Bulletin of Electrical Engineering and Informatics
Vol. 12, No. 2, April 2023, pp. 1159~1170
ISSN: 2302-9285, DOI: 10.11591/eei.v12i2.4777

Web application: efficient immunization by vaccination for children and adults

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Article Info

Article history:

Received Sep 13, 2022
Revised Nov 2, 2022
Accepted Nov 25, 2022

Keywords:

COVID-19
Immunization
Scheme
Scrum
Web application

ABSTRACT

The investigation analysed the correct use of the vaccination scheme in order to achieve efficient immunization for children and adults in the midst of the pandemic; through the use of a web application that will greatly facilitate people in their immunization, since the web application will allow them to create alerts to have reminders at times personalized by the user. Also, the web application will provide a schedule complete personalized immunization according to the personal information of the registered user, on the other hand they will also be able to view the information of the different vaccination centers to achieve a correct immunization. The methodology was Scrum, allows prepared for change and to be able to adapt, as well as allowing proper planning for efficient work. The result obtained from the investigation can be seen in the sur-vey carried out on parents; where satisfactory percentages were obtained since 98% of respondents indicated that the use of a web application for the correct immunization of people is of the utmost importance, in addition to the survey they were shown the prototype of the application and indicated that its use was efficient, educational and easy to use for everyone.

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1. INTRODUCTION

This vaccination desertion is a problem that has been going on for several years, and the arrival of COVID-19 has caused this problem to increase, not only affecting the population but also vaccination establishments, since many of them these had to close temporarily [1]. In a study in Africa, it shows us how there was a decrease in the immunization of people and this due to COVID-19, since it reached 62% of incomplete immunization since there was an overload in health services and a large number of vaccination centers closed due to the measures taken by the state against the pandemic. In addition to adding to the fear of contagion that people have because in a survey conducted in Italy, 34% of respondents did not attend to apply the reinforcement of their vaccines for fear of contagion of COVID-19 [2]. On the other hand, before the pandemic there were 41% of children who did not receive the vaccine in their first year of life [3] and with the arrival of COVID-19, parents did not know how to act in this situation, and this is due to the lack of good guidance from health personnel. Since 46% of those surveyed indicated that they did not receive adequate information on what measures to take in the face of a pandemic in order to continue with the vaccination schedule [4].

In addition, another very common problem for the percentage of unvaccinated people to be high is that due to the pandemic, many families changed their place of residence, either because they were affected

by the decrease in employment, the closure of companies, or the fear of getting infected caused a large number of families to travel to their homes in the countryside. A clear case was in Venezuela where approximately 40,000 Venezuelan migrants had to return to their country in the midst of desperation due to lack of employment and not having the means to subsist [5]. Peru was no exception because a large number of people also sought refuge in their homes in the countryside, the bus terminals were crowded with people, the roads full of pedestrians who chose to escape to the countryside on foot and approximately 167,000 Peruvians filled out registers in their local governments in order to request help to be able to return to their homes [6]. This directly affected the immunization of people since when they changed their place of residence, they would also have to change the vaccination establishment for their children, and this had to be done through a long process where it made it more difficult to comply with the vaccination schedule of minors [7].

Even more so with the arrival of COVID-19, which was responsible for the increase in the percentage of non-compliance and delay in the vaccination schedule, and the results of an investigation show us that there was only approximately 60% compliance with the vaccination schedule [8]. This was not only due to the fear of contagion but also to the decrease in vaccination centers due to the measures adopted by the government in the face of the emergency caused by COVID-19; since there was approximately a 40% decrease in vaccination sites [6]. Research by Kurniawan *et al*. [7] show us how a health center improved thanks to the information services that they began to provide thanks to the use of a website where they processed the vaccine data and integrated information about the centers of vaccination. In the results obtained, it can be seen that various needs of the health center have been met, such as the processing of the personal data of the vaccinated people and the transparency of the information provided to the general public. In this same way, it is thought that the application for the correct use of the vaccination scheme will help not only minors [2], but also all people regardless of age, since it will be possible to provide information on the importance of each vaccine for human beings at each stage of our lives, in addition to avoiding the increase in vaccine-preventable diseases.

The objective of the research work is to efficiently carry out the immunization of children and adults through vaccination. Since by using the application they have access to relevant information about the importance of vaccination, such as knowing how vaccines work and what diseases are preventing by being immunized, secondary effects that could present, places of health establishments, and being able to organize the dates established for a correct immunization of both a minor and an adult. The research paper is organized as follows: section 1 contains the introduction, section 2 the literature review, section 3 the methodology, section 4 the case study, section 5 the results and discussions, and finally section 6 the conclusions.

2. LITERATURE REVIEW

The research work will focus on the study of a correct implementation of an application to control the scheduling of vaccines for children and adults, since this problem has been occurring for years, that a large number of children are not vaccinated in their first years of life. The problem increases when these children reach adulthood, since they do not comply with the indicated booster doses. This problem had an increase with the outbreak of COVID-19, since it caused the number of unvaccinated people to increase by a greater percentage compared to other years.

A problem for which a large part of children is not vaccinated is due to the lack of organization for the control of vaccination schedules by health centers, since in the results of an intense individual survey showed that one of the obstacles that compromise the lack of vaccination in minors is due to the lack of guidance on the part of health professionals [8]. Obtaining in its conclusions that by implementing the computerization of the vaccine card and specific strategies for disseminating the importance of vaccination. They will significantly help to increase the number of vaccinated minors.

In addition, the authors suggest that the solution for more minors to be vaccinated is not only to introduce the vaccination schedule; but to make fewer parents reject the vaccination of their children and to ensure that there is a correct implementation of the vaccination schedule in the first year of life, since its results show that a large number of parents of newborn babies refuse to start with vaccines and that approximately 41% of children do not receive the vaccine in their first year of life [9]. The author concludes that an adequate implementation and dissemination of the vaccination schedule in the first year of life will help parents of minors avoid not vaccinating their children over the years. In addition, Russo *et al*. [2], indicate that the COVID-19 outbreak was responsible for interrupting the vaccination of minors and that the percent-age of unvaccinated minors increased in this last year; and one of the reasons was the postponement of the vaccination by the parents, and this is known thanks to the results of the surveys on the vaccination of minors that they carried out among the families where 34% indicated that they did not attend the scheduled

date vaccination of their minors, for fear of contagion. In addition, in the results of the surveys, 46% of parents indicated that they did not receive enough information about the preventive measures that they should take in situations such as the COVID-19 pandemic. The author concludes that in the face of a pandemic, childhood vaccination can decrease even more, and that in order to prevent the vaccination of minors from being interrupted in another health emergency and the percentage of unvaccinated minors growing, awareness campaigns should be carried out on the safe and as important as it is to vaccinate their children to avoid the reappearance of diseases, strategies should also be implemented to promote the vaccination of minors.

Show us as a health center that did not have optimal data processing and vaccination programming for minors; it improved thanks to the information services that they began to provide thanks to the use of information technologies, such as a website where they processed the data on the vaccines and integrated a vaccination calendar for minors [7]. The results obtained, it is seen that several needs of the health center have been met, such as the processing of personal data of minors and the transparency of the information provided to the general public. Obtaining in its conclusions that for a better management of data regarding the immunization of minors, it is of great importance and helps the implementation of a website to provide information on the schedule of vaccinations for minors and the importance of these vaccines.

In addition, let us know that another very common problem so that the percentage of unvaccinated minors is high, is the forgetfulness on the part of the parents to take their children on their scheduled vaccination dates due to work and daily routines; since in its results it shows that the parents indicated that the reason why they did not vaccinate their children on time was the lack of knowledge about the vaccination calendar and forgetting the vaccination dates [10]. Therefore, it is concluded that the use of a vaccination reminder system for minors for parents would be of maximum help, since it would solve the problem of parents forgetting scheduled vaccination dates. Finally, the authors contributed different points of view on the problems that currently exist so that the percentage of vaccinated minors is so high, however, not all of them talk to us about the implementation of technology to solve these problems, but they continue to raise e implementing mechanical solutions for greater control in the vaccination of minors.

It is here where research work will try to solve these problems. Since by implementing an application to control the schedule of vaccinations for children and adults, help not only to optimize the management of vaccination data for minors. But also, to provide information to the general public, and to make notifications and reminders through emails about the upcoming dates of vaccines, since today we should take advantage of the increased use of technology in our daily lives.

3. METHOD

To carry out the work have used the Scrum method since it allows us to segment a project into blocks as can be seen in Figure 1. In order to develop a simple but functional product and improve it little by little. In addition, it allows us to be prepared and be able to adapt to any changes and thus continue to constantly improve the project.

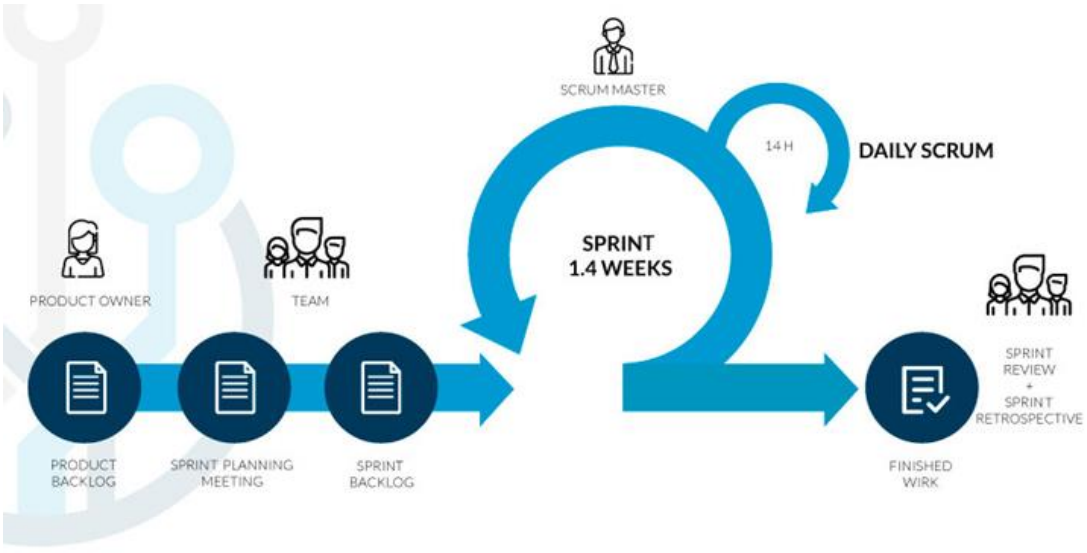

Figure 1. Scrum process

3.1. Scrum

The Scrum method is a process where the team works together in order to carry out a project in an agile, organized and successful way. Sprint planning is a meeting where the work team will plan the tasks to be carried out in the Sprint, where each member of the team is able to understand the objective of the Sprint to carry out a project with transparency. Where the team agrees on what is going to be done and how it is going to be done [11]. The implementation is where the Sprint begins to develop, which will last between 1 to 4 weeks, and there will be daily meetings of 10 to 15 minutes where feedback is given on what has been done so far and what will continue to be done [4]. Also, Sprint review, is a meeting where the review of the project increment is made, where the client will evaluate what was done during the Sprint and indicate if there are any changes [12]. Sprint retrospective is a meeting where the team members evaluate everything that has been advanced in the Sprint and the way in which that progress was made, in order to find improvements that can be made in the next Sprint, since this retrospective is the final event of the Sprint [13].

The 3 roles of the Scrum method: product owner is the person in charge of ensuring that the team constantly contrib-utes value to the business, the one who will collect and be clear about the customer's requirements [14]. The Scrum master is in charge of ensuring that the Scrum process is carried out cor-rectly, in addition to eliminating the obstacles that may arise during the Sprint [15]. The development teams are in charge of developing the application, they work together to meet the objectives outlined in the Sprint and thus at the end of the development cycle to be able to deliver a software increment [16]. The Scrum method uses two tools in its process. Product backlog are the requirements presented by the client, and the work team has ordered them by priority to be able to carry them out in the Sprints [17]. Sprint backlog is the list of tasks that the team has developed to meet the objectives that have been proposed in the Sprint [18].

3.2. Prototype tools

For the design of the application, chose to use Adobe XD. Which is a graphic editing tool used to create prototypes to show the user the interface of a web page or mobile application. The advantage of using this tool is that it allows us to make a pleasant design for the user and gives us the experience that the user would have when browsing the application [19].

3.3. Technological tools

Visual studio is an integrated development environment (IDE) that al-lows the creation of web applications [20]. It was decided to use this tool since it offers a wide variety of tools that allow programming in different programming languages such as C^{++}, Python, JavaScript, HTML5 [21]. Structured query language (SQL) server is a database management system, with which can manipulate the data that will be obtained when implementing the application [22]. This tool is used because it facilitates data management thanks to its powerful graphical environment. In addition to stability and security [23].

3.4. Case study

3.4.1. Sprint planning

– User stories

They are the requirements of the client, but that the product owner has converted into user stories. The backlog product allows prioritization the development team has a clearer idea of what they have to do for the development of the application. Table 1 shows the description of the user stories and the Sprint in which each user story will be developed.

Table 1. User stories

N°	Description	Sprint
1	H1: As a user, I want to see the information on the different vaccines to know the importance of immunization.	1
2	H2: As a user, I want to register or log in to the application in order to have access to the functions.	1
3	H3: As a user, I want to be able to reset my password to access my account again.	1
4	H4: As a user, I want to view the general immunization schedule.	1
5	H5: As a user, I want to register dates and doses of immunization.	2
6	H6: As a user, I want to view the list of locations of vaccination centers.	2
7	H7: As a user, I want to create an alert to have immunization reminders.	3

– Product backlog

Table 2 shows the list of requirements presented by the client, which the product owner has ordered by priority. In addition, the estimate that has been made jointly with the work team is also observed. The backlog product allows prioritization.

Table 2. Product backlog

N°	Estimate	Priority	Sprint
H1	3	Very high	1
H2	3	Very high	1
H8	8	High	3
H6	8	High	2
H7	13	High	3
H5	5	Medium	2
H3	3	Under	1

– Equipment speed

In Figure 2 it can be seen how the speed of the team has been increasing as each Sprint progressed. See that started with a speed of 12 points but finished with Sprint 3 with a speed of 21 points. It is important to set the speed taking into account the story points

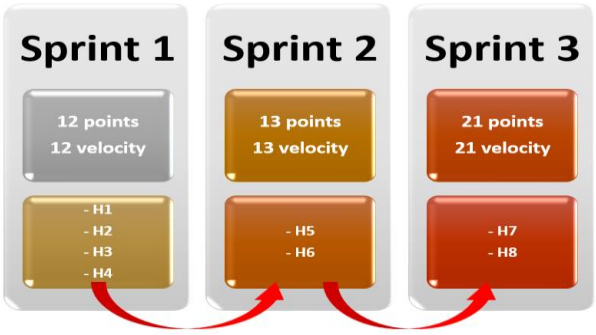

Figure 2. Equipment speed

3.4.2. System architecture

Figure 3 shows the general sequence of activities of the application. Where once the user enters the application, it will connect to the web server and the database. It can view the vaccines already received to date and the vaccines that are missing from the immunization schedule [24], [25].

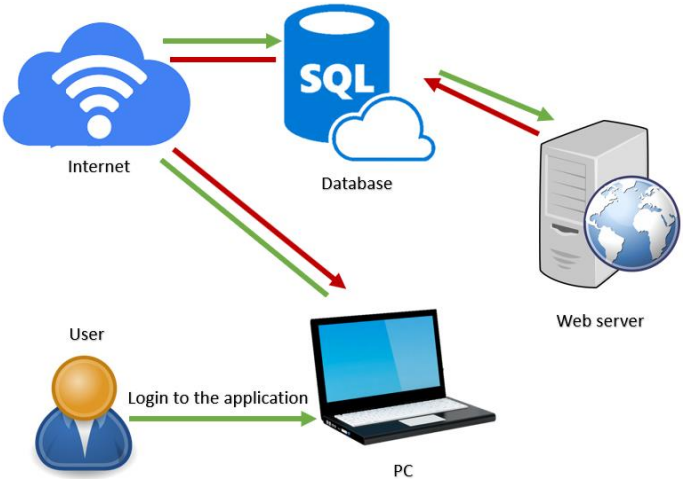

Figure 3. System architecture

3.4.3. Development

– Sprint 1

In this Sprint, user stories 1-4 are developed as shown in Table 1. First, the application's home screen is shown, where you can choose whether to log in or register as a new user. Next, in this Sprint, the

password change and password reset options are developed in case any problem has arisen and the user cannot enter the application. In addition to being able to visualize the general immunization scheme.

– Sprint 2

In this Sprint, user stories 5 and 6 are developed as shown in Table 1. Where the user can record the vaccines already completed, with the dose and date of immunization. At the same time, you can also view the list of locations of vaccination centers, according to a personalized search.

– Sprint 3

In this Sprint, user stories 7 and 8 are developed as shown in Table I. In order that the user can program an alert, in order to have immunization reminders for nearby dates. In addition, the user will see the list of incomplete vaccines, in order to reschedule the immunization.

4. RESULTS AND DISCUSSION

4.1. About the prototype

– Sprint 1

Started Sprint 1 with the creation of the application's home page, where the user will see information on the different vaccines, in addition to being able to log in or register as shown in Figure 4. Next, the login form was created or, otherwise, the user will be able to register if it is their first time in the application, as shown in Figure 5. To finish Sprint 1, the general vaccination scheme was developed as shown in Figure 6. Where the user can select the vaccine, they want to see detailed information, in addition to being able to register if they have already complied with the vaccine and the date of that immunization or otherwise record non-immunized vaccine.

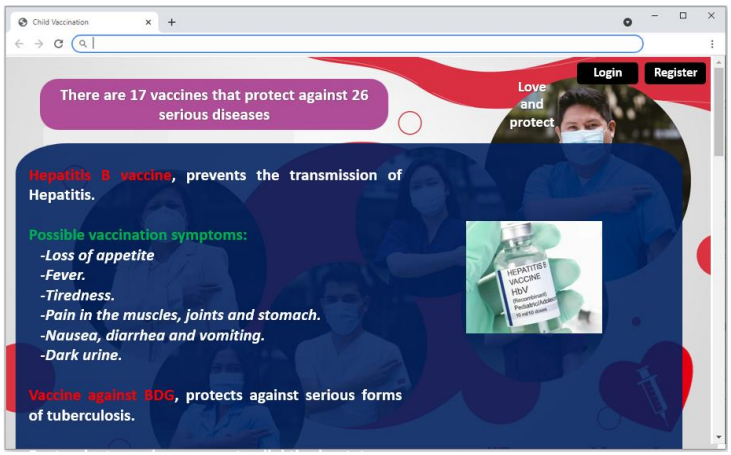

Figure 4. Application initial screen

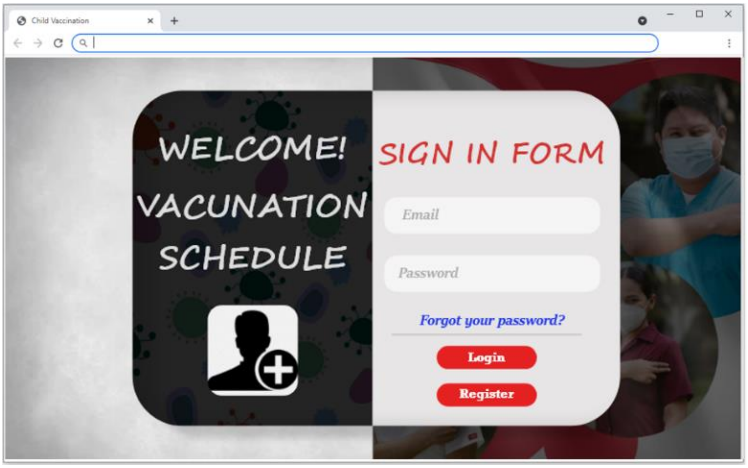

Figure 5. Login form

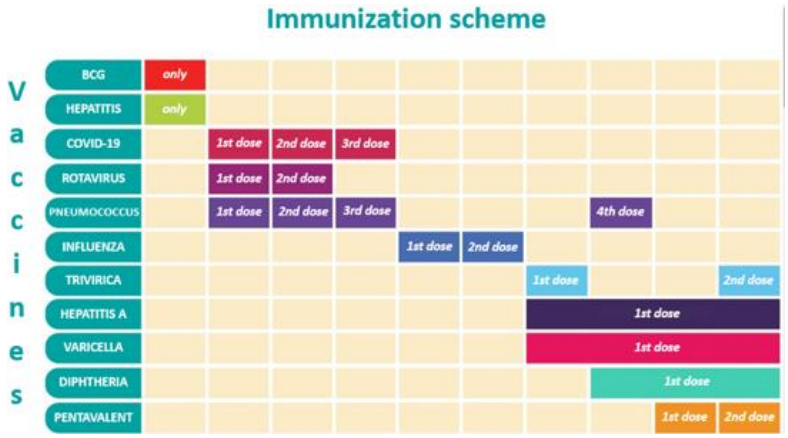

Figure 6. Scheme of immunization

– Sprint 2

Start Sprint 2, with the completion of the registration form of completed vaccines, with detailed information such as dose completed and vaccination date as shown in Figure 7. All the registered vaccines will be stored in the database, for later carry out the respective queries as shown in Figure 8. Next, the prototype for searching for vaccination establishments was carried out, shown in Figure 9. In order for the user to access information on the establishment for their immunization.

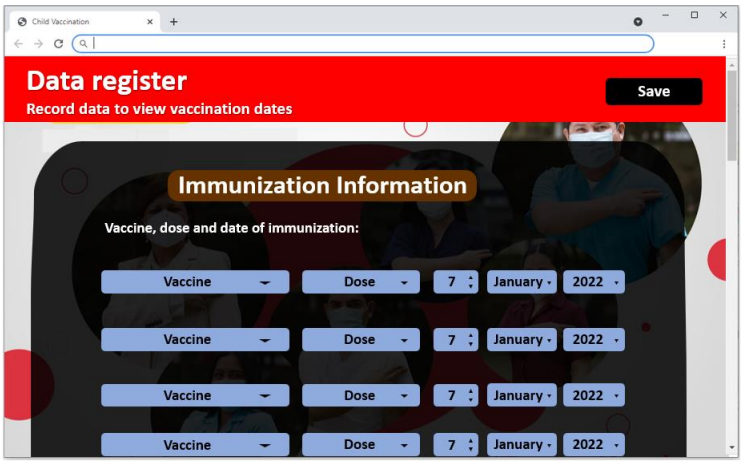

Figure 7. Immunization record

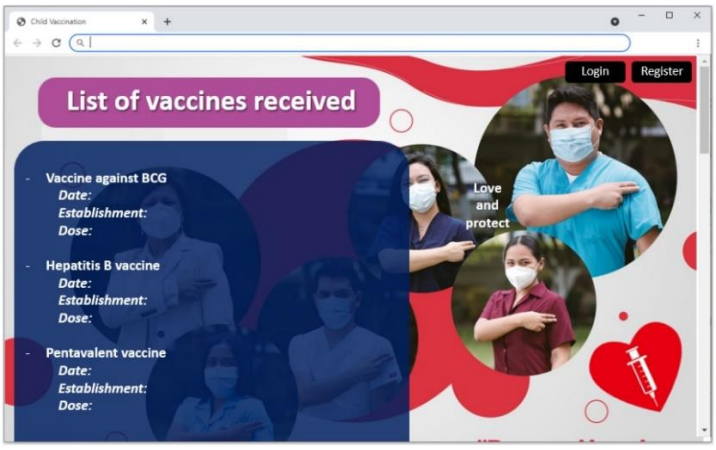

Figure 8. List of vaccinations received

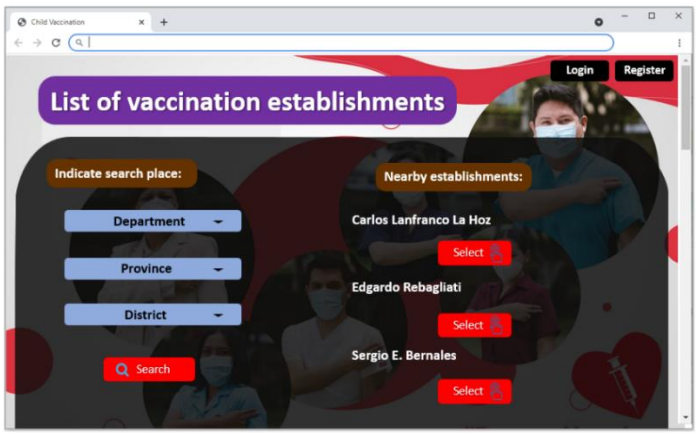

Figure 9. Search for vaccination centers

– Sprint 3

In the same way as the list of vaccines received can be viewed, can also view the list of vaccines not received with the option of creating an alert as shown in Figure 10. Once the "setup alert" option in Figure 10 is selected, can add the alerts want, so that the application makes reminders either days before or weeks before the immunization date, as can be seen in Figure 11. Finally, the user will be able to reschedule any date of an immunization that could not be met, or that will not be met, as shown in Figure 12.

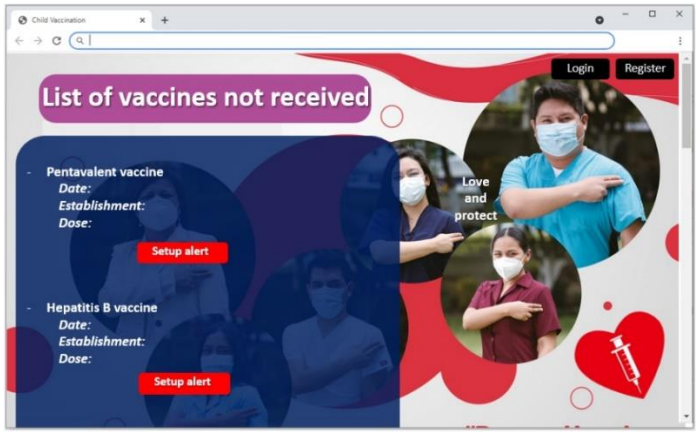

Figure 10. List of vaccines not received

Figure 11. Reating immunization alerts

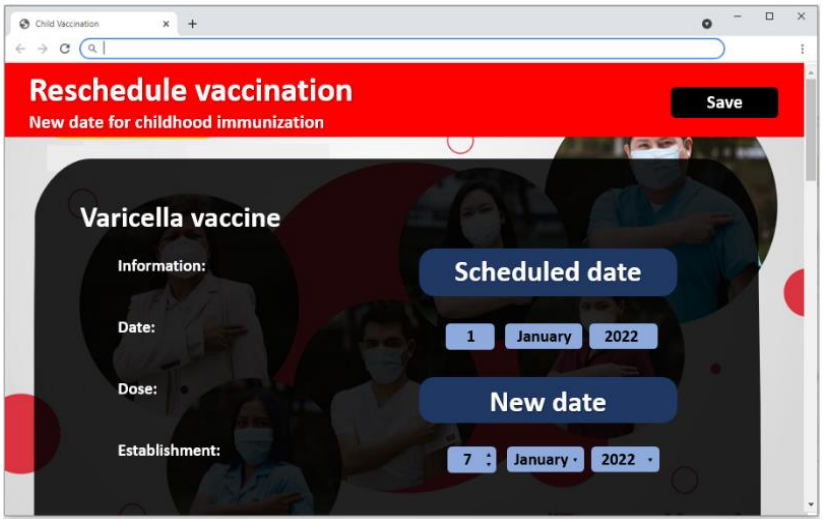

Figure 12. Schedule new immunization date

4.2. About the survey

In order to carry out an analysis of the satisfaction of the users of the application. A survey of 8 questions was carried out to parents, where the parents read the questions, visualize the prototype of the application and answer according to their opinion. More on each question asked in the survey will be detailed below. The survey begins by showing the prototype of the vaccine information screen application, which can be seen in Figure 4, so that the user observes the information on the vaccines that will be displayed in the application, and indicates in the alternatives if they agree or not, of the importance that this information has in the application, and according to Figure 13, it is shown that 89% of parents indicate that they totally agree.

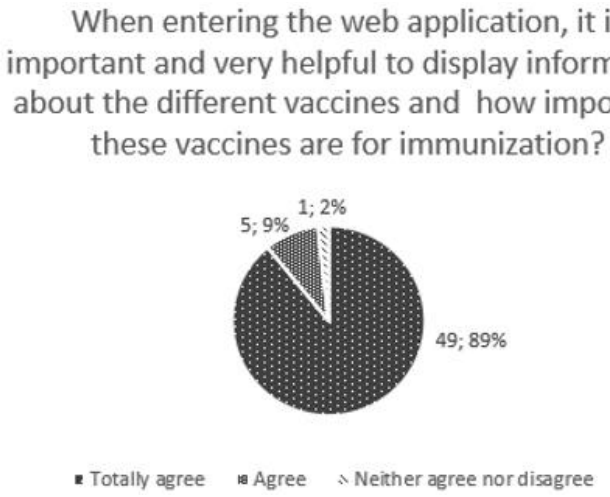

Figure 13. About the content of the application

The next question of the survey dealt with the efficiency of being able to indicate the place where you want to search for vaccination establishments. Thus, avoid setbacks in the search among so many health establishments that exist. Figure 14 can see that 80% of parents indicated that they totally agree with the application having this function.

In addition, the survey asked if they agree that the use of the web application is efficient. Where practically 100% of parents indicated that they totally agree, since according to Figure 15. It can be seen that 98% totally agree, and 2% agree. Finally, it was asked if the application is consistent, clear and simple when using it and is understandable at a glance; in order to check the degree of satisfaction of parents when using the application. As shown in Figure 16, 96% strongly agree that the app is clear and simple.

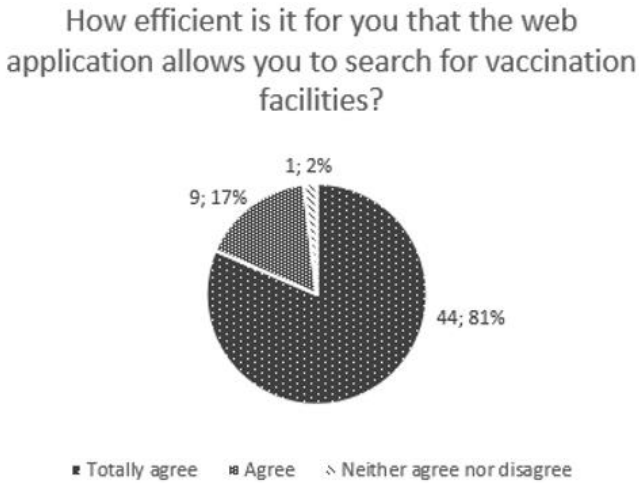

Figure 14. On the efficiency of searching for a vaccination establishment

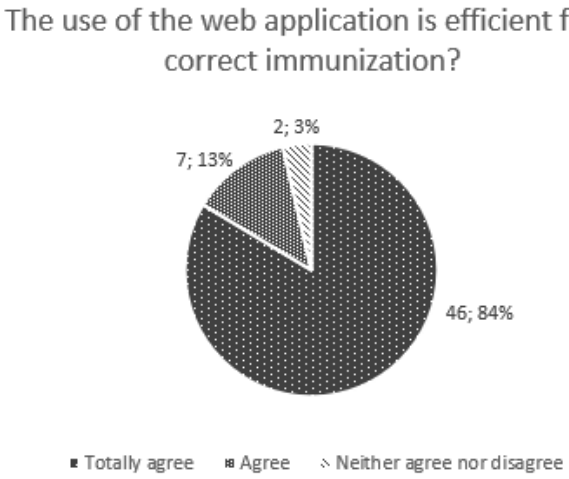

Figure 15. On efficiency of the web application

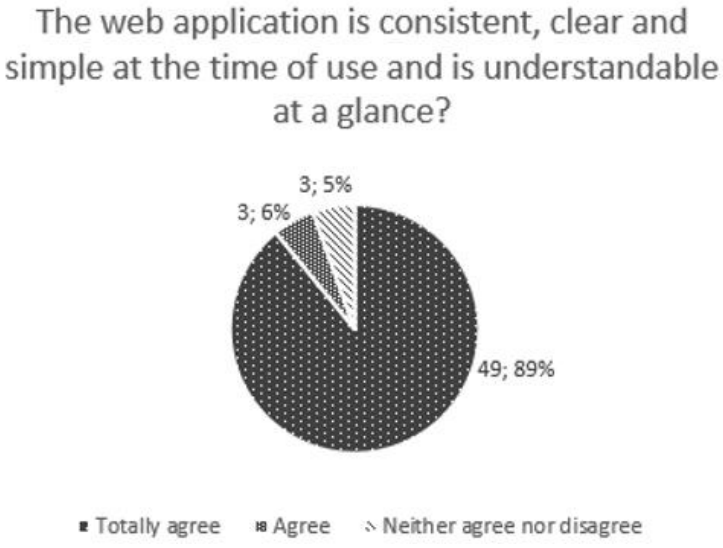

Figure 16. On the clarity and simplicity of the application

5. CONCLUSION

With the satisfactory results of the survey carried out, it is concluded that the implementation of the application will meet the proposed objectives, since the vast majority of parents surveyed indicate that they fully agree on the functions of the application, since apart from providing information on immunizations, the application will help to provide more facilities to the father at the time of being able to schedule immunization reminders, be able to view immunization centers and reschedule vaccines not received. Since with the change of residence that many parents had to make due to unemployment and the fear caused by COVID-19, where many families took refuge in the countryside and in rural areas; and this caused the immunization to decrease. But with the use of the application, this problem will be solved, since the parents will avoid going through all that long and difficult process that had to be done before using the application. And for a correct execution of the application, the Scrum method was used, which greatly helped and facilitated all the work, since thanks to this methodology the requirements that the population needed were met. In addition to the fact that the entire team of work was prepared for the changes that arose during the project, and thus be able to adapt to any situation, thanks to constant communication throughout the project. A great inconvenience and limitation for carrying out the work was the difficulty of gathering information on the requirements for the users of the application, since due to COVID-19 it became more difficult to take surveys of the public. It is recommended that for future work the web application be associated with the information registered in the database of the immunization centers, in order to add new functionalities such as stock of vaccines, separate appointments through the application, changes of health establishments in case there is a change of residence. With this, the web application would be much more complete and there would be a more efficient vaccination management.

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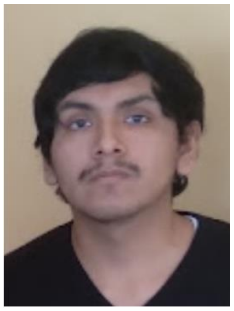

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