Medical Treatment with a Remote Care Technological Solution

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Abstract: The care service for the treatment of diseases is an activity that is performed in person, which uses the usual flow of appointment reservation and waiting time to access care, so that the diagnosis was provided and subsequently the appropriate treatment. Here, we present the development of a technological architecture that will allow you to manage user information to optimize the service in which you can reduce appointment booking time, attention time and even compliance with treatments remotely. Validation of the work proposal was carried out through a mobile solution in the test scenario that functioned as a pilot to demonstrate the feasibility of outpatient care service and to keep remote follow-ups to patients treated against the pathology of overweight. The results show the feasibility of our proposal.

1 INTRODUCTION

In Peru, the application of therapy in the public sector is applied to people who are generally adult patients between 40 and 70 years old, who opt for this method of treatment[1].

However, the current care model for therapy is carried out in the traditional way, that is, in person so that allows the diagnosis and identification of the appropriate treatment for the patient can be completed.

This process requires the face-to-face meeting of the specialist doctor and the patient for the follow-up of the treatment, since the material used in the patient's data can remain on average eight days (Lee et al., 2008; Hou et al., 2015).

Given this, for the patient this process implies non-compliance with the treatments prescribed, since it requires a significant amount time lost in accessing the service due to the following factors.

First, according to the national institute of statistics and informatics (INEI) published in February 2020, shows the average wait time to set an appointment can be up to two and a half days regardless if it is public or private.

The same study also indicates that the average waiting time for the patient to be seen is approximately 51 minutes at the national level.

In addition, the average commute time to reach the health center is calculated to be approximately 31 minutes due to various factors such as the location between users and vehicular traffic[2].

The benefits of the therapy required significant of monitoring and control to improve the physical and mental well-being of the patients.

Monitoring patients through telemedicine makes possible to obtain patterns or make future predictions for patient treatment.

Our contributions are as follows:

- We develop a mobile solution that provides care service for treatment of diseases.
- We propose a solution to encourage patients to comply with the treatments, so that the benefits of applying this therapy will be performed.

  These treatments do not require invasive methods, and these benefits will empower the patient improve their physical and mental well-being.
- We expect to provide the medical care service remotely to patients efficiently.

This work is organized as follows. Section 2 presents the study of the related works. Section 3 describes the technological proposal and the case study completed. Finally, experimental results are presented to validate the feasibility of our proposal.

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[1] Essalud (in Spanish) - 2016

[2] INEI (in Spanish) - 2020

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2 RELATED WORKS

In (Chen et al., 2018), the authors present an intelligent system, called Healthcare System App, for the health care of university students in Taiwan by establishing an interactive diet in which users can record the contents of their diet, nutrients and their exercise routines anytime, anywhere.

The main result that was identified in the study was that the application helped students to achieve the proposed objectives:

- 75% reached the breakfast goal.
- 90% reached the lunch goal.
- 90% reached the exercise goal.

Unlike them, we have established a treatment that interacts with the specialist doctor through the mobile solution platform.

The contribution of (Luhanga et al., 2018) was to present an application that includes the influences and interaction of social support with attachments to physical activities, identifying certain requirements and specifications that users require for its use.

The main results of this study were that 63.04% of the challenges were completed and that the application had a rating of 3.04 out of 5 (Luhanga et al., 2018). Unlike them, we have implemented an evaluation module in the style of a form.

In (Kronborg et al., 2018), the authors analyze patient data in the Telehomecare trial using home measurements through prediction models based on logistic regression.

The main result that was identified in the study was that the optimal combination of predictors (using three physiological predictors and exacerbations) excluding the incidence of exacerbation in patients and populations.

The contribution of (Almeida et al., 2010) is to implement an alternative application that allows the monitoring of patients with amyotrophic lateral sclerosis using Telehome monitoring devices that ensures the transmission of data and request for medical assistance.

The work configuration evidenced the number of hours of use per day, the percentage of spontaneous respiration, backup respiratory rate, average respiratory rates and the percentage of pressures that were reached contributed to an increase in the respiratory activation sensitivity, where the patient felt comfortable with a normal respiratory rate.

In contrast, we implemented a tracking system through weekly evaluations where the patient records user data to track its evolution.

In most of the work, the characteristic is that through the use of different technological tools they can maintain continuous monitoring of patients for the benefit of health.

3 METHOD

In this section we present the main concepts and architecture for our proposal.

3.1 Preliminary Concepts

3.1.1 Technological Architecture

This enterprise architecture model presents a more complete perspective of how you will develop and deploy your application components.

This has four layers, which are business, logic, data and physics that act as a basis for the efficient performance of the information systems that support the service and solution provided users.

The architecture design presents a series of steps to be considered to determine the structure and organization of the information systems

These include the components, functions, nodes, operating systems, data instances and physical devices such as servers computers, mobile equipment, among others that must be defined (Syynimaa, 2019; Lugmaña-Hidalgo and Garrido, 2019).

The main components of our proposal are as follows:

1. **Business Architecture:** The business architecture is defined as the layer that presents the business strategy through a set of requirements specified in mapping the processes.

   To complete, it is important to analyze the processes that make up the current state and identify deficiencies that can be improved so that stakeholders achieve their business objectives (Masuda, 2021; Niemi and Pekkola, 2020).

2. **Data Architecture:** This layer manages the physical and logical information, which will present information through views.

   It is responsible for storing the information in instances which must be consulted by the business stakeholders (Masuda, 2021; Niemi and Pekkola, 2020).

3. **Logical Architecture:** The architecture layer shows the technical aspects for the solution created, where the functions developed for the application that are based on business processes and requirements are used.

It is important to emphasize that this layer is contained in the technological layer because physical executions are required for operation (Masuda, 2021; Niemi and Pekkola, 2020).

4. **Physical Architecture:** In this layer, the lowest-level components of the solution are presented.

   The support the elementary resources for the continuation of the business such as directories, apps, databases, emails, etc.

   Therefore, this layer is essential for the correct execution of the implemented solution, guaranteeing the correct flow of communication and allow for the continuity of the strategic objectives of the business (Masuda, 2021; Niemi and Pekkola, 2020).

3.1.2 Cloud Service

It is a tool that through its design allows easy access to applications or resources over the internet without the need to pay for hardware with dedicated components.

The adoption of services is naturally at the request of the client or company user.

In this global context, people make use of these services consciously even if they do not have deep understandings of the of technologies.

Thus, the management of these cloud services are provided by experts in the field of Cloud Computing who provide information backup, application hosting, among others.

Likewise, the services provided to meet customer needs are called Infrastructure as a Service (IaaS) and Platform as a Service (PaaS)[3].

1. **Infrastructure as a Service (Iaas):** Cloud service that is oriented for IT system administrators who require IT resources from providers so as not to pay for local infrastructure installations and maintenance (e.g., Amazon Web Services, Google Compute Engine, and Microsoft Azure[3]).
2. **Platform as a Service (Paas):** Cloud service that are targeted to application developers, provide capabilities such as database, operating system, and a programming language to meet the needs of development environments[3].

3.2 Mobile Solution

This proposal consists on implementing a mobile solution that will provide medical care service for people who require treatment of diseases.

[3] What is a cloud service? - Citrix - 2020

A series of phases has been identified that will allow us to understand the proper flow of our work.

The phases of the mobile solution are detailed below:

1. **Phase 1 (Analysis):** The problem was analyzed and, secondly to complement the data, surveys were carried out to contextualize the usual tasks required of the users, so that the service could be optimized remotely, including the reservation of the appointment, history of symptoms, means of health monitoring, waiting time for care and time during care.

   Thus, the analysis of the app stores of Apple and Android, to locate any apps related to the tasks required in the environment.

   In addition, in order to identify tangibles in our proposal, we had the need to find programming environments to be used and the Cloud service that through its characteristics would allow the development. of the proposal (e.g., Android Studio and Microsoft Azure).

2. **Phase 2 (Technological Architecture and Development):** This process is presented in Fig 1 and shows the logic application layer found in the application design, including the part of the system with which the user interacts shown.

   These interfaces make use of controllers to communicate with the back-end and the processing logic to make the application work.

   The data layer is where we store our components as CRUD operations this includes links to the Microsoft MySQL database service.

   In summary, both the patient interface and the specialist interface through the use of mobile data or Wi-Fi network to connect to the API hosted in Microsoft Azure where the business logic layer and the Data layer are located, which is finally linked with MySQL.

3. **Phase 3 (Evaluation Process):** This process requires to start with the functional tests that in our case we validate all the flows that the mobile solution incurs.

   Then we have the identification of the case study, considering the recommendations of the clinic and the influx of patients to collect the sample group.

   After, we have the validation where the volunteers were instructed their execution of the mobile solution was supervised.

   A product satisfaction survey to capture opportunities in how to improve the mobile solution will be analyzed.

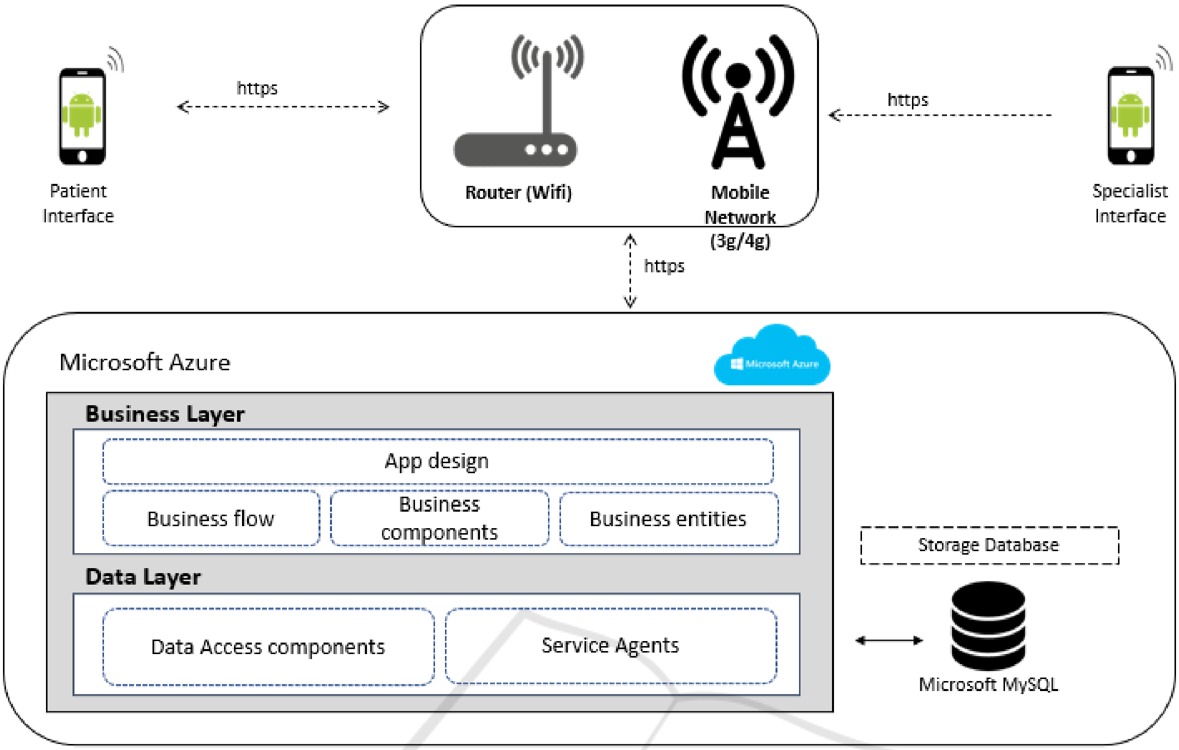


Figure 1: Deployment Architecture Model.

As a final step, the indicators would be evaluated.

4 EXPERIMENTS

The experimentation of this work had three validation sources which compare between the average results shown by outpatient care process in the public and private places, the results of the compliance of the treatment remotely and the satisfaction of the user using the mobile application.

4.1 Experimental Protocol

The solution was developed using the .NET and Kotlin programming language, which made it possible to obtain the expected backend and frontend functionalities.

In addition, it requires the CloudinaryAPI, which enables the solution to manage the upload of images in the cloud.

The APK of our proposal is publicly available at https://bit.ly/2HckOU5.

4.2 Test Scenario

The validation of the proposed model was carried out in a medical center downtown district of Lima, Peru, with 15 patients and one specialist representing 10% of the patients for the month during the COVID-19 pandemic.

In this validation, the volunteers used the mobile solution to record the appointments and request a treatment, allowing a specialist to display applications and address them through their mobile devices.

The patients underwent a process where they recorded essential information; height, age, weight and a photo of their ear, so that the specialist can instruct the therapy points and maintain control of the patient's treatment evolution.

4.3 Results

Table 1 (columns 2 and 5) shows how greatly reduced the time to choose the proper attention of the first 3 items, where the results of the MINSA (Public Hospital) months before COVID 19 pandemic started, compared to our proposal where the average time to book the appointment, waiting time and the time to arrive at the establishment were reduced by 86.36%, 91.8% and 100% respectively.

It should be noted that this public information

Table 1: Main results.

(a) Comparison of current situation with our solution.

Service	Private Entity (minutes)	Public Entity		Our Solution (minutes)
		Before Pandemic (minutes)	After Pandemic (minutes)	
Average time to reserve the appointment	22	5	5	3
Average wait time for care	49	24	8	4
Average time to reach the establishment	31	50	70	-

(b) Results of the Remote Process.

Age State	BMI Average	
	Before Treatment	After Treatment
Young	27.94	27.62
Adult	24.86	24.71
Elderly	26.83	26.42
Average	26.69	26.41

does not consider the information during the COVID-19 pandemic, because the official report was not available at the time of the study.

In Table 1 (columns 3 and 4), where the data given by the private establishment before the pandemic is compared with our proposed solution, it is possible to reduce the treatment wait time in that order between 40%, 83.3% and 100% respectively.

Additionally in the same establishment during the pandemic, the reservation time of the appointment, waiting to receive attention and commuting to the establishment was reduced by 40%, 50% and 100% respectively.

In Figure 2, there is the result of the treatment for the overweight where there is evidence of a decrease in the Body Mass Index (BMI) after the sessions according to the person's life cycle, where the young person (14 to 29 years old) reduced by 1.17%, the adult (30 to 34 years) in 0.64% and the elderly (45 to 60 years) in 1.55%.

Other result of the treatment for the overweight is a decrease in the Body Mass Index (BMI) after the sessions, where the BMI for young people (14 to 29 years old) reduced by 1.17%, for the adults (30 to 34 years) in 0.64% and for the elderly (45 to 60 years) in 1.55%.

4.4 Discussion

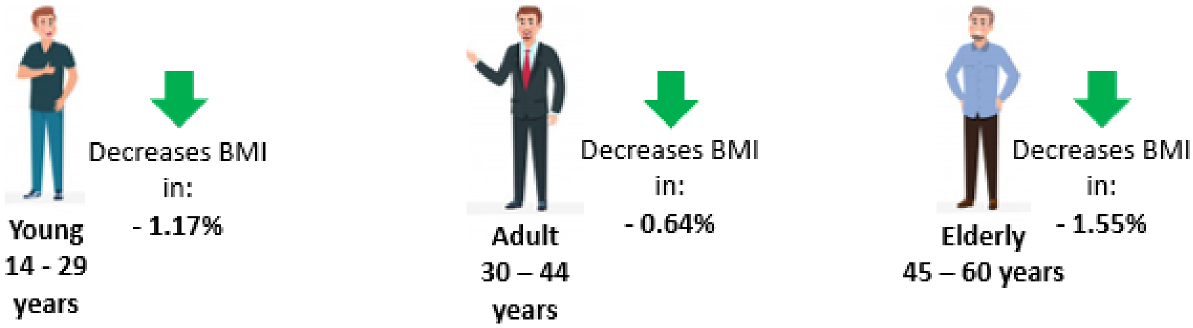
As we can see all the results given by Fig 1, we estimate a quantitative improvement, that reduces the time of care in a public or private establishment that provides treatments.

In addition, according to the results given by Fig 1b and 2, the volunteer patients when following the specialist's instructions through the mobile solution were able to stimulate the atrial cavity according to the recommended points.

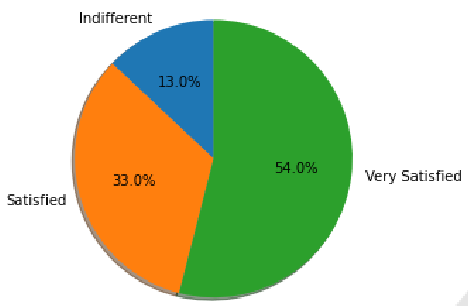
And according to their age groups they managed to decrease the body mass index.

After this, in our mobile solution obtained good to satisfactory references in the survey completed by volunteers where 54% corresponding to the Fig 2 were found satisfied with the mobile solution.

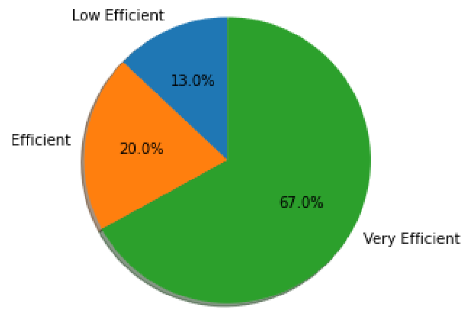
Fig 2 shows that 67% of the people found the mobile solution process very efficient.



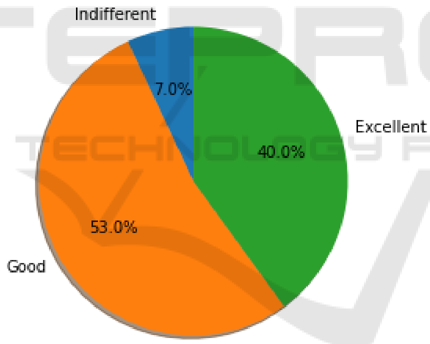
(a) Results of the Remote Process.



(b) Satisfaction for the Mobile Solution Functionalities.



(c) Efficiency of Mobile Solution Process.



(d) User Experience w.r.t. the Mobile Solution.

Figure 2: Comparison of results for different criteria.

In Fig 2, 40% found the user experience with the solution excellent.

5 CONCLUSION

In conclusion, our mobile solution based on our technological architecture improves the patient experience to maintain control and monitoring the treatments.

On one hand, the deployment of this solution enables to optimize remote care by registering appointments and going to specialized centers to access care.

On the other hand, the data collected from our volunteers treated against being overweight through our mobile solution showed that patients were able to decrease their BMI during the first week of the session, therefore, our proposal is able to provide follow-up and control towards patients requiring remote therapy care.

Our results show that the implementation of technologies such as Machine Learning and image recognition, would greatly improve the automation the specialist's instructions identifying the diseases and leads to a better diagnosis.

Furthermore, using Genetic information to seek for historical data about a patients (Arroyo-Mariños et al., 2021) or monitoring symptoms with a similar technological solution for other diseases (Jorge-Lévano et al., 2021).

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