

# e-Vaccine: An Immunization App

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**Abstract** – Due to lack of adequate healthcare, India has high Infant Mortality rates. Making sure that children have access to proper healthcare and immunization against diseases that can be prevented by vaccines, is a huge challenge that is being faced by developing countries like ours. This highlights the importance and need of having a better, smarter system in place, to improve the situations. In this paper, we discuss an android application that was developed to address this concern. This application provides a system to provide information, store records and help parents schedule vaccination appointments for their children.

**Keywords** - Mobile Application, Vaccines, Android Application, Immunization, Children, Vaccination, Smartphone, Mobile Phone

## I. INTRODUCTION

India has a population of more than 1.36 billion, which is around a fifth of the total population of the world, and around 30% of this number are children under the age of 15. [1] It is very crucial to make sure that our youth have access to quality healthcare and that a good immunization program is in place. Not getting the necessary vaccinations at the required age can lead to serious health problems in the child's life. Vaccination rates in India are still not up to the mark, two of the most common reasons being misinformation and forgetfulness. [2] We need mass level immunization programs, better systems to track and record data and programs that will teach the masses about the importance of vaccines, to lower mortality rates. In 2015 in the country, around 1.2 million children lost their lives before turning 5, due to diseases that could've been prevented, if the children had been given on-time vaccination [29], as per a UNICEF report that emphasizes on how serious the situation of healthcare in India is. [30]. In third world

countries like India, no noteworthy technical interventions have been done, that could be successful in changing the scenario of vaccination, unlike some developed countries, where tools like websites and apps have been developed to improve the situations. [4] Some innovative and cost effective measures need to be taken. [5] This paper discusses in detail, the development, functioning, and use of one such smartphone application 'e-Vaccine', to facilitate the vaccination process and help parents and caregivers keep better children's vaccination schedules. It uses Aadhaar Verification for user authentication, lets the user book vaccine appointments in the hospitals in their states, and gives on time updates and reminders for upcoming vaccinations. The application uses OTP verification to let the user login and they will then be able to view their profile, change their children's vaccine history, and add a child to their record. The app also gives the user an option to read recent news articles about childhood vaccines and some FAQs are also included. Here, we also discuss how Mobile apps can affect vaccination levels and make the immunization process easier and more efficient. [6]

## II. LITERATURE REVIEW

The Literature Survey was done by searching through some digital libraries like IEEE, Springer and J-Gate using some specific keywords like Vaccine, Mobile App, Vaccine Management, etc. and studied papers that were published in the last few years, about websites and apps for vaccination management. Out of around 80 papers that were initially extracted, we excluded papers that were theoretical or not from recent years. After carefully going through the abstracts, 20 papers were selected for the literature survey that were technological in nature, relevant to our study.

Table 1: Literature Survey of Vaccination Apps

STUDY	METHOD	RESULT
Immunize - Baby Steps for smart healthcare [1]	The system provided vaccination details of children with their DOBs to store the child's medical history in a common database. An SMS and E-mail based reminder system is also proposed. The architecture is client-server	It helps parents avoid delay in their child's vaccination. Using the data, new learnings can be found and new trends of diseases can also be studied, by using artificial intelligence and data analytics. This will help in improve the healthcare system

	architecture. Relational database, MySQL is proposed for storing data.	
STUDY	METHOD	RESULT
Use of Apps to Promote Childhood Vaccination: Protocol for a Systematic Review [2]	This study reviewed the available evidence on the use of apps to support childhood vaccination uptake and information storage.	A possible limitation is that the quality and number of studies using similar topics may be limited. The results of the study can be used for developing a vaccination app.
e-vaccination: Fingerprint Based Vaccination Monitoring System [3]	The app keeps track of vaccination schedule of children and stores record in a database. Notification is sent when child is to be vaccinated and this is done by fingerprints collected.	The system kept information safe electronically and can be improved by studying and implementing ways to capture infant biometrics and making the database more secure.
ReadyVax: A new mobile vaccine information app [4]	This application had information about vaccines, diseases, common questions, and resources. The relevant screens developed were home, diseases, vaccine, resources, questions, alerts, about and menu. Notification were used for alerts.	The app was used in 107 countries. The most used screen was 'vaccines' and the most common vaccines searched for were DPT, pertussis and tetanus.
An Artificial Intelligence-Based, Personalized Smartphone App to Improve Childhood Immunization Coverage and Timelines among Children in Pakistan: Protocol for a Randomized Controlled Trial [5]	The app had text, voice, pictures and video messages, which were based on previous studies to improve the messages. The messages were reminders, and information about the adverse effects of the vaccine. The app included a vaccination schedule, resources and notifications.	According to the users, the app should have had details about doses and purposes of each vaccination to be given. Parents found that a mobile app was really helpful in tracking the health.
Can mobile technologies improve on-time vaccination? A study piloting maternal use of Immunize CA, a Pan-Canadian immunization app [6]	To evaluate if the use of an app could change beliefs and behaviours related to vaccination, users were asked to attempt surveys before and after 6 months of using the app.	Even though the app was well received, some participants were more likely to vaccinate and others were less likely. On time rate of vaccination was improved.
An Intelligent Baby Care System Based on Smart Phone Application [7]	This app was built with modules about information, benefits and schedules of vaccines, along with age groups. The users are reminded about upcoming vaccines using push notifications.	This application proved to be a helpful tool for parents struggling to manage work lives and family, to ensure that their children can have the required immunity.
Vaxign: the first web-based vaccine design program for reverse vaccinology and applications for vaccine development [8]	This app integrated open source tools and developed modules with user-centric interfaces. Users can add their vaccine information and questions which would be processed by PHP/HTML/SQL. The result is the given to the user.	191,192 proteins have been computed in the app, and the users can use this data by raising queries on the web interface. Vaxign was user-centric app.
Effectiveness of a smart phone app on improving immunization of children in rural Sichuan Province, China: study protocol for a paired cluster randomized controlled trial [9]	The app had the option to record and update information, make appointments, get list of children who missed their vaccination and sending details to the doctors. One survey was done at the end, after 8 months of use.	The study helped to determine how useful an app could be to efficiently manage immunization in China and how it would build the knowledge of parents about vaccines.
Smartphone app uses loyalty point incentives and push notifications to encourage influenza vaccine [10]	A quiz was developed in the app, about the influenza vaccine to educate the users about its importance. If the users were within 200m of a pharmacy, they would be informed via notifications and visiting would give bonus points.	Of the 21469 people who had installed the app, only 96 went to a pharmacy, and out of those, only 38 got the vaccination. About 5% more users had gotten vaccinated, compared to the previous year
Vaccine Prioritisation Using Bluetooth Exposure Notification Apps [11]	An app was developed to use Bluetooth exposure for contact tracing, and based on that, prioritizing vaccination for people.	Hot-spotting and prioritizing by this app could greatly help the authorities to deal with the pandemic until we have the number of vaccine doses needed.
Vaccipack, A Mobile App to Promote Human Papillomavirus Vaccine Uptake Among Adolescents aged 11 to 14 Years: Development and Usability Study [12]	An app was developed, consisting of a vaccine tracker. Basic details about the vaccine were also included. Additionally, 26 stories were included in the app, to promote vaccination	The app was highly accepted and 82% parents and 85% of teens, said that they found the app to be helpful.

Children vaccination reminder via SMS alert [13]	This study is about a system for vaccinations for children, which sent reminders via messages.	This system was accepted by users and can be used by health-care centres and parents who can benefit from it
Immunization and technology among newcomers: A needs assessment survey for a vaccine-tracking App [14]	Refugees attending a healthcare camp in Canada were requested to attempt a survey that had 17 questions about languages, homeland, demographics, and vaccination history if known.	50 people attempted the survey. Arabic was the most common language. 92% of the people owned an android phone but didn't use it for health tracking. 18 had been vaccinated, 23 out of 27 parents had their children vaccinated. And 38 people said they could use such apps if translated to their language.
mHealth Pilot Study: Text Messaging Intervention to Promote HPV Vaccination [15]	By using a survey, it was evaluated what type of content should be included in the text messages. Then, the content was decided for each individual participant.	The study concluded that this intervention caused positive result with respect to the stigma surrounding HPV, and increased knowledge.
STUDY	METHOD	RESULT
Operability, Acceptability, and Usefulness of a Mobile App to Track Routine Immunization Performance in Rural Pakistan: Interview Study Among Vaccinators and Key Informants [16]	An Android app was iteratively developed and used for 2 years, to evaluate how acceptable and operable it is, the data validity and how useful the data would be. Real-time data was used to estimate the volume of vaccination, track children who had incomplete vaccination and make plans to improve.	This app was readily accepted by vaccine officials and district managers. It was considered easy to use and people could rely on data security. As a result, coordination was greatly improved.
Factors associated with referring close contacts to an app with individually-tailored vaccine information. [17]	A survey was done on 1095 pregnant women using a mobile app, with questions about their opinions, beliefs and level of trust on vaccines. Then they were asked to refer the app to 6 people	28% of these expecting mothers referred at least 1 contact and the average was 2.67 people per woman. 93% of those referred were parents, spouses, siblings or friends.
Children Immunization App (CImA) low-cost digital solution for supporting Syrian Refugees in Zaatari camp in Jordan – General description [18]	An app was developed, which showed two short messages about the overall benefits of vaccination. It had details about the benefits of each vaccine, and vaccine accounts could be created for each child. A graphical interface helped parents who were less literate.	The CImA app showed promising results in helping parents to keep track of their children's vaccination details.
Effectiveness of a smartphone app to increase parents' knowledge and empowerment in the MMR vaccination decision: A randomized controlled trial [19]	This study evaluated the effects of two apps for vaccine related knowledge and psychological empowerment. The apps used videos, message and games and the trial was done on parents in Italy. Data was collected by quizzes.	Participants said they received a significant amount of vaccination related knowledge. This app was parent-centred and used games to make parents familiar with the vaccines that their kids need and also increased confidence and reliability on vaccines.
Educating parents about the vaccination status of their children: A user - centred mobile application [20]	Children who were admitted to a hospitals with vaccine-preventable diseases, were eligible for user testing. The app was user centric, with a visual language that is playful and graphical, for the user to have a better experience.	Parents who are well informed are more likely to appreciate and take vaccines seriously. User centric apps help in shifting the attention to the recipient. These apps could further be improved with feedback loops.

### III. PROPOSED SYSTEM

Despite quite a few existing vaccination programs in India, there are obstacles to vaccine preventable diseases being eradicated from the root. [23] To address this issue, the proposed system is an android app, which will help store the child's medical history and help track vaccination efficiently. This can result in a possibly better healthcare system for immunization. This app will let the user learn about vaccines and track their child's immunization. In case the user is new, they can register for the app using a few basic details like their name, mobile number, and state of residence, after which they will be taken to the login page. All the options that are available to a guest user, will also be available for a registered

/ logged in user. Furthermore, registered users will have some additional options as well.

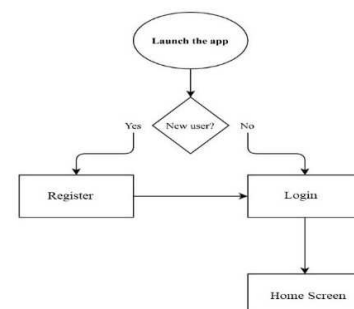


Fig. 1 – Login / Registration for user

On opening the app as a guest user, the user will see options-

- *Vaccines* – A list of important vaccines administered in India, sorted by age of shot.
- *News Coverage* – Latest news articles related to Immunization, to promote child vaccination by emphasising on their importance and benefits.
- *FAQs* – A list of common questions and queries about important vaccinations. The user will also get an option to submit a query, in case it is not already addressed in this section.
- *Login or Register* - The app gives a user the option to login using mobile number and OTP verification.

Once the user logs in, they can see some additional options-

- *My Profile* – User details and record of their children's vaccination
- *Book Appointments* – A feature that will let the user book appointments by selecting a date, time slot and hospital in their state.
- *Updates and Alerts* – Will give reminders about the vaccination appointments scheduled for the month, and other upcoming vaccinations that need to be scheduled.

The app was developed for two kinds of users:

- *Normal User*: Everyone who downloads the 'e-vaccine' app can register as a normal user. They will be provided all the necessary features for appointment booking, vaccine information, news etc.
- *Admin*: Admin users will have access to some specially designed features like checking all appointments, viewing user details, adding hospitals to database, answering user queries and altering details.

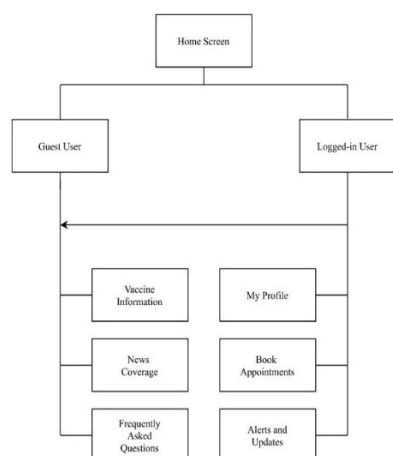


Fig. 2 – Home Screen options for Guest and Logged-in Users

Due to the large-scale usage of smartphones these days, this system makes it easier to store all vaccination data in one place, and does the job of spreading awareness as well as easy

scheduling for the parent, and hence, can improve the immunization statistics in the country.

#### IV. METHODOLOGY

The development of this app was done over several phases. The first phase was planning, in which all the basic functionalities of the app, and the technologies to be used were decided. Brief sketches of the layout were drawn for ease of understanding during the development of the app. When the planning was completed, the team started with the App Development Phase. 'e-vaccine' was designed for Android OS, using Android studio version 4.0.1. The app was programmed in Java. E-Vaccine is designed using Firebase which provides different services like authentication, database, storage etc. Each module consists of a different structure for storing data on to the server. This app uses the Firebase Firestore for storing user data to a database, and Firebase Authentication was used for OTP Verification.

After successful development of the app, the Testing Phase was started, and the app was tested to see if each module completed the functional and non-functional requirements of the app. [25] Once all the separate modules were tested, the combined modules were tested if they were integrated and working together properly. Finally, the app was installed in around 10 smartphones, and users were requested to use these apps and point out any errors or flaws they notice. [27]

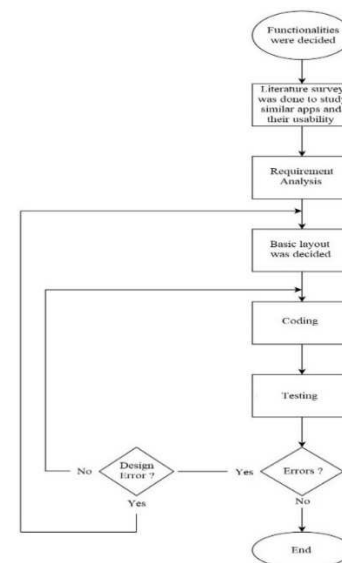


Fig. 3 – App Development Process

#### V. RESULTS AND EVALUATION

Once the developmental and testing phases of the app were completed, it was found that the app was working correctly as per expectations. The complete development of the app, including planning and testing took around 45 days. The users that participated in the testing process revealed that they

found the app useful, and expressed their opinion about a simple interface helping them understand everything better.

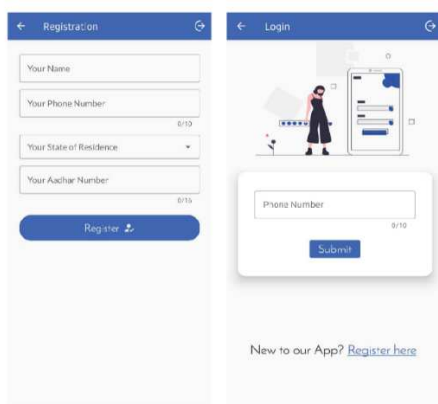


Fig. 4 – Registration and Login Options

The app also gave the user to ask questions in case they had any queries, which could be answered by admin. Including hospitals for every state and Union Territory in the country makes it possible for this app to be used country-wide.

The users said that they would personally use it if such an app was integrated in the healthcare system by the government. [24] They also expressed that the app was a useful tool for them to learn the basic information about childhood vaccinations track them.

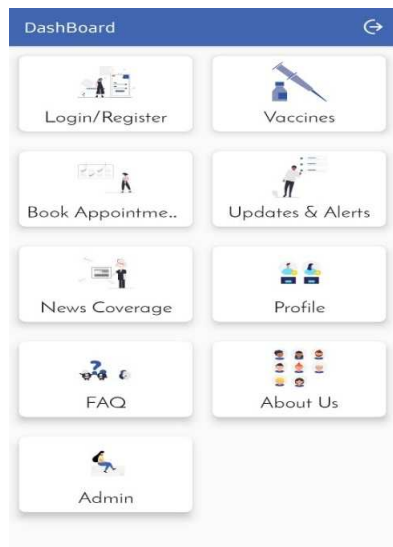


Fig. 5 – Home Screen of the 'e-Vaccine' App

## VI. CONCLUSION AND DISCUSSION

Low vaccination coverage is the main reason behind the increasing number of cases of vaccine-preventable diseases, which further increases mortality rates multiple folds. [3] A smart system that stores user data and their medical information in one place, and makes vaccination management process easier for the authorities, is very important. The

system described in this paper does the job of providing a platform for the user to book and manage their vaccination appointments, and for the healthcare authorities to track the vaccination statistics. With the rapidly increasing use of smartphones and internet, using such a system is very convenient way to manage immunization programs. [1]. Use of big data can further be used to find new medical learnings and patterns about different diseases. Additional functionalities and features can be added to this app, by making it open source. [26] It can further be improved to incorporate not just childhood vaccinations, but adult vaccinations too, especially in times like this when management of Covid-19 vaccinations is a major concern. Improvements can be made to this app, according to the needs of the healthcare system, to enable authorities to track vaccinations using an Aadhaar based system. [28] Thus, technology can be used for apps like this, to increase immunization rates, decrease infant deaths, improve the healthcare system, and improve quality of life in general.

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