

# Immunize - Baby Steps for smart healthcare

## Smart solutions to Child Vaccination

Santoshi Kumari, Haripriya.A, Aruna.A, Vidya.D.S, Nithya.M.N

Department of Computer Science and Engineering

M S Ramaiah University of Applied Sciences

Bengaluru, India

[Santoshik29@gmail.com](mailto:Santoshik29@gmail.com), [avadhanampriya@gmail.com](mailto:avadhanampriya@gmail.com), [arunakore08071992@gmail.com](mailto:arunakore08071992@gmail.com), [vidya.28satish@gmail.com](mailto:vidya.28satish@gmail.com),

[nithya.acs15@gmail.com](mailto:nithya.acs15@gmail.com)

**Abstract**— Smart Healthcare is one of the core infrastructure elements in building smart cities, an initiative taken up by Indian government recently. This emphasizes the need for developing smart solutions to provide better quality healthcare services to all masses. As, India has the highest number of child mortality in the world due to inadequate healthcare, malnutrition and poor sanitation, all of which can be prevented. We present in this paper, a generic system to address healthcare issue, where a common platform to store and retrieve complete child medical history information. It includes mandatory vaccination schedule details of child along with the previous medical history records. Reminders to provide timely vaccinations to their child are also provided to alert parents to give their child health protection. Using Web and Mobile based technology, parents and doctors get access of the child's medical reports online anywhere, anytime with required privileges. This work helps both parents and doctors to provide better quality healthcare services. Finally, the collection of data can further be analyzed to find the trends and pattern of diseases and this can pave a new beginning in the field of engineering and medical research for better and quality living.

**Index Terms**—Smart city, smart solutions, Healthcare, Vaccination, Immunization. (*key words*)

### I. INTRODUCTION

India is the second most populous country in the world, around a fifth of the world's population. Providing quality healthcare to all is a huge challenge and it is complex. Of the total population, 29.7% represent children under age 15[1]. They represent future generation of the country. Ensuring their healthy growth and development is a primary concern. According to World Health Organization reports, 1.5 million children die every year due to vaccine preventable diseases. In case of medical emergency, lack of availability of previous medical history records can cause delay in the medical treatment. Also, delay in giving vaccines increases the risk of a seizure and leaves children at risk for diseases longer.

To address these issues, a generic system is proposed to store and retrieve the child medical records with mandatory vaccination schedule for each child based on their date of birth and as per the vaccination chart provided by Indian Academy of pediatrics, 2016. A web application with access to both parents and Doctor are proposed with necessary privileges. Considering the drastic increase in number of mobile usage, the same is provided in android based mobile application. Reminders on timely vaccination are also proposed to parents

regularly till the vaccination coverage of child is complete. Capturing and storing medical records in a common database can skip the need of carrying paperwork and can help in providing efficient and qualitative treatment to child. Applying analytics on the data can help in research findings in future.

### II. RELATED WORKS

In recent years, urbanization has been increasing with India's transition to faster economic growth [2]. 31% of Indian population living in urban area contributes to 63% of Gross Domestic Product (GDP). The growth in urban population is expected to house 40% contributing 75% of GDP by 2030[3]. Hence, a comprehensive development of social, economic, institutional and physical infrastructure is required in improving quality of life and services. Smart city concept is a step in that direction. Making smart health hospitals are one of the critical pillars of India's smart program.

Cities like Barcelona, Singapore, Copenhagen, London, and Seoul make use of technology like online services, mobile technology to address various issues effectively [4]. For example, Singapore has several mobile apps for health, transport and municipal services with 99% of government services online.

Currently, many such applications have emerged such as Immunize India. With the development of new technologies such as ubiquitous computing, data mining, Internet of Things, Wireless sensors, mobile and many more, m-Health and s-Health systems have emerged [4].

There are many immunization coverage programs happening in India [5]. Despite many programs in place, there are setbacks in eradication of vaccine preventable diseases such as polio [6]. For example, In Uttarakhand, almost every child is incompletely protected and one out of every three children is a dropout from the immunization program [7]. Delay in giving vaccinations may have adverse effects on children [8].

Focus on quantity in vaccination coverage needs to be supplemented with in-time quality vaccination coverage [9]. To provide the quantitative and qualitative vaccination, collating all the vaccination details of child along with previous medical history can effectively address the issue. Hence, a common platform to store and retrieve the medical records and vaccination schedule details of children are needed to provide better healthcare services. The collective medical records of

children can provide an opportunity for doing extensive research in finding various patterns and analysis in future in the technical fields such as engineering and medicine.

### III. PROPOSED ARCHITECTURE

The main goal of the system is to provide vaccination details of the child with respect to the child's date of Birth and to maintain a common database on child's complete medical history. With the enormous increase in the mobile usage and internet, a system to view these details is proposed to have access online anywhere and anytime both in mobile app and desktop based applications are proposed. To remind parents on the timely vaccination shots, a reminder system is also proposed using SMS and E-Mail on the type and date of vaccination. It mainly helps parents and their children to avoid delay in giving vaccination. Doctor can view the vaccination history details along with previous medical records for providing the right vaccination to the child and can upload and update the latest vaccination shot details in the system. This will help doctors provide better quality treatment and services at the right time.

The proposed architecture of the immunization system is client-server architecture with Model View Control pattern. For web application design, JSP technology is proposed. Java based technologies are proposed such as j-query and java scripts are also proposed. Relational database, MySQL is proposed for storing and retrieving the data. As there is more number of android based mobile phones, android based app is proposed. Using php technology and Android studio, mobile application development is proposed. Vaccination chart as per Indian Academy of Pediatrics is proposed to be considered for reminding parents on regular basis till the completion of the vaccination shots to their child.

The client server architecture proposed in the system is as represented in the Figure 1.

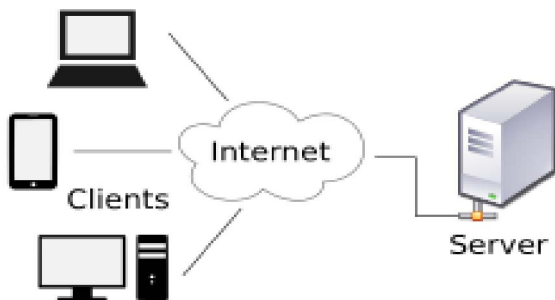


Figure 1 Client Server Architecture

With the client server architecture connected through internet, using java rest api web services the web application development. In this architecture, clients and server communicate over network exchanging messages in a request-response messaging pattern.

Servlet and JSP technologies are proposed for developing web applications. Servlet creates a thread to handle request. JSP provides support to develop web application using java bean, custom tags.



Figure 3 SMS System Overview

The overview of the proposed system with SMS technology is as represented in the Figure 3.

SMS gateway technology is proposed for triggering SMS to the parents on the vaccination due date schedule. Java Restful web services technology is proposed for web application development.

The proposed system for mobile application is as represented in the Figure 4 Android based system. PHP in server side interacts with MySQL database for retrieving and storing data and interacts with android client for using application.

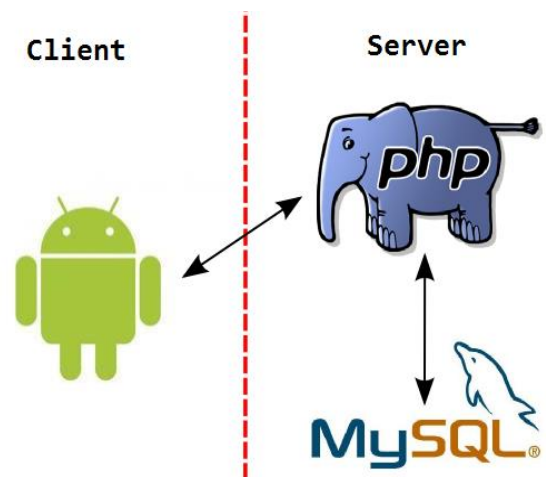


Figure 4 Android based System

For the mobile based technology, using android client and php with connection to MySQL database, system design is proposed.

#### IV. PROPOSED SYSTEM

A Web based application and android mobile based system design and development is designed and developed to store and retrieve the child medical history using the technologies mentioned in the proposed architecture of this paper.

The overview of the vaccination schedule chart proposed is provided in the Figure 5.

I: IAP recommended vaccines for routine use	
Age	Vaccines
Birth	BCG, OPV0, Hep-B 1
6 weeks	DTwP 1, IPV 1, Hep-B 2, Hib 1, <b>RV5</b> 1, PCV 1
10 weeks	DTwP 2, IPV 2, Hib 2, <b>RV5</b> 2/ <b>RV1</b> 1, PCV 2
14 weeks	DTwP 3, IPV 3, Hib 3, <b>RV5</b> 3/ <b>RV1</b> 2, PCV 3
6 months	OPV 1, Hep-B 3
9 months	OPV 2, Measles
12 months	Hep-A 1; 2 dose after 6 months
15 months	MMR 1, Varicella 1, PCV B
16-18 months	DTwP B1, IPV B1, Hib B1
2 years	Typhoid; revaccination every 3 years if ViPS vaccine
4-6 years	DPT B2, OPV 3, MMR 2, Varicella 2,
10-12 years	Tdap/Td every 10 years, HPV

Figure 5 Vaccination schedule chart

Figure 5 represents the IAP recommended vaccination chart [10].

Based on the child's date of birth and vaccination due date based on the age criteria, vaccination due date is calculated by the system. Doctors and parents can view the due date calculation with respect to child.

The activities of Doctor and Parent details are as follows:

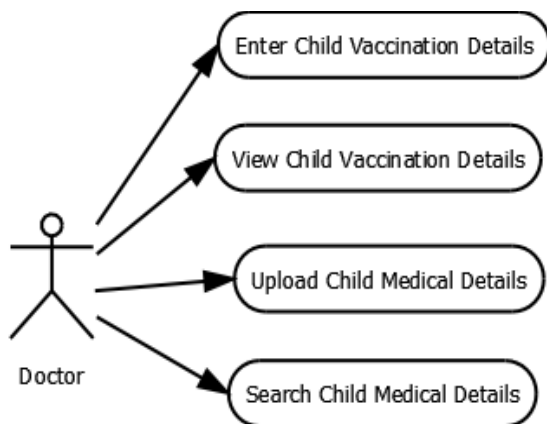


Figure 6 Use case diagram for Doctor

Figure 6 represents the use case diagram for Doctor with the activities is provided.

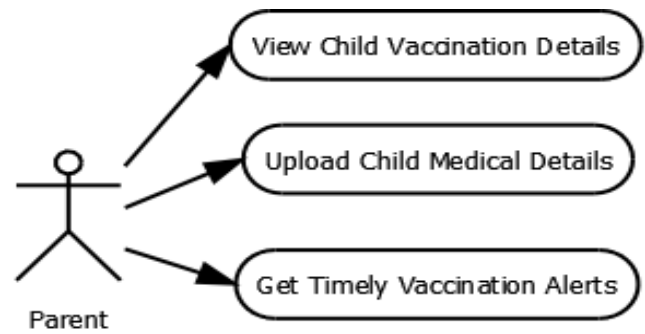


Figure 7 Use case diagram for Parent

The main use cases for Doctor and parent are represented in the Figure 6 and 7 respectively. Separate access privileges to Doctor and Parents are provided for both web and mobile applications. Parent accesses his/her child vaccination and medical history details whereas the Doctor can view the complete child details along with vaccination and previous medical history records.

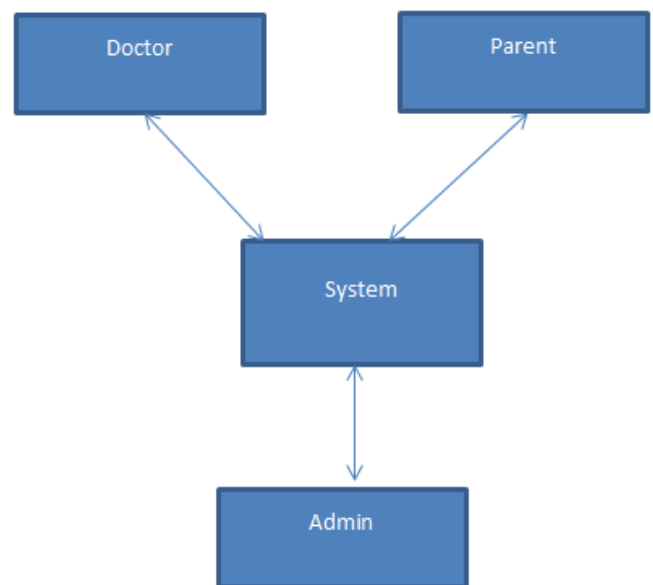


Figure 8 System overview of user design

The system overview design of various users is as represented in the figure 8.

Using java servlet technology, java Server Pages (JSP) in the server side and java script, j-query at client side, web based application is developed. Here, JSP pages are used for the presentation layer, and servlets for processing tasks. Servlet acts as a controller responsible for processing requests and is responsible for deciding the JSP page to forward request. JSP page retrieves objects created by servlet and extracts dynamic

content for insertion within a template. Using MySQL database, data is stored and retrieved.

The diverse functionality of mobile apps can create the potential for transformation of immunization practice both at system and personal level [11]. For mobile application, android based technology [12] and PHP technology is used to deploy the solution.

The access to view the children medical records online anytime anywhere can help treat the child with efficiently and effectively. In case of medical emergencies, where there is a lack of availability of previous medical history in hand, this system comes to the rescue and provides all the necessary information to start the treatment and save lives of many children.

## V. CONCLUSION AND FUTURE WORK

As smart city concepts are taking a big leap, it is very important to adapt to smart solutions. Considering the importance of Smart Healthcare, a common platform to store and retrieve the medical history information is required to share the knowledge in medical learnings and for making efficient diagnose and to give effective treatment. In this paper, a system is proposed with an idea of providing a common platform to store and retrieve medical records of child with mandatory vaccination schedule details to start with as the child mortality rate due to vaccine preventable diseases are significantly high in numbers. As the mobile and internet technology continuous to evolve rapidly, regular alerts to parents for providing timely vaccination to their child/children for giving protection from vaccine preventable diseases are implemented using SMS and E-Mail messages. The facility to view previous medical records can help in speedy diagnose and action.

Data storage on cloud platform in future can enable this cloud enabled technology. Integration to big data can further help find patterns. Based on the collection of all the children data on vaccination and medical history, new medical learnings and findings can also be explored. New trends and patterns of various diseases can also be studied by applying various advanced technologies such as data analytics, predictive analytics and artificial intelligence techniques. This will help in giving better treatment and quality services and avoiding carrying of paper work for medical checkups. This work can further be extended not only to children but elderly also. Through leveraging IT in healthcare technologies, the quality of lives can be increased in future.

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