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# Smart ASHA Pregnancy Monitoring System

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***Abstract*: Even today, the maternal mortality rate (MMR) and the number of stillbirths in India and other developing countries are much higher than that of the developed countries. According to the World Health Organization (WHO), a pregnant woman must make at least four antenatal visits to a health care center to ensure a safe and healthy pregnancy. The Smart ASHA Pregnancy Monitoring System (SAPMS) aims to reduce the MMR by digitalizing the work of the health workers in the unprivileged parts of the country, by enabling them to monitor the pregnancies of the women in their area with the help of smart phones, effectively and efficiently.**

***Keywords: Smart ASHA Pregnancy Monitoring System (SAPMS), Antenatal Visits (ANC), Android platform, website for the authorized health care centers.***

## I. INTRODUCTION

Smart ASHA Pregnancy Monitoring System (SAPMS) aims to reduce the number of stillbirths and Maternal Mortality Rate (MMR) by making sure that every pregnant woman makes at least four antenatal visits to the authorized health care centers as recommended by the World Health Organization (WHO) and also takes at least two doses of Tetanus injection (TT) as recommended by the government of India. The Maternal Mortality Rate (MMR) is defined as the annual number of female deaths per 100,000 live births from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes). The MMR includes deaths during pregnancy, child births or within 42 days of termination of pregnancy for a specified year. For 2016, India's MMR was estimated at 167 maternal deaths per 100,000 live births. In absolute numbers, 45000 mothers die every year due to the causes related to childbirth [1].

More than 80% of the maternal deaths can be prevented by increasing the institutional deliveries and ensuring a proper Ante- Natal Care (ANC) [2]. ANC visits form a crucial part of the Ante-Natal Care as they provide counseling to mothers about the care to be taken during pregnancy and in the preparation of childbirth. Thus, the ANC visits play a significant role in deterring the morbidity and mortality of both mother and newborn. Important issues forming a part of consultation include making plans for transportation to health care center during labor, recognizing the danger signs of serious health problems and identifying the woman as a high-risk patient, making arrangements for a blood donor if needed. It is thus, very essential to enable the pregnant woman to recognize the obstetric complications when they occur and seek care from doctors or midwife without any delay.

National Rural Health Mission (NRHM), which was launched in 2005, introduced an ASHA Worker, under the Janani Suraksha Yojana (JSY), who is a trained female Community Health Activist to act as an interface between the community and the public health care system with a vision to bring down the MMR and IMR (Infant Mortality Rate) by promoting the Ante-Natal and Post-Natal care in her community. Bringing the mothers for the Ante-Natal check-ups, ensuring they take a minimum of two TT injections and encouraging the pregnant women to give births in authorized health centers are few of the important roles of an ASHA Worker to avert the maternal deaths and stillbirths.

However, there is no prevailing system that enables the ASHA worker to monitor the Ante-Natal visits done by the pregnant women. Smart ASHA Pregnancy Monitoring System thus aims to assist the ASHA worker, by letting her know the schedule and status of ANC visits and Tetanus doses of each and every registered pregnant woman. It also helps ASHA in identifying the high risk pregnant women. The project also assists the ASHA worker by letting her know the list of pregnant women having due dates (The estimated date of delivery) within one month. This can enable the ASHA worker to encourage the pregnant women to give birth at an authorized health center, more efficiently and effectively. Further, Smart ASHA Pregnancy Monitoring System also encompasses the immunization of the infant till one year from its birth.

## II. ROLE OF AN ASHA WORKER

ASHA stands for Accredited Social Health Activist. She is one of the key components of the National Rural Health Mission (NHRM) [3]. Selected from the village itself and accountable for it, the ASHA is trained to work as an interface between the community and the public health care system. ASHA is the first port of contact regarding the health care demands of the deprived sections of the population especially women and children. She counsels women on birth preparedness, importance of safe delivery, breast feeding

etc…ASHA also mobilize the community and facilitate them in accessing the health related services available at sub-center/primary health centers, such as immunization, Ante-Natal checkup, Post-Natal checkup, complementary nutrition, sanitation and other services provided by the government.

Although ASHA's are considered as volunteers, they receive an outcome-based remuneration and financial compensation for training days.

ASHA plays a key role in immunization program. Her task is to enumerate all the pregnant women and children and record their immunization status, share the list of newborns in her area with health care center every month. Her task also includes preparation of a due list of beneficiaries for the immunization session in her village and informing them about the same. Along with this, she also has to visit the houses of drop-outs and left-outs to counsel the mothers to immunize their children.

The hierarchy of the Health Care System in India is as follows:

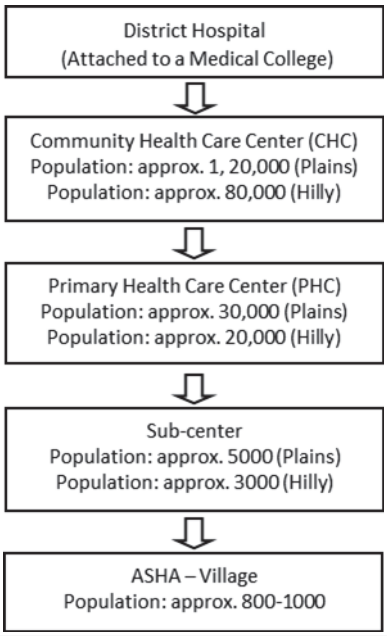



*Fig. 1: Hierarchy of the Health Care system*

## III. RELATED WORK- MCTS

### *3.1 Mother Child Tracking System Software*

The State Government started 'Mother and Child Tracking System' (MCTS) under National Rural Health Mission (NRHM) in January 2011[4]. It is an innovative web based application created to make it easy to connect the service providers such as Primary Health Centers (PHCs), Community Health Centers (CHCs), Asha Workers, Auxiliary Nurse Midwives (ANMs) with the pregnant women as well as the child and enable them to avail all the services efficiently. Services which it takes into consideration are Ante-Natal Care (ANC), Delivery, and Post-Natal Care (PNC) and Immunization services.

### *3.2 Services Offered by MCTS*

#### *3.2.1 Registration of Pregnant Women:*

Registration is done at the Health Facility/Sub-Center whenever a woman visits the hospital for her first Ante-Natal Care (ANC) Service.

#### *3.2.2 Messaging Facility:*

It captures the 4 ANC visits to be performed by the pregnant women, delivery date and then the PNC service and notifies the pregnant women and Auxiliary Midwife Nurses (ANM) by sending them text messages .Once the particular service is been availed such as if one of the pre-natal visit is been done by the woman, ANM has to send the details to the MCTS through a text message which will be then updated in it.

## IV. SYSTEM IMPLEMENTATION

Smart ASHA Project consists of an android application for the ASHA workers and a website for the health care centers.

### *4.1 Smart ASHA Android Application:*

#### *4.1.1 Login Page for ASHA:*

The application is made exclusively for ASHA workers. To prevent the non-authorized users from using the application, ASHA has to login with the username and password given to her by the medical supervisor working at the Primary Health Care center. On click of the login button, the asynchronous process fetches the personal information of ASHA like her name, contact number, village id, Aadhaar card number (ID for the unique identification of a person) in the background, and inserts it into the SQLite database for the offline use.

#### *4.1.2 Registration Page:*

Online Registration of the pregnant woman by ASHA is the first step of the process. The registration fields include edit texts viz. personal details like name, middle name, surname, date of birth, date of last menstrual period, contact number, Aadhaar card number, and checkboxes viz. ANC visit1, ANC vist2, ANC visit3, ANC visit4.

On the successful submission of the form, the patient gets registered in ASHA's table in the MySQL Database on the server as well as in the SQLite database which is local to the android device. This enables the application to work offline since internet connection is not a luxury in most of the villages in India. To synchronize the SQLite and SQL database, the information gets inserted in SQLite database only if the insertion in MySQL database is successful. On click of the submit button, the SQLite database is checked from top to bottom and all the dual entries if made mistakenly, are deleted.

The key used for the process is the Aadhaar card number of each pregnant woman. With reference to the date of last menstrual period, the due date (Estimated Date of delivery) will be calculated and shall be fed to both the databases (MySQL and SQLite) automatically.

*4.1.3 List of registered pregnant women:*

The list view of all registered pregnant women will be present in this activity. Each cell contains serial number, name, surname and the status of the four visits. If the pregnant woman is marked as a high risk patient by the doctor, the corresponding cell in the list view will appear red and green otherwise. This will let ASHA promote the antenatal care more efficiently.

*4.1.4 Profile:*

Every pregnant woman has her own profile in the Smart ASHA application, displaying the current week of pregnancy, current trimester, due date, high risk alert indicating whether or not she is a high risk patient, pending ANC visit if any, the status of all the four ANC visits and the two TT doses. Besides, it also has a provision to manually call, message or switch on an automatic reminder messaging system reminding the pregnant woman about each and every upcoming antenatal visit.

The schedule of the antenatal visits as approved by the government of India is as follows:

*Table 1: Schedule of antenatal visits*

| Visits | Weeks |
|---|---|
| Visit 1 | 0 – 14 |
| Visit 2 | 15 – 26 |
| Visit 3 | 27 – 36 |
| Visit 4 | >36 |

On the assertion of the automatic reminder system, dates corresponding to the start of 9$^{th}$ 21$^{st}$, 30th, 36th weeks from the last missed period date are calculated and pending intents are created for these dates. The intent stores the respective message for each week representing the corresponding visit. The pending intents when are fired, are received by a class extending the service class. The text messages are sent by the SMS manager present here. The pending intents are well protected and replenished by a 'DeviceReboot' class to prevent them from getting deleted on system reboot.

*4.1.5 Successive Visits Missed:*

The pregnant women who happen to miss two consecutive visits appear in a list view in this activity. This will help ASHA identify the ignorant women in her village. She can thus target her focus on educating these women about the necessary antenatal care and on making them aware about the facilities provided by the government to enable a safe and healthy pregnancy.

*4.1.6 List of pregnant women having Due Dates within a month:*

The list of pregnant women having their due dates within four weeks will appear in a list view in the ascending order of the due dates, in this activity. When the activity is opened, an asynchronous background task is initiated. Within this task, the due date of every woman is compared with the current date and is added to the list view, if it lies within the range of four weeks from the current date. This will help ASHA to identify and keep a track of pregnant women who are in the last term of pregnancy, so as to increase their preparedness towards the childbirth and to encourage them to give birth at an authorized health care center.

*4.1.7 Immunization:*

Doses of OPV-1, OPV-2, OPV-3 and measles are considered as the mandatory vaccinations that are to be given within one year after birth.

*4.1.7.1 Registration of the infants:*

The pregnant women who are registered by ASHA already and who have now surpassed the due date will appear in a list in this activity.

This will make it easier for ASHA to identify newborns and get them registered for the immunization. The newborns of the corresponding women are registered in the local as well as the server database. The registration fields include name of the newborn and its birthdate, the rest of the fields like mother's name, father's name, unique identification number, address and contact number will be copied same as that of its mother. Provision is also made to register the newborns whose mothers were not registered before. In this case, a separate registration form will be present, including all the fields as mentioned above. The submission of the form will add a new entry to the local database and update the fields for newborn in the mother-child row in the server database.

*4.1.7.2 Different activities for OPV-1, OPV-2, OPV-3, Measles:*

A separate activity is created for each of the vaccinations mentioned above. The current age in weeks of every registered newborn is calculated. The calculated age is then matched against the standard age in weeks for each vaccination, as given in the table below. If the age matches or differs by plus or minus 1 week, the name of the newborn appears in the list. On the day of vaccination, the ASHA worker will just have to check the list for each vaccination and ensure that the newborns in the list are present. A provision is made to tick

the corresponding vaccination as done in the newborn's profile. This status will get updated in the local database immediately. The updated status will get updated in the server database as well, if the internet connection is strong. Otherwise, a flag in the local database will be set as 1 to indicate that is yet to be updated in the server database. As the android phone receives a stable internet connection, all the entries having the flag set as 1 will get updated in the server database in an asynchronous background process.

*Table 2: Standard age in weeks for each vaccination*

| Vaccinations | Weeks |
|---|---|
| OPV -1 | 6 weeks |
| OPV-2 | 10 weeks |
| OPV-3 | 14 weeks |
| Measles | 9 months |

*4.1.7.3 List of Newborns who have not taken one or more than one vaccines:*

Not taking the vaccines, pose a high risk on the newborns. It is thus very essential to ensure that every newborn is vaccinated properly. The list of such newborns will make it possible and feasible for ASHA to meet their mothers and make them aware about the importance of immunization.

*4.2 Smart ASHA Website:*

*4.2.1 Concept of the Smart ASHA System Administrator:*

Any governing authority like a medical officer of a Primary Health Care center (PHC) or a Community Health Care center (CHC), can pose as an administrator to this model to provide access to only the valid users (ASHAs, Health Care Centers). This will ensure the access to the major features of the SAPMS in right hands.

*4.2.2 Accounts for ASHAs and the Health Care centers down the hierarchy:*

*4.2.2.1 An account for ASHA worker:*

To create an account for ASHA, the administrator has to feed in the personal details of ASHA like her full name, contact number, Aadhaar card number and the user credentials like the username and password. On the submission of the form, the validity of the Aadhaar Card number entered is checked. Also, the village name entered is checked against the list of villages in the country. If the village name and the Aadhaar card number provided are valid, account for ASHA will be created successfully. Along with the creation of the account, a dedicated table for the ASHA worker for the registrations of the pregnant women will be created dynamically in the database. The name of the table is 'ASHAtable' appended with her Aadhaar card number. The Aadhaar card number linked in the name of the table can enable to identify and access the table uniquely. Maintaining unique tables for each ASHA act as hash tables catering a fast access and search time of the required data.

*4.2.2.1 An account for a Health Care center:*

To create an account for the Health Care centers under the respective PHC, the administrator has to feed in only the unique username and password. The administrator can create the account for the PHC and the Community Health Care center (CHC) as well.

*4.2.3 Login for the health care center:*

Authentication of the Health Care center is the major factor of SAPMS. Every Health Care center linked to this system is authenticated with a username and password given by the system administrator.

*4.2.4 Update antenatal visits and TT doses:*

The medical profile of the pregnant woman consisting the information regarding ANC, opens upon entering the valid Aadhaar card number and village of residence of the woman visiting the health care center to get her antenatal visit done. These two fields are used to search the pregnant woman's data from the right database present on the server. Valid submission of the two fields mentioned above, opens the page wherein the medical practitioner can update the antenatal visits and TT doses as done. Along with the seven checkboxes for visit 1, visit 2, visit 3, visit 4, TT dose 1, TT dose 2 and high risk alert, the page contains some other necessary information of the patient as, her full name, contact number, address, estimated due date, age and the gestational period. The updated information gets updated immediately in the database and ultimately in the Smart ASHA Application of the ASHA in the village of residence of the respective pregnant woman, when her android device *receives a stable internet connection.*

*4.2.5 ASHA Monitoring:*

This page consists of a list of the information of all the ASHAs under the respective Primary Health Care center (PHC), in the hierarchy of the health care centers in that area. Each cell corresponding to an ASHA worker in the list is clickable and opens to a page showing the information of all the pregnant women registered by her. The information consists of the personal details of the pregnant woman, the status of her ANC visits and TT doses. As mentioned earlier, an ASHA is a voluntary worker who receives an outcome-based remuneration. Thus, the number of registrations of the pregnant women and the status of their ANC visits and TT doses can help the PHC, to analyze the work of ASHA and plan her incentives accordingly.

## V. SYSTEM DESIGN

The Smart ASHA Pregnancy Monitoring System has a client-server model. It has specific software and hardware architecture. The main task is to integrate these two components to work together.

### *5.1 Software Architecture:*

The software architecture is comprised of the database, server and the client application.

#### *5.1.1 Database:*

The database consists of a number of tables; some are fixed while some are created dynamically. These tables storing the data are implemented in phpmyadmin-MySQL. MySQL database is used as it is easy to use, fast and can store large amount of data efficiently requiring a little configuration.

#### *5.1.2 Client Application:*

The Smart ASHA application is developed in Android studio framework. The application provides an efficient user interface for all the ASHA workers. Android devices being the most popular and affordable of the devices in the world, the android platform was chosen for this system. Moreover, programming in android is easy, user friendly and android has excellent data connectivity.

#### *5.1.3 Server*

The server is deployed on blazer pro using apache-HTTP server. Apache-HTTP server is used as it is robust, free and easy to deploy

### *5.2 Hardware Architecture*

The basic hardware requirement for Smart ASHA Pregnancy Monitoring System (SAPMS) is an android device on which the Smart ASHA application runs a personal computer or any device having access to the internet connection which can run the Smart ASHA website and a server to store the database and host the Smart ASHA website.

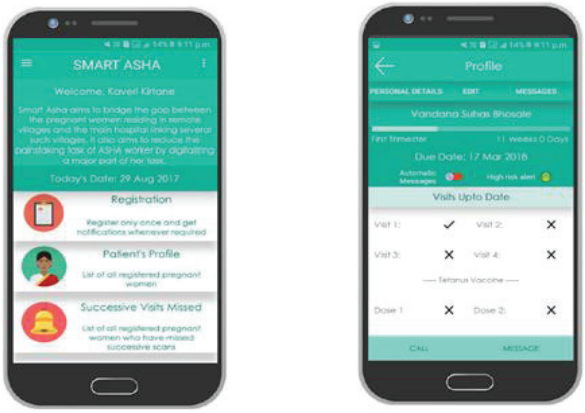



*Fig 2: Main page, pregnant woman's profile*

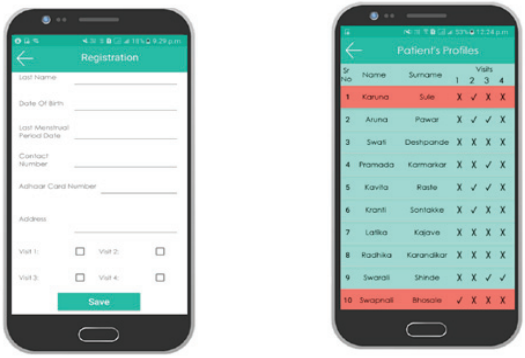



*Fig 3: Registration page, pregnant women's list*

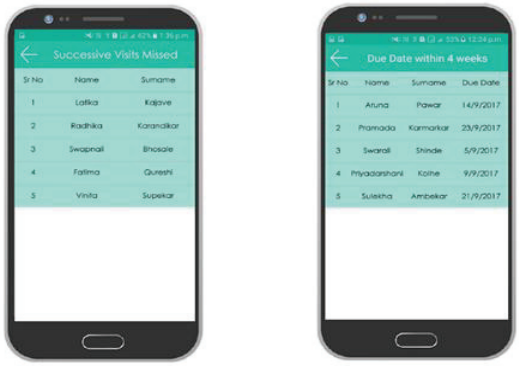



*Fig 4: Successive visits missed list, Due dates within one month list*

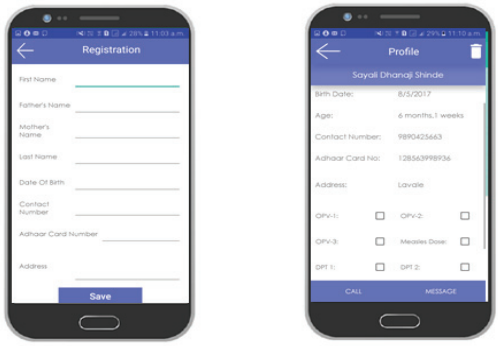



*Fig 5: Registration page, Infant's profile for Immunization*

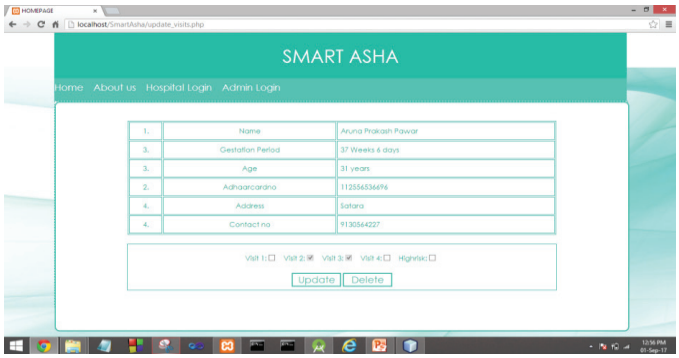



*Fig 6: Page to update ANC visits and TT doses*

## VI. METHODOLOGY AND FLOWCHART

The clients of SAPMS are the ASHA workers and the doctors at the health care centers. User authentication being an important part of the system, every ASHA worker has to log in into the application with valid username and password provided to her by the administrator. Similarly every health care center in the hierarchy shown in the fig1 has to log in into the website with valid username and password provided by the administrator. The administrator of the system is the medical officer present at the Primary Health Care center (PHC). The first phase of the system starts with the one-time registration of the pregnant woman by the ASHA worker. The information of the woman is stored in SQLite and SQL simultaneously maintaining the synchronization. The profile of the pregnant woman is immediately created after the registration, for ASHA's review.

The second phase of the system begins when the pregnant woman visits the health care center to get her Ante-Natal visit done. The doctor at the health care center logs in into the system and opens the tab to update the status of the corresponding visit, TT doses or high risk alert. In order to obtain the relevant data, the Aadhaar card number and the village of residence are fed in to the system. The validation of these two fields redirects the doctor to the webpage containing the information of the pregnant woman like the personal details, gestational weeks along with the checkboxes for the four ANC visits, two TT doses and a high risk alert. The checkboxes for the ANC visits which are already done or have passed are disabled. Similarly the checkboxes for TT doses and high risk alert are disabled if are already marked earlier. The updated status of all the visits, TT doses and high risk alert are saved in the database upon its submission.

In the third phase of the system, when the android device of the ASHA under the respective health care center, receives a stable internet connection, a background process fetches all the information regarding the ANC visits, TT doses and the high risk alert of every registered pregnant woman from the MySQL database present on the server and updates it in the SQLite database local to the device.

Following flowchart explains the working of the Smart ASHA application

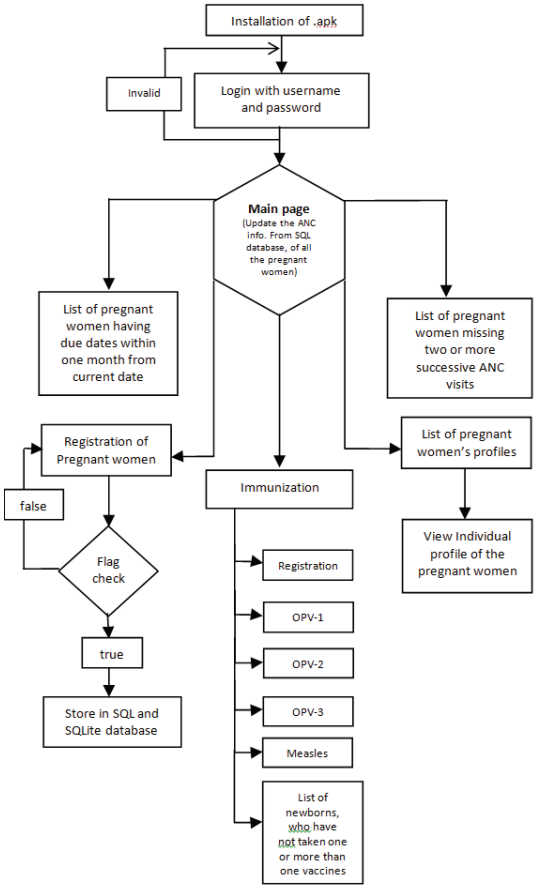



*Fig 7: Working Smart ASHA application*

## VII. IMPLEMENTATION STRATEGY:

We have presented Smart ASHA Pregnancy monitoring System to medical supervisors and doctors specialized in Community healthcare at Bharati Vidyapeeth, Pune. We have also spoken to and presented SAPMS to over 25 ASHA's, reporting to the Mutha Primary Healthcare Center. We made the use pilot SAPMS application for over one month. Then after we collected their feedbacks and found them very positive. We are further planning to introduce it to the medical supervisors at the various Primary Healthcare Centers in Maharashtra.

Following flowchart explains the working of the website.

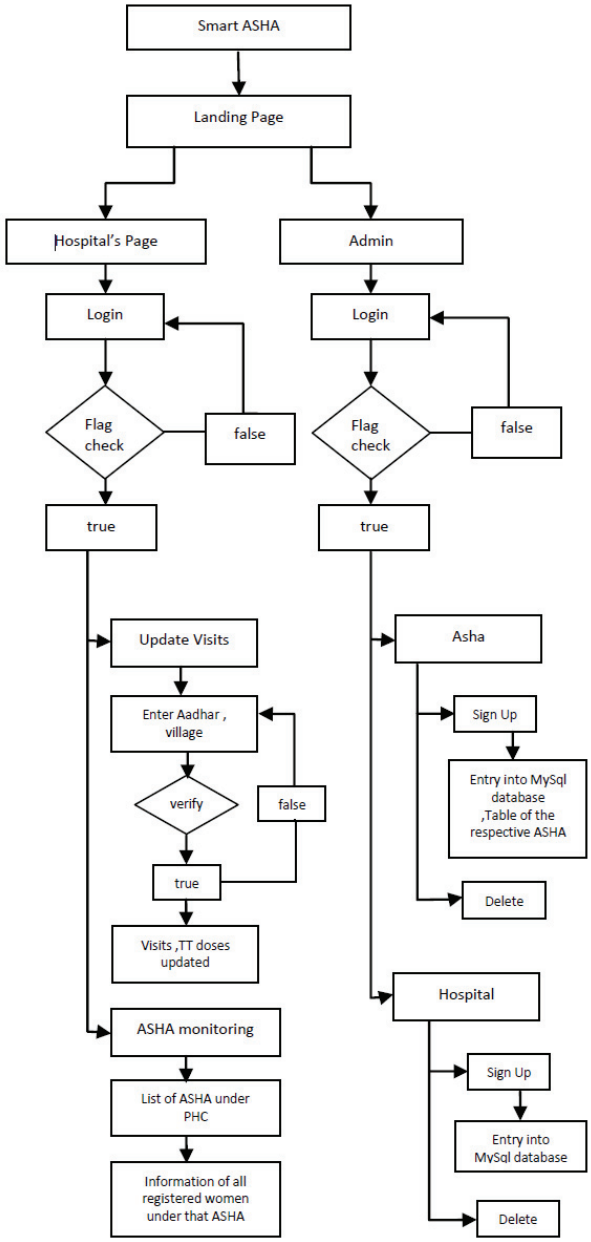



*Fig 8: Working Smart ASHA Website*

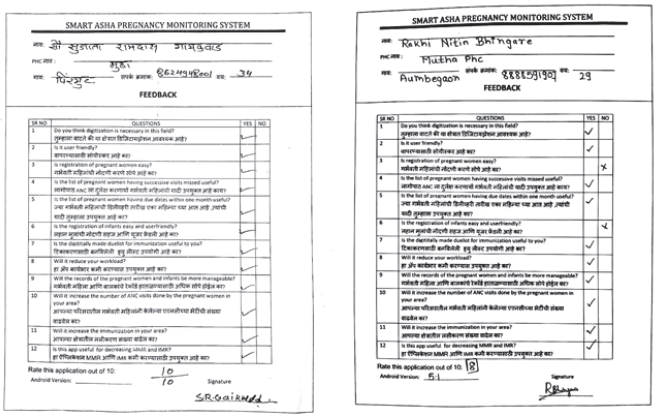



*Fig. 9: Feedback forms of 2 ASHAs*

## VIII. USABILITY OF SAPMS BY ASHA WORKER:

*8.1 Digitalization:*

All 25 ASHAs under consideration found it the need of an hour to invoke digitalization in this area.

*8.2 Easy registration of pregnant women and children:*

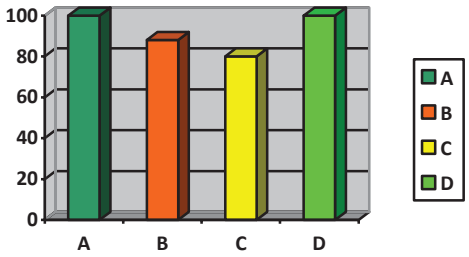
22 ASHAs under consideration, found the registration process of the beneficiaries very user friendly and easy, as they didn't have to carry the register every time they were on a visit. While, 3 ASHAs who were not much acquainted with the smart phones, found the old paper based system easier.

*8.3 Proper monitoring of ANC visits and immunization doses:*

20 ASHAs out of 25, found it useful to keep a track of the women ignoring the ANC visits and immunization doses of their children and thereby essentially increasing the number of ANC visits and immunization. Rest 5 ASHAs told us that the pregnant women in their area are well aware of the process and timely show up for the ANC visits and the immunization doses.

*8.4 Easy capture of due dates:*

All 25 ASHAs under consideration, found the automatic calculations of due dates and reminders for the same very useful. They admitted that they make erroneous calculations while calculating the due dates and that this automation could curb the wrong estimation of due dates. Also, the list of women having due dates within one month was found very beneficial by ASHAs to promote the institutional deliveries in their area.




A: Need of Digitization
B: Easy Registration
C: Monitoring of ANC visits
D. Easy capture of due dates

*Fig. 10: Result after using APP and Website*

## IX. CONCLUSION

The objective of the Government to reduce the maternal mortality rate can be achieved by Smart ASHA Pregnancy Monitoring System (SAPMS). The Smart ASHA application is a tool for ASHA which can help her perform her duties in an efficient and a smarter way. The registration of the pregnant women by the grass root workers in villages can

connect maximum number of pregnant women to the health care centers. This will help the government to avail the ante-natal care to the pregnant women in large number. The application helps the ASHA worker to keep a track of the ANC visits done by each and every registered pregnant woman in her village. The application also helps her identify the women not making the mandatory ANC visits to the health care centers, indicating a necessity to increase the medical awareness. The health care centers on the other part can view the performance of ASHAs by analyzing the number of registrations done by her and by the number of women in her village who are doing their ANC visits regularly. The client server model is very easy to implement and user friendly. The proposed technique provides an easy and effective way to curb the maternal deaths in the unprivileged parts of India.

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