

## Towards the Automatic Management of Vaccination Process in Jordan

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**Abstract**—Rural communities in developing countries are faced with many challenges due to its geographical and demographic conditions. This has been evident in many studies and surveys. Health issues are among the top priority challenges in governments' agendas. One important example is the vaccination of new born babies and young children. Vaccination is generally considered to be the most effective method for preventing infectious diseases. The rate for non-vaccination is much higher among communities in rural and remote regions. Information and Communications Technology can play an important role in assisting the government to manage the process and help reduce the rate of non-vaccination. In this paper, we describe a mobile system developed to electronically manage the vaccination process. Early evaluation demonstrates the benefits of such system in supporting government activities.

**Keywords**- *information and communications technology for development; health systems; mobile application; vaccination; rural areas.*

### I. INTRODUCTION

Governments in developing countries, and even in developed ones, face challenges with relation to services provided to communities living in rural and remote areas. Among these, health services occupy high priorities in government planning and funding. Quality health services are offered in capital and big cities. This is mainly because those cities offer more opportunities to medical staff to forward their careers in addition to the ease of life and many other advantages. This leaves rural areas and remote communities deprived of specialized and experienced medical staff. It is not difficult to imagine that many medical cases will have to travel to the capital city or other big cities to obtain needed treatment; or wait till the next medical day in their region (where a consortia of medical doctors visit rural areas) to happen. This has been a challenge even in advanced societies. A good example is [1], a study by Lenthal et al. describing the challenges facing rural Australia as a result of decreasing numbers of nurses and midwives.

Another characteristic challenge in remote areas, due to geography and the dynamic demography, is coverage. Governments face daunting task to outreach for those communities with awareness information, health warnings, medical specialists' visits and other events. In the case of Jordan, the government and related NGOs spend considerable budget to produce and print leaflets and

produce TV and radio content. However, the question remains about efficiency of coverage among intended population.

Information and Communication Technologies (ICTs) are now widely considered by developing countries as the motor of growth, the driver of efficiency and effectiveness and the tool to enhance human development. With the advancement of ICTs and the Internet, communication and web-based technologies can be exploited to address many challenges with relation to improving coverage and obtaining a much needed accurate statistics and information.

In recent years there has been concrete evidence on the impact of social networking website in many aspects of life. An obvious and recent example is current events in the Middle East and North Africa. Many claim major roles for social networking tools such as Facebook and Twitter in the dynamics of these events [2]. These tools are changing the way people communicate, receive and exchange information. Such tools easily attract users as they are discrete, connect large number of individuals and eliminate the middlemen. While most popular networking websites are social in nature, professional networking websites can also be used as an efficient and cost effective tool to tackle issues and problems in society.

Many ICT interventions have been introduced to address social challenges including those of rural communities. In [3], the authors addressed the role of mobile technology and the viability of this technology in enhancing productivity, facing poverty, and improving social conditions in general. Jun [4] provided several evidences in China on the impact of mobile applications socially such as addressing employment.

One very important and priority sector is health. As mentioned earlier, quality health services are specific to large communities and adequate services or support are not available for rural areas. Health is an obvious sector that can benefit from opportunities that the technology offers as shown in many studies. In a comprehensive study [5] carried out to assess the application of ICT in health sector in terms of accessing information and disseminating awareness content in Uganda, Omona and Ikoja-Odongo concluded that there is need to support and promote ICT as the most effective tool for health information access and dissemination. The opportunities and benefits of mobile and wireless technologies for healthcare service delivery, improving patient safety and reducing cost were also the subject of a research by Ping Yu et al. [6]. The study

researched m-health solutions and the challenges for developing and deploying m-health applications. Maeda et al. [7] proposed a framework for mobile application for health education and awareness.

Recognizing the important role ICT can play in improving the outreach and the feedback from health services, we started a pilot project concerned with enhancing health services to women and children in remote and rural communities in Jordan. The aim of the project is to evaluate the impact of ICT on improving such services and compensate for the lack of experts and medical staff. The project contains tool for medical practitioners to interact with the public regardless of their geographical proximity. The system allows contributions from medical doctors, medical students, nurses, pharmacists and other medical personnel in Jordan to assist stakeholders (whether doctors or patients) with questions related to health issues. Also, it allows interaction between users (patients) themselves to form common interest support groups. The system's information channels, such as mobile phones allow access to health information to such groups in a cost effective manner.

In this paper, we report on one module of the project that recorded some encouraging results qualifying it to be adopted nationally. The module is concerning the management of the vaccination process of new born babies and children. The importance of such module comes from its impact on health. Most children who are not appropriately immunized are at risk of serious conditions. The automatic management of vaccination is therefore a necessary application.

## II. THE CHALLENGE OF VACCINATION

Ever-changing vaccination schedules can be confusing for providers (clinics, doctors, hospitals) and parents. The Ministry of Health maintains a vaccination program that is updated and checked regularly. As soon as a new baby is born, parents are given a card with the vaccination schedule. It will be then the responsibility of the parent to follow the dates of each vaccine. Possibly, it's not an issue in urban communities with all existing electronic gadgets to remind people. Nevertheless, compounding this problem is the fact that vaccination records are often scattered. In rural areas in particular, the process is manual and records are kept on cards given to parents and on papers kept at local clinics. When records are scattered, it is difficult to assess whether a patient is up-to-date or not. It makes it harder for parents in rural and remote communities to maintain the process especially that the process is stretched over a long period of time.

On the other hand, it is also the responsibility of the clinic or the doctor to make sure that enough vaccines are stored in the local clinic to cover the need for the area they serve. Clinics usually have no statistical information on volume of vaccines needed daily or weekly. This can also lead to other challenges like storage. Clinics in rural communities are occasionally not equipped to store vaccines for long period of time.

Recent research has demonstrated specific and practical procedures medical staff can adopt to improve effectiveness

in immunizing children, including the following: 1) sending parents reminders for next vaccination; 2) using printed material during calling at local clinics to remind parents and staff about importance of vaccination and vaccination table; 3) contribute to keep a statistical records on immunization rates for improvement effort.

Vaccination coverage in Jordan nationwide is relatively high [8]. Statistics show that the rate is higher in urban areas than rural.

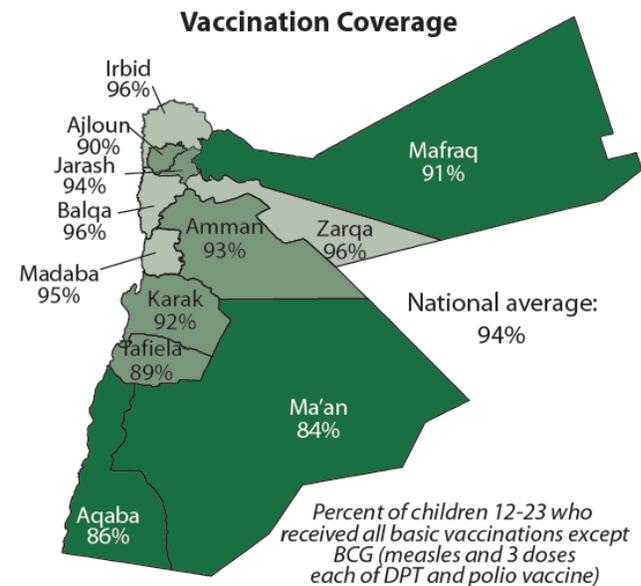


Figure 1: Vaccination coverage in Jordan (source: Jordan 2007 Population and Family Health Survey)

Figure 1 shows the vaccination rate among communities in rural areas (such as in the governorates of Ma'an, Tafiela and Aqaba south of Jordan) are lower than other governorates. The reason can be attributed to lack of effective awareness, illiteracy rate, lack of reminders and lack of medical personnel. Any intervention should address these issues.

## III. SYSTEM REQUIREMENT

From the challenges mentioned in the previous section, an ICT intervention to manage the vaccination process will contribute to improving the vaccination rate especially among residents of rural and unprivileged areas. The high-level requirements of the system are to:

- 1) Register new born babies with the system and calculate the vaccines based on the vaccination schedule maintained by the Ministry of Health.
- 2) Issue reminders to parents reminding them on the date and the type of the due vaccine.
- 3) Issue reminders and volume information to clinics on the number and types of vaccination they will be expecting to perform in a specific day to make sure they secure the needed quantities.

4) Provide awareness information to parents to help them establish the importance of the vaccines for their children.

To identify the interaction requirements of the system, we need to understand the main stakeholders and how they will use the system. We have two main stakeholders: parents and clinic staff. Following are description of the main stakeholders:

**Parents:** Usually parents in rural communities are not exposed to technology such as internet and all the tools that come with it. In a survey conducted prior to the design of the ICT intervention to investigate the best way for the system to interact with those users, it was noticed that more than 90% of the surveyed users own at least one mobile phone. This is quite significant penetration rate. Most of these phones are basic ones. The usage of mobile phones is for the purpose of making and receiving calls as well as communication through text messages. Our conclusion was that any project should have a mobile component to communicate information with the users.

**Clinics:** When we mentioned clinics servings rural and remote communities, we are assuming basic infrastructure. No internet or computer. Some of the clinics are even mobile clinics to provide services to the moving population (Bedouins) and they tend to have minimum equipments. Any solution to be adapted nationwide should take into consideration the cost factor i.e. minimum is to be spent on infrastructure. Clinic staff should have the option to interact with the system using the internet if possible, or using smart mobile devices which are cheap to acquire and install.

#### IV. MOBILE APPLICATION

Given the identified requirements, we designed the vaccination management system based on a clear identified scenario and simple workflow.

**Workflow:** Clinic staff registers new born babies with the system. This can be done either using the internet (website) or, if the infrastructure is not there, using smart phone over 3G networks. The application can be downloaded and used with any java enabled phone. The clinic personnel need to capture basic information about the child (name, date of birth, weight, height and contact details of parents) and send the information to the system as an SMS message. Once the information of a new child have been received and stored, the system uses the vaccination schedule issued by the Ministry of health to calculate the dates of the vaccines for the registered child and store them on the database. The system continuously checks the database to produce a report of which children due to be vaccinated in a certain day. The system automatically sends the parents a reminder on the next vaccine for their child and at which clinic. Also, the system sends statistical and volume information to clinics about expected children and vaccines at a certain date. When the vaccination of a child takes place, the clinic personnel send this information to the system to maintain the child record. Figure 2 summarizes the workflow of the system.

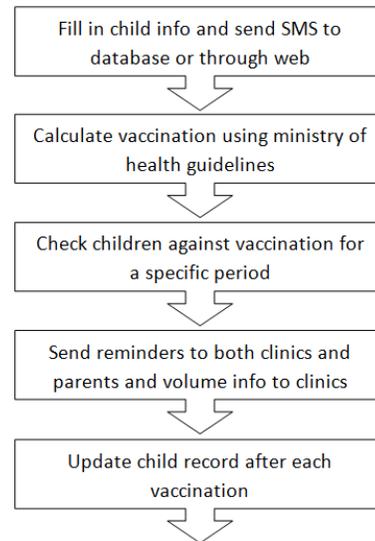


Figure 2: Work flow of the system.

The database maintains up-to-date record of vaccination to be used by decision makers at the ministry to obtain information for the purpose of reporting and planning.

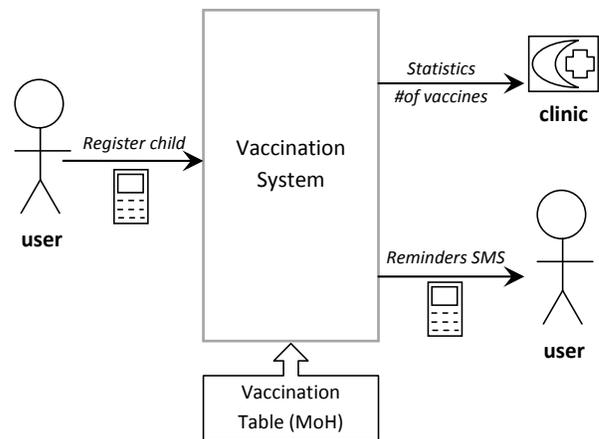


Figure 3: Architectural design for the Automatic vaccination system

Figure 3 depicts the architectural design of the system, the input/output channels and support information. Figure 4 provides more details about the process and the modules in the system.

**Objectives:** The main aim behind the design of the pilot system has been to measure the advantages and impact of ICT interventions in enhancing vaccination process and support health clinics and hospitals in rural and remote communities. During the life of the project we attempted to answer the following key research questions: (1) Could ICTs contribute to the enhancement of the general health of rural and remote communities? and (2) What is the minimum infrastructure needed for the deployment of the automatic vaccination management system?

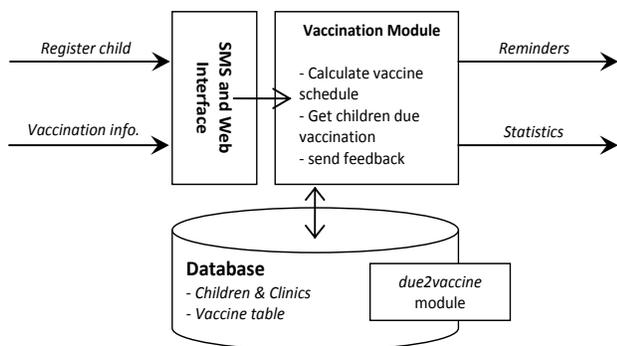


Figure 4: Main components of vaccination system

**Implementation:** Our intervention was developed using the following technologies: Java Server Pages (JSP) and Java Servlet for the Dynamic Interaction with the users in the user interface; J2ME to develop mobile application; Hyper Text Mark-up Language (HTML) for the Content of the static pages in the system; JavaScript for the validation of the data entered by the users; AJAX for the smooth interaction in items (Data Swap without DB Rendering); The Tag-libs technology for the Modularity and Template adaptation in Inner and Main Pages; MySQL for database functionality; and XML for the optimized and structured data transfer.

## V. EVALUATION

We made the necessary awareness about the availability of our system to concerned stakeholders and we started to collect the needed information to answer our research questions. Five clinics in Jordan were selected serving communities in remote and rural areas. The selection was made together with the Ministry of Health based on need analysis. We provided these clinics with minimum infrastructure required (i.e. a netbook and a smart mobile phone per clinic). Valuable information were collected (either by interviews and/or questionnaires) from various stakeholders with this regards. The evaluation at this early stage is subjective and is based on user experience with the system. We noticed that all feedback from clinics were positive. The system allowed them to plan for both number of staff needed and number of vaccines required. Several comments were made about the use of mobile devices as a data entry device compared to using a laptop in terms of easiness and correctness. Parents who tried the system expressed their satisfaction on receiving reminders about the process. Parents are only receiving a couple of line text in the form of SMS and don't need to report or perform any data entry. Basic mobile phones were suitable for the task.

The subjective evaluation showed that user experience from using the system was smooth and realized with satisfaction. However, and in order to obtain a clearer picture in terms of benefits on how this module help tackling and important issue which is children missing vaccination (higher in rural areas), a wider deployment is needed nationwide once a decision is made to adopt the solution.

Overall, and in spite of the advancement in mobile applications developments and innovations, there are certain challenges: (i) Concrete evidence: we are in need of a robust analysis and evaluation tools and standards of mobile intervention in health to help designing better and effective services; (ii) Legislations: this is quite important to establish a clear policies and laws to govern ICT interventions and their deployment; (iii) Sustainability of ICT interventions, sustainability is important issue for ICT4D projects. There should be clear understanding of how to fund these projects from both public and private sectors and to continue to provide resources and (iv) Capacity building: there should be focus on building the competency of various stakeholders in terms of ICT usage. Also mobilize resources to bridge the technological gap facing rural communities.

## VI. CONCLUSION AND FUTURE WORK

Deploying the pilot vaccination management system in selected clinics serving remote communities demonstrated the impact ICT interventions can have on enhancing services and its outreach. More research and investigation is needed to deal with smooth and effective online communication between patient and health workers. Future work will focus on widening the evaluation to include more clinics and region in rural Jordan to reach a working system that can be adopted nationally.

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