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Innovating in the Detection of Depression in Young Adults: Development of a Mobile Application Based on the Enhanced Cascade Model

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Abstract. Depression is a disorder that usually begins in early adulthood, having a duration according to the World Health Organization (WHO) from a couple of months to a couple of years, however, in approximately 20% of cases there is a chronic evolution that results in a high mortality rate by suicide due to lack of adequate treatment. Therefore, the objective of this project is to facilitate the tools for an adequate care of depression, mainly in young adults through the development of a mobile application that monitors patients. To carry out the project, the enhanced cascade model was implemented, because the feedback between the different phases of the system development life cycle is important to make the appropriate modifications. The application of interviews and the use of brainstorming were the selected way in which all the system requirements were designed and the goals to be met by the system were adequately defined.

Keywords: Depression, Young Adults, Mobile Application

1 Introduction

Depression is a disorder that usually begins in early adulthood (NIMH, 2015), having a duration according to the World Health Organization (WHO) from a couple of months to a couple of years, however, approximately 20% of cases have a chronic course that results in a high mortality rate by suicide due to lack of adequate treatment. Worldwide, depression represents the fourth leading cause of disability in terms of loss of healthy years of life, and in Mexico it is the leading cause of disability for women and the ninth for men (Berenzon, 2013). However, approximately 20% of cases present a chronic course that results in a high suicide mortality rate due to the lack of adequate treatment (OMS, 2001).

Disorders of this type can be treated with general measures and psychotherapy. Psychotherapy is a space that is built by a therapist and a patient, with certain tools (assessment, analysis, understanding and intervention), which are placed at the service of a person who requires help. Therefore, the objective of this project is to facilitate the tools for proper care of depression, mainly in young adults through the development of a mobile application that monitors patients. A web system will also be included as part of the project in which the user will be able to know more detailed information about the records generated in the Android application, in this will be given to know more about depression. At the same time the administrators will be able to access a section where they will be able to see the general information collected in all the accounts of the application. To carry out the project the enhanced waterfall model was implemented because the feedback between the different phases of the system development life cycle is important to make the appropriate modifications. The application of interviews and the use of brainstorming were the way in which all the system requirements were designed and the goals to be met by the system were adequately defined.

2 Requirements

Requirements elicitation techniques allow to know the requirements involved in the project. There is a great diversity of techniques for the elicitation of requirements, for the collection of the project requirements the interview and brainstorming techniques were used. The interview is one of the most useful techniques for obtaining information. It is a widely used technique and requires good preparation of the analysts. The way it is approached and the relationship during the interview is important (García, 2007). For the development of this project, interviews were conducted with various experts on the subject (in the field of health) who provided key information regarding the measures that support the fight against depression, the relevant documentation of the interviews was made and the various requirements to be developed in the system were identified.

The aforementioned requirements are listed below:

Functional requirements:
1. FR.1: Login.
2. FR.2: Register.
3. FR.3: Update account data.
4. FR.4: Link user accounts.
5. FR.5: Establish emergency contact.
6. FR.6: Cancel links.
7. FR.7: Press panic button.
8. FR.8: Registration of emotional state
9. FR.9: Registration of resting state.
10. FR.10: Consult virtual chat question.
11. FR.11: Apply predictive model.
12. FR.12: Display general status.
13. FR.13: Display depression status.
14. FR.14: Retrieve password.
15. FR.15: Login to website.
16. FR.16: Manage users.
17. FR.17: Manage links.
18. FR.18: Manage emotional and rest status.
19. FR.19: Generate reports.

Non-functional requirements:
1. NFR.1: Account access.
2. NFR.2: Database Backup.
3. NFR.3: Registration error.
4. NFR.4: Empty fields.
5. NFR.5: Error loading data.
6. NFR.6: Internet connection.

Interface requirements:
1. IR.1: Intuitive interface.
2. IR.2: Color palette.
3. IR.3: Consistency.
4. IR.4: Supporting texts.

Quality requirements:
1. QR.1: Performance.

Evolution requirements:
1. ER.1: Modularity.

Project requirements:
1. PR.1: Duration

Support requirements:
1. SR.1: Mobile device.
2. SR.2: Web browser.

3 Design

For the development of the system, a three-tier architecture was used, which allows the distribution of the application's functionality among three independent systems, named below:
- Presentation (or client) layer: This layer shows the graphical interfaces designed, which allow the user to interact with the system (forms, reports).
- Business (or intermediate) layer: This layer is dedicated to the business logic. Here, the actions to be performed through the presentation layer are received, and the corresponding updates are performed in the data layer. This layer functions as the intermediary between the presentation layer and the data layer (validations, calculations, processes...).
- Data access layer (or server): The function of this layer is to store, update and query all the data contained in the system (Databases, tables, stored procedures).

The advantage of the three-tier architecture lies in the clear separation of responsibilities, which facilitates maintenance, scalability and collaboration in software development. In addition, it allows that changes in one tier do not directly affect the other tiers, which improves the flexibility and modularity of the system (IBM, 2014). The modeling of the project architecture is shown in Figure 1 below.
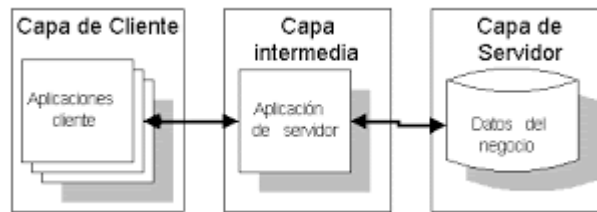

Figure 1. Three.tier architecture of the project

For the design of the corresponding user interface, two main types of sketches were made, firstly those necessary for the interaction with the mobile devices from the user's side, then those sketches made for the website windows in which the administrator also interacts will be presented. Figure 2 shows the first screens to be shown to the user, being the main page, the option to register or log in and the login with an email and password.

Figure 2. Main Screen, Login or Registration Selection and Application Login

Figure 3 shows the form to properly register in the system by entering the user's personal information, a main window (after logging in) where the user's profile data is displayed and a menu with all the available options at the top. In the last screen you can see a graph with the levels of depression detected in the user.

Figure 3. User registration, User information and Graph with levels of depression in the application.

As the last window in the application's user interface is the system configuration section where you can update data, link with caregivers, security policies, about the system and the doubts section. The next window shows a view for the caregivers where a map with the location of the monitored person will be displayed when he/she presses the panic button. The last window shows the virtual advice section which will be a simple chat between the system and the monitored (Figure 4).

Figure 4. User Settings, Caregiver Information and Virtual Counseling in the Application

Finally, the interface sketches for the website are placed with the corresponding login for users, visualization of their emotional state for patients, and user management by the administrator within the website (Figure 5).

Figure 5. Login, Status Display and User Management on the Web Site

The database was created using MySQL WorkBench software, in which 6 main entities were identified (Caregivers, Supervised, Breaks, Emotions, Locations and States) from which 5 more tables were derived to establish the foreign keys that would allow the corresponding tables to be related. The following figure displays the previously described database and the corresponding relations between all the entities.
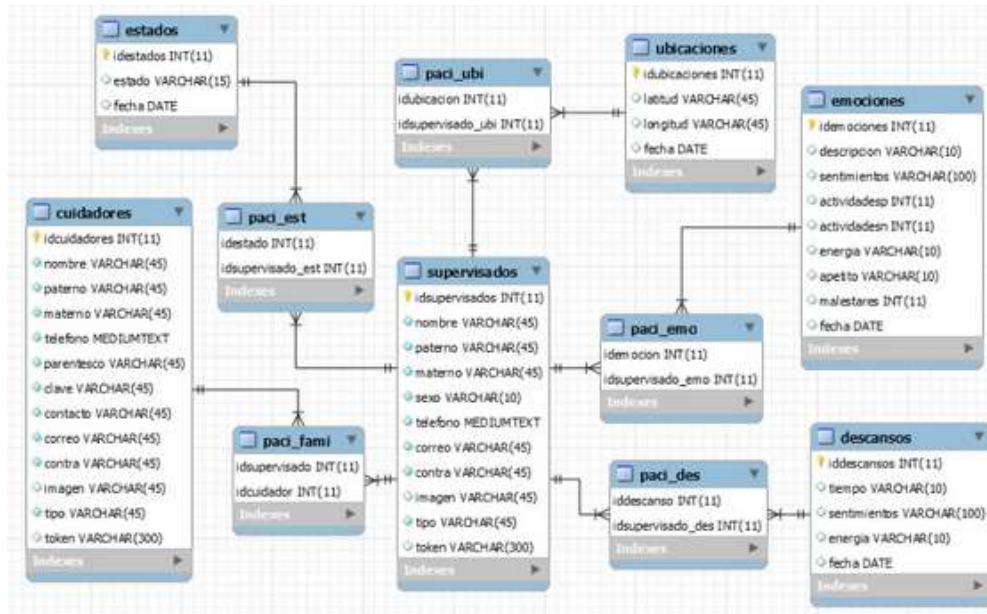
Figure 6. Relational Database Model

4 Implementation

The implementation of the system was done using the enhanced waterfall model, using Java and PHP as the main programming languages and various libraries and tools for the correct development of the application. The integrated development environment used was Android Studio due to the power as a code editor both in Java and other languages, the developer tools it provides and in general the unified environment it provides to develop on all Android devices (Android Developers, 2019). The following figure shows how all the components of the system interact according to the three-tier architecture implemented, where the server interacts with their respective components and the user interacts with his Smartphone through the HTTPS protocol.
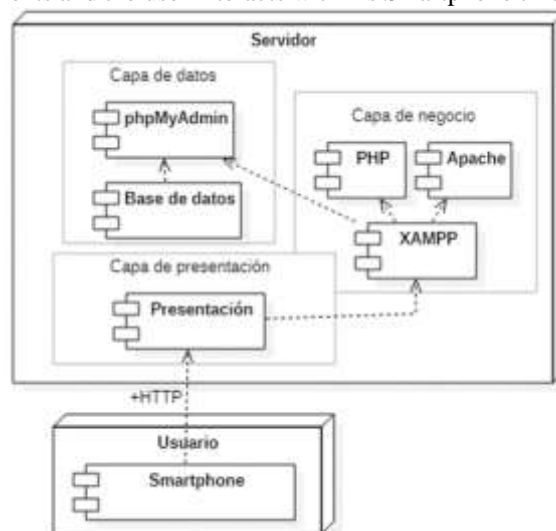
Figure 7. Diagram of system components

At the moment of implementing the system there were a series of problems mainly regarding the use of XAMPP for the management of the MySql service as well as the connection between the server and phpMyAdmin, causing that the application would not perform successful queries to the database. This was solved by first changing the port for the MySql service to 3307 and creating a new user with the necessary privileges to perform the necessary queries with the server.

5 Software testing

This section describes the various tests to which the system was subjected in order to validate that the previously stated requirements were satisfactorily met. The first point is to define the technical characteristics of the Android mobile devices on which the tests were performed (Table 1 and 2):

Table 1. Technical specifications of device 1

Technical specifications of device 1	
Modelo device model	Samsung J6+
Android version	9.0 Pie
Storage capacity	32 GB
RAM memory	3 GB
Date	March 24, 2020

Table 2. Technical specifications of device 2

Technical specifications of device 2	
Modelo device model	Motorola Moto G5
Android version	7.0 Nougat
Storage capacity	16 GB
RAM memory	2 GB
Date	March 24, 2020

The execution of the test plan was carried out according to the format defined for each functional requirement, in which the correct behavior of the mobile application will be evaluated, ensuring a correct experience for the users of the system. Each of the tests indicates the functional requirement to be tested, the person in charge assigned to carry out the test and the person responsible for evaluating it, as well as a description of the actions taken and the results obtained at the end of the test, allowing to have a detailed record of the system's test plan.

Table 3. Functional requirement 1 test format

FR. 1 Login	
GENERAL TEST DATA	
Requirement to be tested: FR.1 Iniciar sesión	Executor: Maria Arely Gabriel Romero
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes
Development	
Objective: Test the correct functioning of the login.	
Conditions of execution: The user will be able to enter the system using the email and password with which he/she has previously registered.	
Inputs: Email and password	

Actions	Expected results	Achieved results
1. Run the system. 2. Select "Log in". 3. Enter the e-mail and password of the registered user. 4. Click on the "Login" button.	1. Display the system startup window. 2. Show password form and password. 3. Show startup window	The system login was performed correctly.
Test evaluation: The test was carried out successfully.		
Corrective actions: None.		

Once the test was successfully completed, Figure 8 shows the correct login to the mobile application as well as the main window with the user's data.
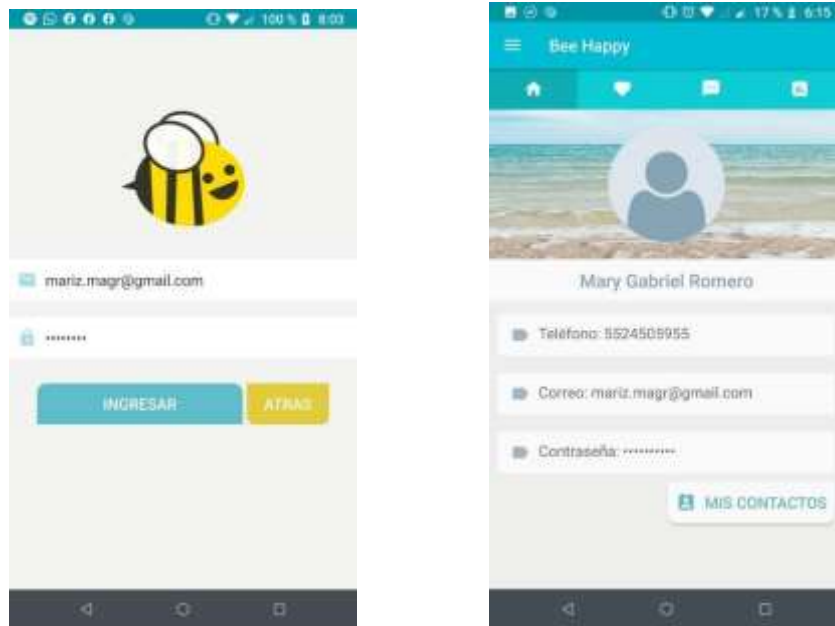

Figure 8. Login and user window in the mobile application.

Table 4. Functional requirement 2 test format.

FR. 2 Register		
GENERAL TEST DATA		
Requirement to be tested: FR. 2 Register	Executor: Juan Carlos Hernández Trujillo	
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes	
Development		
Objective: Show the operation of the registry where the user signs up in the system.		
Conditions of execution: The user must fill in the required data for the system to validate them and if they are correct, register him/her in the system.		
Inputs: Name, surname, password and email.		
Actions	Expected results	Achieved results

1. Execute the system. 2. Select the option to register in the system. 3. Fill out the user registration forms. 4. Send the data.	1. Show the start window. 2. Show the form. 3. Perform registration.	The registration is carried out correctly, in the same way the system validates possible errors.
Test evaluation: The test was carried out successfully.		
Corrective actions: None.		

Once the test was successfully completed, Figure 9 shows the correct user registration within the mobile application as well as the window with the user's data.
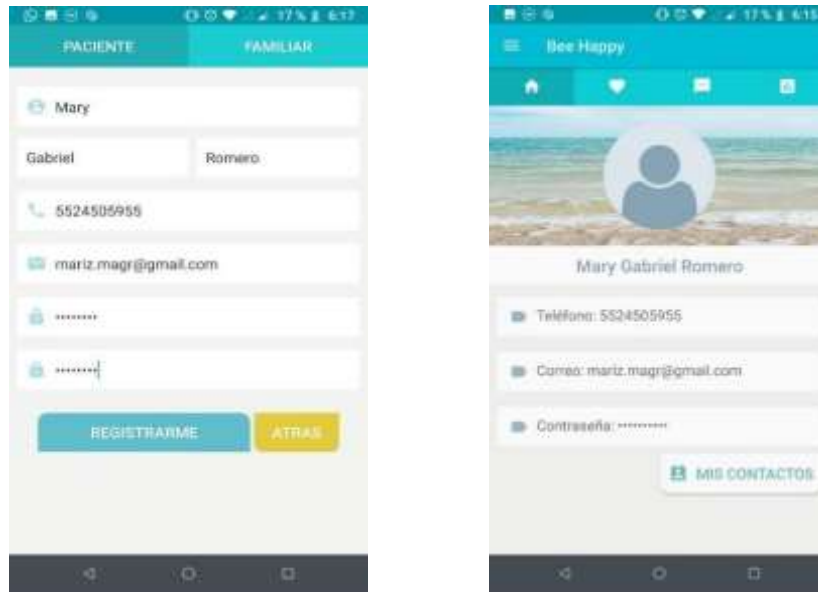

Figure 9. User registration and information in the mobile application

Table 5. Functional requirement 3 test format

FR. 3 Update account data		
GENERAL TEST DATA		
Requirement to be tested: FR. 3 Update account data	Executor: Maria Arely Gabriel Romero.	
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes	
Development		
Objective: Test the update of the user's account data.		
Conditions of execution: The user must change the data to be modified in the registry.		
Inputs: Data to edit.		
Actions	Expected results	Achieved results
1. The user selects the account avoidance option. 2. The user edits the fields to be modified. 3. Selects "Save".	1. Your account information is displayed. 2. The application updates the data in the database.	The update of the user data is successful and the system takes into account possible errors.

| Test evaluation: The test was carried out successfully. |
| Corrective actions: None. |

Once the test has been successfully completed, Figure 10 shows the correct editing of the data, going through the confirmation of the changes and finally showing the edited user data.

Figure 10. Editing user data in the mobile application.
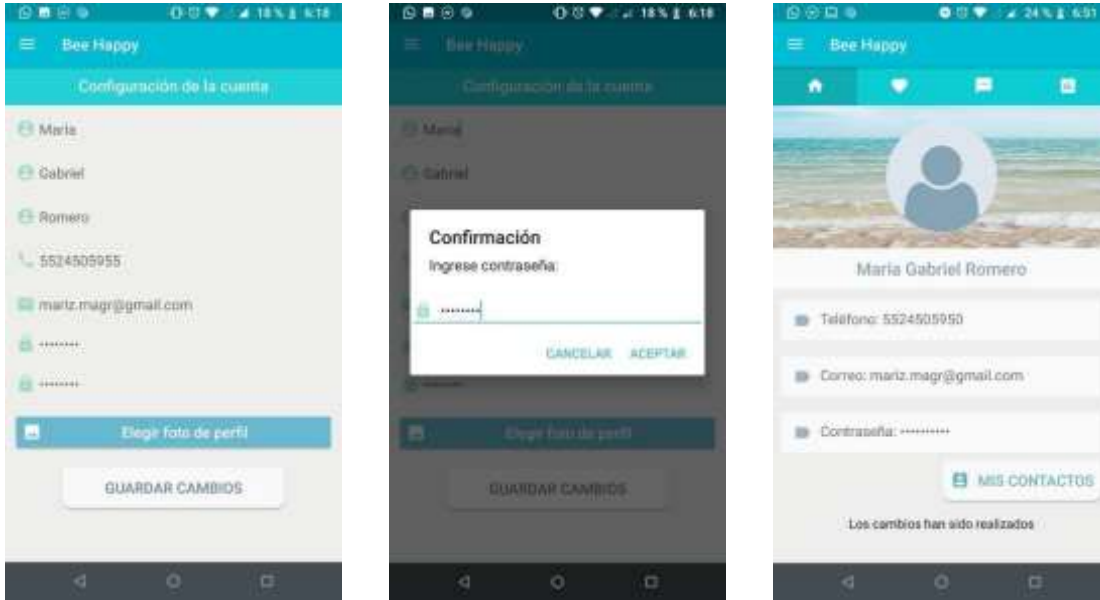
Table 6. Functional requirement 4 test format

<table>
<tr><td colspan="3">FR. 4 Link user accounts</td></tr>
<tr><td colspan="3">GENERAL TEST DATA</td></tr>
<tr><td rowspan="2">Requirement to be tested: FR. 4 Link user accounts</td><td colspan="2">Executor: Juan Carlos Hernández Trujillo</td></tr>
<tr><td colspan="2">Evaluator: Dr. Miguel Ángel Ruiz Jaimes</td></tr>
<tr><td colspan="3">Development</td></tr>
<tr><td colspan="3">Objective: Create a linkage between the users so that they can later receive the user's information and also be selected as an emergency contact.</td></tr>
<tr><td colspan="3">Conditions of execution:The user must have the user's password to be assigned.</td></tr>
<tr><td colspan="3">Inputs: Linking key.</td></tr>
<tr><td>Actions</td><td>Expected results</td><td>Achieved results</td></tr>
<tr><td>1. Select the option to add a user.
2. Enter the linking key.
3. Select "Add".</td><td>1. Displays the window of added contacts.
2. Adds the contact to the contact list.</td><td>The user can add a new user to his contact list.</td></tr>
<tr><td colspan="3">Test evaluation: The test was carried out successfully.</td></tr>
<tr><td colspan="3">Corrective actions: None.</td></tr>
</table>

Once the test has been successfully completed, Figure 11 shows the process required to link the users and the possibility of being established as an emergency contact.
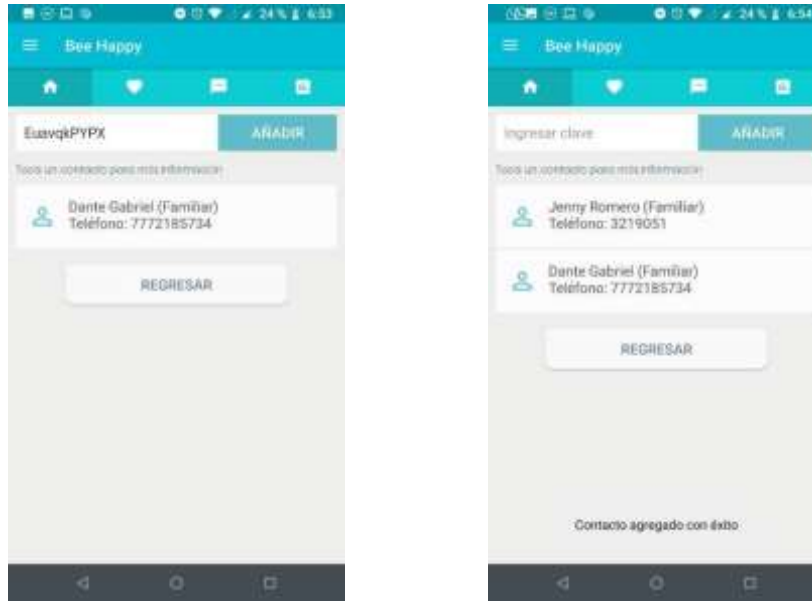
Figure 11. Linking of user accounts in the mobile application.

Table 7. Functional requirement 5 test format.

FR. 5 Establish emergency contact		
GENERAL TEST DATA		
Requirement to be tested: FR. 5 Establish emergency contact	Executor: Maria Arely Gabriel Romero	
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes	
Development		
Objective: Display the correct operation to establish a contact as an emergency contact.		
Conditions of execution: The user must have at least two registered users, because if there is only one, it will be assigned by default as emergency contact.		
Inputs: None.		
Actions	Expected results	Achieved results
1. Enter the contacts section. 2. Select the contact to establish. 3. Select "Establish emergency". 4. Confirm the action.	1. Displays the contact list. 2. Open the contact's profile. 3. Show confirmation. 4. Set as emergency contact.	It was possible to establish a user as an emergency contact.
Test evaluation: The test was carried out successfully.		
Corrective actions: None.		

Once the test has been successfully completed, Figure 12 shows the process required to establish an emergency contact and the options available for communicating with that contact:
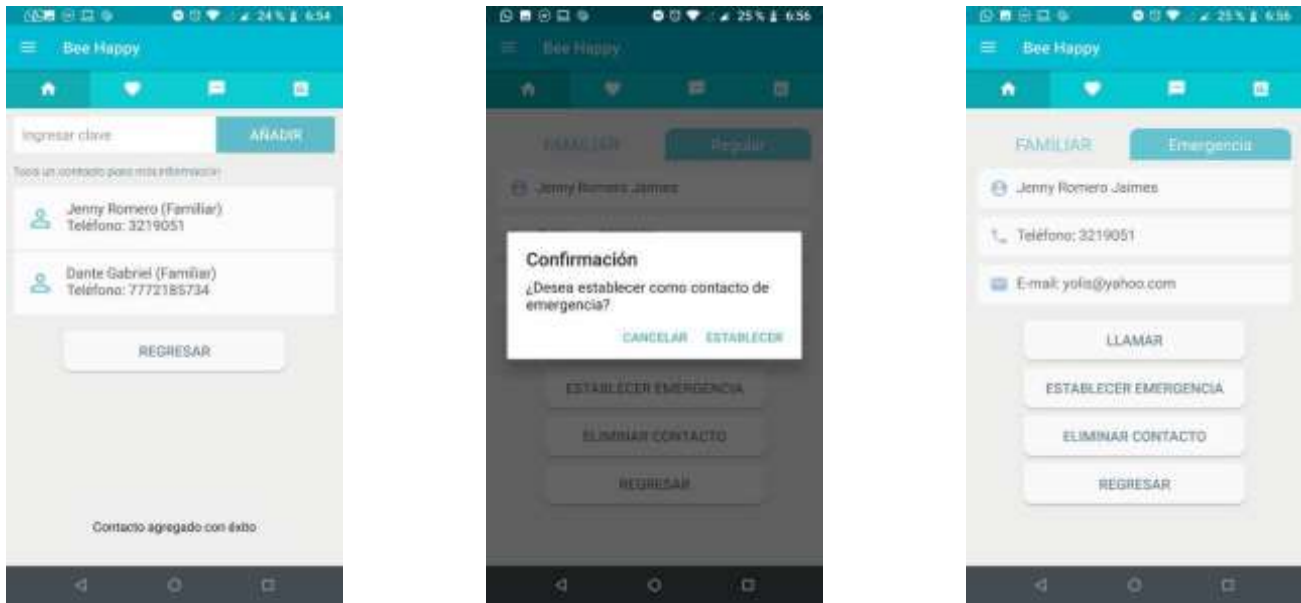
Figure 12. Establish user emergency contact in the mobile application.

Table 8. Functional requirement 6 test format

FR. 6 Cancel links		
GENERAL TEST DATA		
Requirement to be tested: FR. 6 Cancel links	Executor: Juan Carlos Hernández Trujillo	
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes	
Development		
Objective: Provide the option for the user to delete a contact from his list.		
Conditions of execution: The user must access the profile of the person to be deleted and select the option, in the case of an emergency contact this cannot be deleted.		
Inputs: User to delete		
Actions	Expected results	Achieved results
1. Select the contacts option. 2. Enter the user's profile. 3. Select the delete option. 4. Confirm the action	1. Display the list of contacts. 2. Display user information. 3. Ask for confirmation. 4. Remove the user's link.	The user can delete the user of his choice as long as he is not the emergency contact.
Test evaluation: The test was carried out successfully.		
Corrective actions: None.		

Once the test has been successfully completed, Figure 13 shows the process required to remove the linkage of a user as long as this user is not the emergency contact:
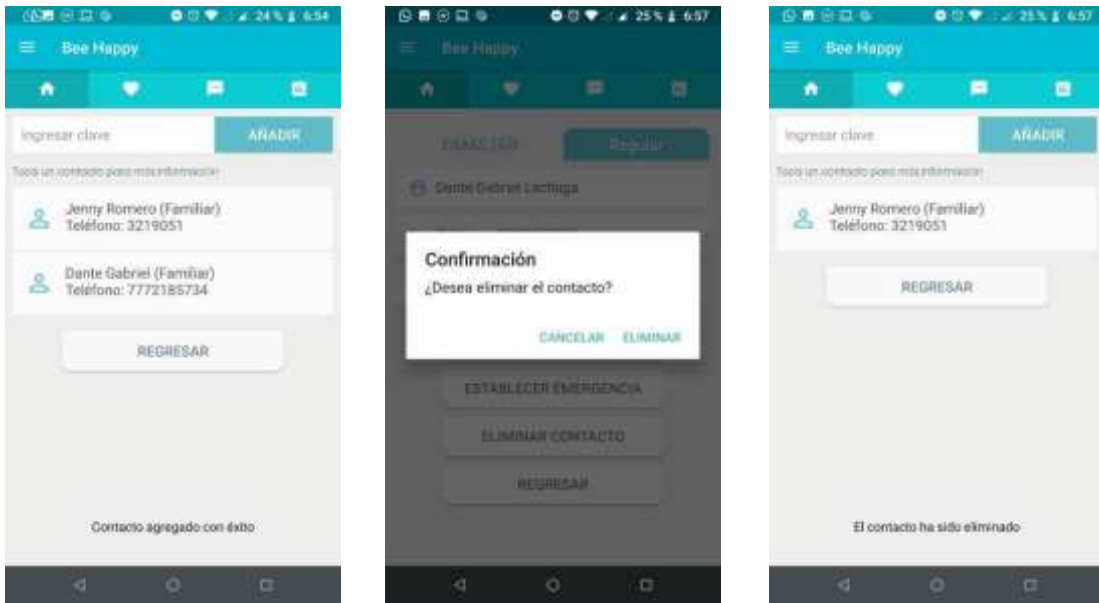
Figure 13. Deleting a user account in the mobile application.

Table 9. Functional requirement 7 test format.

FR. 7 Press panic button
GENERAL TEST DATA

Requirement to be tested: FR. 7 Press panic button	Executor: Maria Arely Gabriel Romero
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes

Development
Objective: Show the functionality of the panic button.
Conditions of execution: The user must press the panic button to send the alert to the caregiver user.
Inputs: None.

Actions	Expected results	Achieved results
1. The user presses the panic button. 2. Confirm action 3. A confirmation message is displayed.	1. Confirmation is requested. 2. The notification is sent. 3. The caregiver user receives a notification with the address.	The system sends a notification with the contact's information and address when pressed.

Test evaluation: The test was carried out successfully.
Corrective actions: None.

Once the test has been successfully completed, the user's activation of the panic button and the notification displayed to the emergency contact can be seen in Figure 14:
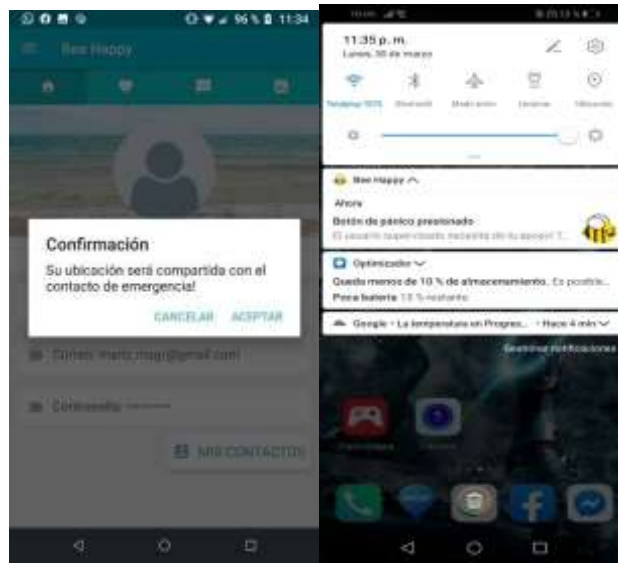
Figure 14. Use of the panic button and administrator's notification in the mobile application.

Table 10. Functional requirement 8 test format.

FR. 8 Registration of emotional state		
GENERAL TEST DATA		
Requirement to be tested: FR. 8 Registration of emotional state	Executor: Juan Carlos Hernández Trujillo	
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes	
Development		
Objective: Display the functionality of the emotional state register.		
Conditions of execution: The user must enter the correct data in the emotional register option.		
Inputs: Feelings experienced during the day, activities performed, energy level felt, appetite level, discomforts that affected the day.		
Actions	Expected results	Achieved results
1. Select the option to register the emotional state. 2. Fill in the registration data. 3. Click on save.	1. Display the forms of the emotional register. 2. Register the emotional data in the database.	The system validates the data and registers it in the database.
Test evaluation: The test was carried out successfully.		
Corrective actions: None.		

Once the test has been successfully completed, Figure 15 shows the recording of the emotional state by the user and the notification shown to the emergency contact:

Figure 15. Recording of the emotional state in the mobile application.

Table 11. Functional requirement 9 test format.

FR. 9 Registration of resting state		
GENERAL TEST DATA		
Requirement to be tested: FR. 9 Registration of resting state	Executor: Maria Arely Gabriel Romero	
	Evaluator: Dr. Miguel Ángel Ruiz Jaimes	
Development		
Objective: Display the correct execution of the rest status registration in the system.		
Conditions of execution: The user must fill in the required data correctly.		
Inputs: Time of start of sleep, time of waking up, energy level felt when waking up, type of feelings felt when waking up.		
Actions	Expected results	Achieved results
1. Select the sleep registration option. 2. Fill in the corresponding data. 3. Select "Save".	1. Show the sleep registration form. 2. Save the records in the database.	The system validates and stores the data entered correctly.
Test evaluation: The test was carried out successfully.		
Corrective actions: None.		

Once the test has been successfully completed, Figure 16 shows the recording of the emotional state by the user and the notification shown to the emergency contact:

Figure 16. Recording the state of rest in the mobile application

6 Conclusions

During the course of this project, the overall objective was successfully achieved, which consisted in the development and implementation of a mobile application capable of detecting the state of depression in users by monitoring relevant variables, with the purpose of providing adequate support. Throughout the development process, challenges arose that affected the progress of the project. It was necessary to acquire knowledge on various topics on an ongoing basis and to conduct research to apply principles from different areas of knowledge, such as psychology, in the implemented system. In addition, it was necessary to learn how to create a detection model using data mining techniques, collect data through forms and then implement all of this in both the mobile application and the website. The Bee Happy project has considerable potential, given the growing interest in intelligent systems that monitor people's daily lives. Therefore, some future opportunities for the project include expanding the amount of information available to enrich the predictive model database, integrating biometric data to improve the reliability of the system, incorporating a virtual treatment system with psychologists to interact with users, and expanding the age range of participating users.

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