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The Design and Development of Parent-Children Vaccination Alert System

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Abstract

Elevated rates of child mortality in many developing contries can be attributed to a complex interplay of poverty, malnutrition, and a host of preventable and non-preventable diseases. While vaccines for many of these diseases have been widely disseminated in developed countries through efforts from organizations such as WHO, UNICEF, and the Bill & Melinda Gates Foundation, adherence to vaccination schedules remains suboptimal in less affluent nations. This shortfall is largely due to the challenges parents and guardians face in scheduling and maintaining vaccine appointments for their children. To address this gap, our study employed the Design Science Research Process (DSRP) model to develop an integrated booking and SMS reminder system aimed at simplifying the immunization process. The application was engineered using Object-Oriented Agile methodologies and incorporates a prototype for client testing and early-stage implementation. As immunization stands as a cornerstone for managing vaccine-preventable diseases, this system offers a crucial solution to enhance child healthcare. It not only aids in reducing mortality rates but also simplifies the documentation and archival of vaccination records, thereby improving their accessibility. This system introduces an innovative approach that allows parents to book their child's vaccination appointments online, thereby eliminating the need for physical presence at healthcare facilities. The implementation of this system is expected to alleviate congestion in clinics and hospitals, streamlining the vaccination process and potentially improving overall public health.

Keywords: Children vaccination, Immunization of children, Immunization alert system, healthcare management, Prototype for vaccination alert.

1. INTRODUCTION

One of the most effective methods to reduce disease and mortality from vaccine-preventable diseases (VPDs) is childhood immunization [1, 2]. Maintaining high vaccine coverage is necessary to effectively reduce VPDs, with the WHO aiming to reach 90% coverage. In 1974, the WHO launched the expanded program on immunization (EPI) [3] and in Botswana, it was formally established in 1979 with

only 7 vaccines, namely Small Pox, BCG, DPT, Tetanus Vaccine, Measles and Oral Polio vaccines.

To successfully control and eliminate vaccine-preventable infectious diseases, timely vaccine coverage must be achieved and maintained as planned [4]. However, significant proportions of children in many countries continue to miss out on all basic vaccines, and VPDs continue to pose a public health risk [5], with the highest rates of child mortality still in Sub-Saharan Africa. Lack of communication between kid parents and medical personnel is one of the most often cited causes of missed vaccines in children [6]. Prior reminder not given (32.9%), mother's forgetfulness (26.6%), mother's busyness (27%), mother's ignorance of the need to return for additional doses (19%), and unknown location of vaccination (16%) were the main contributing factors for missing the vaccination doses and failing to vaccinate on time according to previous studies [7]. This calls for the creation of a suitable vaccine distribution strategy that uses mobile technologies [8].

By enabling interactive and prompt access to pertinent information, mobile communications technology has the potential to improve adherence to healthcare services [10]. One of the most popular mobile communication methods that allows for the sending and receiving of text messages is the short message service (SMS). Due to the recent increase in mobile phone use and the widespread use of the existing services by consumers, SMS-based services are now more appealing to service providers and users[10].

Mobile text message reminders are thus one of the reasonably priced strategies to increase participation in health programs. Different studies in Bangladesh[11], Beirut [12] and Pakistan [6] demonstrated that a mobile phone intervention has been shown to improve child health services. Although mobile health interventions show promise for improving healthcare, little is known about current practice in underdeveloped nations, where the technology's viability is questioned because mHealth is a relatively new idea[13]. The creation of automated reminder systems with the most recent understanding of the local context is necessary for the successful implementation of SMS-based mobile health interventions. In most developing countries, the current vaccination schedule is by written appointment. However, such an approach may not be sufficient because parents may forget due to a tight work schedule and daily routines [14]. Although most government provides free weighing, immunization, growth and development monitoring at childbirth up until infancy, these efforts have not yielded substantial results because reminders for follow-up, completion of next level vaccines are written or cards which are given to parents. Most of these children never completes the vaccination because the parents do not show up for appointment. Aside from the standard paper-based system issues, there is no system in place to manage the entire vaccination process [15] making most countries within the Africa region to

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lag behind in immunization, and thus suffer from a high proportion of vaccine preventable diseases[16].
Notably, reminders and recall for vac
cination have been shown to improve health-seeking behaviours and are recommended for use in routine and supplemental measles immunization activities[16].Hence, there is a need to develop a system that will manage the vaccination reminder systems, combine resources and reach parents via short message service particularly in Southern African countries [17]. Several studies done has shown that SMS vaccination reminder has led to improvements in vaccination uptakes using various metrics: through the increase in vaccination coverage, decrease in dropout rates, increase in completion rate, or decrease in delay for vaccination [16, 17]. Therefore, this research aimed to design and develop a parent-children vaccination alert system to help parents with booking for their child's vaccine appointment, meets appointments dates and thus reduce the long queues at the health centres.

2. LITERATURE REVIEW

Parent-children vaccination alert system is an immunization alert system, more of a reminder system to remind parents/caregivers about immunization of their children. The short message service (SMS) is a characteristic of second generation (2G) mobile technology which is limited to 140 to 160 alphanumeric characters, without graphics or images. The GSM, TDMA, and CDMA mobile phone networks that it is supported by are a reasonably straightforward message system. SMS-based services are becoming more attractive to service providers and customers due to the recent growth in mobile phone use and the broad use of the current services by consumers [18]. It has been discovered that using short message service (SMS) messaging, or "texts," to encourage interaction with patients about medical treatments increases vaccine series completion and boosts immunization rates.

Furthermore, Henry and Mercy [19] created a digital system in Waithaka Health Center that will transform the immunization information system in the vaccine booklet. The initiative will completely automate the immunization procedure at the health center by gathering all immunization information. The technology will improve record keeping and enable easy access to immunization records in addition to minimizing paperwork and the use of vaccine booklets. Okuboyejo and Eyesan [20] investigated various admirable qualities provided by mobile technology in health information management systems before presenting a mobile technology-based medical alert system for outpatient adherence in Nigeria. The SMS and voice features of mobile phones are utilized by the system. By calling and texting patients to remind them of their visits and prescription schedules, the system has the potential to increase drug adherence in the outpatient context.

Patients will also be informed of the advantages and hazards of following the regimen.

Furthermore, Eze and Adeleye [21] also sought to compare the projected costs of such systems to the costs of a health personnel-based defaulter tracking system in order to provide evidence supporting the need for the development and deployment of automated client Reminder-Recall systems for the Nigerian National Routine Immunization Programme. A parallel group, multi-center, randomized controlled trial with multistage sampling was carried out. When it came to receiving routine vaccinations, the intervention group that received SMS reminders outperformed the control group by a significant margin.

Renugadeve and Sivakumar, who are still interested in how mobile technology can be used in health information management systems, proposed creating an Android app that sends e-mails and app notifications to parents who register in the app, reminding them to give their children the recommended vaccines and diet [22]. Obahiagbon and Odigie [23] A software system framework that combines child immunization procedures with the creative potential of telemedicine has been presented. It would both offer nursing mother advising services and a mechanism for alerting parents to the availability of a child vaccine for a given time period.

The studies by Downer, Meara, and Da Costa showed that sending appointment reminders as SMS text messages to patients' or their caregivers' mobile phones is an efficient and successful way to increase attendance at outpatient clinic appointments. They discovered that the FTA rate in the out-patient clinics of our hospital was much lower in a group that received an SMS text reminder compared to a group that did not receive one (14.2% vs. 23.4%). Other studies using posted letters, manual and automated phone calls, and appointment reminders have reported decreases in FTA rates ranging from 6% to 19%. 1,5,7-9. Our decrease in FTA rate was consistent with that seen when utilizing these conventional reminder strategies, indicating that SMS messaging is at least as effective as these ways[24].

According to Kumari[25], A smart healthcare solution called Immunize - Baby Steps was developed. The system provided kid immunization information along with their DOBs in order to store the child's medical history in a single database. Additionally recommended is an SMS and email-based reminder system. The architecture is client-server. The relational database MySQL is recommended for data storage. It helped parents avoid delaying their child's vaccinations. New insights and trends in disease can be found in the data by using artificial intelligence and data analytics. This will help to improve the healthcare system[25]. Use of Apps to Promote Childhood Immunization: Protocol for a Systematic Review was the subject of a study. This study looked at the data already available on the use of apps to promote vaccination among kids and data preservation. It's possible that

there aren't as many or good studies on related topics as there need to be. The study's conclusions can be used to create a vaccine app[26].

Also being used was an app called e-vaccination: Fingerprint Based Vaccination Monitoring System. The software keeps track of children's immunization schedules and records the information in a database. The collection of fingerprints is used to notify parents when their child is scheduled for vaccination. By researching and putting into practice techniques for capturing child biometrics and strengthening the database's security, the system, which kept information safe electronically, can be improved[27].

Effectiveness of a smartphone app to improve parents' awareness and decision-making capability around the MMR vaccination: They conducted a randomised controlled study[28]. In terms of psychological empowerment and knowledge-related outcomes, this study looked at the outcomes of two vaccine-related applications. The study concentrated on Italian parents and the apps had games, texting, and movies. Quizzes were used to collect data. Participants reported having learned a lot about vaccines. This software was developed with parents in mind to educate them about the immunizations their children require and to boost their confidence in vaccines[28].

According to Domek[29, mobile phones offer a huge potential to enhance health outcomes in low- and middle-income countries (LMICs) by addressing large populations at a cheap cost due to their widespread use and relative affordability. Many LMICs still have below-acceptable vaccination rates, which puts kids at risk for needless morbidity and mortality. Although evidence-based patient reminder systems can increase childhood immunization rates, their implementation in low-resource settings has proven challenging. SMS text messages are a potential low-cost option with the benefit of scalability at little to no added expense. This proof-of-concept study demonstrated that, in an LMIC with few parents unable to use SMS and high parent satisfaction, a novel SMS technology application may be extensively adopted. To ascertain efficacy, larger research with adjustments to the SMS system are required[29].

A recommendation for worldwide routine immunization services and other periodic medical services is client reminder and defaulter tracking[14]. The findings of this study on mobile phone-based reminders and defaulter tracking have reinforced the effectiveness of this adaptive strategy in achieving complete and timely immunizations, especially in today's fast-paced world where being unavailable or simply forgetting an appointment is a common occurrence. Studies have revealed that most parents of under-immunized children are unaware that their child is out of date on vaccines, and both parents and healthcare professionals frequently overestimate the immunization status of their children or patients. This reminds me of the study's main hindrance to acceptance of mHealth: "I never

forget appointments," leaving program implementers with the burden of providing proof of necessity during stakeholder or public education[21].

There are several patient record management information systems, as numerous literature evaluations have conclusively shown. According to the reviewed literature, the bulk of current healthcare management systems are extremely general, challenging to use, and their designs cannot be altered to operate with the Child Immunization Information Management System. Due to this generalization problem, it may be disastrous if important information is removed or abstracted. Fortunately, these consequences can be avoided by specializing, which is why a parent-child vaccine (Immunization) alert system is needed. This system must incorporate a vaccination appointment reminder system that uses mobile telephony technology to send the proper Short Message Service (SMS) to parents of children who have upcoming vaccination appointments. It is a component of a healthcare management system with expertise in efficiently managing data on kid immunizations. This gap will be filled by creating and implementing a child immunization information management system.

3. METHODOLOGY

Research methodology is a procedure that describes the methods for accomplishing the goal of the research report[30] . It analyses the topic and gives out processes that will be conducted with the sole aim of developing a vaccine alert system. This section presents the methodology applied in this research.

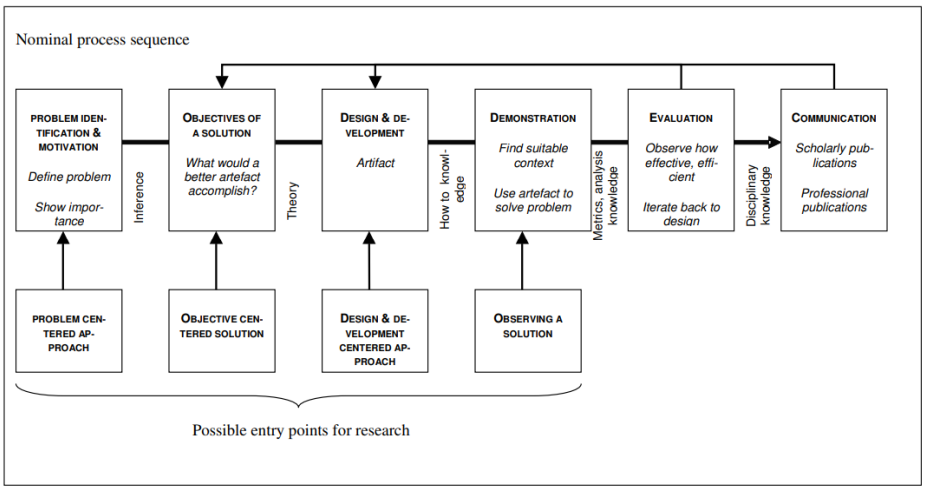

Figure 1. Design science research process (DSRP) model[31]

The development of the Design Science Research Process (DSRP) model as shown in figure 1 included six steps namely:

3.1 Problem identification and motivation.

This is the first step that identifies the problem and the motivation. As stated in section 1, this study seeks to design and develop a parent-children vaccine alert system to help parents with booking for their child's vaccine appointment, meets appointments dates and thus reduce the long queues at the health centres. The era of COVID-19 saw a clear need to visit the hospital and healthcare facilities strictly on appointment to avoid crowding; increase in child mortality rate due to parent missing vaccination appointment, lack of awareness on vaccination etc. The above provided motivation for this study.

3.2 Objectives of the study.

The objectives of the study are to:

1. conduct a review of literature to identify the contribution of research to solving the above problem and to identify research gap. This was done in section 2 of the paper,
2. to design using computer aided software engineering (CASE) tools a solution to the above identified in section 1,
3. develop a software prototype to implement the CASE tools designed in 2 above.

3.3 Design and development.

This phase of the methodology presents the design of the prototype using UML diagrams as part of the CASE tools solution to the identified problem in section 1 and to fulfil objective 2.

UML Diagrams of the proposed patient-child vaccination system. The flowchart of the prototype is shown in Figure 2. As depicted in the flowchart, the child's parent is expected to login before using the system otherwise, the parent is asked to register on the system. Two categories of users are allowed namely: Admin and the parent. The admin is a staff of the government who oversee the operation and maintenance of the system. The parent can add a child to the system, book vaccination appointment and select a suitable date and time for the vaccination of the child. While the admin can manage the child information, add needed vaccines to the system and manage notifications sent to parent about the status of the vaccination and reminders. Each of the system users can perform certain operations. A refinement of the above processes with specific details about added functionalities are shown in the Use Case diagrams of Figure 3 for Admin and figure 4 for parent. The admin can add new health centres created by the government as well as added newly employed health workers or vaccination ad-hoc workers. The admin manages workers on the vaccination system as well as assign workers and supervisors for each vaccination type. Therefore, the entire

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processes involved in the administration of the system rest with the admin. A sequence diagrams is used to show processing flow within the various components in the order of execution or according to time. The sequence diagram for admin and the patient Use Cases are shown in Figures 5 and 6.

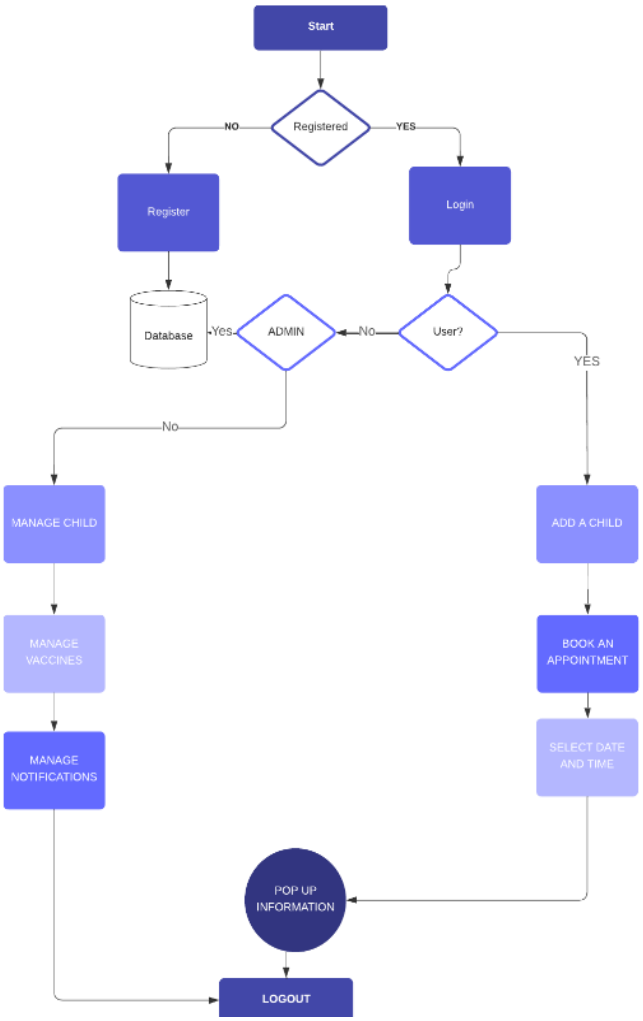

Figure 2. Flowchart for the Proposed System

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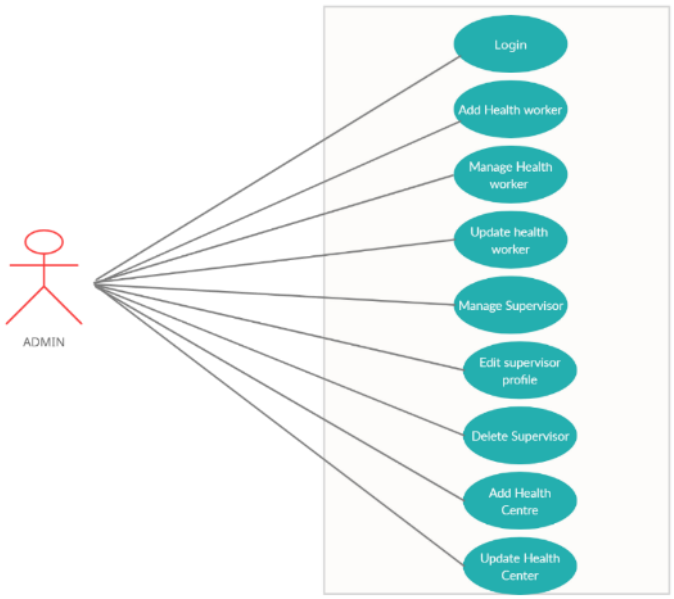

Figure 3. Admin Case diagram

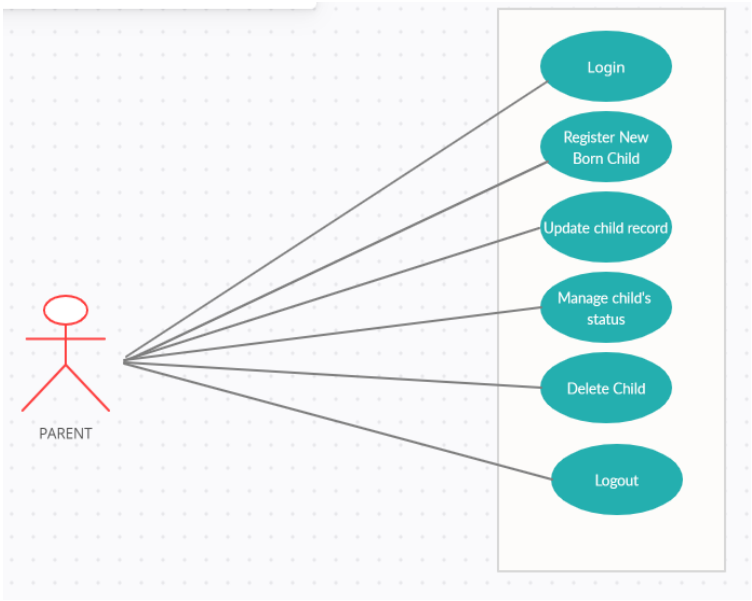

Figure 4. Parent Use Case Diagram

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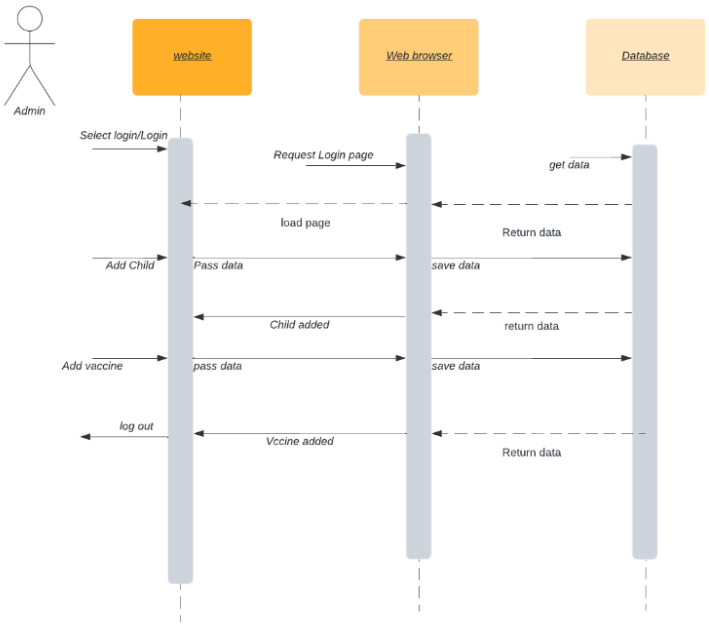

Figure 5. Sequence diagram of Admin

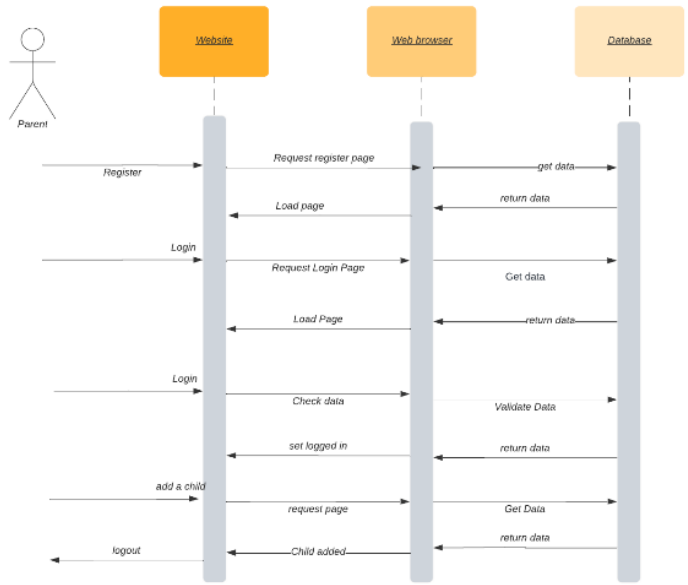

Figure 6. Sequence diagram of Parent

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Demonstration: This entails making use of the developed system to solve the problem for which it is intended. The system workability was demonstrated in figures 7-12 in the discussion of result session.

Evaluation: The system developed in this research was evaluated using structured walk-through, peer review and desk-checking. The results obtained shown in figure 7-12 were consistent and robust.
Communication: Communicating the result of this study will be done through publication within the research community and making the software tool and all the documentation including the sample test results available to government through the department for Health and other related government agencies

4. RESULTS AND DISCUSSION

The results of the prototype test run are presented and discussed in this section. Figure 2 shows the flowchart of the proposed system. Each parent/guardian is expected to register to use the system. At the system startup, the user will be asked to entered login credentials or registered as Admin staff (responsible for system operation) or a Parent. The information entered will be stored in the data repository. The user has access to register their child(ren), book an appointment for vaccination, and select the date and time for vaccination. The admin can manage the record of the children, health worker, health supervisor, vaccines, and send notification to Parent about vaccines availability and update/book appointment dates for vaccination.

Figure 3 and figure 4 show the use cases diagrams for the Admin and Parent and the functions they can perform while using the system. The admin is in charge of adding new health workers and supervisors employed for vaccination purposes, manage the activities of the health workers and the supervisors, make changes to health workers and supervisors stored details. While the Parent can add newly born children to the system, update existing children's details, manage, and delete children details from the system.

Figure 5 and figure 6 are the sequence diagrams showing the sequence of events that occurs along timelines and how one events triggers another. The various input operations that trigger sequence of events leading to response generated to users of the system are captured. As seen in figures, Admin and Parents are the actors that triggers events namely log in, add health workers and children respectively on the website (vertical bar), then these data are processed by the web browser (second vertical bar) by carrying out the instructions to add item to the data and processed reports are added to the database as updates (third vertical bar). The bars aligned the various operations in the order of execution.

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The system was developed using CSS and JavaScript with Visual Studio code 2019. Visual studio code provides an advanced code editor, and other tools for easier application development. While the database for this system was designed using Microsoft SQL server 2019, the key justification for selecting Microsoft SQL Server as the database design tool is that it supports the highest levels of flexibility, scalability, data integrity, and data security in addition to providing higher performance as it is one of the most popular open-source relational database management systems (RDBMS). It is a common choice of database for usage in web applications and it is also employed in many high-profile web applications. This section explains the implementation of the core functionalities for the Parent-Child vaccination alert system. Therefore, some of the interfaces/screenshots captured from the system test run were used to illustrate these functionalities. Figure 7 shows the registration form for new users where they can add a child/ward and book an appointment. The user will provide such details as username, lastname, gender, birthdate, phone numbers, birthplace, and the type of user the person is, and click "login". All the data will be capture on the database backend.

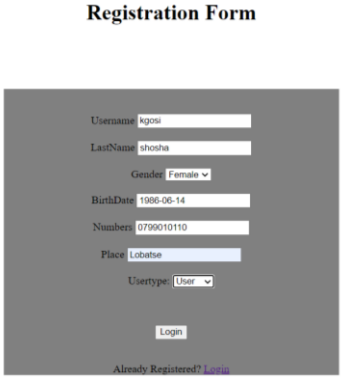

Figure 7. The registration form of the system.

After creating a user, he/she can log into a user home page as shown in figure 8, where the user can add the child's information to the system. The child's information can be updated by both the user and the admin. The user can also proceed to book for vaccination appointment via the system, and all the data will be stored on the database backend.

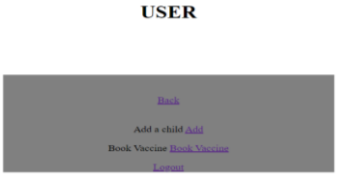

Figure 8. User home page interface

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From logging in as a user, the user clicks 'Add' to add the child on the system and complete the child details as shown in Figure 8. The information that is required to add any child on the system is name, surname, birth certificate number and the name of the parent as shown in figure 9.

Figure 9. Adding a child into the system

Figure 10 shows the complete database of registered children for vaccination by their respective parent with the details of children and parent combined.

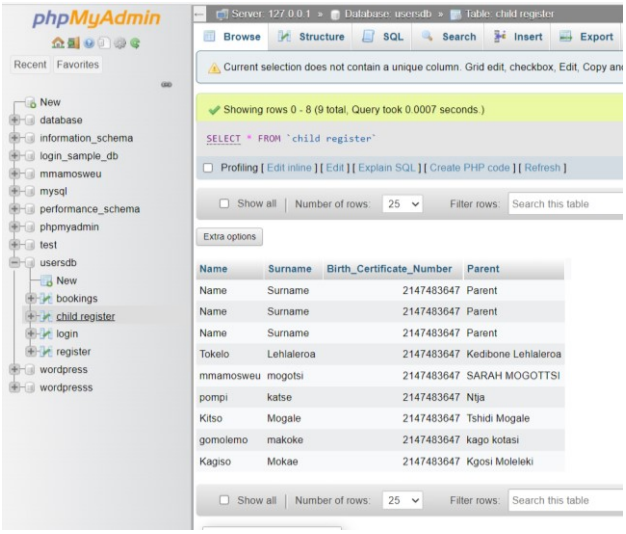

Figure 10. Database of Registered children

Figure 11 shows the booking form for vaccination, where the user is required to fill in the child's name, gender, name of the parent and location and add to the database. After completing the required information about the child, the user proceeds to select an appointment date as shown in Figure 12.

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Figure 11. Booking for appointment for Vaccination

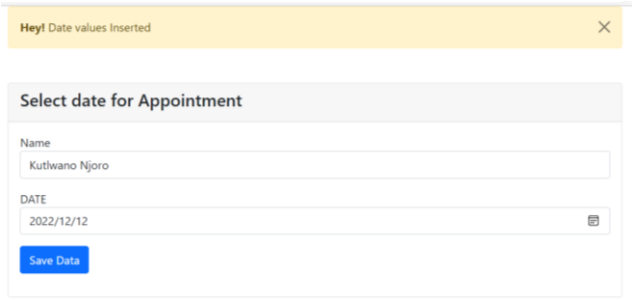

Figure 12. Appointment date selection option

A reminder will be sent three (3) days before the appointment date and repeated daily up to the date of the appointment. On the date of the appointment, the reminder will be sent every three hours to ensure that the parent does not forget or miss the appointment. This we believe is one of the most effective ways to mitigate against children mortality resulting from missing vaccinations.

5. CONCLUSION

In this study, vaccination alert system has been developed and test run. Structured walkthrough was conducted among peer teams and desk-checking was done by the researchers and the results were consistent with that shown in figures 7-12. The system was developed using Agile method of prototyping for easy of testing and interaction with client before the final version is released. With this system, it is expected that parent/guardian of children will take advantage of the system and register their new-born child and other children within vaccination age so that with adequate vaccination and a follow-up appointment, child mortality rate can be reduced to the barest minimum. We therefore recommend that the government through its Ministry of communication and health should mount intensive awareness campaign and sensitization about the developed system in print, radio, and television media within the country. There should be a legislation on punitive measures against parent/guardian who fail to vaccinate their children or who refuses to keep to vaccination appointments because the reminder system makes

it easy for every parent not to miss their appointment. In future, the researchers will extend the system to include reminders for all patients who visits the hospitals or medical facilities for any form of medications and for which further medications are required to complete the required doses. The system should be able to keep track of the dates for appointment and remind the patient when they are due to collect further medications.

REFERENCES

[1] Z.A. Mekonnen, F.N. Hussien, B. Tilahun, K.A. Gelaye, A. Mamuye, "Development of automated text-message reminder system to --improve uptake of childhood vaccination in North-West, Ethiopia," Online Journal of Public Health Informatics, vol. 11, issue 2, Sept 2019.

[2] J. Lei, M.R. Balakrishman, J.F. Gidudu, P.L.F. Zuber, "Use of a new global indicator for vaccine safety surveillance and trends in adverse events following immunization reporting 2000–2015," Vaccine, vol. 36, issue 12, pp. 1577-1582, Feb 2018.

[3] W.H. Organization, World health statistics 2016: monitoring health for the SDGs sustainable development goals. 2016: World Health Organization.

[4] B. Pond, A. Bekele, S. Mounier-Jack, H. Teklie, T. Getachew, "Estimation of Ethiopia's immunization coverage–20 years of discrepancies." BMC health services research, vol. 21, issue 1, pp. 1-9, Sept 2021.

[5] M.C. Restrepo-Méndez, A.J.D. Barros, K.L.M. Wong, H.L. Johnson, G. Pariyo, F.C. Wehrmeister, C.G. Victoria, "Missed opportunities in full immunization coverage: findings from low-and lower-middle-income countries." Global health action, vol 3, issue 9, pp. 30963, May 2016.

[6] A.M. Kazi, M. Ali, K. Zubair, H. Kalimuddin, A,N, Kazi, S.P. Iqbal, J. Collet, S.A. Ali, "Effect of mobile phone text message reminders on routine immunization uptake in Pakistan: randomized controlled trial." JMIR public health and surveillance, vol. 4, issue 1, pp. e7026, May 2018.

[7] A. Haji, S. Lowther, Z. Ngan'ga, Z. Gura, C. Tabu. H. Sandhu, W. Arvelo, "Reducing routine vaccination dropout rates: evaluating two interventions in three Kenyan districts, 2014." BMC Public Health, vol. 16. issue 1, pp. 1-6, Feb 2016.

[8] D.G. Gibson, E.W Kagucia, B. Ochieng, N. Hariharan, D. Obor, L.H. Moulton, et al., "The mobile solutions for immunization (M-SIMU) trial: a protocol for a cluster randomized controlled trial that assesses the impact of mobile phone delivered reminders and travel subsidies to improve childhood immunization coverage rates and timeliness in Western Kenya." JMIR research protocols, vol. 5, issue 2, pp. e5030, May 2016.

[9] K. Harding, G.A. Biks, M. Adefris, J. Loehr, K.T. Gashaye, B. Tilahun, et al., "A mobile health model supporting Ethiopia's eHealth strategy. Digital medicine" vol. 4, issue 2 pp. 54, Aug 2018.

[10] C. Lin, N. Mistry, J. Boneh, H. Li, R. Lazebnik, "Text message reminders increase appointment adherence in a pediatric clinic: a randomized controlled trial." Int J Pediatr. doi: 10.1155/2016/8487378 Dec 2016.
[11] M.J. Uddin, M. Shamsuzzaman, L. Horng, A. Labrique, L. Vasudevan, K. Zeller, et al., "Use of mobile phones for improving vaccination coverage among children living in rural hard-to-reach areas and urban streets of Bangladesh." Vaccine, vol 34, issue 2, pp. 276-283, Jan 2016.
[12] N.J. Vickers, "Animal communication: when i'm calling you, will you answer too?" Current biology, vol. 27, issue 14, pp. R713-R715, July 2017.
[13] A. Oyo-Ita, C.S. Wiysonge, C. Oringanje, C.E. Nwachukwu, O. Oduwole, M.M Meremikwu, "Interventions for improving coverage of childhood immunisation in low-and middle-income countries." Cochrane Database of Systematic Reviews, vol. 7, issue 7, doi: 10.1002/14651858.CD008145.pub3 July 2016.
[14] A.H. Abbas, Y. Yusof, "Children vaccination reminder via SMS alert." in IEEE 2011 International Conference on Research and Innovation in Information Systems. Kuala Lumpur, Malaysia, 2011.
[15] N.P. Motlogelwa, T. Seipone, G. Malema, G. Malema, A. Chirunga, "Infants Growth and Development Monitoring: A Prototype Mobile Application ? A Case for Botswana Health Care Services" in Environment and Water Resource Management / 837: Health Informatics / 838: Modelling and Simulation / 839: Power and Energy Systems conference, DOI: 10.2316/P.2016.837-007 Jan 2016.
[16] K. Manakongtreecheep, "SMS-reminder for vaccination in Africa: research from published, unpublished and grey literature." The Pan African Medical Journal, vol 27 (Suppl 3), issue 23, doi: 10.11604/pamj.supp.2017.27.3.12115, June 2017.
[17] A.A. Adewale, A. Abdulkareem, A.A. Adelakun, "Development of an SMS Based Alert System using Object Oriented Design Concept." International Journal of scientific & technology research, vol. 3 issue 5, pp. 71-76, May 2014.
[18] G. LeBodic, Mobile messaging technologies and services: SMS, EMS and MMS. 2nd ed. John Wiley & Sons, 2005.
[19] H.P. Gommans, M. Wangar, "Waithaka Health Centre Immunization Information System." International Journal of Scientific and Research Publications, vol. 4, issue 10, pp. 149-158, Oct 2014.
[20] S. Okuboyejo, O. Eyesan, "mHealth: using mobile technology to support healthcare. Online journal of public health informatics." vol. 5, issues 3, pp. 1-10 2014.
21. G.U. Eze, O.O. Adeleke. "Enhancing routine immunization performance using innovative technology in an urban area of Nigeria.", West African journal of medicine, vol. 34, issues 1, Jan-Mar 2015.

[22] P. Renugadeve, V. Sivakumar. "A Study on Vaccination and Immunization Reminder of Children Through Mobile Phones. "Research journal of Pharmaceutical biological and chemical sciences, vol. 8, issue 3, pp. 922-927 2017

[23] K. Obahiagbon, B. Odigie, "A Mobile Architecture for Childhood Vaccine-Preventable Illnesses Expert System." African J Computing ICT, vol. 8, issue 2: p. 61-74, 2015.

[24] S.R. Downer, J.G. Meara, A.C. Da-Costa, "Use of SMS text messaging to improve outpatient attendance." Medical journal of Australia,. vol. 183, issue 7, pp. 366-368, 2005.

[25] S. Kumari, A. Haripriya, A. Aruna, D.S. Vidya, M.N Nithy. "Immunize—Baby steps for smart healthcare: Smart solutions to child vaccination." in 2017 International Conference on Innovations in Green Energy and Healthcare Technologies (IGEHT). DOI: 10.1109/IGEHT.2017.8094048 Mar 2017.

[26] C. de Cock, M. van Velthoven, M. Milne-ives, M. Mooney, E. Meinert. "Use of apps to promote childhood vaccination: systematic review." JMIR mHealth and uHealth, vol 8, issue 5, p. e17371. May 2020.

[27] S. Vidhya, B.A. Sabarish, J. Rajivkrishnan, P. Sachin. "E-vaccination Fingerprint based vaccination monitoring system." Int. J. Pure Appl. Math, 2 vol. 118, issue 7, p. 623-627, 2018.

[28] M. Fadda, E. Galimberti, M. Fiordelli, L. Romano, A. Zanetti, P.J. Schulz. "Effectiveness of a smartphone app to increase parents' knowledge and empowerment in the MMR vaccination decision: A randomized controlled trial." Human vaccines & immunotherapeutics, vol 13, issue 11 pp. 2512-2521, Nov 2017.

[29] G.J. Domek, I.L. Contreras-Roldan, S.T. O'Leary, S. Bull, A. Furniss, A. Kempe, E.J. Asturias. "SMS text message reminders to improve infant vaccination coverage in Guatemala: a pilot randomized controlled trial." Vaccine, vol 34 issue 21, pp. 2437-2443, 2016.

[30] P. Baxter, S. Jack. "Qualitative case study methodology: Study design and implementation for novice researchers." The qualitative report, vol 13 issue 4, pp. 544-559, 2008.

[31] A.G. Fiks, K.F. Hunter, A.R. Localio, R.W. Grundmeier, T. Bryant-Stephen, A.A. Luberti et al., "Impact of electronic health record-based alerts on influenza vaccination for children with asthma." Pediatrics, vol 124 issue 1, pp. 159-169, Jul 2009.