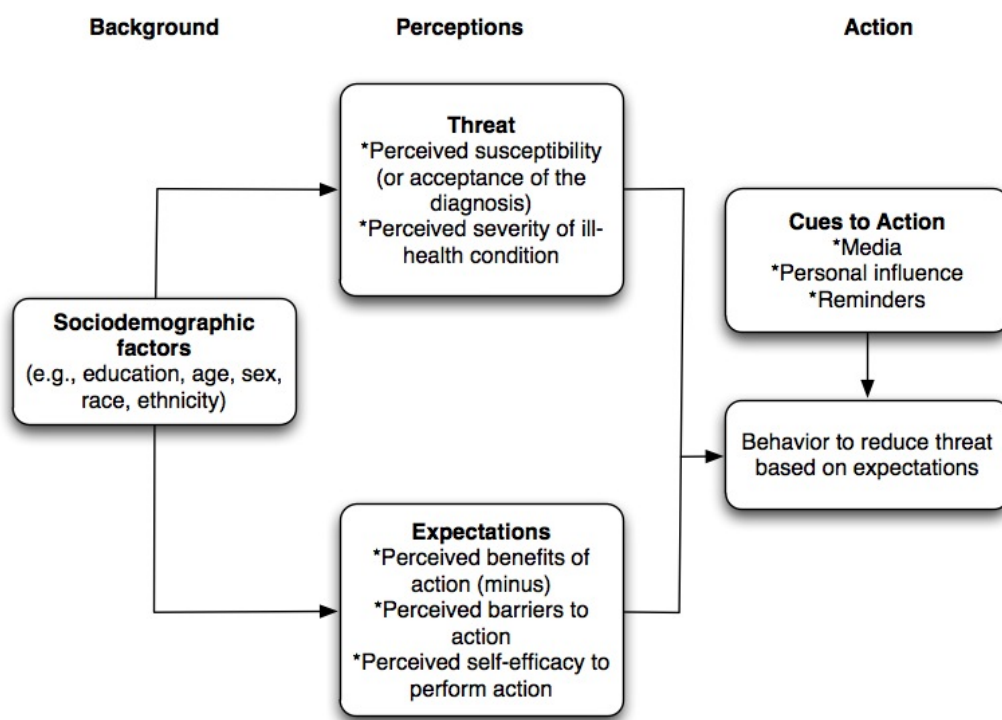


Figure 1. The Health Belief Model (adapted from Rosenstock et al., 1994)

Two additional concepts were later added to the original model. They are: cues to action and self-efficacy. After conducting extensive studies on the likelihood of action in the context of health behaviour, Strecher et al. (1997) proposed that the readiness to take action is persuaded by additional factors, especially cues to action. The cues can be bodily events like identified symptoms or environmental triggers such as information sourced by media, reminders, incentives, etc. (Hayden J.A, 2008, Strecher, et al., 1997, Lefebvre, 2000). Self-efficacy was introduced at a later stage. This concept relates to the confidence in one's ability (self-efficacious) to take an action to implement a behavior change (Bandura, 1977, Sarcinci et al., 2011, Hayden J.A, 2008, Strecher et al., 1997). This construct plays an important role in adoption, initiation, and maintenance of health behaviours and is a key construct of the Social Cognitive Theory (Bandura, 1977, Luszczynska, A., and Schwarzer, 2003).

### 3 The K-Unit Health Information Dashboard (KHID) and Example

Based on the Health Belief Model, if the belief variables (severity, susceptibility, benefits and barriers) can be targeted by specifically designed ICT intervention, it may be possible to exert a pressure and coerce the populace to a likelihood of reporting RTI/STI symptoms. Our initial interviews with the women in the communities demonstrate a willingness to use cellular phones to report symptom. The K-Shree Health Information Dashboard (KHID) is a mobile technology-based ICT solution that can enable communication and engagement between the women in the communities and the health care workers. It primarily serves two main objectives: 1) gather symptomatic data (self-reported) from women with RTI/STI related morbidity, and 2) identify information gap so that prescriptive instructions can be furnished to those requiring immediate care. The framework for this approach is show in Figure 1.

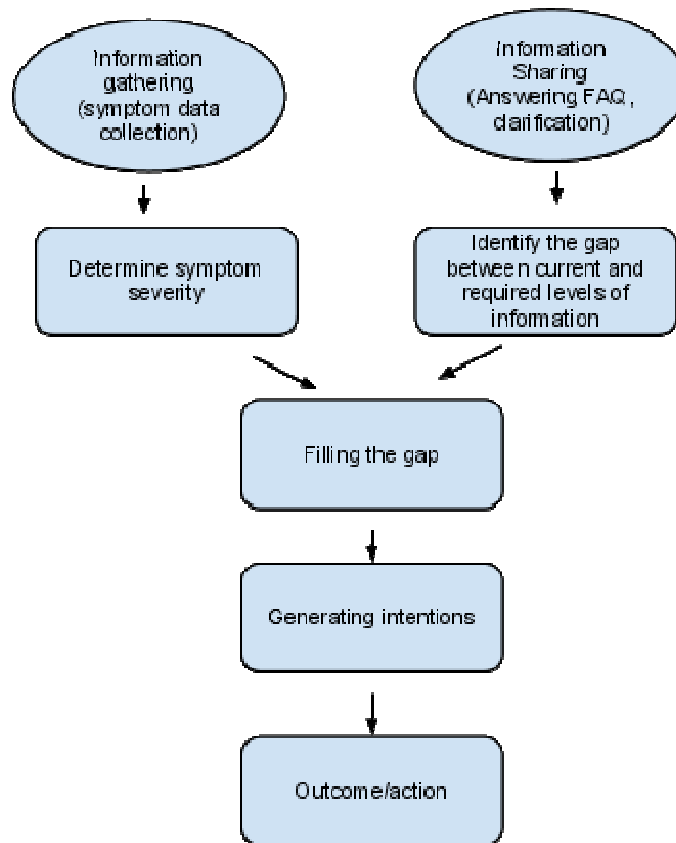


Figure 2. The health reporting and gap analysis framework

The KHID information filing system is designed to capitalize on the proliferation of mobile phones among the members of the community. It is designed for the nascent environment characterized by individuals with a little or no technological competency, minimal literacy levels, and culturally inculcated in a combination of substantiated beliefs and appropriated desires. For the health worker, the KHID software offers extensive dashboard capabilities with features to conduct gap analysis based on the symptoms filed by patients and respond quickly to those requiring immediate care. The system will allow the health workers to correct (or legitimize) beliefs about perceived threats associated with specific health

symptoms, communicate messages intended to reinforce the desire to improve health and influence intentions that can influence a likelihood to pursue health modifying action.

### 3.1 Data Management

The KHID system will allow the JPHN or the Area Development Society (ADS) representative to very easily manage the units of administrative hierarchy (ADS, Ward, Kudumbashree unit) and Patient data. It relies on the SMS (Short Message Service) technology to collect and share patient health conditions. The system uses the standardized micro messaging format for transmitting and interpreting the text messages. An action code always form the first value in the message (Table 1). After the message has been processed the system acknowledges by returning an appropriate confirmation message to the sender. In addition, a JPHN may create, edit or delete records using the web-based administrative interface without having to rely on text messages (Figure 3). The web-based administrative interface of the KHID system also offers extensive data analysis and visualization features.

Action Code	Description
50	Create a New Patient
60	Create a New Ward
70	Create a New Kudumbashree (k-unit)
80	Create a New ADS
99	Report a New Symptom for a Patient

*Table 1. KHID Action Codes*

### 3.2 Creating a New Patient

A JPHN or the ADS representative who wish to add a new patient to the system can do so by sending a SMS text message containing an action code and the necessary information.

To create a new patient, the ADS would send a text message in the format “50 WARDID FIRSTNAME LASTNAME”. For example, to create a patient named Priya Gupte for Ward 75 the ADS would send a SMS message in the following format: “50 75 Priya Gupte”. The action code 50 (Table 1) allows the system to recognize that the user is requesting to create a new patient record. The system verifies if the Ward with ID 75 exists in the database. If the Ward does not exist, an appropriate message is returned to the user indicating the exception. Otherwise, the system checks to see if a patient with the name “Priya Gupte” exists in Ward 75. If a patient with the name “Priya Gupte” exists in ward 75, a message is returned to the user stating “A patient [name] exists in ward [id] with the Patient [id]” (the fields in the square brackets are data units determined by the application in real time). If the Ward exists and the patient does not exist, a new patient record is created in the database and the Patient ID is returned to the user. The data flow for the patient creation process is depicted in Figure 4.

## KHID administration

















Khid	
ADSs	 Add  Change
FAQ Requests	 Add  Change
FAQs	 Add  Change
K Units	 Add  Change
Patient Symptoms	 Add  Change
Patients	 Add  Change
Symptom Codes	 Add  Change
Wards	 Add  Change

Figure 3. The KHID administration interface.

### 3.3 Creating a New Ward

To create a new ward, the ADS representative would text a message in the format “60 ADSID WARDNAME”. For Example, if the ADS wanted to add a new Ward with the name ‘Beach Ward’, they would text the message “60 112 Beach Ward”. The action code 60 indicates to the system that the ADS representative is trying to insert a new ward under the ADS number 112. The system checks whether the ADS already exists, and if it does not, an error message is sent in response. Otherwise, the system creates the Ward and returns the new Ward’s ID to the sender.

### 3.4 Creating a New Kudumbashree (K-Unit)

To create a new Kudumbashree using SMS, the representative would text a message with the format “70 ADSID KUNITNAME ” such as “70 112 Cochin Corporation”. The system then checks to see if the record already exists in the database. If an ADS with the ID does not exist, a response is sent to indicate that ADS has to be created first. The user would then need to create the ADS before continuing. The system will then check if the k-unit with the given name is in the system. If the k-unit already exists in the system, the application will inform the user by forwarding the ID of the existing k-unit record. If the k-unit does not exist, one is created and the new ID is returned.



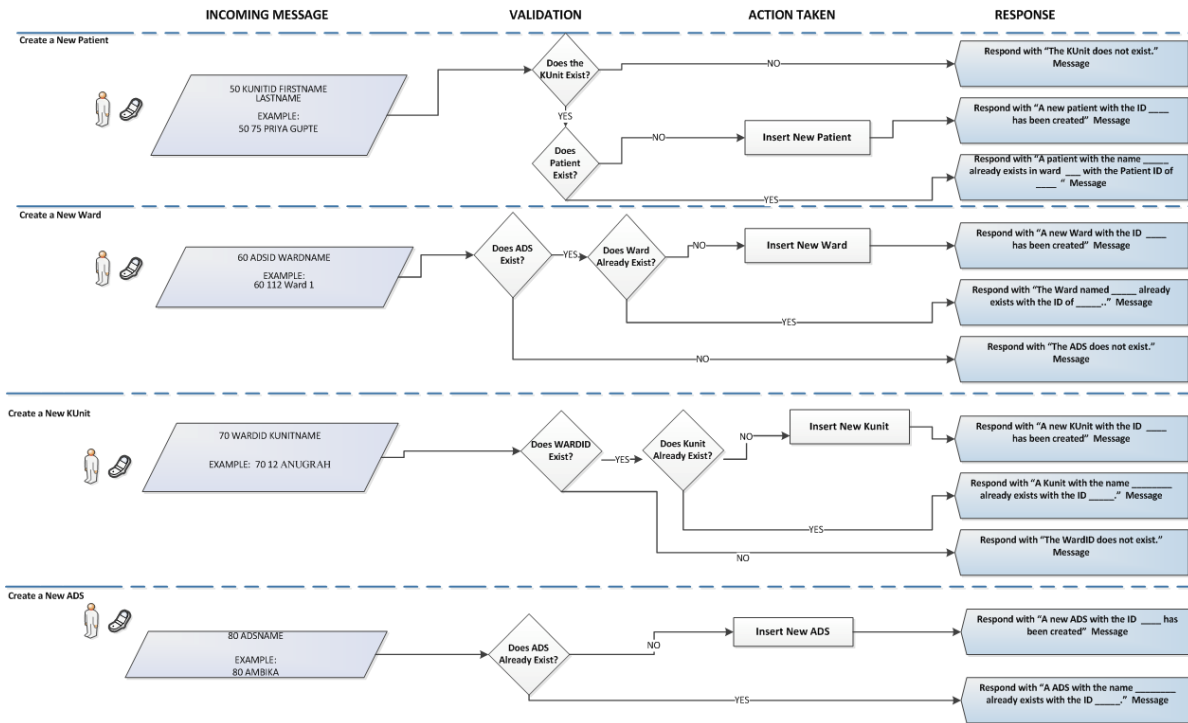


Figure 4. Data flow diagram for JPHN activity

### 3.5 Creating a New ADS

As before, creating a new ADS can be done through the web interface of the application or via SMS texting. To create an ADS using SMS, the user would send the message in the format "80 ADSNAME". The system would use the ADSNAME field to search the database for existing record with the same name. If the ADS exists in the system, the reply text will return the existing ID of the record to the user. If the ADS does not exist, the system would create a new record and return a message containing the ID of the newly created ADS. The data flow for creating the various administrative units is shown in Figure 4.

### 3.6 Reporting Patient symptoms

An individual in the community, the JPHN or the ADS representative may report symptoms for a patient. Figure 5 shows the data flow diagram of how an individual may submit the symptoms to the KHID system.

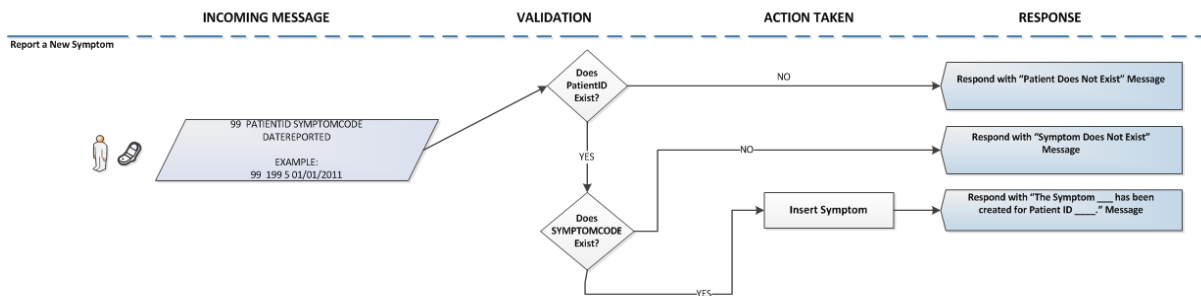


Figure 5. Data flow diagram for reporting patient symptoms

To report a patient’s symptom the user would use SMS to create the record. The format of the message for creating a new symptom is “99 PatientID SymptomCode DateSymptomObserved[optional]”. An example of such a SMS text message will be “99 1 2 3”. On receiving the text message, the system first checks if a patient exists in the database. Although the originator of the SMS can be determined by the application via caller ID, the PatientID is used as the primary record identifier. This ensures that a k-unit member can file symptoms under circumstantial constraints such as having a non-functional phone, unavailable texting features, not owning a phone, or sharing another person’s phone. If the patient does not exist, the system returns a notification text to the user to contact the JPHN for registering the patient in the KHID system.



Figure 6. Screenshot from the KHID application to create patient symptom record

If the patient is positively identified, the symptoms 2 and 3 are recorded for the patient with ID 1 and an acknowledgement message is returned. The default case does not require the user to enter a date (the server will insert the date automatically when the SMS is received). The option to enter the date is provided in case the user wishes to provide the date when the symptom was first observed. Figure 6 shows an example of the SMS text that will be send by a patient to report symptoms (as viewed from the message testing feature of the application software).

The symptom codes (twelve) are distributed to the women in the communities in the form of a single page pamphlet. The symptoms and the corresponding codes are adopted from the Reproductive and Child Health Survey developed by the International Institute for Population Sciences (IIPS, 2006). The Indian Institute of Population Survey uses the same set of symptom in their annual district surveys. The JPHNs play an active role in providing basic training to the women on using the cell phones and distribute the symptom-code pamphlets. As mentioned earlier, all information can be managed (create, edit, delete) using the web-interface of the application.

## **4 Discussion and Evaluation**

For the women in the under-served communities, the intention to seek a health modifying behavior is tempered by desire (e.g., wanting to improve health to care for their children) and corroborated by beliefs (e.g., believing that all women can get such diseases). The communities are traditional societies immersed in age old beliefs and communication networks. The women have minimal levels of knowledge regarding treatment options. The likelihood of adopting a health modifying action is dampened when the inadequate educational background prevents the permeation of knowledge and information. As one interviewee states,

“I feel that there is some problem with my reproductive system. But it is not getting any worse. So I think, I can manage like this for some more time.”

An ICT based intervention can serve to inform the population about health options, mitigate gaps in asymmetrical and incomplete information, and educate the public on consumable health services.

The solution proposed in this research is currently being tested in the three different outlier communities in the state of Kerala in South India. Over the duration of eight months we have conducted 45 interviews and 7 focus group discussions. The objective was to determine the information gap and to raise awareness about the potential of ICT to empower women in filing RTI/STI symptoms. In the current phase of the study, the grass root workers are being trained to use the KHID system and the target population is being taught to report symptoms using the mobile phone. The next phase of the project will involve a questionnaire-based survey of the JPHNs and ADS representatives. The feedback will be used to assess the design artifact and to determine any shortcomings and needed improvements. Data will be collected from the target communities to determine the impact of ICT intervention. Since literacy levels of the target population make it impossible to conduct a survey, open-ended semi-structured interviews will be carried out to gather information from the women in the communities. Qualitative analysis will be used to determine whether ICT intervention would promote the likelihood of reporting RTI/STI symptoms. Empirical evaluation will help to ascertain the extent to which the gap between the current and required levels of information is filled by using the ICT solution.

## **5 Conclusion**

The global action plan adopted by the United Nations specifically addresses the need to accelerate progress in women and children’s health (UN, 2011). The state of Kerala in South India is different from the rest of the nation as far as achievements in health-care are concerned. Regional and gender-based disparities can be discerned in the dispensation and utilisation of the health care services in this region. The unreported health care needs of women, especially reproductive health care, form a big gap in tracing the morbidity map of the State. The existing Health Information System in the State falls short in tracking and including ‘unreported’ reproductive health issues. A system avoiding such invaluable information is

likely to be ineffective and weak. The KHID solution aims to improve the reporting of unreported RTI/STI problems among women in the lower socio-economic group of the society.

For the professional health worker, the proposed ICT solution will help to increase the knowledge of existing information gaps in the communities they serve. It will serve the workers to identify and reach those who require clinical attention. Even in cases where a patient seeks clinical consultation, the existing information filing system fails to keep track of the symptom records. The KHID solution offers a simple and effective way to maintain historical data about the patient symptoms. It offers analytical capabilities with drill-down features and query-based visualization. In a country like India with a significant rural presence, the information generated by the KHID dashboard can serve as the basis for formulating and implementing future public health policy changes. The framework proposed in this paper provides an analytical perspective to identify information gaps when communicating and engaging with those living in the least privileged communities. For researchers in IS working on developing ICT solutions for developing countries, it provides the foundation for further research and development in this critical area.

Our future research will focus on determining if the system can be generalized for utility in similar communities in other parts of the country as well as in other deserving areas of the world. The three outlier communities where the ICT solution is currently tested varies marginally in their socioeconomic and environmental profiles. Whether the variances are accommodated in the system and the degree to which the specifically designed ICT intervention proves successful to coerce a likelihood of action remains to be determined. We plan to interpret and elucidate the outcome once the planned data collection is completed in the next phase of the research.

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