

Prototype of a mobile application for the registration and diagnosis of patients infected with tuberculosis in the Huasteca Hidalguense region

Prototipo de aplicación móvil para el registro y diagnóstico de pacientes infectados con tuberculosis en la región de la Huasteca Hidalguense

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Abstract

This project aims to document the migration of the web prototype for the registration of patients potentially infected with tuberculosis in the Huasteca Hidalguense to a mobile application that facilitates usability through different devices for the Sanitary Jurisdiction No.10 of Huejutla de Reyes, Hidalgo. The methodology used is Xp Extreme Programming, which allows rapid development, with a panorama and more used approach to agile software development; it has as phases planning, design, coding and testing. As a result, a mobile prototype was developed, using React Native technology, which is adapted for this project that is intended to be scalable and cover a wide range of devices, regardless of the technology, or the manufacturer because the framework used has the ability to perform cross-platform applications, optimizing development time. This research has as its main advantage the transparency of the application for users, because they will be able to use any mobile device regardless of the operating system for its operation, eliminating restrictions and limitations to the personnel of the Health Jurisdiction for the registration of samples of patients potentially infected with Tuberculosis in the region of the Huasteca Hidalguense, streamlining the diagnostic process.

Tuberculosis, Mobile, Huasteca

Resumen

Este proyecto pretende documentar la migración del prototipo web para el registro de pacientes potencialmente infectados con tuberculosis en la Huasteca Hidalguense a una aplicación móvil que facilite la usabilidad a través de diferentes dispositivos para la Jurisdicción Sanitaria No.10 de Huejutla de Reyes, Hidalgo. La metodología empleada es Programación Extrema XP, que permite realizar un desarrollo rápido, con un panorama y enfoque más utilizado del desarrollo de software ágil; tiene como fases planeación, diseño, codificación y pruebas. Como resultado se desarrolló un prototipo móvil, usando la tecnología React Native, que se adapta para este proyecto que tiene la intención de ser escalable y cubrir una amplia gama de dispositivos, sin importar la tecnología, ni el fabricante debido a que el framework empleado tiene la capacidad de realizar aplicaciones multiplataforma, optimizando el tiempo de desarrollo. Esta investigación tiene como principal ventaja la transparencia de la aplicación para los usuarios, debido a que podrán utilizar cualquier dispositivo móvil sin importar el sistema operativo para su operación, eliminando restricciones y limitantes al personal de la Jurisdicción Sanitaria para el registro de muestras de pacientes potencialmente infectados con Tuberculosis en la región de la Huasteca Hidalguense, agilizando el proceso de diagnóstico.

Tuberculosis, Móvil, Huasteca

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Introduction

In the Sanitary Jurisdiction No. 10 of Huejutla de Reyes, Hidalgo there is a support web prototype, carried out as a first Stage of the research work presented in this article, but with a limited scope that does not satisfy all the accessibility needs remote, which is what is intended to be achieved in this research.

It is important to remember that this dependency is of great importance for the well-being of the community and, since it does not have a mobile prototype, limitations arise since the web prototype does not meet the needs of registering samples of possible cases of Tuberculosis.

It should be noted that in the Huasteca Hidalguense region there are localities located in remote places, where the internet service is null or inadequate, and it is precisely in these places where the personnel of the Sanitary Jurisdiction No. 10 of Huejutla de Reyes, Hidalgo must perform patient sample records.

That is why the main restrictions presented by the web application is that records cannot be made when the internet service is not available in some localities, the control of the lifting of tests is not properly documented, generating delays in the diagnosis and care of the patients; Therefore, it is necessary to complement the operation of the web system with a mobile application to improve access and information processing, since it is not available and represents delays in the delivery of results and patient care.

With the development of this project, the management of patient data will be optimized to better control the information collected, offering users two technologies that adapt to their work activities either in the office or in the field. Diagnosis has an efficient management, avoiding duplication of registration to the laboratory staff, to reduce the workload and keep a precise control of each sample, so the patient can be attended without delays.

Theoretical fundament

Tuberculosis is caused by Mycobacterium Tuberculosis, a bacteria that almost always affects the lungs. It is a curable and preventable condition. The infection is spread from person to person through the air. When a patient with pulmonary tuberculosis coughs, sneezes, or spits, he expels tubercle bacilli into the air. It is enough for a person to inhale a few bacilli to become infected. It is estimated that a quarter of the world's population has latent tuberculosis, a term applied to people infected by the bacillus but who have not yet become ill and cannot transmit the infection. (WHO, 2018)

Despite technological advances and great efforts by health personnel, tuberculosis continues to be a serious public health problem. Every second, a new TB bacillus infection occurs in the world. According to the figures reported by the WHO, in 2015 a new patient appeared every 3 seconds and another died every 18 seconds. (Orozco, and others, 2018)

Between 2000 and 2011, acute respiratory infections (ARI) remained the main cause of disease in our country. Its incidence rate went from 29,441.34 to 23,672.84 cases / 100 thousand. (SIAVE, 2012).

Tuberculosis in Mexico

Tuberculosis in Mexico has not been eradicated; The number of deaths has been reduced by more than 45 percent, but the incidence has been maintained, with a slight decrease in the number of cases. For 2009, in our country, according to a report edited by the National Committee to Fight Tuberculosis and Respiratory Diseases, 5 thousand Mexicans die a year from this disease, about 30 thousand new cases are known per year and another 1000 are infected daily.

Approximately 84% of patients who enter treatment are cured, 2.5% die and 13.5% are recorded as failure, abandonment of treatment. These proportions vary according to the location of the disease. (Orozco, Nesbitt, & González, 2009). More recent studies estimate that there are 2,000 to 2,500 deaths per year, and according to figures from the Ministry of Health, more than 19,000 new cases are reported annually. (Castillo & Antonia, 2018).

In Hidalgo, pulmonary tuberculosis continues to be a public health problem, by stratifying municipal risks in 2016 with accumulated mortality from pulmonary tuberculosis 2009-2014, accumulated morbidity from pulmonary tuberculosis 2010-2015, detection coverage 2015, percentage of Drug resistant tuberculosis and percentage of failures, relapses and abandonment of treatment, high risk is identified in 45 municipalities: 12 located in the region of La Huasteca, 3 in the Sierra de Tenango, 8 in the Sierra Alta, 2 in the Sierra Baja, 3 in the Sierra Gorda, 3 in the Tulancingo Valley, 1 in the Mining Region, 1 in the Altiplano and 12 in the Mezquital Valley.

With medium risk, 28 municipalities are recognized, representing 33.3% of the total and the remaining 11 municipalities are classified as low risk. (Secretary of Health of Hidalgo, 2016)

Mobile app

Mobile technologies and their continuous advancement are fostering a new generation of applications, these are the so-called "mobile applications". A mobile application is considered to be software developed for mobile devices. Mobile refers to being able to access data, applications and devices from anywhere and at any time. These types of applications are developed taking into account the limitations of the devices themselves, such as low computing power, low storage capacity, limited bandwidth, etc. (Enriquez & Casas, 2013).

React Native

For React Native, it all started as an internal hackathon 6 project within the walls of Facebook's offices and has since grown into one of the most popular frameworks. React Native did something that web developers had been trying to do for several years before the hackathon: write mobile apps in JavaScript.

Many of the concepts introduced by React are applied in React Native; for example, better health management techniques, a one-way data flow in applications, component-based UI construction, and much more.

It is currently compatible with iOS and Android, and due to its acceptance and success there are plans to expand to other platforms. The main innovation of React Native is that even though the applications are written in JavaScript, they are compiled in native code, so their performance is much better than the so-called hybrid applications. These applications are written in JavaScript, HTML and CSS and run in WebView (a browser built into an application). Additionally, React Native offers a web-like development experience, such as real-time reloading of your application during development, which is very nice. (Lazcano, Valencia, Baena, & Venegas, 2019)

Methodology

Extreme programming (XP)

To illustrate an agile process in more detail, an overview of Extreme Programming (XP), the most widely used approach to agile software development, will be given. Although the first activities with the ideas and methods associated with XP occurred in the late 1980s, the fundamental work on the subject had been written by Kent Beck. A variant of XP called XP Industrial IXP was proposed in a more recent era. IXP enhances XP and targets the agile process to be used specifically in large organizations.

The XP process

Extreme programming uses an object-oriented approach as the preferred development paradigm, and encompasses a set of rules and practices that occur in the context of four structural activities that could be described as their life cycle, which are detailed and developed below: planning, design, coding and testing.

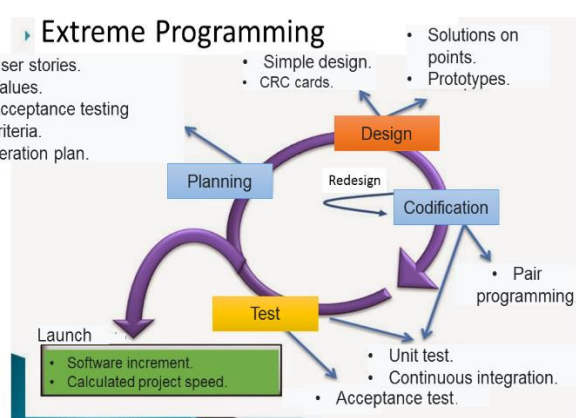


Figure 1 Life cycle of the XP methodology

Planning The planning activity (also called the planning game) begins by listening to the requirements gathering activity that enables the technical members of the xp team to understand the business context for the software and acquire the sensitivity of the output and key features and functionality that are required. Listening leads to the creation of some "stories" (also called user stories) that describe the required output, features, and functionality of the software to be built.

Design. xp design rigorously follows the ms principle (keep it simple). A simple design is always preferred over a more complex representation. In addition, the design guides the implementation of a story as it is written nothing more, nothing less. Designing for additional functionality is discouraged because the developer assumes it will be required later. Xp encourages the use of crc cards as an effective mechanism for thinking about software in an object-oriented context.

Coding. After the stories have been developed and preliminary design work has been done, the team does not start coding, but instead develops a series of unit tests on each of the stories to be included in the delivery in course (software increment). Once the unit test is created, the developer is better able to focus on what needs to be implemented to pass the test. nothing strange is added (ms). Once the code is complete, it is unit tested immediately, providing instant feedback for developers.

Evidence. It was already said that creating unit tests before coding begins is a key element of the xp approach. The unit tests that are created must be implemented using a framework that allows them to be automated (so that they can be run repeatedly and with ease). this encourages a regression testing strategy whenever the code is modified (which is often the case, given the philosophy of redesign in xp). (Pressman, 2010)

Developing

Planning

In this phase, meetings were held with personnel from health jurisdiction no.10 of Huejutla de Reyes, Hgo. to obtain the necessary requirements in the development of the mobile application. In these meetings, information was obtained corresponding to the color palette, typography, modules, activities, delivery times, type of data to be captured and the traceability of the process. This investigation lasted 14 weeks, then the time management for each activity.

Number.	Activities	Scheduled / Finished	Weeks													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Planning	S														
		F	OK	OK	OK											
2	Design	S														
		F				OK	OK	OK	OK	OK						
3	Codification	S														
		F									OK	OK	OK	OK		
4	Test	S														
		F													OK	OK

Figure 2 Project planning

The different user stories were also carried out, which describe the actions and functionalities to be carried out.

The lists of user histories for the mobile application are login, personnel registration, registration of municipalities, localities, medical unit, personnel, laboratory worker, patients, type of personnel, sending of tests, test section, test notification, section of Control sent, user screen, personal data configuration and medical unit user.

The information collected in user stories is very important since it comes first-hand and accurately describes the needs that each user requires from the application.

User Story	
Number: 12.	User: 3 tests will be performed on patients who have symptoms of tuberculosis, they will also be scheduled natural tests every 28 days for their treatment.
Story Name: Test Section	Developing risk: The tests must be taken correctly because if the tests are taken incorrectly, they will be rejected.
Business priority: High.	
Estimated points: 0.4 weeks.	Assigned iteration: 1st. Iteration.
Responsible programmer: Alvaro Antonio Hernández Perez.	
Observations: Pending.	

Note: This table shows the user story designed for taking patient tests in the mobile app.

Table 1 User Stories example

Design

At this stage, the preliminary sketches of the mobile prototype forms are included. The design of the graphical user interface was prepared based on the design requirements requested by the personnel of the Sanitary Jurisdiction No.10 of Huejutla de Reyes, Hgo. Adjusting to your usability needs. Here are some prototype designs.



Figure 3 Application staff registration screen

Coding

At this stage, once the user stories have been developed and the preliminary design work has been done, a series of unit tests was developed for each of the stories that were included in the current release (software increment) . After the unit test was created, there was instant feedback for developers.

A database was developed that has six tables all related by their primary and foreign key.

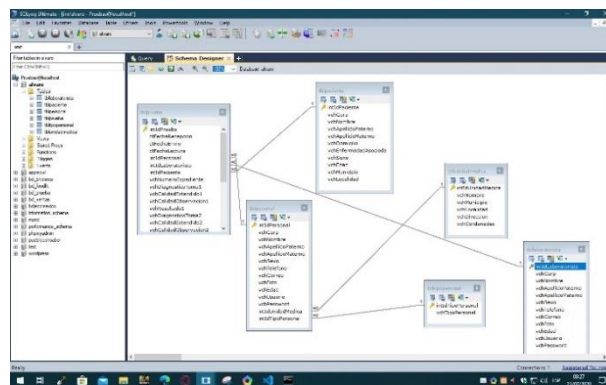


Figure 4 Application database

For the coding of the different modules of the mobile application mentioned in the design stage, the development technologies php, react native and java script were used.

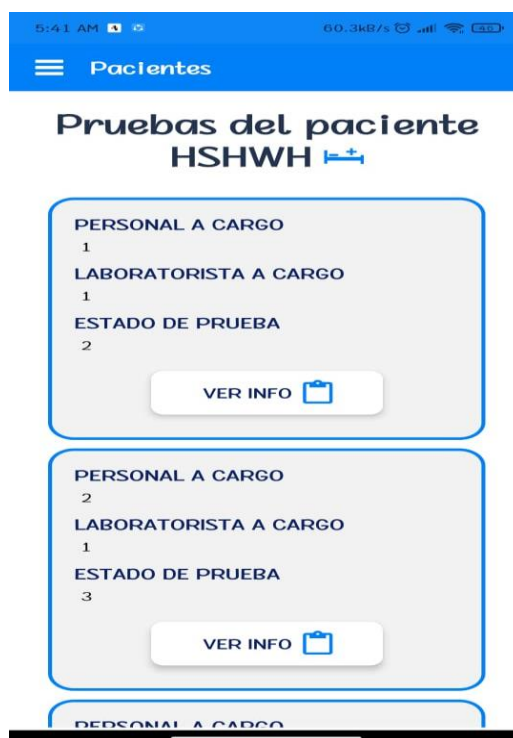


Figure 5 Patient tests screen to be displayed in the application

Once the tests have been taken from the patient, they will appear in the list of tests already taken in the test, the necessary information will appear, such as the name of the doctor in charge of taking the tests, the name of the patient on whom the tests were performed and the laboratory worker. who is in charge of examining the evidence and delivering the results.

Evidence

Data validation tests were carried out to ensure that the information entered in forms is correct, considering user stories.

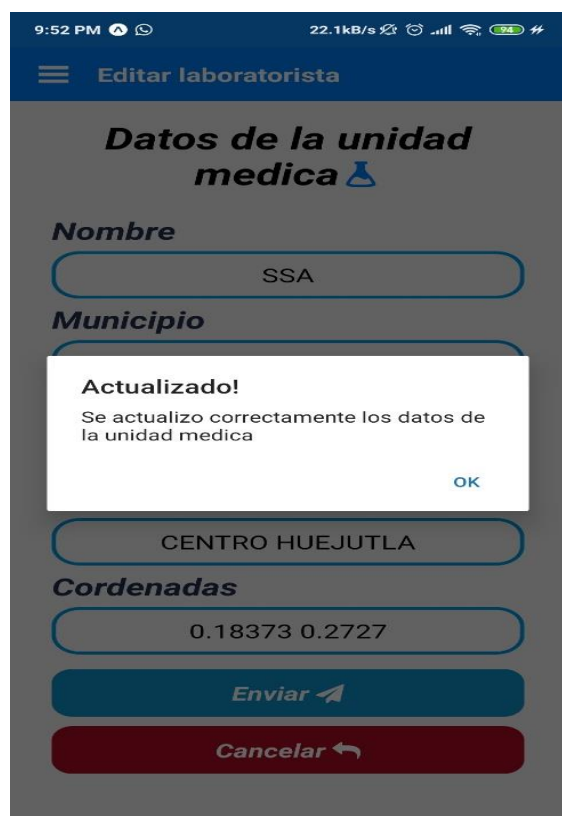


Figure 6 Patient tests screen to be displayed in the application

As you can see, the data of the medical unit is being updated by the administrator since he has found an error in the data and has to be corrected. For this, it has two buttons, one is to cancel the process and the other is to save changes. If the administrator chose the wrong unit just by canceling the process, this will not alter the data, but if it is the correct unit, just saving the changes will give us the message the data was saved correctly.

Results

The result of this research was to develop a mobile application to speed up the registration of patients potentially infected with tuberculosis in the Huasteca Hidalguense.

This process was carried out through constant communication with the personnel of the Sanitary Jurisdiction No. 10 of Huejutla de Reyes, Hgo. and the Academic Body of Information Technologies of the Technological University of the Huasteca Hidalguense where the need arose to migrate some modules of a web application previously developed with the same purpose to a mobile environment and to give continuity to this project to reduce the damage caused by this disease.

With the migration of the application from a web environment to a mobile one, important benefits were obtained, optimizing the registration process due to the reduction of the restriction of making sample registrations due to the lack of internet service in remote places, as well as, opened the range of options in terms of devices used to carry out this process.

The choice of the Extreme Programming (XP) methodology is based on the need to develop an application quickly and adequately so that it could be implemented in a short period of time that contribute to the actions undertaken by the State Secretary of Health. of Hidalgo through Sanitary Jurisdiction No. 10 in the campaign to eradicate tuberculosis in the Huasteca Hidalguense region.

Conclusions

With the completion of the mobile application for the registry of patients potentially infected with tuberculosis in the Huasteca Hidalguense region, a second stage of this project is concluded that complements and adds benefits to the work previously carried out between the Academic Body of Technologies of the Technological University of the Huasteca Hidalguense and the Sanitary Jurisdiction no. 10 from Huejutla de Reyes, Hgo. that were focused on a web environment.

The intention of this project is that the mobile application is first used exclusively by health personnel assigned within the Huasteca region, to later be implemented in other jurisdictions, agencies and health entities of the state of Hidalgo.

It is also proposed to apply the Official Mexican Standards and quality standards for the processing and safeguarding of information, considering the ethics of the users and the privacy, integrity and availability of the data of each patient.

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To the personnel of the Sanitary Jurisdiction No. 10 located in the city of Huejutla de Reyes, Hidalgo.

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