Reducing Infant Mortality Using Mobile Applications

A paper on the potential impact of using technology to increase vaccination in infants.

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***Abstract*— Today's world is characterised by professionals who have minimal time with their families and especially their young children. Working mothers find it hard to keep track of the vaccines their babies have received and there exists no mechanisms to remind the mothers of the same. This paper proposes the development of a mobile application to increase the number of children who get timely vaccination in line with the attainment of United Nations Millennium Development Goal 4 (MDG4). This application is aimed to be used by working mothers for tracking vaccination dates for infants below 12 months of age. The Chanjo App is to be located in Kenya, where the target demography is found.**

Using the Object Oriented Analysis and Design methodology, the plan is to develop an application that will allow mothers to plan their infant's immunisation as well as receive timely notifications on their schedule. This will be aided by the current boom in the uptake of smartphones (android and iOS) in the Kenyan consumer space [6]**. It can be rightly assumed that the system can be implemented in numbers sufficient to achieve the MDG4 goal.**

I. INTRODUCTION

Infant mortality rate has been at high percentages for quite a long time in Kenya as compared to more or almost equally developed countries. Infant mortality rate according to Kenya Demographic Health Survey conducted in 2003 is 77 per 1,000 live births.

In efforts to reduce the number of deaths, the government conducted its first ever countrywide measles campaign from June 17-23 2002. This was among the many diseases to be vaccinated against. (Unicef.org, 2016) The result was that about 40% of the children's population benefited. This was major breakthrough and prevented 18,000 infant and child deaths that year.

There have also been campaigns to increase the health care for mothers in the country, such is the Beyond Zero Campaign initiated by First Lady Margaret Kenyatta on the 24th of January 2015 in the city of Nairobi (UNAIDS,2014). An annual run is conducted to raise funds to improve maternal and child health outcomes in the country.

Awareness meetings have also been conducted to inform the citizens on the importance of vaccines and in addition, door-to-door administration has been initiated (KenyaForum, 2016). Surveys and programs have been put up to try improve the sector. The World Health Organisation, for instance, have been doing surveillance on the immunisation coverage in the country in 2015(WHO, 2016). However, despite all these, extra efforts have to be put to completely do away with this concern.

II. LITERATURE REVIEW

A. Current infant vaccination status

Kenya has a population of 39,002,772(2009 census) with 6,616,901 being below the age of five. Kenya's average vaccine coverage for DTP3 (Diphtheria-Tetanus-Pertussis) stands at an average of 87%.(Calhoun, Lisa M.,2013) [2].There has been a general increase in the routine child/infant vaccination coverage worldwide since the early '90s; giving way towards the attainment of the United Nations Millennium Development Goal 4 (MDG4) aimed at cutting down child mortality by two thirds by 2015. This achievement seems unlikely to be achieved without putting in more effort towards curbing preventable diseases. Diseases for which vaccines have been developed are classified under preventable diseases.

Despite the definite progress in childhood vaccination coverage, there is still cause for worry for Kenya. A recent study carried out in Gem (Wagai and Yala Divisions), Nyanza Province [1], Kenya by the Kenya Medical Research Institute (KEMRI)/Centres for Disease Control and Prevention (CDCP) Health and Demographic Surveillance System (HDSS) that involved a small sample of mothers who were enrolled and randomized to receive mobile phone text message reminders to bring their child in for vaccination as well as a conditional cash incentive for timely vaccination. This study found that vaccination coverage with the second dose of the pentavalent vaccine within 4 weeks of the target date achieved almost 95% compared with 60% among children of mothers who did not receive text message reminders.

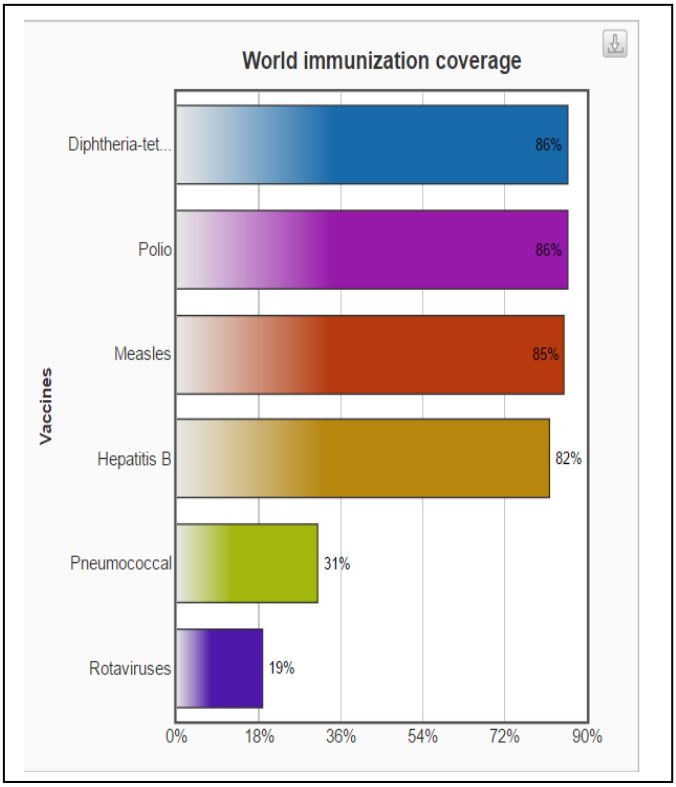

Figure 1. World Immunisation coverage (Source: WHO) [5]

B. *Current vaccination implementation strategies*

The Kenya Division of Vaccine and Immunisation (DVI) recommends that, by 12 months of age, children receive bacillus Calmette–Guerin (BCG), three doses of polio vaccine, three

Vaccine	Ages of administration of routine immunization se
BCG	At birth
OPV	At birth, 6wk, 10wk and 14wk
DPT-HepB-Hib	6wk, 10wk and 14wk
Pneumococcal vaccine (PCV 10)	6wk, 10wk and 14wk
Measles	9 months
Yellow Fever	9 months
TT	Pregnant women
Vitamin A	6m,12m,18m,24m,30m,36m,42m,48m,54m and 60r

Figure 2. Immunisation table for Children under 1 year and Pregnant women

doses of a pentavalent vaccine (a combination vaccine comprising five vaccines, namely diphtheria, pertussis, tetanus, *Hemophilus influenzae type b* [*Hib*], and hepatitis B), and one measles vaccine. Vaccination of their infant has been a requirement imposed on parents from the time they have successfully delivered their child. An infant immunisation chart is administered to them by the government to make sure they follow up appropriately. In addition to standard practice the government supports vaccination campaigns in partnership with NGOs such as the most recent nation-wide Rubella and Measles vaccination drive [3] in between March and May 2016[4].

C. *What needs to be addressed*

Much of what keeps most of the population from adequately vaccinating their infants is ingrained in the country's poor infrastructure and their individual economic situation. Larger distances to the medical centres, vaccine schedules of different clinics, cost/availability of public transport and/or unpassable roads.

Narrowing down to individual cases peculiar scenarios such as having the infant sick at the time of vaccination, lost vaccination cards, out-of-stock vaccines/syringes, lack of financing or even the weather conditions at the time vaccination is due. In more extreme cases the mother/parents may be illiterate or may hold religious beliefs that give doctrine against vaccinating. The mother could also be pregnant with another child and not be able to walk the infant to vaccinating centres.

III. METHODOLOGY

A. *Analysis*

I) *Functional Requirements*

The data entered by the user of the system involves the registration details. These include name, email address or a phone number, date of birth of the child and a password.The first screen is a sign up form, entry of details take place and are saved into the database. The second screen is a log in form that verifies the authorisation. The next screen in the immunization schedule; a list of the vaccination calendar. Also found here are notification buttons to allow for notifications to the user's contacts provided. The system output a vaccination calendar upon login and notification messages upon activation of such. The user, assumed to be a parent or guardian of the child, is the one who enters data into the system. The back end data is catered for by the developers, or the administrator.

This system complies with the CDC and the UNICEF drawn out schedules and follows all its requirements in terms of immunization dates and modes.

II) *Nonfunctional Requirements*

Usability. The system's most used function; the schedule screen and the push-notifications have been set up in such a way as to enable the user to have an easy experience.

Supportability. A documentation will accompany the launch of the system. This documentation will give a guide on how the application ought to work and various tests that were carried out.

Reliability. This project ought to incorporate a dynamic and much stable database to ensure data retention and good maintenance.

Security. The log in verification system and data encryption in the database will ensure that the user's information are kept safe.

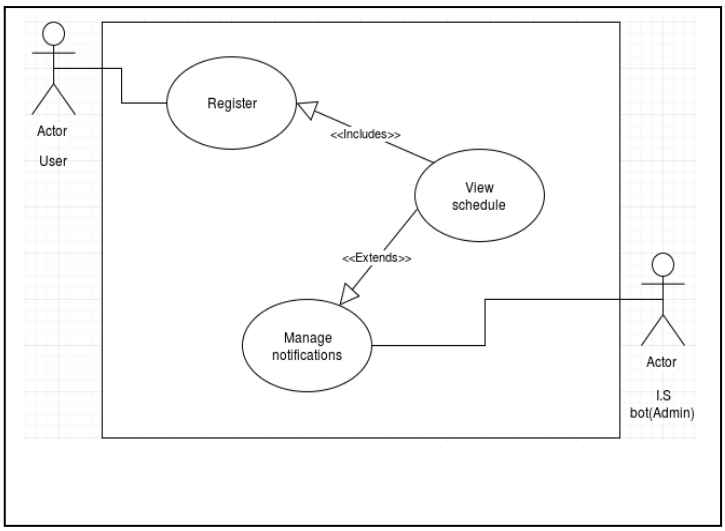

Figure 3. Use Case Diagram

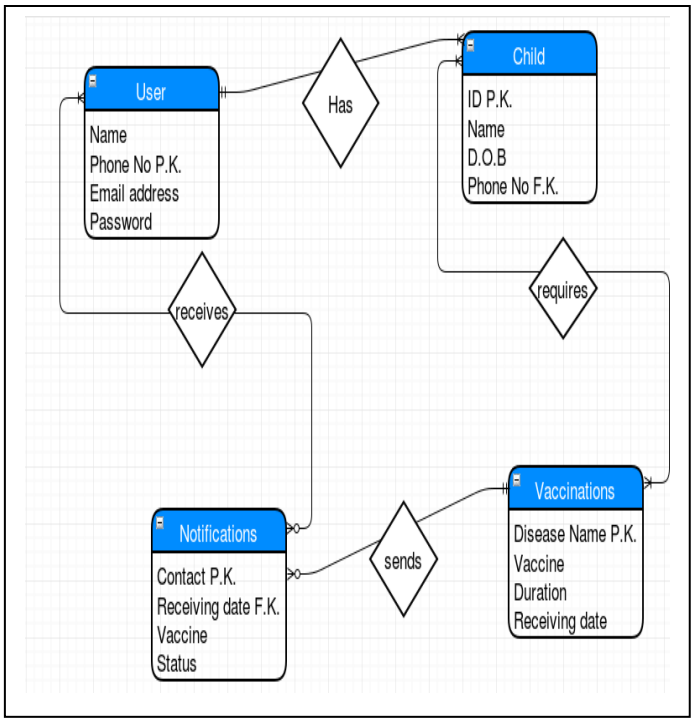

Figure 4. Entity Relationship Diagram

B. System Development Tools and Techniques

I) Android Studio 2.0

This is the main tool employed in the development of this system. This is primarily because the system is going to be a mobile application, meant to run on android platforms. In addition, Android Studio has the required set of features which are quite useful for the process.

II) Android Simulator

This will be used as the mode of testing. This simulator comes embedded in Android Studio and will run the code on a virtual android phone.

III) MySQL

This is the database Management System to be used. MySQL is not only easy to use, it enables local server hosting. In addition it is widely used.

IV) Draw.io

This website has been used in most software design drawings required. It has a variety of tools and drawings and thus has been effective. In addition, since it is online, it is quite efficient.

Certain techniques will be used; Modelling will be implemented. Here, a graphical representation of the concept is first manually drawn before the actual implementation. This provides a starting point which proves worthwhile during the implementation.

C) Deliverables

The final expected deliverable is a functional mobile application that will run on the android system platform. It should meet all the functional requirements as stated in its specifications.

IV. SYSTEM IMPLEMENTATION AND TESTING

Implementation

A) Login Module

I) Interface

This is the first interface the application user will interact with upon launch of the app. It consists of two input spaces and two buttons; a 'login' and a 'sign up' button.

II) Function

The input spaces are where the user can input their phone number and password and proceed to login to their local account on the phone. The login button will submit the entered data and a check will be performed against the internal database to confirm the credentials provided.

The sign up button will take the user to another interface where they can set up a local account on the phone to access Chanjo.

III) Screenshot

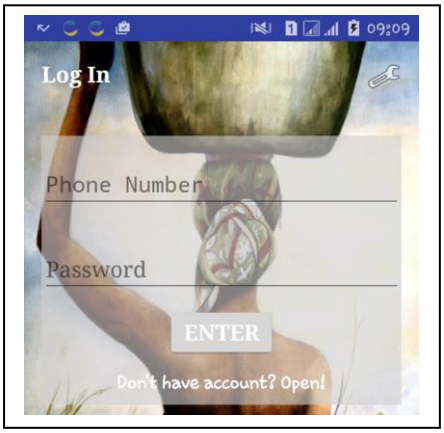

Figure 5. Login screen

B) Sign up module

I) Function

This is the screen where a new user would enter their details.

II) Screenshot

Figure 6. Signup screen

C) Home Module

I) Function

This is the application's main screen from where all other screens converge.

II) Screenshot

Figure 7. Home Screen

D) Kuhusu module

I) Function

This interface gives the user information about the application and its purpose.

II) Screenshot

Figure 8. About screen

E) Schedule module

I) Function

This gives the app user a table that lists all the vaccines recommended for administration.

II) Screenshot

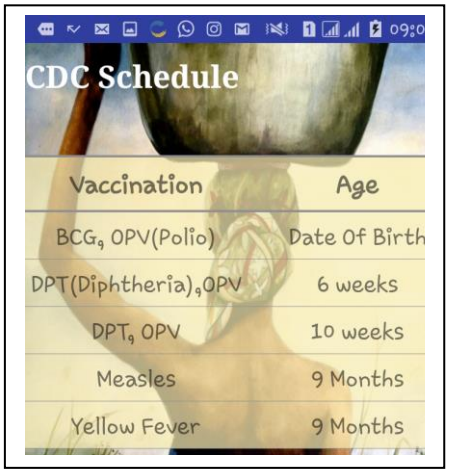

Figure 9. Schedule Interface

F) Watoto module

I) Function

Here, the app user can 'manage' infants to who will be tied to their account.

II) Screenshot

Figure 10. My Kids Interface

G) Language module

I)Function

The user can specify choose what language to use as they feel comfortable.

II) Screenshot

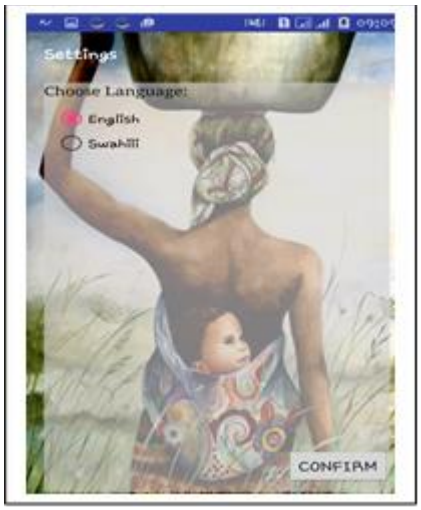

Figure 11. Settings/Language Interface

Testing

Testing was conducted mainly through the black-box testing technique with a select group of volunteers providing test data for the application. The volunteers used phones on which the application was pre-installed. Several scenarios were created for testing purposes, centred on simulating everyday application use (for example navigating menus, creating accounts, viewing schedules et cetera).

The first scenario was that of a user launching the application for the first time on their device. The application successfully launched on all devices tested (Android 4.4.1 up to Android 7.0).

Second scenario was an existing user logging in. The application also passed this test. Subsequent menus were confirmed to be functional and smoothly interconnected.

The last scenario was of a user logging out. An extra scenario tested the multi-tasking readiness of the application. This was comfortably achieved with smoothness that improved with hardware capability as well as the Android versions of test devices.

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