Mobile App Design: Logging and Diagnostics of Respiratory Diseases

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***Abstract*—Over the years, a wide variety of respiratory diseases have caused a high mortality rate throughout the world. This was again observed with the appearance of the pandemic, COVID-19. In addition, the most affected are people living in extreme poverty. The objective is design a mobile health application for the registration and diagnosis of respiratory diseases. For this, the RUP methodology was applied, because it easily adapts to various types of projects. Its use, together with the UML process development software, allows the analysis, implementation and documentation of object oriented systems. For validation, a user survey was carried out and the questionnaire was based on the dimensions of functionality, efficiency, effectiveness and satisfaction. Obtaining as a result a positive qualification to the design of the application and its acceptance due to the reduction in the time to obtain the diagnosis. In conclusion, a mobile health application design was successfully carried out so that patients can register and have the diagnosis of respiratory diseases from the comfort of their home.**

***Keywords*—Mobile app; Covid-19; diagnosis; respiratory diseases; RUP methodology**

I. Introduction

In the world there are a large number of diseases of varying degrees of danger that affect the respiratory system. From 2020 to the present, COVID-19 caused by the SARS-CoV-2 [1], virus is characterized by symptoms similar to those of a common cold. As it progresses, it causes multi-organ damage, including respiratory distress [2]. Therefore, this pandemic has generated a high rate of morbidity and mortality worldwide. The people most likely to have a fatal prognosis are those who present pre-existing diseases to contagion, so they are classified as a high-risk group. The most vulnerable people are the poorest people [3].

Another disease that strongly affected Latin America is influenza. This was observed in the research [4], where the author compared information from 10 countries (Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama, Ecuador, Brazil, Argentina and Chile). The data analyzed were influenza A subtypes H1N1, H1N1pdm09, and H3N2, influenza B subtypes Victoria and Yamagata, and non-subtypes of both types. The results showed that of the 37,087 cases reported between the years 2004-2012, the most predominant was type A influenza.

On the other hand, the investigation [5], was carried out in Peru, between the years 2011 and 2016 due to the large number of deaths caused by acute respiratory infections (ARI). The purpose of this study was to make known which were the most affected departments. For this, geographic information systems were used. From there, information was obtained on the existing conditions in those areas. The findings showed the various factors that caused the disease in Peruvian children under 5 years of age.

Thus, currently going through the global pandemic, COVID-19, people have become more aware of health care [6]. This situation allowed mobile healthcare applications to expand and evolve faster and stronger. The development of smart mobile health applications allow improving the effectiveness and efficiency of various processes. The use of monitoring features, appointment booking scheduling, self-diagnosis, emergency care and home visit received a positive response from users. Given these results, the RUP methodology was used in the software development process because it provides techniques that team members must follow in order to increase their productivity and generate a high-quality product.

In this context, the present work objective to design the prototype of a mobile health application that presents characteristics of remote registration and diagnosis through a questionnaire of symptoms. Being these relevant factors to avoid the prolonged time of exposure to various pathogens that further complicate their clinical picture. Therefore, its importance lies in improving the effectiveness and efficiency of the registration control processes and patient care [7].

Finally, the structure of the work is broken down into six sections. Section II explains the review of the literature, section III the methodology, section IV the results, section V discussions, and finally section VI the conclusions and future work.

II. Literature Review

This section focuses on analyzing the different investigations related to this research work, finding its results and conclusions.

A. Background

COVID-19 appeared in Wuhan, China and is caused by the SARS-CoV-2 virus. This strain that infects humans became a pandemic due to its easy transmission. Reason that caused a high rate of sick and dead around the world. The studies carried out showed that the greatest number of deceased were

elderly people and those who had pre-existing diseases. Little by little, the specialists were documenting information about this lethal disease and sharing it with the rest of the countries in order to find a solution. In addition, the most reputable web platforms around the world were very important in order to obtain real-time statistics on reported cases [8]

The rapid increase in cases of the global COVID-19 pandemic was due to the fact that doctors in this country initially had great difficulty in identifying infected people. This highly contagious disease is characterized by causing acute respiratory distress syndrome. Therefore, in case of presenting some other disease, the mortality rate increases [9].

In Peru, the MINSA website reports data about the population and Covid-19, such as the number of positive cases, numbers of hospitalized, deceased and vaccinated, number of people who underwent antigen and rapid tests. This information is found segmented by departments of the country and months, but general statistics are also found [10].

B. Related Work

The Rational Unified Process (RUP) [11] methodology can simplify the process of analysis and design of information systems, but of course, each method will have its advantages and disadvantages in certain situations and conditions. Using the RUP method you can accept changes to improve existing prototypes so that they can produce an acceptable system, and the changes that occur are considered as part of the development process itself.

This research [12] explains that mobile applications, by integrating medical records electronically into the health record system of hospitals, facilitate the management of medical treatments and interventions. The application made for the local hospital Sidi Said located in Meknès - Morocco resulted in a high rate of approval by patients by obtaining positive results in improving their health by monitoring their illnesses at home and by the patients. doctors, who with timely information could make better health decisions.

Today there are various techniques applied in desktop, web and mobile environments; which facilitate the human being to carry out a series of processes according to the author [13]. In this sense, the use of technologies for the diagnosis of respiratory diseases becomes a very favorable process when a chatbot is used together with a mobile application because it allows more accurate results.

Artificial intelligence (AI) occurs in different contexts such as industry, biology, computer science in order to give solutions. It has been widely demonstrated that in order to make this tool highly effective, the knowledge of expert professionals is required. According to [14] this entered information is contrasted with the data entered by those people who present symptoms of respiratory diseases. Using the information provided by experts increases the accuracy of the result that indicates the diagnosis of respiratory diseases presented by the individual.

The author's research [15] focuses on pneumonia; respiratory infection resulting in inflammation of the lungs. The causes of this respiratory disease can be attributed to viruses, bacteria or fungi. Rural people in developing countries have limited access to doctors, medical diagnostic centers, and hospitals. Therefore, for this article, a smartphone-based app for preliminary detection of pneumonia using X-ray images was designed and developed. The app was developed in Android Studio and incorporated the Tensor Flow library.

The mobile technology model proposed by the author [16], for online ambulatory health care information, uses a cloud platform. The model consisted of four phases: 1) The selection of structured data; 2) The integration and storage of data in a cloud database; 3) Real-time data testing using a data analytics service; 4) The results of the pharmacological consultation are displayed through a mobile application and the geolocation service can determine the closest pharmacies to the current location of the patient.

In summary, different research works were compared and it was observed that the authors focus on the development of mobile applications for the health sector with attributes such as functionality, quality and design. However, no reference is made to existing integration problems in the health system, which makes it difficult to obtain information from all health centers in the country.

III. Methodology

For the development of the application, the analysis of various methodologies was contemplated; According to [17] the development of good software depends on the use of adequate methodologies that allow compliance with existing standards for this type of project. This section explained the methodology, as well as the tools used in the development of a mobile application to improve the registration and diagnosis of patients with respiratory diseases in Lima-Peru. Its uses are due to the fact that they help in reaching objects in an agile way.

The methodology that served as a guide for the development of the project was the Rational Unified Process (RUP) methodology, according to [18] it allows adjusting various components and repeating phases of the cycle as many times as necessary until the software meets the requirements and objectives. Among the functions it offers are the assignment of tasks and responsibilities within the company to guarantee the production of high-quality software.

The development of the mobile application was carried out in Android Studio, according to [19], the integrated development environment (IDE) was introduced in the years of 2013 and is based on IntelliJ. What makes it a powerful code editor is that it provides built-in services and allows for a wide variety of customization options for Android app development.

SQL Server was used as a database manager as a knowledge base in which the user interacts in order to manage possible diagnoses based on the questions asked in the mobile application, according to [20] the importance of Database security is something that has to be considered in projects, giving as an example basic database security guidelines.

A. RUP

The methodology called Rational Unified Process (RUP), was applied with the purpose of creating high quality software. This agile methodology allows developing projects on a small

and large scale, since it adapts to the needs of different types of projects, especially in the use of each role. Additionally, it can also be used in projects that require reengineering [21].

1) RUP Life Cycle: Fig. 1 shows the life cycle of the RUP methodology where spiral development is implemented according to [22]. In the life cycle, tasks are performed in four stages or phases where a variable number of iterations occur. The first few iterations (during the Inception and Discovery phases) focus on understanding the problem and the technology, defining the scope of the project, eliminating critical risks, and establishing a baseline.

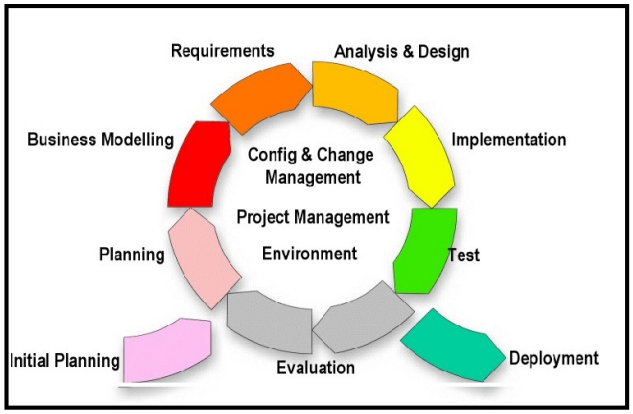


Fig. 1. RUP Life Cycle.

2) Phases of the RUP Methodology: The RUP methodology it is divided into four phases: Introduction, which defines the business case and scope of the project, identifies the most important use cases for the system and the stakeholders that interact with the system; in the development phase, an architectural prototype is built, which ensures minimizing risks and loss of information; construction phase to add functionality to the system; and the purpose of the transition phase is to deliver the system to the end users and make the appropriate adjustments or improvements, since failures often occur during testing [23].

3) Key Principles of the RUP: The RUP is based on 6 key principles; adapt to the process, maintain the balance of priorities, demonstrate value iteratively, allow collaboration between teams, focus on quality and raise the level of abstraction [24].

B. Tools and Programming Language to Develop the Prototype

This segment detailed the tools to be used to develop the prototype of the mobile application focused on improving the registration and diagnosis of respiratory diseases caused by Covid-19, as well as the programming languages to be used and the database.

1) Mockplus: The fabrication of the prototype was carried out in Mockplus [25], a tool that facilitates the creation of prototypes. It makes design faster, smarter and easier. It is integrated with more than 100 components with which any software prototype for mobile, web and desktop applications can be designed. Also, you can work online and offline on Windows PC.

2) Android Studio: Android Studio is an environment integrated development (IDE) that has a large number of methods and access to components that allows you to develop applications on Android. According to [26], this powerful code editor based on IntelliJ IDEA has a wide variety of development tools and offers various productivity functions.

3) Java: For the development of this application, the Java programming language because it is compatible with Android Studio. According to [27], this high-level programming language allows developers to write more robust, secure and stable code. It is widely used by programmers because it is a high performance, dynamic, simple and easy to understand language. In addition, it provides great advantages such as improving the efficiency of programming and the practicality of the software.

4) SQL Server: The Microsoft SQL Server tool (MSSQL) that allows you to store and manage the confidential data of both people and companies is regularly updated. This relational database manager is used by many users because it adapts correctly to various development platforms, such as .NET [28]. Additionally, according to [29] Android Studio with the Java language together with the SQL Server database. The integration of these technological tools allows the company's objectives to be achieved because it contributes to the improvement of processes where it is necessary to manage large volumes of data.

IV. Case Study

A. Development of the methodology

Based on what was mentioned above and the procedures that were detailed, an Android application based on registering and diagnosing people who present symptoms of respiratory diseases will be implemented.

1) Start Phase: This section defines the scope of the project with the clients, the risks associated with the project are identified, the plan of the phases and the subsequent iteration are drawn up, the software architecture is also detailed in a general way.

Definition of the Scope of the Project with the Clients:

To know the existing needs, the interview was used as a data collection instrument. The information obtained can be seen below:

- Patient: Let it be a mobile application to have quick access to registration and notifications in case of rescheduling of a medical appointment.
- Receptionist: Display the dates, hours and specialties of the doctors, taking into account the limit number of visits per shift and the shift changes made.
- Doctor: That the application be interactive with patients so that they can improve the diagnostic process.

Table I shows the methodologies and the platform used for the development of the project.

TABLE I. METHODOLOGY AND PLATFORM FOR DEVELOPMENT

N°	Description
1	Methodology learned in the university journey
2	Methodology used to date in various companies
3	Applied in small and large scale projects

2) Elaboration Phase: At this stage, define the requirements and is where a preliminary solution is designed, use cases are selected to define the underlying system architecture, and the first domain analysis is performed.

Definition and Determination of Requirements: After collecting the information from the business actors, the most relevant requirements for the development of the project are determined.

Table II mentions the functions that the system will present.

TABLE II. FUNTIONAL REQUIREMENTS

Code	Description
RF01	Enter the app
RF02	user management
RF03	Log management and diagnosis

Process Use Cases Table III lists the people who participate in the process related to the system access use case and the actions they should perform.

Table IV mentions the people who participate in the process related to the registry and diagnosis management use case and the actions that they must carry out.

Fig. 2 shows how the different parts of the system interact with each other in order to carry out a task, and the order in which the interactions are performed when executing a specific use case.

Table V shows the table based on the sequence model where the tasks to be performed by the system are mentioned.

3) Database Construction Phase: the basis of The aforementioned data was designed based on a rigorous analysis of the requirements that were obtained from the interviews with the different users, including doctors, patients and the receptionist. Observing the database from all perspectives will help avoid errors.

TABLE III. LOGIN USE CASE DIAGRAM

Use cases	Use cases
Actor	Doctor, Patient and Admission
Description	Each actor must enter the system, entering their username and corresponding password.
Preconditions	The staff requests user registration from the administrator.

TABLE IV. LOG MANAGEMENT AND DIAGNOSIS

Use cases	Log management and diagnosis
Actor	Doctor
Description	The medical actor will fill out the diagnostic questionnaire for respiratory diseases
Preconditions	The staff must have the role of doctor

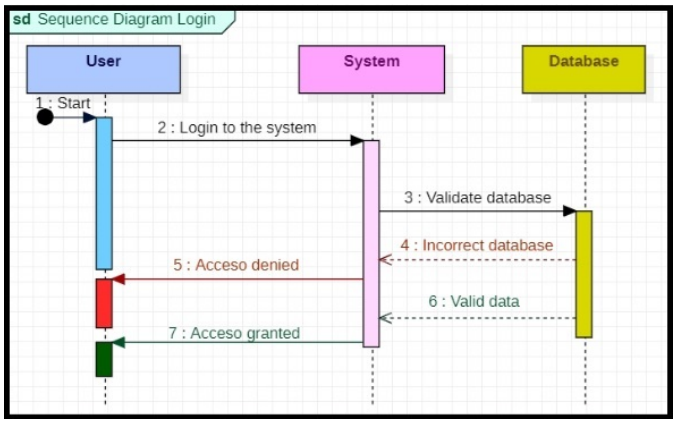


Fig. 2. Sequence Diagram Model.

TABLE V. SEQUENCE DIAGRAM MODEL

Code	Description
MDS01	Enter the app
MDS02	user management
MDS03	Log management and diagnosis
MDS04	care management

Fig. 3 shows the schema of the database in which the various tables and the relationships between different entities of the system are shown.

4) Construction Phase: The function of this phase is complete system functionality, clarify outstanding requirements, manage changes accordinglyo the evaluations made by the users, and improvements are made for the project.

In Fig. 4(a) you can see the login, which is where the user and password are validated to start the session and in Fig. 4(b) the home screen is shown in which there is a layer that is used to receive notifications, a section with information related to the respiratory system, a section for locating the closest hospitals to your location and an icon to display the menu.

In Fig. 5(a) the options menu is displayed to access the COVID-19 survey, survey history and profile interfaces and in Fig. 5(b) the Covid-19 prediction interface is observed where The symptoms presented by the patient are selected and saved.

In Fig. 6(a) is the interface where it is shown the graph of the probability of presenting a respiratory disease, below the recommendations and then options to communicate with a health personnel and in Fig. 6(b) the survey history details all the times the survey has been carried out, the disease detected, the date, state and probability percentage.

In Fig. 7(a) the user profile is presented, consisting of the photo, full name and role of the user, followed by icons of social networks with which it can be linked, under general vision options, settings and change of password and in Fig. 7(b) you can see the option to change the password displayed where you must enter the current password, the new one, repeat the new one and press the button to change the password for this to be done.

In Fig. 8 you can see the option to disconnect that allows

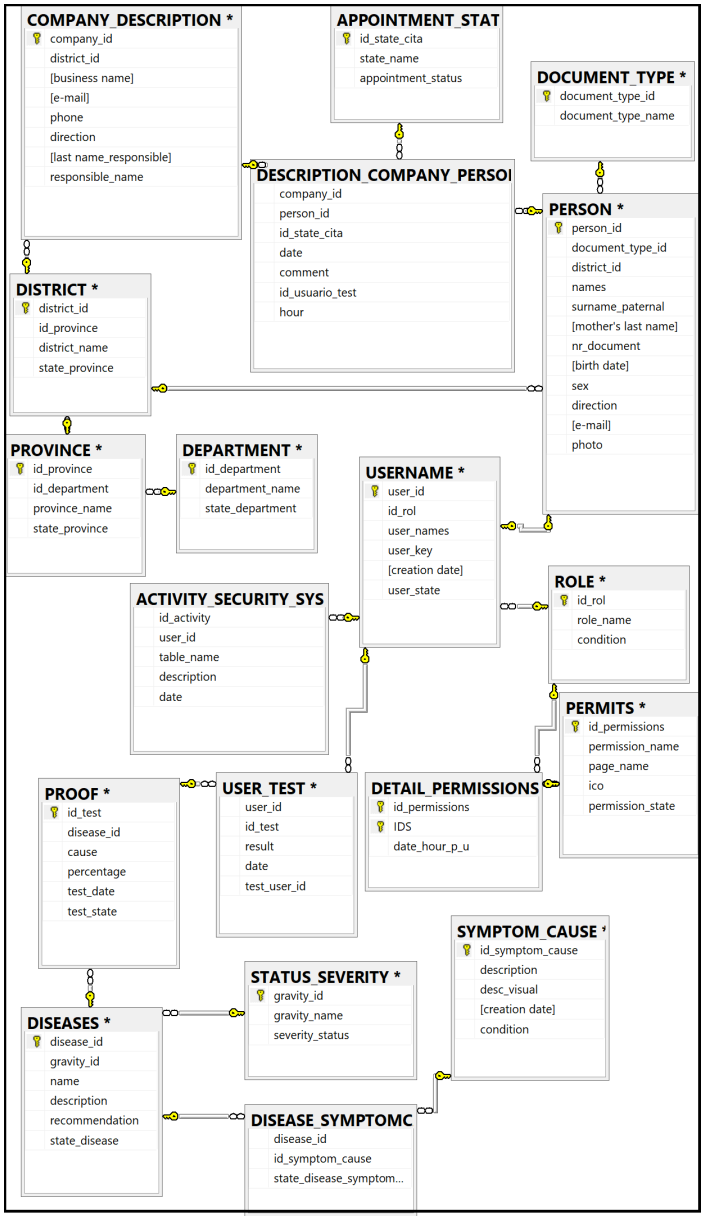


Fig. 3. Database.

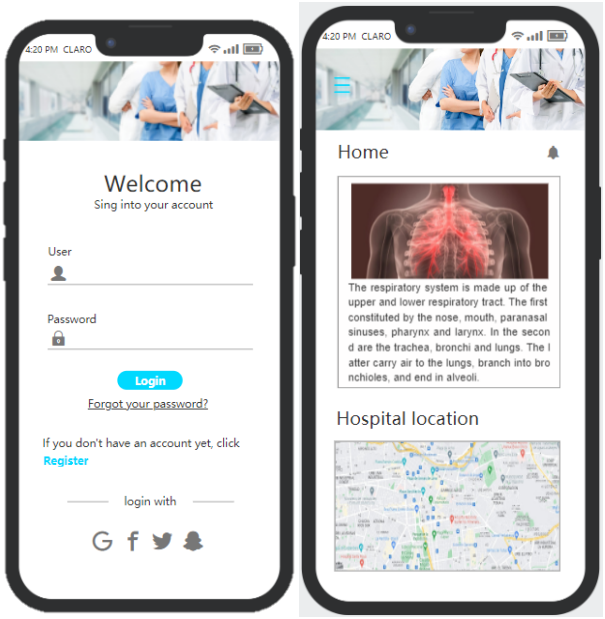
you to exit the session, which will redirect the user to the login view.

5) Transition Phase: In this phase, the purpose is ensure that the software is available to end users, correct errors and defects found in acceptance tests, train users and provide the necessary support.

V. Results

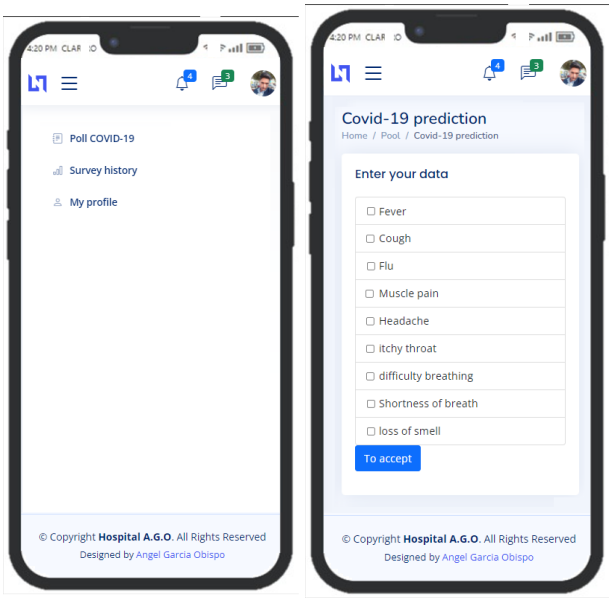
A. According to the Prototype

Fig. 4 presented the login and home modules. The first module allows entry to the session after verifying that the entered user has been previously registered; in addition, the password must correspond to said user; this is done for security reasons. Fig. 5 presented the menu of options offered by the application and the prediction of Covid-19. In the latter, the



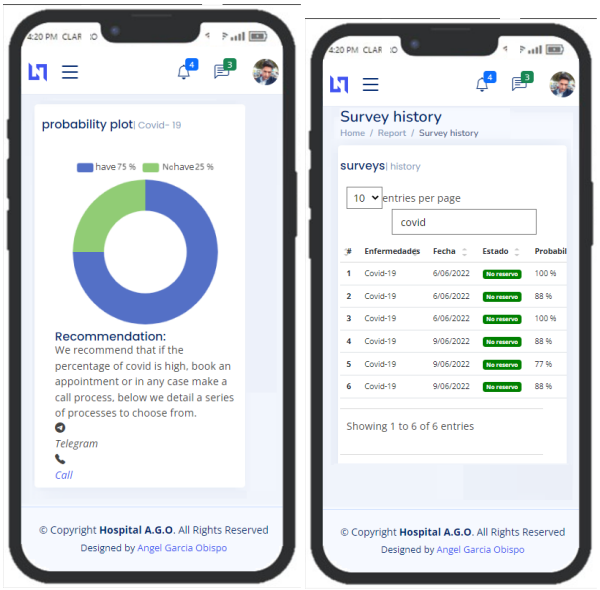
(a) HU-07 (b) HU-08

Fig. 4. Login and Home Prototype.



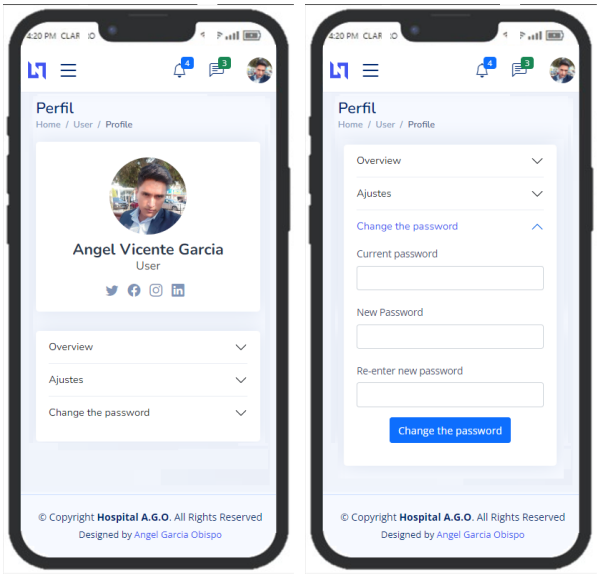
(a) HU-09 (b) HU-10

Fig. 5. Menu and Prediction of Covid-19.



(a) HU-11 (b) HU-12

Fig. 6. Probability of Covid-19 and Survey History.



(a) HU-13 (b) HU-14

Fig. 7. Profile and Password Change.

user selects the symptoms that they present and when pressing the To accept button, Fig. 6 will show the probability that a person has of have Covid-19 according to the information entered and the survey history where it is recorded each time the symptom survey has been carried out. On the other hand, Fig. 7 presented the profile and password change modules and finally in Fig. 8 the option to disconnect was presented, which allows to exit the session correctly.

1) The Results According to the Dimensions: What research method the survey technique was used to know the

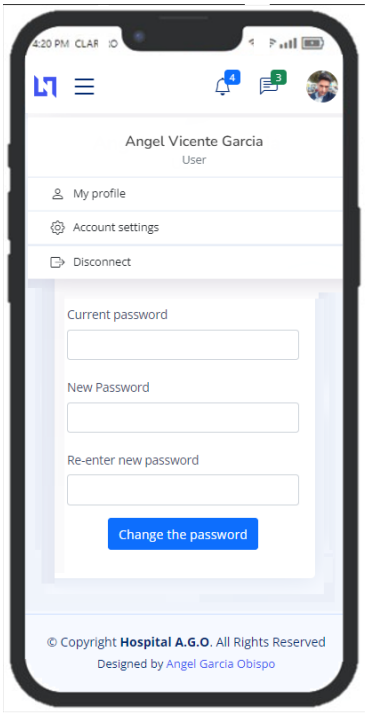


Fig. 8. Disconnect.

TABLE VI. ACCORDING TO THE SURVEY

Dimension	N°	Question
Functionality	P01	Do all the filling fields allow to enter the data correctly?
Functionality	P02	Do all the buttons work correctly?
Functionality	P03	Is the data saved correctly?
Functionality	P04	Does the application correctly show you the closest hospitals to the area where you are?
Functionality	P05	Does the signs and symptoms questionnaire allow multiple selections?
Effectiveness	P06	Do you perceive any slowness in the use of the application?
Effectiveness	P07	Does the result shown by the application correspond to the diagnosis given by your doctor?
Effectiveness	P08	Should the questionnaire be updated depending on whether new symptoms are found?
Efficiency	P09	¿La navegación es fácil e intuitiva?
Efficiency	P10	Does it take time to display the results or give an answer?
Efficiency	P11	Are all the functions of the application easily accessible?
Efficiency	P12	Did the application allow you to obtain a diagnosis quickly?
Satisfaction	P13	The results obtained that were evaluated with the doctor. Did I demonstrate the effectiveness of the application?
Satisfaction	P14	Do you feel that the application is user friendly?
Satisfaction	P15	Are you satisfied with the questionnaire?

opinion of users (patients, doctors and other users) about the application. To do this, 15 questions were asked that are grouped into four dimensions as shown in Table VI.

2) About the Survey: Upon completion of the user survey, it was possible to obtain 51 answers that allowed generating Table VII. It shows in detail the results obtained in the

response options yes, regularly and no presented by each of the questions asked. In Fig. 9, the results obtained in each of the dimensions are presented graphically according to the response options.

TABLE VII. RESULT OF EACH QUESTION IN PERCENTAGE

Dimension	Numero pregunta	Si	Regularmente	No
Satisfaction	P13	41%	39%	20%
	P14	100%	0%	0%
	P15	20%	78%	2%
Funcionalidad	P01	100%	0%	0%
	P02	100%	0%	0%
	P03	100%	0%	0%
	P04	41%	59%	0%
	P05	80%	0%	20%
Eficacia	P06	2%	59%	39%
	P07	59%	41%	0%
	P08	100%	0%	0%
Eficiencia	P10	2%	59%	39%
	P11	61%	39%	0%
	P12	22%	78%	0%
	P09	100%	0%	0%

The measurement of the scale was made based on 1 which denotes a high approval of the application, 2 denotes a medium approval of the application and 3 denotes a low approval of the application.

3) Phase of Assigning Scores to Securities: In this phase its purpose is to assign a range of values to the answers of the questions in order to know if the application meets the needs of the users. These will be in accordance with the assigned dimensions in order not to neglect the answers obtained. The score to be taken into consideration is found in Table VIII.

4) Assignment of Scale Indicators: In this phase its purpose is to define the percentage of the validity of each question with the sole purpose of obtaining a better validity of the program. Table IX serves to determine the scale in which the application is found.

5) About Data Analysis with SPSS: Next the graphs obtained from SPSS are detailed.

In Table X it is observed the Frequency percentage of each question and answer.

About the Chart Fig. 9 details the graph obtained based on the results obtained, favoring the implementation of the program, hoping that the survey obtained is the most appropriate to obtain the result.

TABLE VIII. ASSIGNMENT OF SCORES TO SECURITIES

Puntaje	Descripcion
1	Si
2	Regular
3	No

TABLE IX. ASSIGNMENT OF INDICATORS TO SCALES

Escala de porcentaje	Descripcion
1% al 30%	Bajo
31% al 60%	Regular
61% al 100%	Bueno

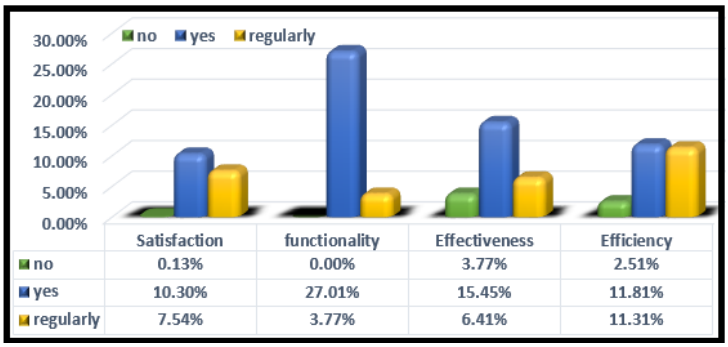


Fig. 9. Result in Percentage.

TABLE X. FREQUENCY PERCENTAGE OF EACH QUESTION AND ANSWER

Question	Response	Frecuencia	Porcentaje	% válido
P01	yes	11	100	100
P02	yes	11	100	100
P03	yes	11	100	100
P04	yes	5	45	45
	not	6	55	55
P05	yes	9	82	82
	regularity	2	18	18
P06	yes	2	18	18
	regularity	4	36	36
	not	5	45	45
P07	yes	5	45	45
	not	6	55	55
P08	yes	11	100	100
P09	yes	11	100	100
P10	yes	2	18	18
	regularity	4	36	36
	not	5	45	45
P11	yes	7	64	64
	not	4	36	36
P12	yes	4	36	36
	not	7	64	64
P13	yes	6	55	55
	not	5	45	45
P14	yes	11	100	100
P15	yes	2	18	18
	regularity	2	18	18
	not	7	64	64

B. About the Methodology

The selection of the methodology used in this research work was made after making a detailed comparison with each of them. Due to the qualities found and based on the nature of the project, the RUP methodology was chosen. The reasons why it stood out from the others is that despite being structured, it is also flexible and because it allows tests to be applied in the various phases of software development, which guarantees the delivery of a quality product.In the option of choosing between the Rup and Scum methodology, Rup was chosen since it was adapted to the research carried out; since Scrum works with sprint and finished product adapting to change, instead Rup allowed to work with the identification of functional requirements that are modeled through prototype design. It also allowed to make the documentation for each stage.

VI. DISCUSSIONS

The analysis of the literature review [11] allowed us to compare the RUP methodology against other software development methodologies, in order to use the best option

for the present work. From here, the RUP methodology could be identified as the best alternative due to its adaptability. On the other hand, in the investigation carried out, a series of findings were found due to the survey carried out where 79 percent were satisfied, coinciding with the author [30], regarding the use of a tool for detecting respiratory diseases in mobile phones, notwithstanding the research carried out by the author [14], it is very different since they used an interview looking at the opinion of the users involved. Regarding the prototype, the author [31], coupled the topic of a prototype on a web page and compare it with the research carried out, not having a coincidence since it limits us to only web prototypes without the use of an expert system. According to the efficiency results obtained, it agrees with the author [16], in that there isa fast response when displaying the results. Likewise, there is concindence with the function of diagnosing respiratory diseases with mobile application of the authors [15], however, they differ in the way of obtaining data on the symptoms presented by users.

VII. Conclusions and Future Works

In conclusion, in the present research work it was possible to successfully design a mobile health application for the registration and diagnosis of patients with respiratory diseases, by using the RUP methodology for its development, the quality of the product is guaranteed. In addition, it is supported by the survey of 51 users; which validated that the application meets the criteria of functionality, efficiency. efficacy and satisfaction. Likewise, the application allows people who suffer from respiratory diseases to register their information and have diagnosis from the comfort of your home. Regarding the limitations of the research, there is the lack of validation of the prototype by experts, since the collection of information about respiratory diseases was collected only from the bibliographic review. In addition, the data used for the survey has been limited to symptoms that occur in a small group of respiratory diseases; this is due to the time in which the data collection was carried out.

Based on the designed prototype, it is recommended to expand the functionalities of the application in future research in order to more accurately detect respiratory diseases. Future research is needed to expand the collective understanding of the application of other emerging technologies in health applications and to optimize diagnostic results in patients with respiratory diseases.

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