*Original Article*

# Telemedicine Prototype to Improve Medical Care and Patient and Physician Safety in Lima-Peru

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**Abstract -** *This research article is based on the use of telemedicine following the pandemic that affected the world, applied in various hospital complexes, clinics, and basic health service centers in our country, and the availability of medical services in the cloud as it is a way to prevent patient-doctor contagion and vice versa. The development of telemedicine aims to ensure and increase the welfare of doctors and patients due to the context. This research paper presents a telemedicine prototype developed in SAP Cloud Platform specifically with Build me that has a very friendly, well-structured, and secure interface for health professionals and patients. On the other hand, thanks to the agile scrum methodology's potential iteratively and incrementally, it was possible to achieve the expectations. The result of the research is that telemedicine prototypes improve medical care and the safety of patients and doctors since telemedicine has a great potential to improve the provision of medical services, where professionals can provide a better and more effective service. Patients receive medical care without the inconvenience and with absolute safety in the current context.*

*Keywords* – *Build me, Medical Services, SAP Cloud Platform, Scrum Methodology, Telemedicine prototype.*

## 1. Introduction

According to the World Health Organization, telemedicine is the provision of health services using information and communication technology to diagnose, treat and prevent the spread of disease to health care professionals and their patients [1]. In 2013, about 30,000 virtual meetings were held in Latin America, which, with a simple connection, allows for remote meetings, real-time exchange of information, and medical care generation [2]. The 2019 corona-virus pandemic (Covid-19) has driven the increased use of technology remotely. When physical contact poses a risk to patients and physicians, telemedicine offers a means to provide care at a safe social distance [3]. It allows for caring for patients with acute or routine illnesses and analyzing if medical tests are required. It offers particular advantages for families with limited resources, such as avoiding transportation, child care, and additional time needed for office visits. For these reasons, telemedicine has been proposed as a solution to past health care inequities and successfully implemented in affected populations [4].

Providing safe care for both parties and streamlining medical care by allowing doctors to see more patients. The promise of access to telemedicine for all Peruvians is to expand the costs for the acquired devices, which causes a precaution at the level of cost and profits [5]. This is because doctors and patients must have the equipment, but because the total costs are minimal, the precautions are minimal. Given the continuing saturation of healthcare systems, virtual care (telemedicine) is a key answer to large-scale deployment as a substitute for human medical care worldwide. Achieving the three-fold objective: caring for the influx of patients suffering from an infection that requires isolation and intensive care, caring for regular patients suffering from diseases that require constant attention, and protecting providers [6].

To date, all three objectives have been achieved, and telemedicine has become widely known. Most physicians now see telemedicine as a viable option for protecting themselves and their patients. It is understood that obstacles and difficulties have also been encountered, but there are more positive experiences [7].

The constant interruptions caused by the pandemic since 2019 have exacerbated the prevailing deficiencies in Peru's health system. As a result, not all Peruvians, but only a fraction of the population, are properly cared for. Meanwhile, more and more citizens find themselves without access to high-quality healthcare for economic, geographic, or cultural reasons [8]. Over time, the failures will become increasingly evident and severe. The country will have to face the depletion of public funds that have promised so much support to the struggling economy and healthcare sector [9]. The

health system will likely be forced to provide more value or services with fewer resources while facing financial challenges and a shortage of physicians in various specialties.

This research aims to develop a telemedicine prototype to improve the care and safety of patients and physicians in Lima-Peru.

This research has the following structure: the second section will describe in detail the methodology used to develop the work, the third section will present the case study, the fourth section will present the results and discussions, and the fifth section will present the conclusions.

## 2. Methodology

In this research, a hybrid methodology was used where the first 2 stages of the soft systems methodology were included to analyze the statistics and the unstructured situation or those involved, and the agile scrum methodology to develop and present each deliverable in the required time with the following tools.

### 2.1. Scrum Methodology

This part shows the steps to develop the research project, as it allows for much faster advances to deliver them on time with their respective roles defined by scrum.

#### 2.1.1. Product Owner

It is responsible that the items in the backlog are prioritized and updated; it also ensures that everyone understands the objectives of the project and the tasks to be performed.

#### 2.1.2. Scrum Master

He is the leader and ensures that the whole team understands and uses the Scrum methodology correctly.

#### 2.1.3. Development team

They determine how long it will take based on performance metrics they have already done and how they will be organized. The activities considered in this methodology are the following [10].

#### 2.1.4. Backlog Product

The product backlog allowed us to place all the requirements. These are prioritized in de ascending order from highest priority to lowest. It is applied through prioritization techniques on the requirements [11].

#### 2.1.5. Sprint Backlog

These are the tasks to be performed by the development team, where the goal is to develop each task called Sprint, for this study has the following Sprint: login, registration of a new user and query, and query management for each patient [12].

#### 2.1.6. Follow-up or daily meeting

In this activity, they don't have to meet every day for 15 minutes and stay in the same place for the whole Sprint; it is a meeting of the development team only, not for all stakeholders [13]. They usually ask questions like, "Is there anything holding you back?" What are you planning to do today? What obstacles did you encounter along the way?.

#### 2.1.7. Sprint Review

At this point, the development team, the product owners, and the scrum master participate since the development team shows the results obtained to the product owner [14].

#### 2.1.8. Sprint Retrospective

In this step, you can see the points of improvement of the work progress and give the point of view of the lessons learned from the processes carried out by the whole team that is integrated with the project [15]. See Figure 1.
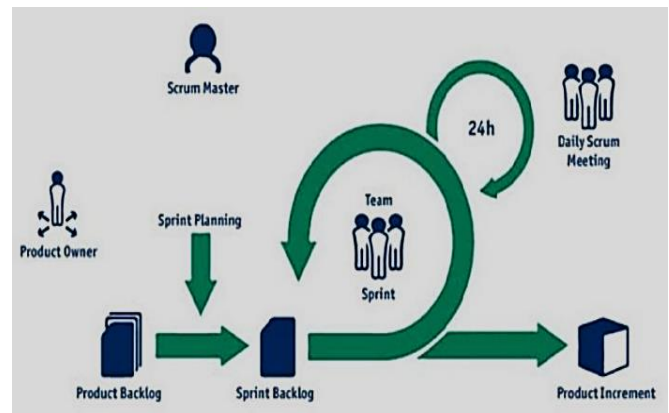


**Fig. 1 Scrum process architecture**

### 2.2. Tools to develop the prototype
#### 2.2.1. Sapui5

The Sapui5 core provides a solid foundation that simplifies the management of many aspects of modern rack-to-rack development.

#### 2.2.2. JavaScript

JavaScript is a programming language for the web. It indicates that JavaScript is an interpreted language and is implemented as part of a web browser, allowing to improve of the interface and simultaneously making the web pages dynamic [16].

#### 2.2.3. Sap hana cloud platform

SAP HCP es una plataforma de servicios diseñada para ser compartida entre Sapui5 y Sap S4 hana. Como plataforma empresarial abierta diseñada para impulsar la innovación, la integración y la extensibilidad de las aplicaciones a través de la agilidad, la flexibilidad y las opciones, se basa en el marcado JavaScript y HTML.

### *2.2.4. Sap S4 hana*

This tool is a step ahead of the transaction data recording system. It shows us that it is a proprietary database of SAP ERP and SAP Business Suite.

### *2.2.5. Build me*

It allows stakeholders and users to visualize the design and helps shape the interface before programming begins. It also creates an html markup language to facilitate application development.

## 3. Case Study
### *3.1. Unstructured situation*

The first stage of this research work describes the causes that have already been identified and chosen as central problems due to the context that has been affecting the world, within which we have the process of virtual medical care and virtual consultations in the health field in our country. The problem results in the health sector, whose patient dissatisfaction has discredited medical institutions [17]. The disrepute covers not only hospitals, clinics, and health centers but all those who work in the health sector, such as doctors, administration, and hygiene.

This problem in Peru has been going on for years, and it is impossible to change the endless queues, the fights for a place, or the total disorganization of the patients because they want quick attention. It is due to the problems that Peru has always experienced, such as the centralization of hospitals [18], the weak relationship between institutional bodies that does not allow a rapid reaction even in the 2020 period of the pandemic, the speed of response of health systems have taken the lives of both patients and doctors, the unit is a problem of the past in the Peruvian state that limits the relationship between the state and the population demonstrating the existing crisis [19].

The covid-19 pandemic affected the Peruvian state economically, causing the saturation of its health systems and even reporting deaths at the door of the health institution itself, including the delay of attention to the national police of Peru and its armed forces, bringing as a consequence the deterioration of citizen control that in turn caused more people to be infected and continued to saturate the health system. Physician fatigue is also a major factor because a tired doctor does not provide the necessary attention or satisfaction and his or her speed of care slows down markedly. For these reasons, there is a clear need to improve the health literacy of citizens since it also depends on them that the health system does not collapse quickly. On a global level, the problem stems from the over-saturation and collapse of the health systems, rooted in distribution and working conditions. In other nations of the Organization for Economic Cooperation and Development, the average number of physicians is 3.3 per 1000 population [20], a condition that is not met.

### *3.2. Structured Situation*

Figure 2 shows the stakeholders identified in the use of telemedicine in Peru Medical center as a health care entity whose purpose is the satisfaction of its users-consumers since dissatisfied users create a bad institutional image. Ministry of Health is an entity regulating health-related processes whose purpose is to provide quality care that involves the good treatment, humanism and warmth in care [21], and the real capacity to solve problems and resources. SUNASA (National Superintendence of Health Insurance), Patients as a subject whose objective is to be treated for their discomfort or health, doctor as a subject whose objective has traditionally been only to seek the good of the patient in individual form, making a good diagnosis and prescription for the cure in front of pathology or malaise [22]. Technological resources have to be the intermediaries between users; these devices can be mobile, portable, or static. The telemedicine platform, as an environment designed for medical care between patients and doctors, aims to help make medical care equitable for all helping to reduce waiting for lines and allowing care to reach all sectors. Virtual consultation is a requirement whose objective is the interaction between patient and doctor is with the camera during the video call, chat interaction, attached photos that will help the medical consultation and in addition to artificial intelligence that allows a probable diagnosis or relates the symptoms with a probable treatment [23]. In addition to an A.I. (Artificial Intelligence) that will support a list of possible diagnoses.
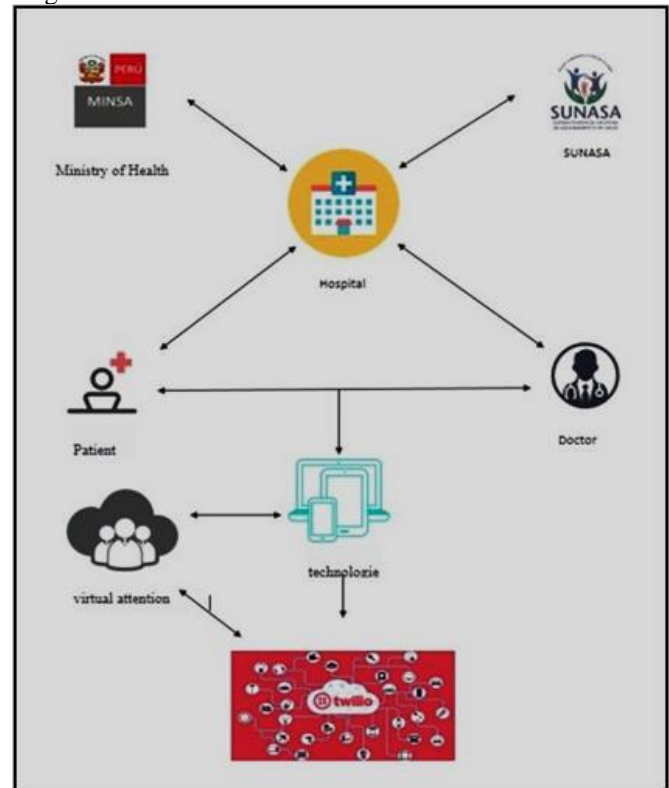


Fig. 2 Structure of those involved

### 3.3. Scrum Process
### 3.3.1. Backlog Product

They are the most outstanding user stories elaborated through the estimation of the phi that consists of meeting and voting by importance according to the company's criteria. These are the following ones see Table 1.

**Table 1. Table of prioritized stories**

| Related Stories | Nº | Priority |
|---|---|---|
| -As a doctor, I want to log in for my careonline | 2 | 1 |
| -As a doctor, I want access to the medical history to evaluate the patient's condition constantly. | 1 | 2 |
| -As a doctor, I want a button to start thevideo call | 3 | 3 |
| -As a doctor, I want a chat to start the videocall. | 6 | 4 |
| -As a doctor, I want artificial intelligenceto know possible diagnoses. | 7 | 5 |
| -As a doctor, I want a place to add prescriptions. | 9 | 6 |
| -As a patient, I want to see the day and timeof the scheduled appointment. | 10 | 8 |
| -As a patient, I want to access the appointment directly.5 | 5 | 9 |
| -As a patient, I want to have a button to starta video call. | 11 | 10 |
| -As a patient, I want a live chat to be able tocontact the doctor. | 13 | 11 |
| -As a patient, I want a place to put photos tohelp understand the disease | 14 | 12 |
| -As a patient, I want a place to receive theprescription attached by the doctor. | 8 | 13 |
| -As a patient, I want to end the medical appointment. | 12 | 14 |

### 3.3.2. Sprint Backlog

The Sprint to be displayed is defined.

• **Sprint 1** (Login and Registration)

The patient and doctor can access the virtual appointment as long as they are registered, as shown in Figures 3 and 4. This first Sprint will be determined by the following histories ordered by priority level. This will be shown in the login history table; see Table 2.



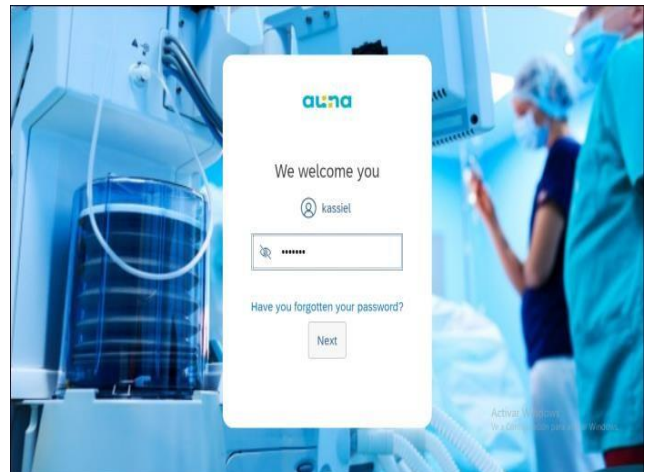**Fig. 3 Prototype in building me in the login**



**Fig. 4 Prototype in building me in the login**

**Table 2. Table of prioritized stories**

| Related Stories | Nº |
|---|---|
| -As a doctor, I want to log in for my care online | 2 |
| - As a patient, I want to log in and register for anappointment | 4 |

As shown, entering the user and pressing the next button automatically search the database. At the end of the process, the password is entered, allowing us to see what has been written, validating in the database related exclusively to that user; if you make a mistake, you will have the option to recover it.

• **Sprint 2** (Management of medical consultations)

In this process of medical consultation management, the doctor and patient will be able to see a record of all the appointments, but the central appointment will be organized as an initial position and in a noticeable box to enter the consultation together with a calendar for greater orientation

that will organize the appointments by priorities between urgent and mild in Figure 5. and Figure 6. you can see the organization by day, week and month. We will order the related histories see Table 3 in table medical consultation histories that are related to the own consultation between the patient and the doctor linked with the respective buttons that will allow the other functionalities that will be seen in the following Sprint that will be detailed later as the following view and the functions of the calls, in addition, we will create a unique and unrepeatable virtual room.



**Fig. 5 Prototype appointment viewer**
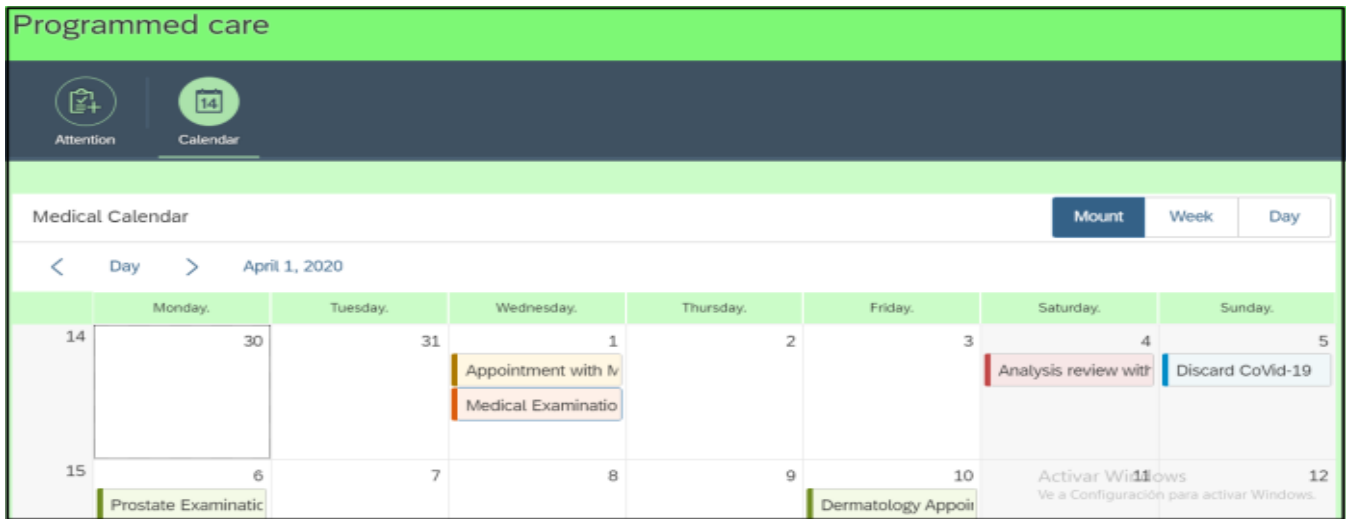


**Fig. 6 Prototype see appointment in the calendar**

**Table 3. Management history table consultation**

| Related Stories | Nº |
|---|---|
| - As a patient, I want to log in and register for anappointment | 10 |
| - As a patient, I want to make an appointment to contactthe doctor | 5 |

• **Sprint 3** (Medical Consultation)

In this process, the doctor and the patient will interact with the chat, making prescriptions; the prescription will be visible to the patient but editable for the doctor, as shown in Figure 7. The histories were related to the medical consultation, see Table 4.

**Table 4. Table stories medical consultation**

| Related Stories | Nº |
|---|---|
| - As a doctor, I want to have access to the medicalhistory to evaluate the patient's condition constantly | 1 |
| - As a doctor, I want a chat to contact the patient | 6 |
| -As a patient, I want a live chat so I can contact thedoctor | 13 |
| -As a doctor, I want a place to attach prescriptions forthe patient to be treated | 9 |
| -As a patient, I want a place to receive the attachedprescription to get my treatment | 8 |

As shown in Figure 7 y Figure 8. There is a detail on the left side of the medical history and an attached document where the patient adds documents and their time. The doctor will see the attached documents of the patient for more detail. In addition, the live chat is located on the right side with the eyelash where you will put the recipes. In addition, add is a button that can be used to go back and return to the menu of appointments, and lastly has the button to start the video called both doctor-patient and patient-doctor, either can initialize. This section details the prescription with a patient with the medication to take.
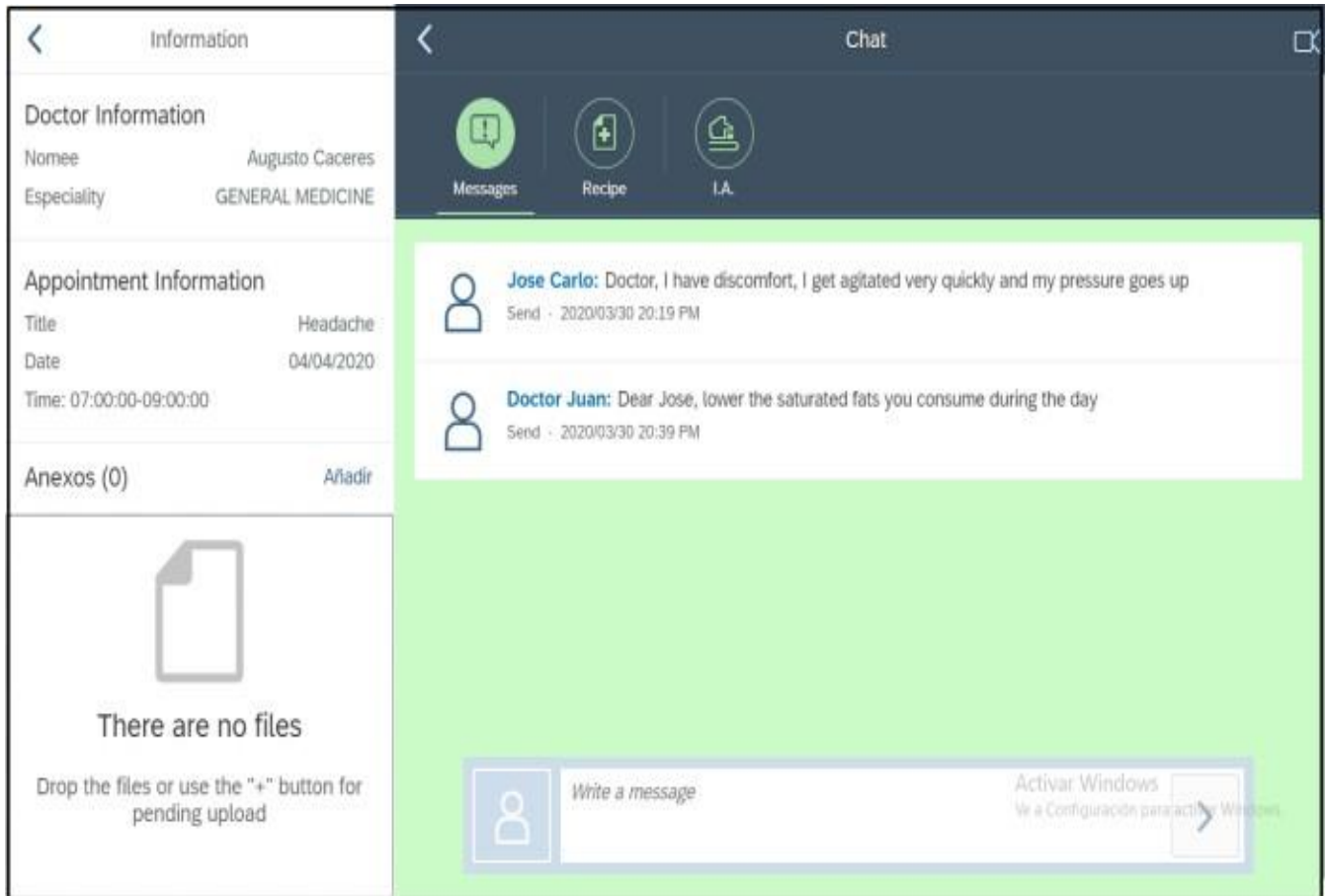


**Fig. 7 Prototype Live Chat**
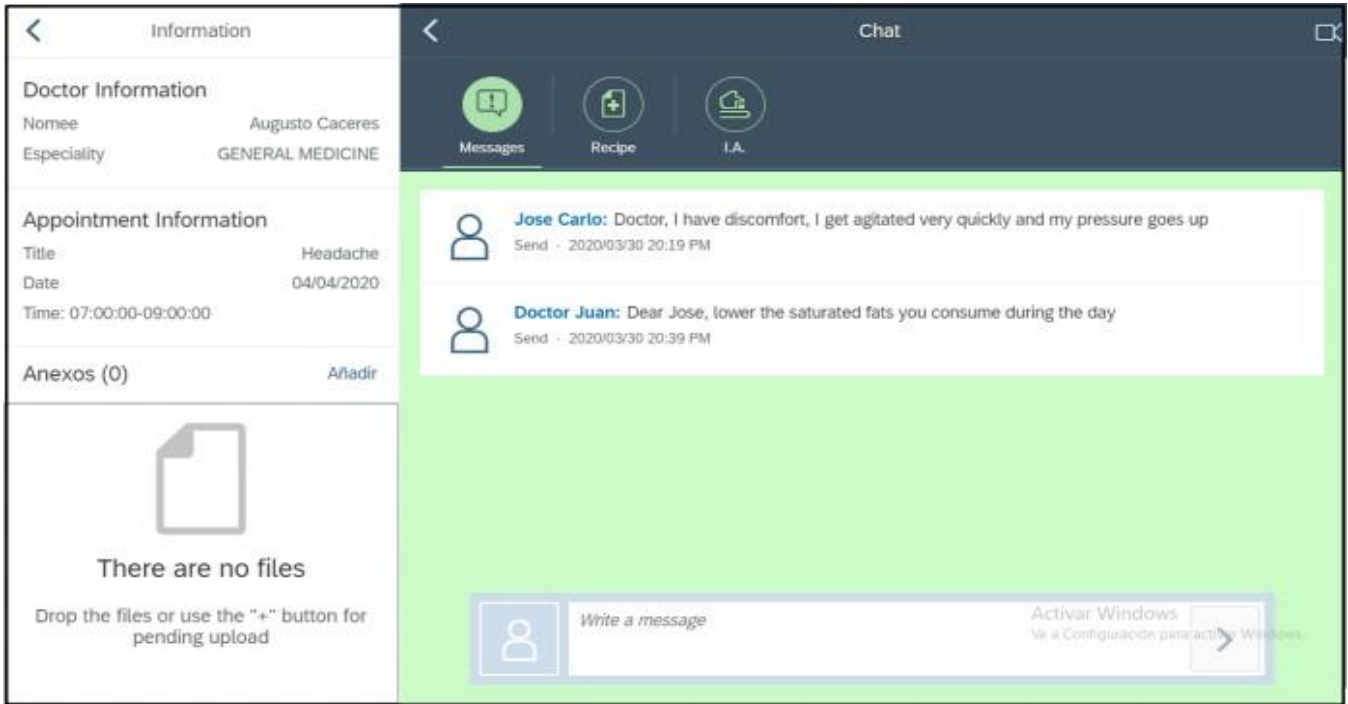
**Fig. 8 Prototype Recipe**

• **Sprint 4** (Document insertion and video call management)

In this section, we implemented the functionality of inserting a photo, pdf, excel, or word files to help the physician with references about the pathology, as shown in Figure 9 and Figure 10. The functionality to create rooms for video calls has also been added; see Figure 11. relate the histories of users who have related Table 5 in addition to the button to end the call. And as the last step is the connection of video calls within a room through the Twilio video tool that allows the creation of exclusive connection rooms for patients and physicians, one room per appointment.
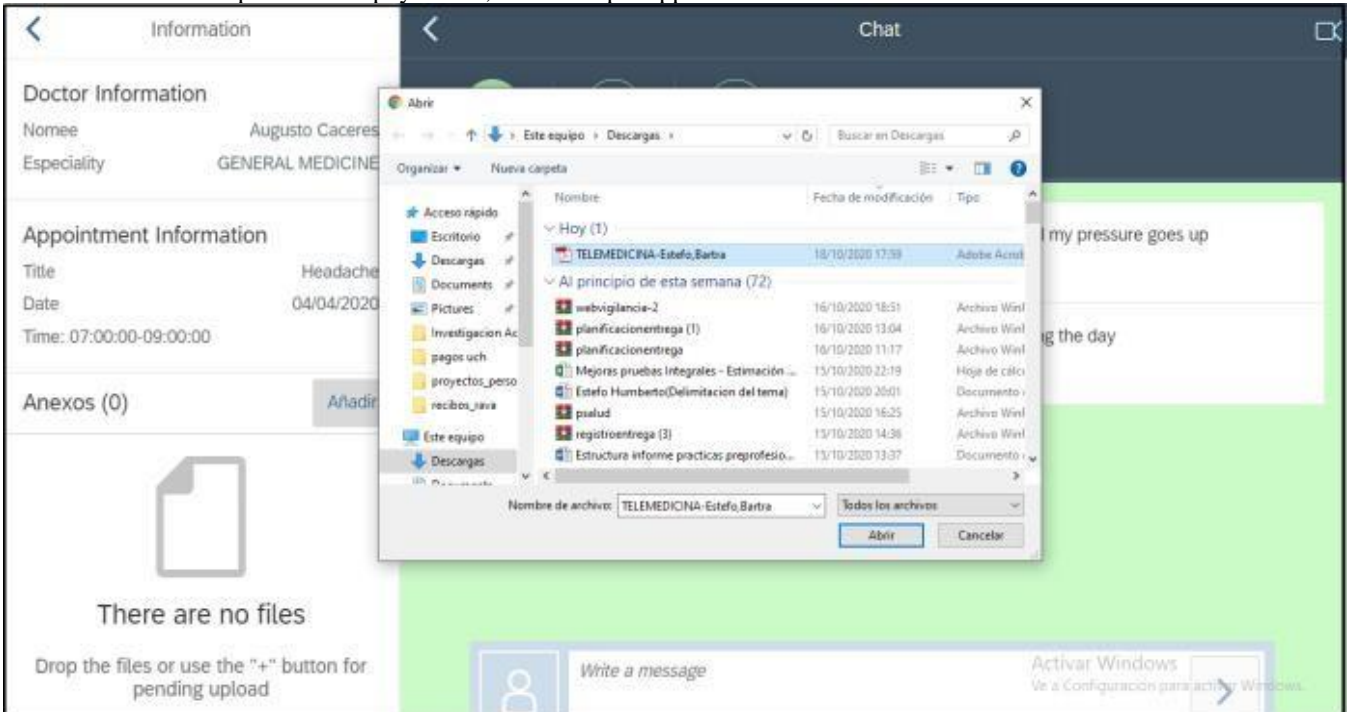


**Fig. 9 Prototype Upload Files**
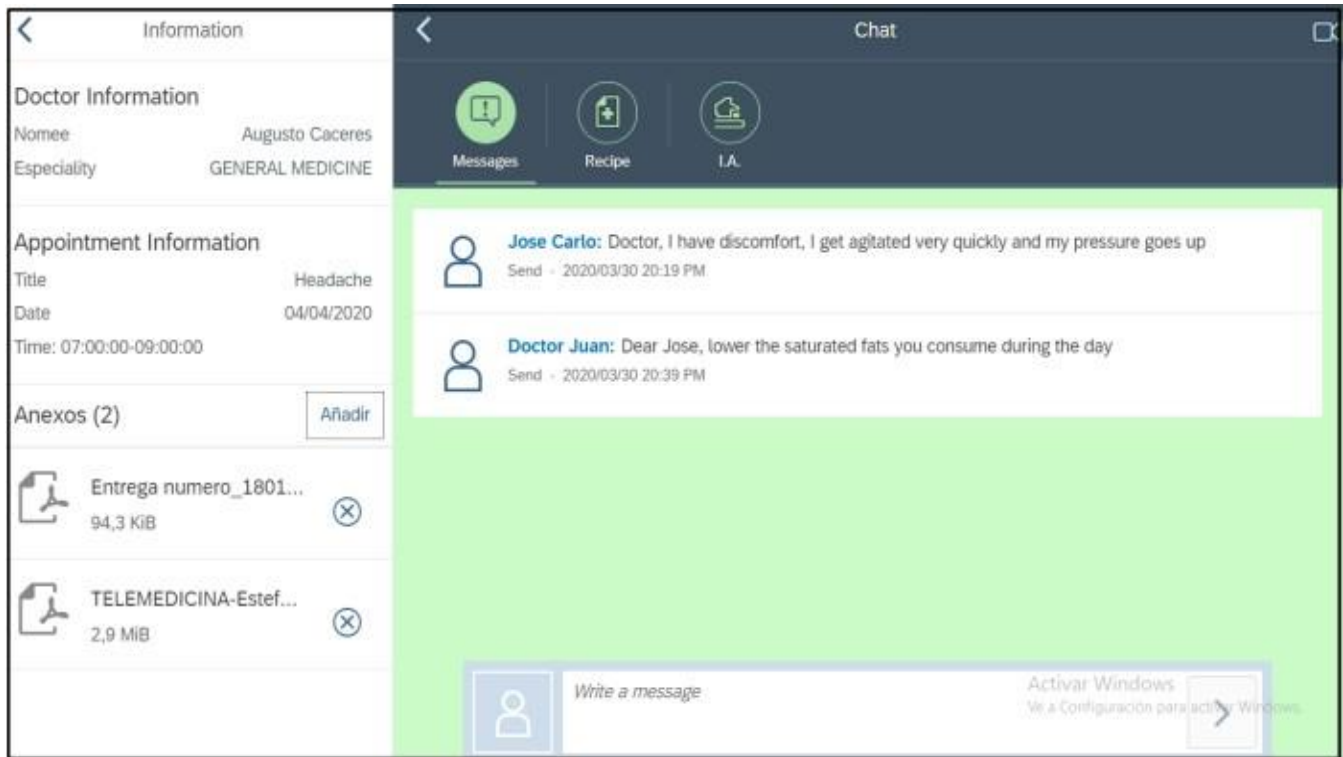
**Fig. 10 Prototype Upload Files**



**Fig. 11 Prototype call**

**Table 5. Table stories insertion documents and video call**

| Related Stories | Nº |
|---|---|
| - As a doctor, I want a button to start the video call. | 3 |
| - As a patient, I want a button to start the videocall. | 11 |
| - As a patient, I want to have a place to put pictures tohelp understand the disease. | 14 |
| - As a patient, you want to terminate the medicalappointment. | 12 |

**. Sprint 5** (Creation of Artificial Intelligence)

The functionality of the artificial intelligence starts; it will analyze the patient's data plus what is attached as evidence and what the camera detects, resulting in a list of possible ailments together with the recommended treatments, see Figure 12. For related histories, see Table 6.
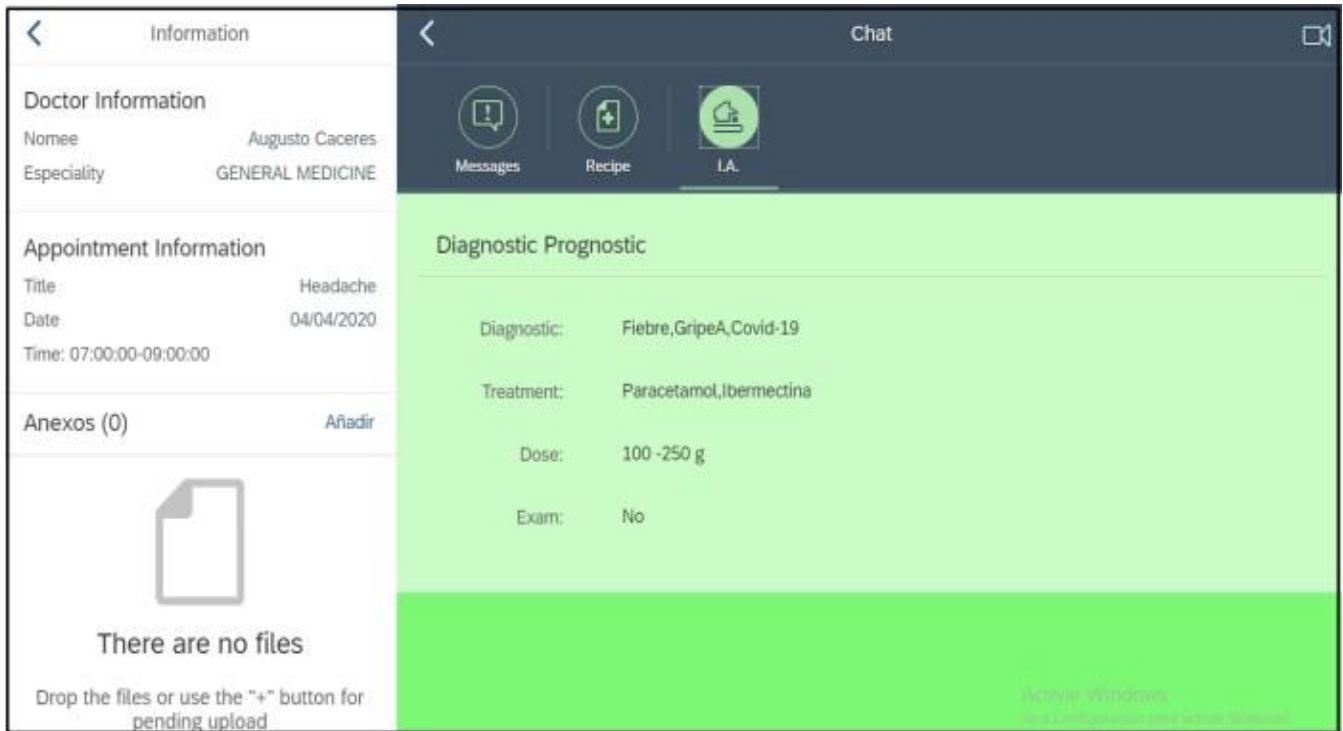


**Fig. 12 Prototype call**

**Table 6. Table stories creation of artificial intelligence**

| Related Stories | Nº |
|---|---|
| - As a doctor, I want artificial intelligence to knowpossible diagnoses. | **7** |

### 3.3.3. Follow-up or daily meeting

To avoid complications, the Daily Scrum will be performed in the same place, in this case in the development room of our organization, and at the same time throughout the Sprint. It is a meeting only for the Development Team, not a meeting for all stakeholders in the project; on the other hand also presents progress to monitor the progress of the Sprint based on the amount of work pending, as shown in Figure. 13, you can see the items that are already completed as item 1, some tasks that are in progress and those that are pending are the numbered items.
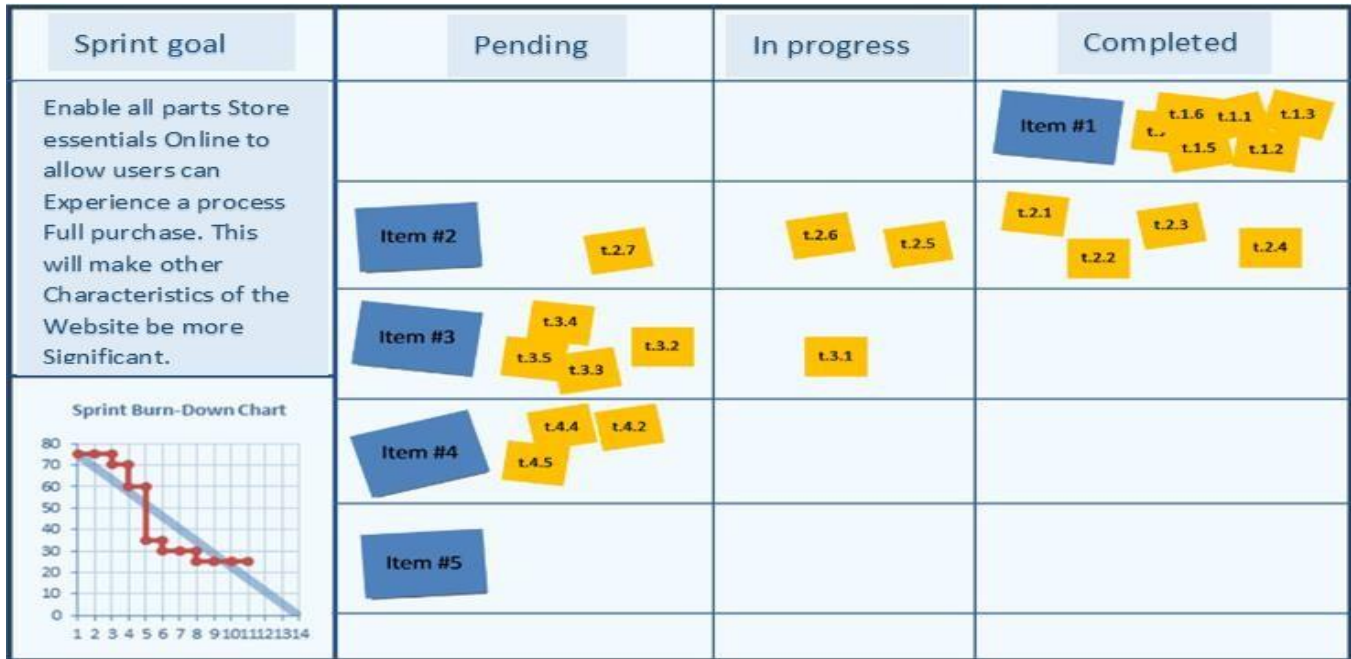
**Fig. 13 Daily Scrum**

### 3.3.4. Sprint Review
At this point, a review by the development team of each completed Sprint, with a duration of 3 hours and a half, to see the progress that was met, according to the planned objective of each Sprint, then the stakeholders ask questions.

### 3.3.5. Sprint Retrospective
The retrospective allowed us to make continuous improvements. To do this, meetings were held to see what was done well, what needed to be improved, and what we could improve. It will contribute iteratively in each Sprint to improve the activities again.

## 4. Results and Discussion
### 4.1. About the case study
In the case study, a system is designed to work for organizations such as medical facilities (hospitals, polyclinics, etc.) with its functionality, which has been accepted and approved by the scrum team.

Compared to other research projects such as "Unified System and Attendance Logging with Arduino and Raspberry Pi," the company has developed attendance logging software that, when used, is done using the RUP method before emulating the system in question. This research work proposes to design software using the scrum methodology. These steps can be customized with floating-volume tools and contracts such as SAP and Build Me, which allow the tool to find and load the code of what is designed to build it in the development phase to reduce the work time and workload of scientists and programmers, as shown in Figure 14. The research has achieved rapid results, satisfaction, continuous improvement, and organizational adaptation.
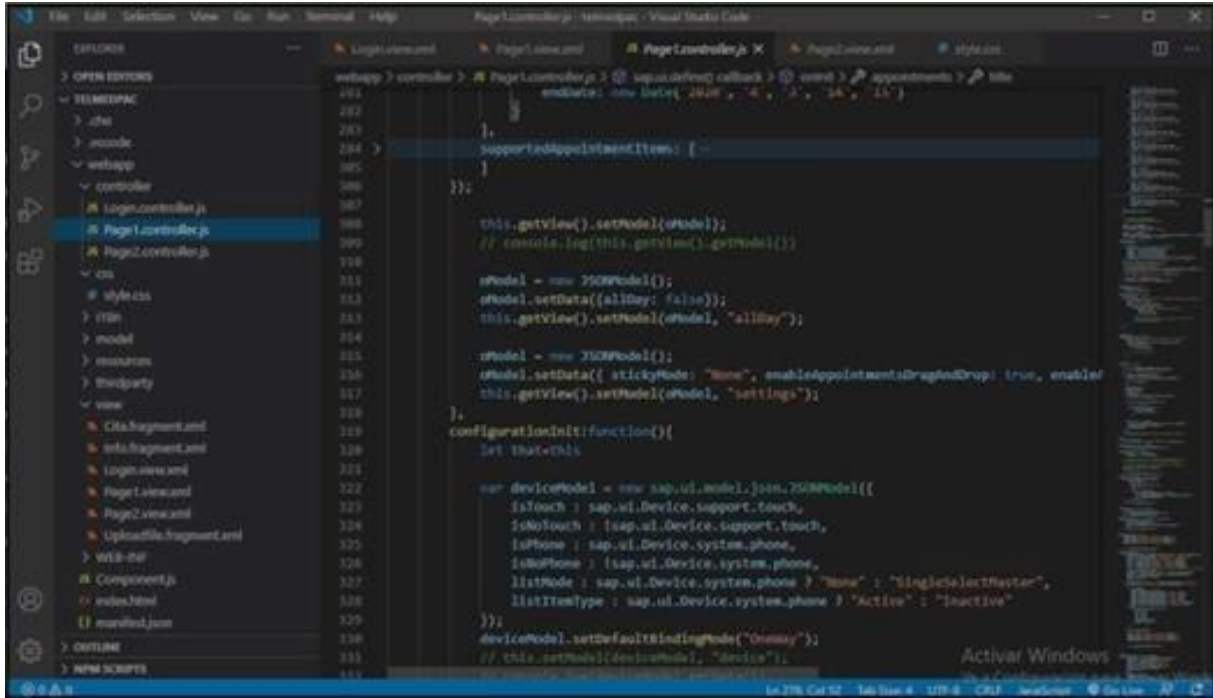
**Fig. 14 JavaScript code**

As shown in the figure shown, the JavaScript code; however, the tool not only downloads the JavaScript code but also the html and xml code see Figure 15 and Figure 16 using the Sapui5 libraries.

In Figure 15, you can see the XML code from the Sapui5 libraries, an example of which are the buttons, titles, tables, entries, texts, etc.
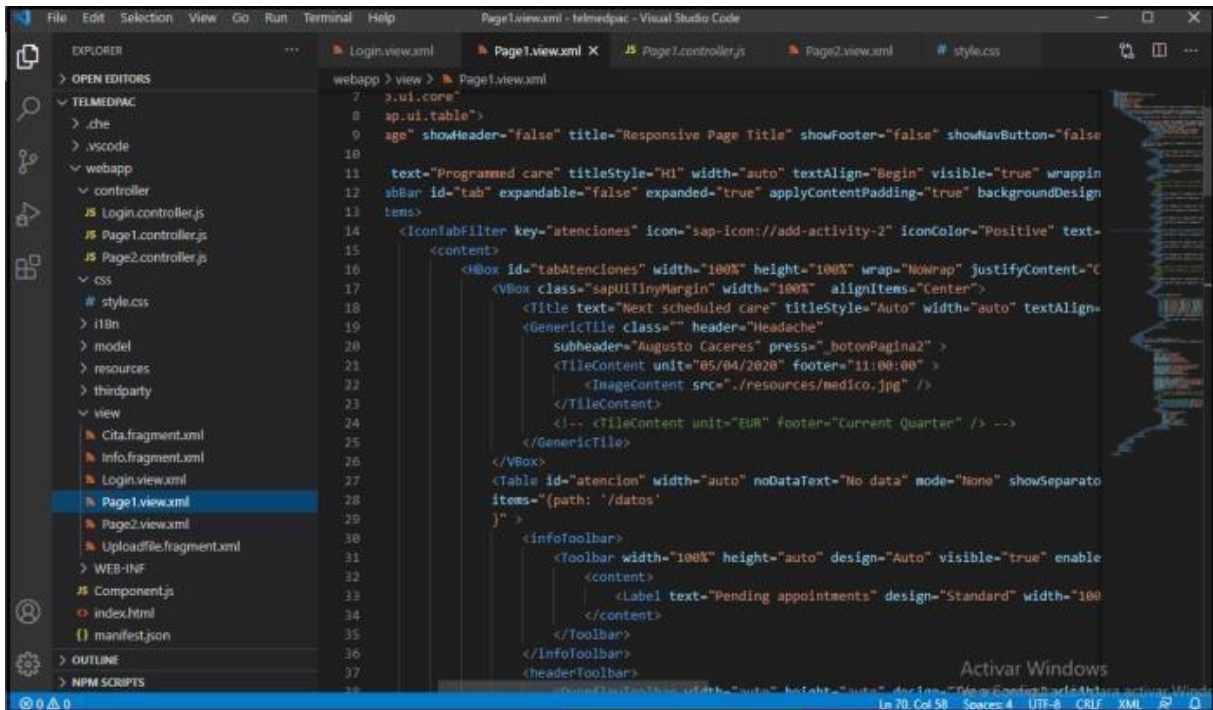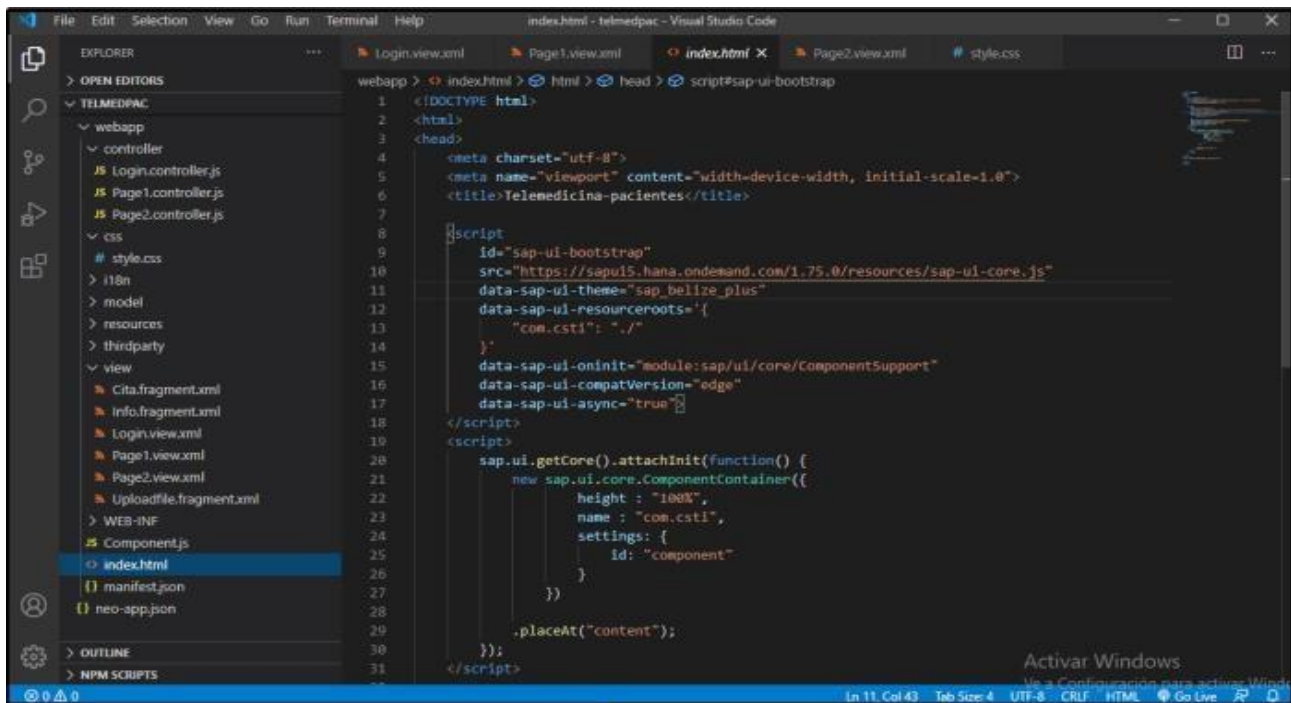


**Fig. 15 HTML Code**

Figure 16 shows the sapui5 libraries where it is shown how to call it and identify it together with its support.



**Fig. 16 HTML Code**

### 4.2. About the methodology

In the methodological part, the scrum methodology was used, with the participation of the development teams, which were able to continuously improve the software in terms of usability and quality [24]. According to his work analysis, he is 81% productive and 76% pleasant. Likewise, the advantage of using scrum is that it promotes teamwork and the permanent review of the project progress in each Sprint. So that the proposed objectives are met and thus obtain a good result [25]. On the other hand, one of the drawbacks is live chat, as most people are not used to working individually, as they do not have meetings to reach an agreement and see the progress of the work [26]. Therefore, it should be emphasized that when designing a telemedicine system, the methodology of all aspects of the system is also considered, involving the first two phases, which deal with the situation with structured and unstructured situations.

## 5. Conclusion

In conclusion, this research has successfully created a telemedicine prototype to improve the care and safety of patients and physicians in Lima-Peru. Development has contributed to society and the health community in various medical specialties, where they did not have an alternative solution. On the other hand, telemedicine made it possible to improve health systems based on their policies. One limitation found was that at the beginning, there was resistance from the authorities to the use of telemedicine. This, in the beginning, caused the project's delay; meetings were held to raise awareness of the importance of the implementation of telemedicine.

Regarding the use of the Scrum methodology in developing the prototype, constant change and adding new requirements were possible. Therefore, there was a risk reduction, and it was possible to work repetitively. In the future, with the development of this prototype, we intend to implement artificial intelligence in the different Hospital Complexes, Clinics, and Basic Health Services Centers of Peru to increase the response capacity when making a video call. It is suggested as work future complement with the use of expert systems.

## Acknowledgments

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