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Prototype of A Monitoring And Prevention System For People Vulnerable To Cardiac Arrest And Covid-19 Using IoT And SAP Cloud Platform

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Abstract — *In the present work of investigation due to the worldwide conjuncture is being based on a system of monitoring and prevention for people vulnerable to cardiac arrests and covid -19 by means of the implementation of Arduino plates linked with an oximeter to measure the oxygenation in the blood that will help to monitor and to prevent cases of mortality in Peru. For the development of the project, we used the Scrum methodology and helped to develop an orderly manner and with daily communication and the advantages that this methodology provides are that it is incremental and iterative so that we can update, add or remove certain sprints that may not be useful. On the other hand, for the development of the prototype, we used builme , a tool for design with a code generator that is exclusively from SCP, where the interfaces are included as real-time information to monitor patients either from anywhere in the world to prevent early death.*

Keywords *— Build me; Covid-19; Scrum methodology; SCP; Cardiac arrest.*

I. INTRODUCTION

According to the World Health Organization, it has considered Covid-19 a pandemic and defines coronavirus-2019 (Covid-19) as a disease caused by the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), thus affecting also people vulnerable to cardiac arrest since patients with previous cardiovascular disease are more at risk of suffering adverse effects from Covid-19 [1]. Doctors report non-normal cases of Covid-19 as well as patients with low blood oxygenation but no breathing difficulties, which means that the patient may not feel sick from the disease until it is very serious. On the other hand, people without a history of cardiovascular disease are at risk of suffering incidental cardiovascular complications [2]. In February 2020, the first case of Covid-19 was officially registered in Latin America, raising the region's awareness and concern. In our country, cases were registered in March 2020 [3]. 3] Currently, cases have increased exponentially, and therefore the need to carry out this prototype of heart frequency monitoring and prevention has increased due to the fact that the majority of patients who attend different health institutions are unable to adequately control their hearts in order to prevent a possible heart attack [4].

Today there are a variety of methodologies that help us to develop all kinds of projects according to the need for them. Methodologies such as RUP, PMBOK are ideal for projects with defined functionalities, fixed deadlines, and even limited resources [5]. On the other hand, we have agile methodologies such as Scrum, XP, etc. They allow us to develop projects quickly with the necessary documentation and adaptable to constant change, being a strong point for projects related to IoT [6]. So for this research, we used the Scrum methodology, as it is suitable for the development of software development and planning projects. The main benefit identified that will have a great contribution at the time of implementation are the continuous deliveries, allowing us to develop applications in a modular way, where each module is fully functional [7].

This research work proposes the creation of prototypes using the Scrum methodology together for both the software and hardware sides, working in parallel developed in the case study section where from user stories described by some doctors, patients, and even family members of patients were designed prototypes and planning that meet the requirements raised by the people mentioned above [8].
Additionally, the technologies to be used for a possible implementation were considered. The project approach is based on a cloud architecture (SAP Cloud Platform), taking advantage of the services available [9].

The objective of this research work is the realization of prototypes (System, Methodology, Technologies, Architecture) that, when implemented, comply with the monitoring and prevention of diseases and deaths due to the low level of oxygen in the blood.

The research work has a simplified structure, leaving aside known topics and focusing more on techno-scientific issues, in point I we have the introduction where we present the problems, the methodology used for the development of the project, and the objective of the project, as point II we have the methodology used as well as the proposed technologies. Then we have the implementation in section III, which is the case of study where following the steps of the methodology, we make the objective, reaching the section of results and finally conclusions.

II. METHODOLOGY

The methodology to be used in the following Scrum research work will help us in the collaborative practices that minimize all types of risks in the development of a project.

The advantage of using this methodology is that there is no final delivery of the project, but rather that partial deliveries are made on a regular basis so that this is what most benefits the recipient of the project. Therefore, Scrum is particularly suitable for complex environments, where changes occur very often and on the fly and where speed, flexibility, adaptability, and competence play a key role in developing the project.

On the other hand, to understand SAP Cloud Platform solutions, it is necessary to take into account some basic concepts that will serve for the study and design of the software and hardware that will use this work. The electronic elements used will serve to configure them as input or output peripherals and to be able to perform different types of tests. We will now outline the most important points about the methodology to be used in this research. It is a framework that consists of Practices, event roles, artifacts, and rules [10].

Scrum presents the following stages:

A. Layout Backlog Planning

Basically, here we analyze, discuss and update what is going to be delivered in the sprint and how it is going to be done, where the person in charge is the Product Owner who makes sure that the items in the backlog are updated and prioritized, and the development team is the one who is going to do it, how it is going to be organized and how long it is going to take [11].

B. Sprint Tracking

In this activity, they meet not necessarily daily for 15 minutes, and in the same place, they usually ask questions [12], for example, is there something preventing them from moving forward? What do you have planned to do today, etc.?

C. Sprint Review

In this activity are the development team, the Product Owner, and the Scrum master, where the development team shows the result to the Product Owner and then inspects it if it is ok [13].

D. Retrospective

Here, the opportunity is given to improve, to apply the lessons learned, the development team can do it, and the next sprint takes place. [14]

In Figure 1, we show in a visual way the steps explained above for the realization of the project (Scrum Life Cycle).

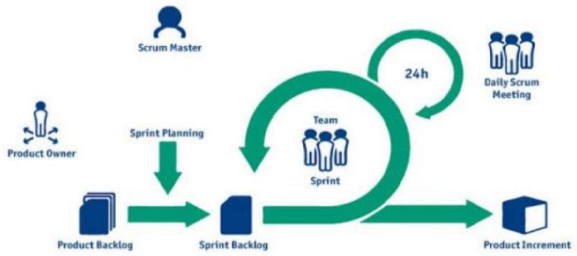

Figure 1. Scrum life cycle

Technologies and Development Tools: Cloud computing is undoubtedly a technology that gives a new approach to data processing, optimizing costs that can be used to obtain better performance, however, has some difficulties when using cloud computing and the internet of things this is due to network latency [15],. Given the magnitude of information that IoT devices emit and need, it is important that the information is transmitted with the maximum possible speed, so we chose to use an architecture proposed by open Fog that has as a principle the connection of intelligent devices and IOT devices without any internet connection as well as data processing locally we are talking about computing in the fog that will be able to analyze the information very quickly and only communicate with the cloud when necessary [16], [17]. Likewise, the Internet of things is causing a technological revolution that represents the future of computing and communications, and for its development, the support of some technologies is necessary [18], such as sensors that play a very important role in closing the gap between the physical world and the world of information, since they are capable of collecting data from their environment. For the development of the project, the use of the Internet of things is indispensable since it is necessary to obtain data from people who use the oximeter or also known as a pulse meter, which is an electronic device that measures the oxygen saturation in the blood and the heart rate [20] that will be implemented with the use of Arduino; the data will travel to a mobile device linked through Bluetooth.

SAP Cloud Platform (SCP) is the SAP cloud platform with a large number and variety of services [21]. The following services will be used for the development process:

•Java Fee, Service to deploy applications in Back End (API).

•Web IDE Full-Stack, Service to develop in SAPUI5, Fiori.
•Build, Service to layout SAPUI5 prototypes.
•Identity Provider, a Service that deals with security.
•Hana Database Service, Hana Database Service.
•Mobile Services, Service to use cell phone hardware.
•Portal, Service where SAPUI5 applications are deployed.

The Java quota mentioned above allows us to deploy Java applications in a virtual machine. We will implement api rest services using the SOA architecture and the Spring Boot [22], Spring Data, Spring Web Flux frameworks, etc. The Java application will expose services that will be consulted whenever necessary, and this service will take care of all the business logic such as notifications to registered family members, storage of historical patient information, and also as a receiver of information from the IOT devices hand in hand with the reactive programming that plays an important role for IoT solutions, as we mentioned before the IoT devices require a constant and almost real-time data exchange, so it is necessary to use the mentioned technology.

For the predictive analysis of information, the Google artificial intelligence library called Tensor Flow [23] will be chosen. Thanks to the use of this library, the system will be able to predict when a person might suffer from cardiac arrest in order to take the necessary measures to combat it, and even predict when a person might die from Covid 19.

The realization of the prototypes will be carried out by a service described above (Build me) that serves as the layout of SAPUI5 Front End applications.

III. CASE STUDY

In this space, the Backlog Planning of each of the functionalities will be developed.

A. Scrum Methodology

The following shows the implementation of Scrum with the phases indicated in the methodology.

a) Backlog Planning

The most relevant user stories are shown in Table I, which can be modified, updated, and even deleted.
User stories:
- As a patient manager, I want to be able to know which patients are registered and to be able to register those who are not yet part of the medical center in addition to being able to generate some reports and clinical histories to have better management of the clients.

- As an administrator, I want to be able to assign medical personnel to patients who are being monitored, in addition to managing family members or people close to them, managing contacts where we can be contacted to notify them of any unusual activity.
-As a doctor, I want to publish medical reports on the patient's condition so that I can keep track of the patient's health.

- As an Administrator, I want to have control of the health personnel in charge of carrying out the monitoring by the patient, to see information as the date of monitoring, the time of monitoring this to put a control that the assigned personnel this carrying out their tasks.

- As a doctor, I want to see different indicators that show information such as the patient's heart rate, blood oxygenation level, and so on, in order to monitor the patient's health.

- As a patient, I want to know if I am prone to cardiac arrest or vulnerable to death from respiratory disease so that I can take the necessary action.

- As a family member, I want to know the status of my patient and be notified if there is any abnormality in the patient's health so that I can take action and avoid complications.

- As a doctor, I want to visualize the information obtained by the oximeter implemented to monitor the patient's health.

b) Follow-up of the Sprint

For the implementation of the user stories, we made a segmentation in three increments that are as follows:

Increment 1: Management and maintenance of patients by the medical center: It consists of a section where the administrator will be able to manage and give maintenance to users that are part of the medical center, will be able to visualize the patients, to generate detailed and specific reports and to enter to the monitor of patients that will be detailed later and to a section of configuration of the same one as it is shown in Fig. 2.

Increment 2: Configuration for constant monitoring of patients: This section consists of two divisions. On the one hand, we have the assignment and configuration of the medical personnel responsible for the monitoring and, on the other hand, the administration of family members or people trusted by the patient. In each section, we have the possibility to configure contacts that will be used to send alerts and notifications about the patient's status, as well as automatic document management that will be updated daily with reports of the patient's status, among others. In addition, it has a monitoring history section where the administrator can review a detailed list of views that the patient has had; this to have control of the staff and verify that the people in charge of them fulfill their work, as shown in Fig. 3.

Increment 3: Mobile device oximeter configuration: They consist of a mobile application to be able to perform various

configurations such as the connection to the oximeter via Bluetooth. Additionally, the application will have the capacity to transmit the information pre-processed to the server.

Increment 4: Patient monitor: It consists of a board that displays information obtained by the oximeter in a time interval, data such as heart rate, the level of oxygen in the blood in addition to the use of Machine Learning predicts what state can be in the following hours (stable or unstable), also shows the data

Oximeter reading and reports any unusual activity or relapse prognosis to the people previously configured as shown in Fig. 4.

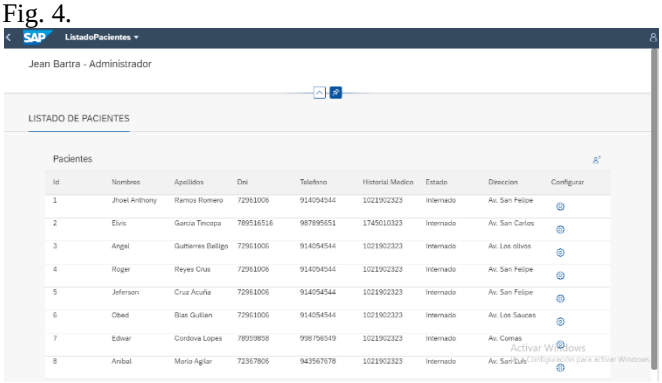

Fig. 2 Patient Management Screen

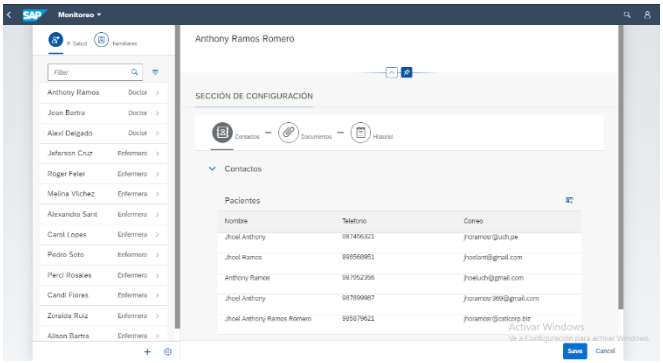

Fig.3 Medical Staff and Family Assignment Settings Screen

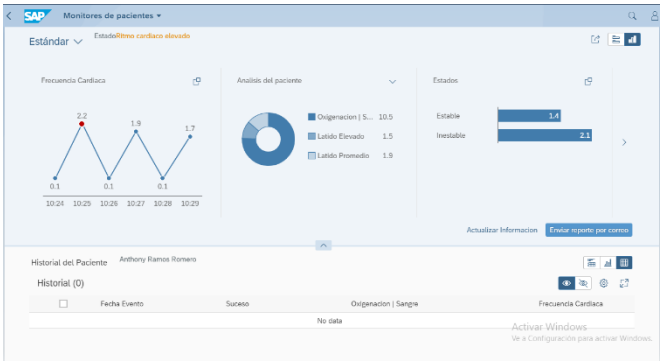

Fig. 4 Data Presentation Screen (Monitor)

c) Sprint Review

Once it has concluded with the tasks raised at the beginning, the development team goes to present the built parts (Sprint); for this case, the review will last about 3 hours and a half so that the owner of the product confirms that the increase covers the expectations and objectives planned in the planning of the sprint after that will open a round of questions and suggestions to take the feedback from stakeholders. Therefore, this part generates very valuable information for both the owner of the product and the team as a whole since we will have a high-level view of the product in order to improve and successfully embark on the next sprint planning.

d) Retrospective

Together the Scrum team assesses the procedure and technologies used in the development of each sprint as the SAP CLOUD PLATFORM both to develop the front-end and SAP S4 HANA for database administration, BUID ME the tool for the prototype, and finally the Arduino together with the oximeter if in case the interested parties suggest something new in the process as the analysis of the problems and aspects that can be improved.

IV. RESULTS AND DISCUSSIONS

Next, the results obtained about the development of the research results about the methodology, technology, and the case of the study will be shown. For the analysis of the prototype of the monitoring and prevention system, a comparison of the results about the methodology with other methodologies was considered, such as the traditional one, where the agile methodology that was chosen for this research is highlighted. On the results of the technologies, the results are also explained detailing the proposed architecture, and also on the case study, the comparison of another research with a different methodology is explained.

A. About the methodology

The results with respect to the methodology used were highly favorable for the development of the same, this thanks to the Scrum methodology for its agile character, open to change, and above all, the incremental and complementary functional deliveries [24]. In the Scrum methodology, the final stakeholders and the entire development team have made possible the continuous advancement of the software if we talk about usability and quality. According to the analysis of the work done has a productivity of 91% and in communication 78% [25]. On the other hand, the advantage of using this methodology is that it manages to encourage teamwork, change, constant increase, speed, and regular delivery of the Sprint. Particular detail is the very frequent direct conversation that can be uncomfortable for some people who are not used to working individually and without constant meetings [26]. In summary, it is noted that the design of the monitoring and prevention system also considers. In Table I, we see the comparison of traditional

and agile methodology where we can see that the agile methodology is better adapted to software development because of its incremental model and because it adapts to changes because the project is innovative and uses technologies that are constantly changing.

TABLE I: Comparative Table

Traditional Methodology	Agile Methodology
Predictive	Adaptive
Rigid process	Flexible process
Software delivery at the end of the development	Consistent software delivery
Extensive documentation	Little documentation
It is conceived as a project	A project is subdivided into several smaller projects.

B. About the technologies

The results in relation to the technologies used were ideal for research, technologies such as IoT, which was a fundamental part of the research as we will be able to obtain data on the levels of oxygenation of the blood; For the processing of these data, Fog Computing was important since it allows us to pre-process the information before sending it to the Cloud Computing. Once the data is processed and sent to the cloud, it can be monitored from anywhere on the planet thanks to mobile and web applications, in addition to this, in order to be able to predict vulnerable people, technologies such as Machine Learning (Tensor Flow) and in-memory database (Hana) were favorable for the large volume of data.

In Fig. 5, we show the based on what was explained above where we have the electronic devices (Oximeter) connected to a Mobile device that pre-process the information and reduce the load of sending data to the cloud. The communication with the cloud will be through the Http protocol. The services used in the cloud are such as the Hana database and Machine Learning. The APIs will process all the business logic that can be stored and presented in a web application.

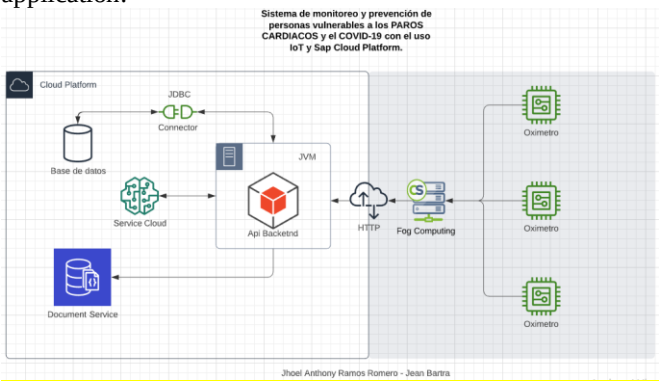

Figure 5. Proposed architecture

C. About the case study

In the case study, the design of the system that has been implemented for patients who are vulnerable to heart attacks and covid-19, where the prototypes were made, and the most important fields for its functionality were included, in which these were reviewed and approved by the Scrum team. In comparison with other research work, such as "Attendance recording and consolidation system using Arduino and Raspberry Pi," they have designed an attendance recording software, wherein the case of use, they implemented their project using the RUP methodology until the system was simulated. In this research work, the software design was proposed using the steps of the scrum methodology, which are adaptable, with variable scope contracts and tools such as the SAP platform and Build, allowing this tool to download the code of what was developed for its construction in development, reducing the work time and a load of researchers and developers. The research work achieved as a goal the rapid achievement of results, to the satisfaction, continuous improvement, and adaptable to organizations.

The results with respect to the case study were satisfactory since the general purpose was fulfilled, the user stories were developed with requirements proposed by some people who are dedicated to the area of health among common people, the planning of deliverables is based on the minimum requirements to work incrementally and ended with a product that meets the solution to the problem raised.

V. CONCLUSIONS

Finally, in the present research, the objective is being achieved, which is to make a prototype of prevention and monitoring with the purpose of safeguarding the life of people vulnerable to heart attacks and covid-19. The development and application have favored the society and the health community in diverse medical specialties since previously they seemed to be elusive due to their high technological requirements, being one of the reasons considered more outstanding of the context that is lived today in pandemic, this context has made many systems evolve much more, such is the case of this system. On the other hand, the need to improve monitoring and prevention systems must also be supported by the development of better health policies, adequate management of the legal component, and greater awareness among health professionals and patients of the potential benefits. Therefore, this system has great potential to improve the delivery of health services to the community.

The use of the Scrum methodology in the development of the prototype made possible the constant change and the addition of new requirements. Therefore, there was a reduction of risks and it was possible to work in a repetitive way in such a way that it was possible to develop also the electronic part that in fact is very important in this project.

In the future with the development of this prototype, it is intended to implement to the various hospital complexes, clinics and centers of basic services in health of Peru using artificial intelligence to increase the capacity of response when realizing the monitoring and to be able to prevent it before a mortal situation since for the moment it has been implemented of independent form only to directly to private complexes, particular doctors for his later application to the patients.

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