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# Optimizing Vaccine Access: A Web-Based Scheduling System with Geo-Tagging Integration and Decision Support for Local Health Centers

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## Abstract

The system created aims to produce an online vaccination appointment scheduling system with geo-tagging integration and a decision-support mechanism for neighborhood health clinics. With a decision support mechanism that suggests the essential vaccines based on their account details, it is made to meet the unique vaccination needs of each patient. The system includes immunizations that are accessible locally, and patients and midwives can manage their own corresponding information through personal accounts. Viewers of websites can visualize the distribution of vaccines by purok thanks to geotagging. The Agile Scrum Methodology was modified by the researchers for early delivery, change flexibility, and continual system improvement in order to accomplish the study's main goal. In order to assess the system's acceptability in terms of functional adequacy, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, it was designed in accordance with the ISO 25010 Product Software Quality Standards. Following the assessment, the system was given an average total weighted mean score of 4.62, which represents a verbal interpretation of "strongly agree". This score demonstrates that the evaluators were in agreement that the system met the requirements of ISO 25010 for Product Software Quality Standards.

## Keywords

Online Appointment Scheduling, Geotagging, Decision Support, Vaccination, Neighborhood Health Clinics

## 1. Introduction

In the current technological era, digital solutions are being utilized to address various societal issues. Modern technology has enabled different sectors to address their unique requirements. Effective change management is crucial in the success of transition from paper-based system to an electronic Healthcare Information System [1]. Vaccines are one of the most effective public health measures for preventing disease and reducing the burden of infectious illnesses. With unexpected outbreaks and emergencies like the COVID-19 surge, proper scheduling of vaccines has become a critical responsibility of local government units.

The existing healthcare system should address the standard delivery of health care [2]. A good scheduling system relies on an efficient health record system because most scheduling activities are linked to the registration and filing unit. Citizens now have more options for scheduling appointments and greater access to online platforms.

The automation of the existing process in Health Centers improves the efficiency of records of each patient [3]. The University of Minnesota (2022) conducted a study that revealed a need to regulate client flow and reduce waiting times after several walk-in clinics were held. In response, planners swiftly implemented an online block scheduling system. Clients could register for a 15-minute time slot to receive their vaccination, and vaccinations were administered on a first-come, first-served basis within each time block. The system performed exceptionally well, improving clinic operations by reducing waiting times, establishing a consistent and predictable patient flow, maximizing resources and vaccines administered per unit of time, and ultimately increasing the number of vaccines administered at mass clinics. Integrated medical information systems are becoming an essential part of the modern healthcare systems [4].

By incorporating geo-tagging into the vaccination scheduling system, the local government unit can easily pinpoint the location of vaccinated individuals and determine the number of vaccinated people in a particular area. This technology not only enhances the efficiency and productivity of the LGU, but it also enables them to keep up with other municipalities offering similar services, which is a win-win situation for all parties involved. The importance of health care information systems has been highlighted in the studies by [5] [6].

The developed system is a comprehensive system that covers common vaccines available at local health centers. The system provides online scheduling for individuals, reducing the time required to inquire about available vaccines. It also includes notifications for registered users about upcoming vaccination schedules and important announcements. Geo-tagging will be implemented to monitor vaccine data and vaccinated individuals easily. Additionally, other local government units that offer the same services will benefit from the study because the system can be adapted to their needs.

Research Questions:

1) What are the main features of the proposed system?

2) How can the geo-tagging and mapping feature be integrated into the development of an online vaccination appointment scheduling system?

3) How can a decision support approach be incorporated into the proposed system?

4) How can the system be evaluated using the Software Quality ISO/IEC 25010 standards, including functionality suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability?

## 2. Methodology of Study

The goal of the study was to improve vaccine accessibility by creating a web-based scheduling system with integrated geotagging and decision support for neighborhood health clinics. The study employed a descriptive research methodology in order to fulfill this objective. The researchers were able to collect accurate and trustworthy data using this methodology, which enabled them to create a successful web-based scheduling system.

By creating a web-based scheduling system with geotagging integration and decision support for neighborhood health centers, the study aimed to maximize vaccine access. The construction of a successful web-based scheduling system was assisted by the accurate and trustworthy data collected using a descriptive research methodology. By employing a variety of approaches and methods to assess the consistency and quality of data collection, the study ensured reliability and validity.

### Software Development Methodology

For the creation of the system, the researchers adopted Agile Scrum as the software development methodology. Agile promotes evolutionary software development, adaptable planning, early delivery, and change flexibility for continuous improvement, according to [7].

The project has been developed continually using agile until the evaluations indicated that the system met their criteria. If the assessment indicates that the requirements are not being satisfied, the development process was to be restarted, beginning with the new evaluation requirements. The developers' major focus is on the system's development, as the technique made authoring documentation easier by using "user stories", or short informal descriptions of features. The developer collaborated extensively to ensure that communication was constant, highlighting the importance of collaboration in the development of the system.

**Requirements Phase**. The first stage of the agile development process. The requirements or new needs have been determined during this phase based on the client's interview and evaluation; these requirements will be utilized as a guide for the developer in the subsequent phases. During this phase, the developer will

define the initial requirements based on their interviews with various potential project users.

**Design Phase**. The physical, logical, architectural, and test designs of the system have been created and refined during this phase. This design serves as a roadmap for developers during the development and testing phases. The developer developed or modify a blueprint that is been used in the development phase during this phase.

**Development Phase**. The development or implementation of the requirements and design begins in this phase. The project is produced or modified during this phase/stage in response to design revisions. The initial development phase of this project begins with the documentation of Chapters 1 - 3 and ends with the design phase after each iteration.

**Testing Phase**. In this phase, the developed system is tested for possible bugs using the designed test cases using white box and black box testing.

**Deployment Phase**. In this phase, the system is deployed for the client. During the deployment, the system will be continuously evaluated by the client to check if their requirements are met.

**Review Phase**. In this phase, the evaluations of the client are gathered and reviewed to check if the system already meets the requirements or if new requirements are to be created.

## 3. Results and Discussion

Findings for the Request Questions

**Problem 1. The significant features of the system**

1) Account Registration—The developed system consists of 2 types of users the administrator's account and the patient's account. Admin users don't require any registration since the local health center only consists of one midwife username and password will be given to the user and it can also be updated within the settings. For the patient account the system requires email and password for the registration, upon creating an account the system is capable of sending code in the email to complete the registration process that is shown of **Figure 1**.

2) Patient Account—**Figure 2** shows the Patient Account. This feature includes different types of modules such as scheduling, geotagging view, record management and profile management. Upon logging in to the account for the first time the system includes prompt message to update their profile. Patient account is will be used by the parents of every child who will avail of vaccinations within the local health center. Children registration is also part of the profile module and will eventually serve as the vaccine card of each child.

3) Announcements Page—**Figure 3** shows that unregistered users can also visit the website yet it only has a limited feature one of which is the announcement page. On each page visitors will be capable of viewing certain announcements from the local health centers. At the bottom part, it also includes contact us button, when the website viewer clicks the button, it will be redirected to the registered email of the admin to send certain concerns.

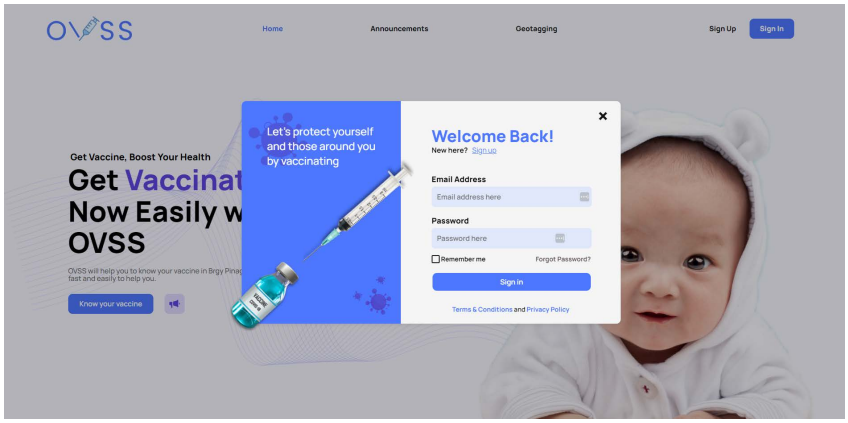


**Figure 1.** Account registration.

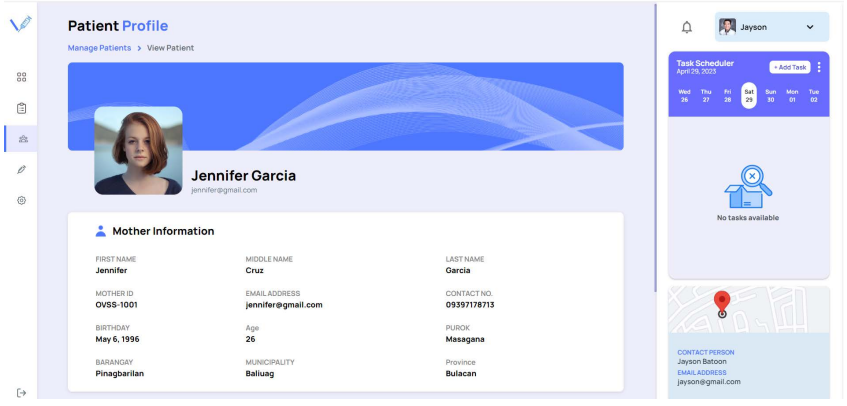


**Figure 2.** Patient account.

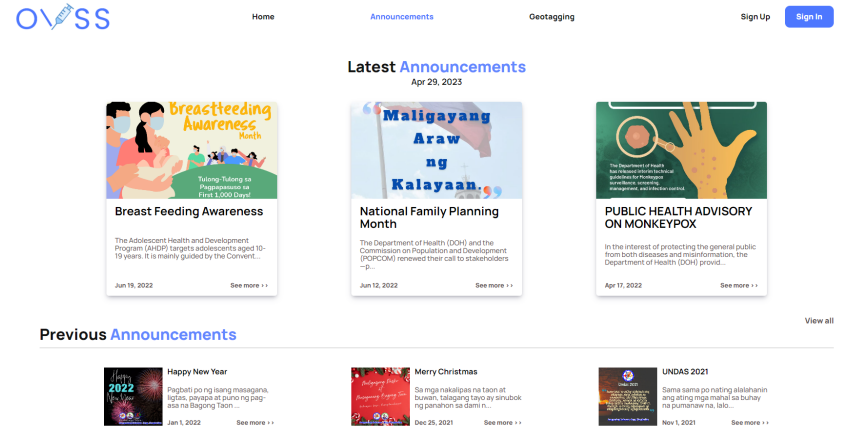


**Figure 3.** Announcement page.

4) Vaccine Management—This module is only available in the administrators account wherein the midwife has the capability of inputting available vaccine with corresponding details such us dosage, intervals, required age, image and description as shown in **Figure 4**. This module also includes printing of vaccines. The admin is also required to encode the stocks of each vaccine that will be use to limit the request of appointment schedule.

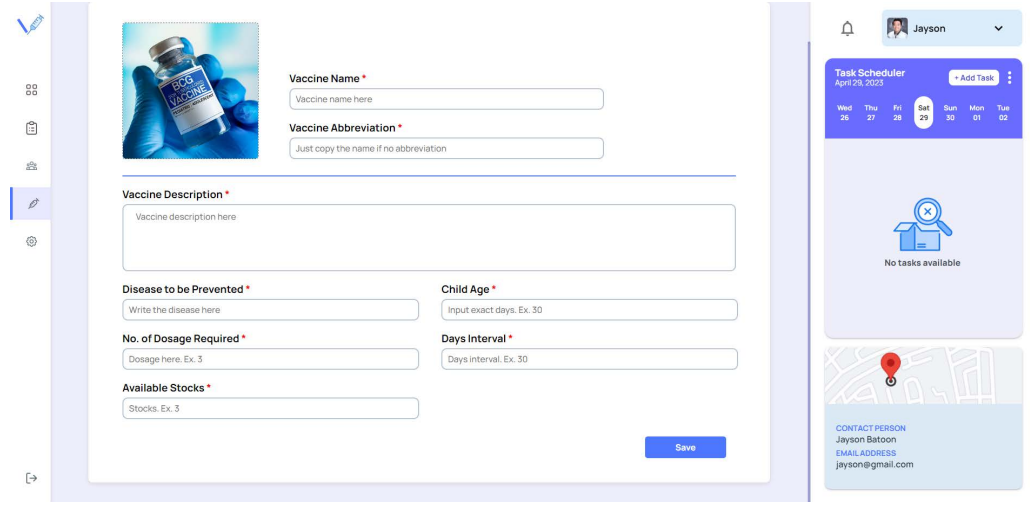


**Figure 4.** Vaccine management.

5) Patient Management—**Figure 5** shows the developed system includes a module for patient management the administrator's accounts are capable of creating an account to patient. This module includes viewing of patient details and viewing of their personal details. It can also produce reports in pdf format that can be filtered by date and other category.

6) Schedule Management—Every appointment of each patient will be seen within this module wherein the admin has the capability to accept certain appointment if it meets the requirements of the child. The system also includes reject button this button will be used if a certain child won't meet the requirements for each vaccine. Based on the interview to the local health centers some of their patient didn't avail all the vaccines required for each child resulting to reject some of the patient's request. This module is capable of printing reports in pdf format that can also be filtered as shown in **Figure 6**. The module for scheduling management is available only for registered users only. The patient is required to choose the date of appointment and the name of the child if ever the parents have 2 or more child.

**Problem 2. Integration of Geo Tagging to the developed system**

The generation of customized reports in mapping cases occurrences serves as tool in the delivery of relevant programs and services [8]. Geo tagging is a visual representation in a map view that gives additional details to the site viewer. The page is available for registered and unregistered user which has the image map of the initial health center which is the barangay pinagbarilan. Tag was place per purok of the barangay that can be clicked to show certain details. The map available is consist of three tags corresponding to three 3 puroks within the barangay. Filters is also available to have an accurate result of vaccinated individual based on the purok name and vaccine name. Geo tag is linked to the database of each patient since each record is consist of name and address the system will just simply identify the purok of each individual and add it to the geo tag together with the additional details shows in **Figure 7**.

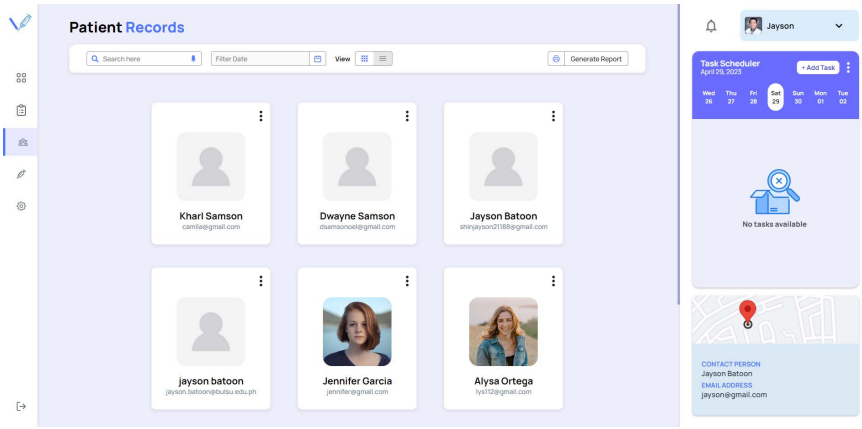


**Figure 5.** Patient management.

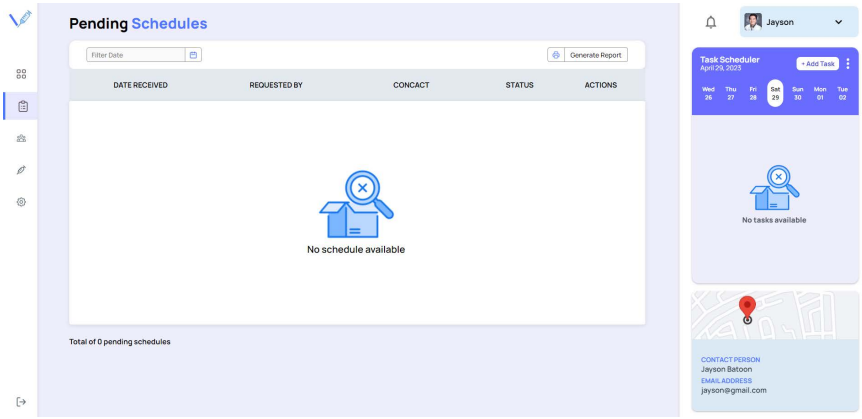


**Figure 6.** Schedule management.

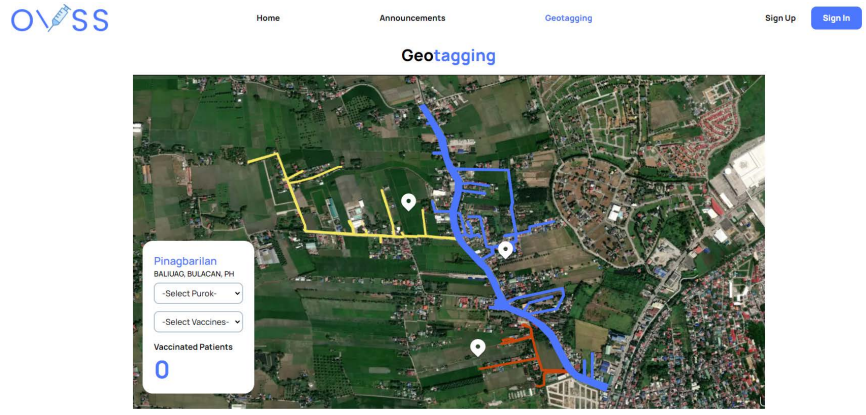


**Figure 7.** Geo tagging.

**Problem 3. Integration of Decision Support Mechanism Process Flowchart**

The importance of decision support systems based on community-based approaches has been highlighted in the study [9] [10]. The decision support mechanism was integrated to avoid errors in giving recommended vaccines. **Figure 8** shows the process of the Decision Support Mechanism; the first process

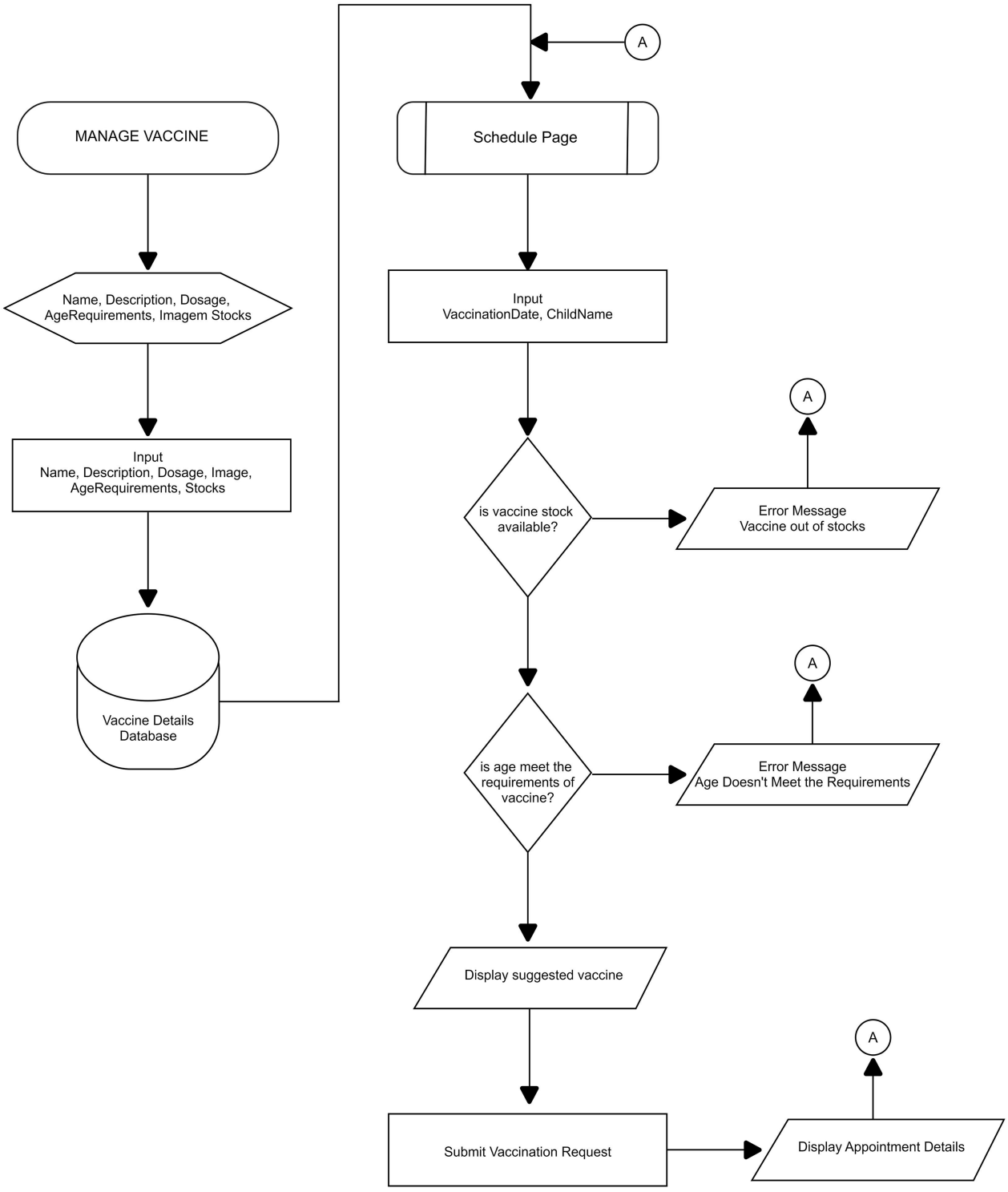


**Figure 8.** Decision support algorithm.

includes the encoding of vaccine details such as name, dosage, intervals, age requirements, stocks, and description and will automatically save in the database and will be used to execute simple algorithm. Vaccine stocks will be used to limit the schedule request of the registered patients the admin will be required to in-

put number of available vaccines. Dosage refers to the number of times if a certain vaccine required how many injections with corresponding intervals it is the identifier use to compute the next dates of vaccination visit for each patient. Intervals is the variable used to schedule each dosage properly the next visit of the patient will be dependent on the dosage and intervals of each vaccine. When the patient plans to have an appointment for the vaccines they will be required to input their prepared date and child name the decision support mechanism will decide what vaccine is suggested to the child age and even checking if the vaccine was out of stocks or not. This mechanism benefited the patient to have an accurate vaccine and at the same time have a secured slot for the vaccine.

**Problem 4. Respondents' acceptance result based on ISO/IEC Standard 25010:**

1) Functional Suitability. In terms of the three sub-characteristics under functional suitability, the application received a verbal interpretation of "strongly agree" the respondents of the study agreed that the system meets required standards. The system is capable of manipulating different functions of the system like management of vaccine schedules and patient records.

2) Performance Efficiency. The developed system received a verbal interpretation of "strongly agree" in terms of performance efficiency. It shows that the time behavior, resource utilization, and capacity as sub characteristics perform well. The evaluators agreed that the system can store and displays a large amount of content while some partial data was being hidden. The system is also capable of launching in a short period of time from the web server. Requesting data from the server is also efficient.

3) Compatibility. In terms of compatibility the developed system received a verbal interpretation of "strongly agree" based on the evaluation result. It performs normally even when other application is running within the same web browser.

4) Usability. In terms of usability, the system received a verbal interpretation of "strongly agree". The system can be easily recognized by the user as an information management system that focuses on health services. The evaluators also agreed that the system provides brief instructions on some complicated functions. The system also provides a search engine to find specific data or information.

5) Reliability. A verbal interpretation of "strongly agree" was given to the system in terms of reliability. The evaluators agreed that the information provided in the system is correct and up-to-date with consistency. The system also responds quickly to the user's selection and action. The system also catches errors properly without affecting other actions taken by the users.

6) Security. In terms of security, the developed system received a verbal interpretation of "strongly agree". All evaluators agreed that the system is provides confidentially, integrity, and authenticity of the data secured. Validation of data before storing is part of the system functions.

7) Maintainability. The developed system received a verbal interpretation of "agree" in maintainability. The developed system is a modular application. Its assets and components may be utilized in other systems as well. It is also simple to examine for future development or determine failure causes.

8) Portability. Based on the evaluation results, the application gained a verbal interpretation of "strongly agree" in portability. The developed system performed well on the various devices with different hardware and software specifications used by the evaluators. The admin account is light on requirements both on hardware and software.

## 4. Conclusion

After evaluating the system with different users, the researcher has concluded that it is useful. Patient management is made more effective by the system, as it enables the public health center to easily monitor and track each individual's vaccines. Additionally, the integration of an appointment scheduling system reduces patient waiting time and the need to visit the health center just to inquire about available vaccines. To cater to the needs of all residents, a progressive mobile view is included, making it adaptable for various users. The decision support mechanism also helps staff to provide accurate dates for each patient's next vaccine visit, as timing is critical. Overall, the system is beneficial, not only to first responders and users, but to other health centers offering the same services.

## 5. Recommendations

The study provides the following recommendations for future researchers who plan to develop a similar system with the same features and services:

- Include messaging services to inform patients of their schedules.
- Develop an inventory management system that covers not only vaccines but also other available medicines in local health centers.
- Implement QR codes and generate printed identification cards for patients to facilitate monitoring of their personal records.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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