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PAPER

Mobile Recommendation System to Provide Emotional Support and Promote Active Aging for Older Adults in the Republic of Panama

Nila Navarro[1], Denis Cedeno-Moreno[1](✉), Víctor López[1], Ericka Matus[2], Ivonne Nuñez[1], Dimas H. Concepción[1]

[1]Technological University of Panamá, Panamá City, Panamá

[2]Specialized University of the Americas, Panamá City, Panamá

denis.cedeno@utp.ac.pa

ABSTRACT

Aging brings with it physical and cognitive changes that can lead to health problems such as chronic disease and cognitive impairment. Technology is a fundamental ally in improving the quality of life of older adults by enabling accurate and early diagnosis. In this context, we present a mobile application designed to provide emotional support and guidance, thus contributing to the well-being of this demographic group. Our study was based on quantitative research methods, using an experimental approach on a sample of users aged between 60 and 80 years. The results showed that 93.3% of users found the app to be a useful resource for adopting a healthier lifestyle. The app provides specific recommendations, such as breathing exercises to reduce anxiety, recreational activities, exercises tailored to physical ability, and meditation practices. These specific features have been shown to improve the well-being of older adults by providing a personalized approach to the challenges of aging.

KEYWORDS

Mobile technology, healthy living, older adult, mHealth, self-care, digital health

1 INTRODUCTION

Throughout our lives, we go through different stages of development that play a fundamental role in our identity and growth. From infancy to old age, we experience remarkable changes in physical, emotional, and social aspects. Childhood is characterized by rapid growth and development, providing us with social, cognitive, and emotional skills that will accompany us throughout our lives. In adolescence, characterized by physical and emotional changes, we begin to explore emotions and form meaningful relationships that can last a lifetime [1]. Adulthood is characterized by making important decisions about work, family, and lifestyle, and by gaining experiences that allow us to face challenges with resilience.

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Finally, old age, a natural aging process, brings physical and mental changes, but can also be a time of wisdom, reflection, and gratitude. Staying physically and mentally active and enjoying meaningful relationships and experiences is essential at this stage.

However, aging can also bring challenges such as reduced mobility, memory, and overall health, which can lead to a loss of independence and the need to rely on others for daily activities [2]–[4]. In this context, technology can be an invaluable ally. Assistive devices, such as hearing aids and prosthetics, improve hearing and mobility, while apps and online platforms keep seniors connected to friends and family and encourage mental activity [5]–[10]. In addition, technology provides access to health, education and entertainment services that contribute to lifelong learning and enjoyment [11]–[18].

Today, the world is experiencing a rapidly aging population. According to the World Health Organization, the number of people aged 60 years and older is projected to double by 2050, from 900 million in 2015 to approximately 2 billion [19]. Given the challenges faced by older adults, especially in the context of the COVID-19 pandemic, we propose the development of a mobile application that functions as an emotional and physical tool for this demography. This application would provide resources and services to help older adults stay active, connected, and healthy. For example, it could offer physical and mental exercise suggestions to maintain mobility and mental agility, health tracking tools to monitor vital signs, nutrition and dietary information, and social connectivity features to stay in touch with friends and family.

This research makes three fundamental contributions: first, it presents a mobile system designed to foster autonomy and active aging in older people, addressing psychosocial problems such as loneliness and isolation, especially critical in health crisis situations; second, it emphasizes the importance of accessible and customizable interfaces that allow this demographic group to make informed decisions about their health; and finally, it proposes a comprehensive evaluation of the effectiveness of digital interventions and underscores the relevance of adapting these technologies to different cultural contexts, exemplified by their implementation in the Republic of Panama, in order to better understand the specific needs and obstacles faced by older adults in diverse cultures.

This article is structured as follows: Section II outlines the related works and the motivation behind the conducted study. Section III elaborates on the methodological procedure employed for the study's development. In Section IV, the testing process and initial findings are explained. Section V engages in a discussion of the primary discoveries. The conclusions drawn from this study and potential avenues for future research are presented in Section VI.

2 BACKGROUND

Technology has emerged as a key tool in healthcare to improve medical care, disease prevention, diagnosis, treatment, and patient recovery. Mobile computing, using mobile devices such as smartphones and tablets, has played an important role in healthcare, allowing patients to monitor their health in real time, access their medical information, and seek advice and treatment online [20], [21].

Wearable devices, such as smartwatches and activity monitors, also allow patients to monitor their health and physical activity in real time [22]–[25].

The impact of technology has been so pronounced that many advances have been made in education, with studies highlighting the benefits of online education, access to educational resources through mobile devices, and personalization of education to meet the needs of each student [26]–[34]. In addition, the technology has

been applied in several locations, including the United States, the United Kingdom, Ireland, Jerusalem, Beijing, Shanghai (Malaysia) and Hong Kong, where projects have been undertaken to develop mobile applications for health telemonitoring, the use of wearable devices such as medical monitors and fall detection systems, mobile applications for mental illness and mobile applications to combat loneliness [35]–[44]. These initiatives represent significant advances in the integration of technology into healthcare and education for the benefit of older people.

Therefore, mobile technology has emerged as a powerful tool for developing healthcare applications for the elderly to improve medical care for this population.

This study is framed within the concept of active aging as suggested by the World Health Organization (WHO), which defines it as "a continuous process of optimizing opportunities to maintain and improve physical and mental health, independence and quality of life throughout life" [45]. Dynamic aging implies engagement with society and obtaining shelter, support, and protection. Its fundamental principles are health, participation, and security. The health aspect is based on the prevention of diseases and disability. Participation encompasses involvement in the workplace, volunteer activities and educational opportunities tailored to individual needs. The safety component aims to ensure the physical and emotional well-being of older individuals [46], [47].

2.1 Related work

To ensure that the most relevant and appropriate articles on the target topics were selected for this study, we established a set of criteria. These criteria were based on factors such as content relevance, source quality, and authority, as well as the publication date and current relevance of the topic being discussed. Based on these criteria, we selected the most useful and trustworthy articles for reference. Our selection criteria are listed in Table 1.

Table 1. Selection criteria

Search Criteria	
Publication Type	Conference papers and journal articles
Language	English
Year Range	Published between 2015 and 2023 to ensure that the information gathered was up to date
Search Engines	PubMed, Mdpi, BASE, SCOPUS, IEEE Xplore
Topic	Use of mobile technology as a support to improve quality of life

Here, we describe the articles that met the established criteria. Several studies have been conducted on the use of mobile technology in healthcare for the elderly population. In [48], the authors focused on the development of a mobile time-banking system for community care of elderly people. This system allows community members to exchange time and skills to help elderly people who require assistance with their daily activities. It also aims to improve the quality of life of the elderly and reduce the economic burden on formal caregivers. Another study [49] reviewed the effectiveness of mobile health applications for the self-management of patients with chronic obstructive pulmonary disease. The results indicated that mobile applications can be effective tools for improving quality of life and reducing symptoms in patients with this disease. Patients who used mobile apps reported greater adherence to treatment plans and better management of their health.

The authors of [50] examined the acceptance of mobile technology among older adults. They found that the acceptance of mobile technology varies among older adults and depends on factors such as accessibility, ease of use, and perceived value. Most older adults consider mobile applications to be useful for monitoring their health. However, they have concerns regarding the privacy and security of their personal information. Similarly, the authors of [51] focused on the relationship between the use of mobile devices and loneliness among older adults during the COVID-19 pandemic. The results indicated that the use of mobile applications can reduce loneliness in older adults because it allows them to stay in touch with friends and family, as well as to access information and support services.

Through a systematic review and meta-analysis, the authors of [52] evaluated the impact of mobile applications on medication adherence in patients with cardiovascular diseases. The results suggest that the use of mobile devices can improve medication adherence, which can significantly affect the prevention and treatment of cardiovascular diseases. Similarly, the authors of [53] conducted a review and compared mobile health applications for elderly care. They identified the common features of effective mobile applications for elderly care, including ease of use, personalization, and accessibility. It was also found that mobile applications can be useful for improving communication between patients and healthcare providers, as well as for promoting a healthy lifestyle. Finally, the authors of [54] conducted a systematic review of the design of persuasive features and interfaces in mobile health applications for older adults. The results indicated that the design of mobile device applications should consider the needs and preferences of older adults and provide visual and auditory feedback, as well as customization options. Additionally, the importance of careful evaluation of the impact of mobile health applications on the health and wellbeing of older adults was emphasized. Table 2 shows each of the approaches and functionalities used in the various studies cited.

Table 2. Summary of the approaches and functionalities in the cited works

Approach	Functionality	Reference
Mobile time banking system for elderly care	Exchange of skills and time to support the elderly.	[48]
Mobile Health Apps for Chronic Obstructive Pulmonary Disease Self-Management	Improved COPD management and compliance.	[49]
Technology adoption among the elderly	Useful for health monitoring; privacy concerns.	[50]
Mobile apps to reduce loneliness in the elderly	Reduces loneliness, promotes connectedness.	[51]
Mobile applications and medication adherence	Improves medication compliance.	[52]
Comparative study of apps for elderly care	Supports communication, health care interaction.	[53]
Persuasive design in health apps for the elderly	Tailored design, feedback, impact evaluation	[54]

2.2 Problem description and motivation

The issue addressed in this article focuses on the use of mobile technology in the health care of older adults. The effectiveness of health apps in chronic disease self-management, the acceptability of the technology among older adults, and the potential benefits of this technology were examined. It also identified challenges

such as developing effective and user-friendly mobile health applications, addressing privacy and security concerns, and ensuring equitable access to this technology.

According to data from Panama's National Institute of Statistics and Census, shown in Figure 1, the proportion of adults over 60 years of age in the population continues to grow steadily and is projected to represent 24% of the total population by 2050. This increase highlights the urgent need to address the emotional well-being and quality of life of this growing population of older adults [55].

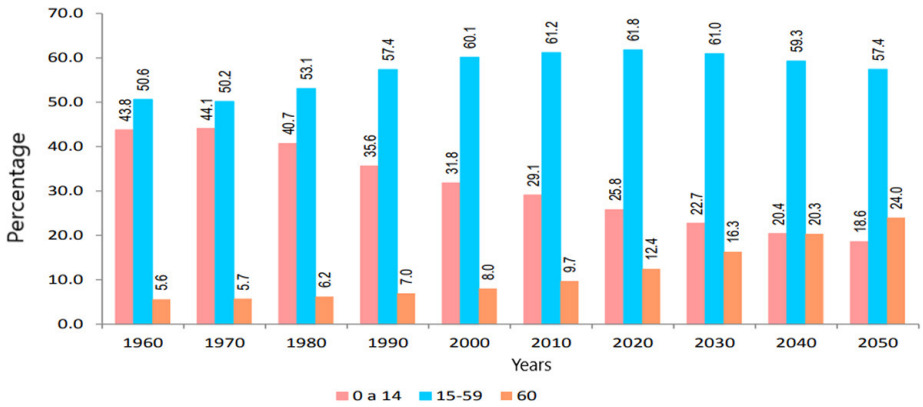

Fig. 1. Percentage distribution of population estimates and projections by major age groups: As of July 1, period 1960–2050 [55]

On the other hand, Figure 2 presents estimates and projections from the United Nations, which indicate that by 2050, one in five people in the world will be 60 years of age or older. The aging of the population is not limited to Europe and North America, but also extends to other regions of the world [56].

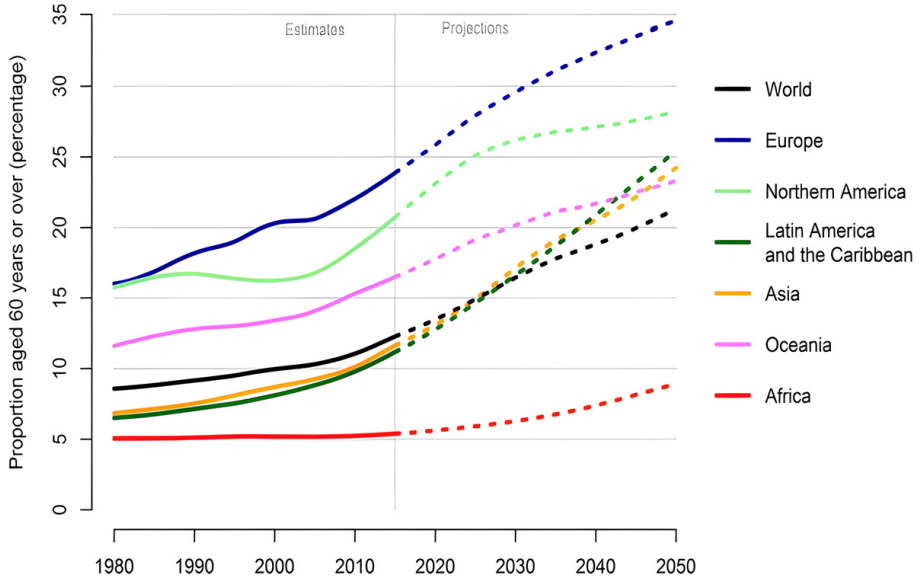

Fig. 2. Percentage of population aged 60 years or over by region, from 1980 to 2050 [56]

Faced with this demographic reality, our project, which is at the intersection of innovation and social relevance, seeks to explore how mobile technology can contribute to improving the emotional and mental well-being of older adults in Panama. Our goal is to promote an active and emotionally satisfying aging that meets the needs of this growing population.

3 MATERIALS AND METHODS

3.1 Methodology

The Kanban methodology was adopted in this study because it is a highly visual methodology that allows us to obtain a clear and current view of the status of each task, as well as the overall progress of the project. This facilitated decision making and the identification of bottlenecks that could delay development [57]–[59].

Additionally, this methodology is highly flexible and adaptable, which is particularly important for projects with relatively small teams. In the absence of a full team for handling different responsibilities, Kanban enables a single person to manage and assign tasks according to the capacities and schedules of individuals.

Moreover, Kanban focuses on a constant flow of work, that is, a developer can always prioritize and work on the most important tasks for a project. Additionally, Kanban facilitates the rapid identification and resolution of problems because tasks are broken down into smaller and more manageable elements.

The Kanban methodology approach is based on a set of key suggestions, as shown in Figure 3, that are designed to optimize work management and promote continuous process improvement. These suggestions provide insights into how to effectively approach work planning and execution to promote agility and efficiency. They are described below:

- Visualize your work: Depict tasks on a visual board using cards that progress as they are completed.
- Limit Work in Progress: Set limits on work in progress to maintain a steady flow and avoid overload.
- Manage Workflow: Create columns that represent stages of the process by moving cards between them.
- Make rules explicit: Establish explicit rules for moving cards and making decisions.
- Study and implement feedback: Analyze metrics and feedback to adjust and optimize the ongoing process.

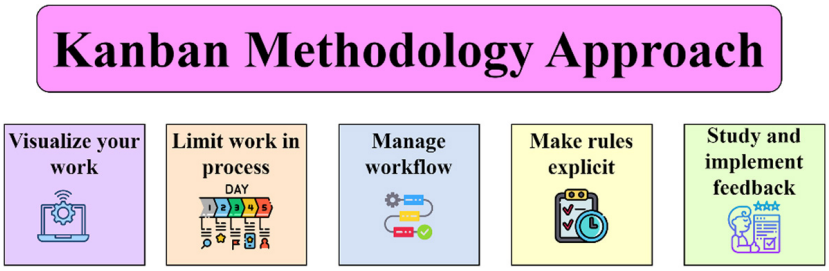

Fig. 3. Graphical representation of the Kanban methodology principles

3.2 Proposed architecture

The physical architecture of a mobile application refers to its physical structure and arrangement of its constituent elements. Figure 4 illustrates how the proposed mobile application is organized by highlighting the main components and their relation to each other. An optimal design is important for ensuring that the mobile device application functions efficiently and effectively and meets the established objectives.

The meticulous design of the physical architecture of our mobile application, designed specifically to meet the needs of older users, has required extensive consideration of a wide range of critical factors. Our efforts revolved around ensuring its effectiveness and utility within this demographic niche. From the very beginning of the development process, we placed the utmost importance on creating a structure that provides a profoundly accessible and user-friendly experience. The result is a thoughtfully streamlined interface, where each visual component is carefully sized and designed to enhance legibility and clarity. This approach ensures that older users are empowered to engage with the application intuitively and comfortably.

In addition, our design approach incorporates innovative elements that facilitate a more seamless integration of the application into the lives of older users. Using subtle but powerful design cues, we enable users to effortlessly navigate the interface by tapping into their existing cognitive and motor patterns. This innovation comes not from reinventing the wheel, but from optimizing the user experience based on a deep understanding of the unique needs and challenges of this demography. In this way, our application's architecture serves as a bridge, combining advanced technology with the real-world needs of older users in a way that is both groundbreaking and pragmatic.

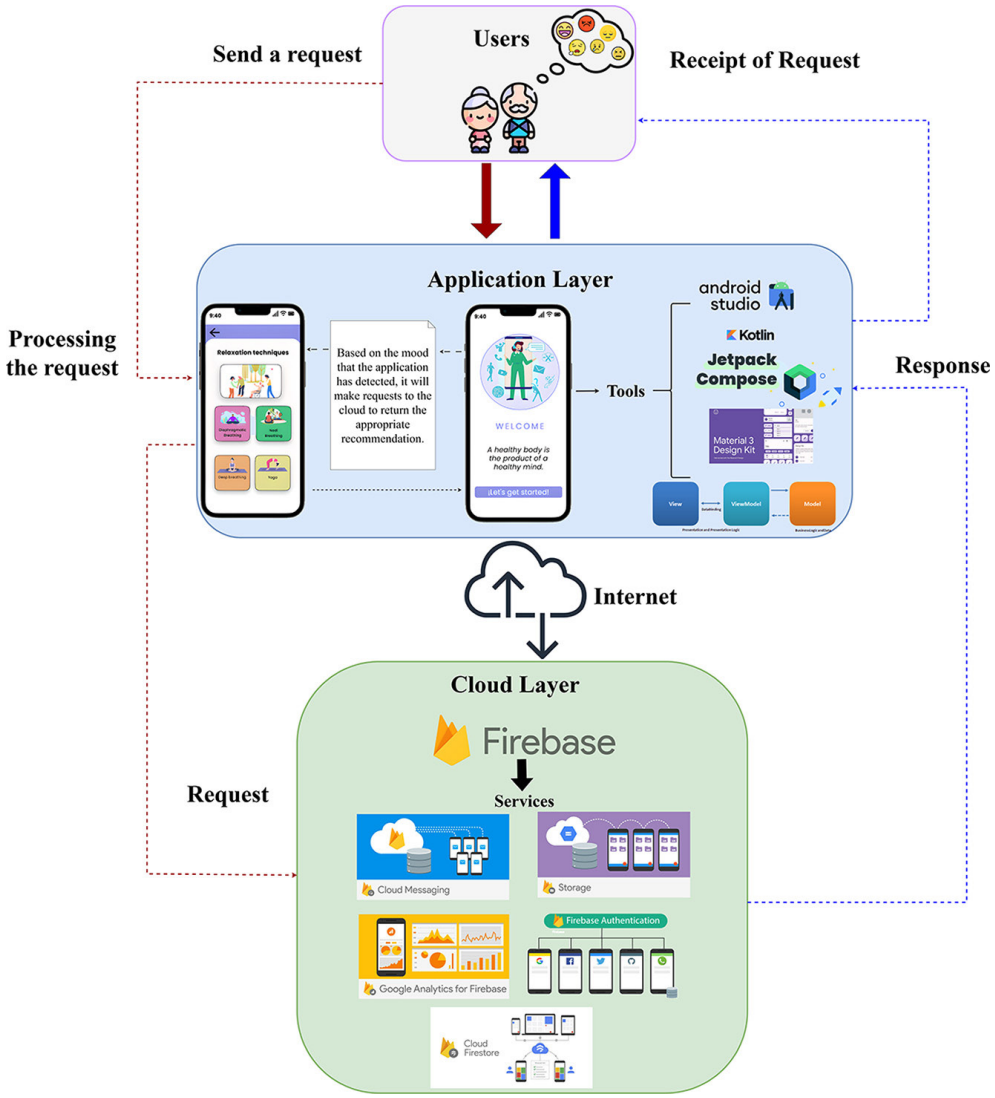

Fig. 4. Physical architecture

Further, we describe how each component of the proposed architecture works.

User interface: The design of the application's user interface has been carefully woven around the specific needs of older adults, a group that is mostly over the age of 60. We took on the challenge of addressing the common difficulties they face when interacting with small visual elements or small buttons.

With this in mind, we have significantly increased the size of the buttons in the application. This approach aims to provide not only a stronger presence, but also a typography that allows for smooth and effortless reading. Recognizing that legibility is a critical factor, we have carefully selected fonts that are easy on the eyes and minimize eye fatigue.

The selection of icons in the interface has also been the subject of careful consideration. Each icon was chosen with clarity and ease of interpretation in mind. This choice results in an experience where visual elements intuitively communicate their function, reducing the need to decipher or interpret ambiguous symbols.

Similarly, the internal navigation of the application has been designed with the intention of being a user-friendly guide. The visual hierarchy has been designed to be consistent and accessible, and each step through the application has been designed with clarity to minimize any potential for confusion. Our focus on design is not limited to aesthetics but is firmly rooted in the ability to enhance the user experience. Through these efforts, we aim to provide seniors with a platform that not only meets their needs, but also allows them to explore and participate in a comfortable, rewarding, and enriching way. Figure 5 shows the visual representation of the mobile application that is part of the presented architecture.

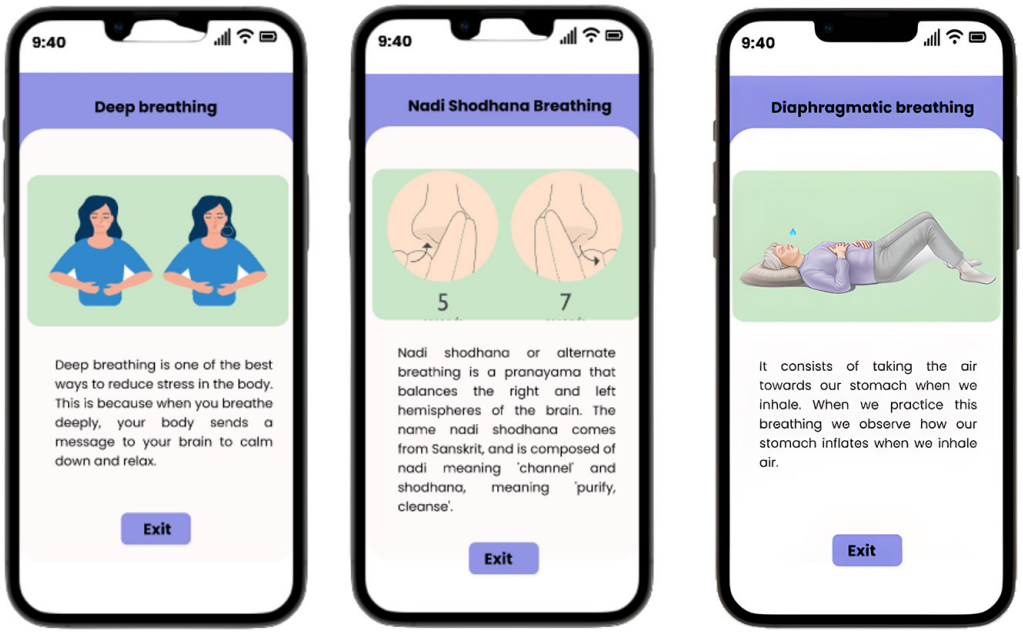

Fig. 5. Mobile interface of the application

Application Layer: The process of developing the mobile application was meticulous, with careful attention paid to each stage of the project. Android Studio was chosen as the central platform to bring the vision to life. The combination of Kotlin and Jetpack Compose proved to be the ideal choice for implementing the user interface, giving the design a contemporary and compelling dimension [60], [61].

Architecture played a key role in the development, and the choice of the MVVM architectural pattern was paramount. This approach allowed for a clear separation of responsibilities, dividing the logic into Model, View, and ViewModel. The resulting structure not only ensured organized and maintainable code, but also fostered efficient collaboration among development team members [62].

A significant evolution occurred with the integration of Material 3 design components. This addition not only improved visual consistency, but also gave the user interface an intuitive and familiar feel. Material 3's design philosophy fit seamlessly with the overarching goal of creating a user experience focused on needs and convenience.

Throughout the process, significant efforts were made to optimize performance and ensure a seamless user experience. Extensive testing protocols were implemented to identify and correct potential bugs, contributing to the stability and reliability of the final application. Figure 3 shows the prototype development environment.

Cloud Layer: Authentication: Firebase Authentication was seamlessly integrated into our application as an integral part of its functionality. This service allows us to establish a robust user authentication system, ensuring that only authorized users have access to the data stored within the application. We also leverage the additional security features it provides, such as password recovery and account management, to provide a secure and reliable experience for our users [63].

Cloud Storage: Firebase Cloud Storage plays a critical role in our application by providing us with a cloud-based repository for storing various types of files. We use this service to store photos, videos, and other relevant files that are critical to the operation of our application. This allows our users to access these files anytime, anywhere, even when they don't have access to their mobile devices or tablets. Additionally, the inherent security measures within Firebase Cloud Storage ensure the protection of files, mitigating any potential loss in the event of user device issues.

Communication: Communication is a central feature within our application tailored for senior users. We have seamlessly integrated Firebase Cloud Messaging (FCM) to enhance our messaging capabilities. Through FCM, we can send real-time notifications to our users to keep them informed of important events and updates within the application. The ability to deliver personalized push notifications, targeted to specific user groups, allows us to always promote effective and relevant communication.

Analytics: Firebase Analytics serves as a central tool within our development approach. Through this service, we aggregate and analyze valuable data about how users interact with our application. This includes metrics such as usage frequency, preferred features, and user behavior. These insights provide us with essential information to make informed decisions and optimize the application to meet the preferences and needs of our user base.

Figure 6 shows the Firebase control panel with the services in use.

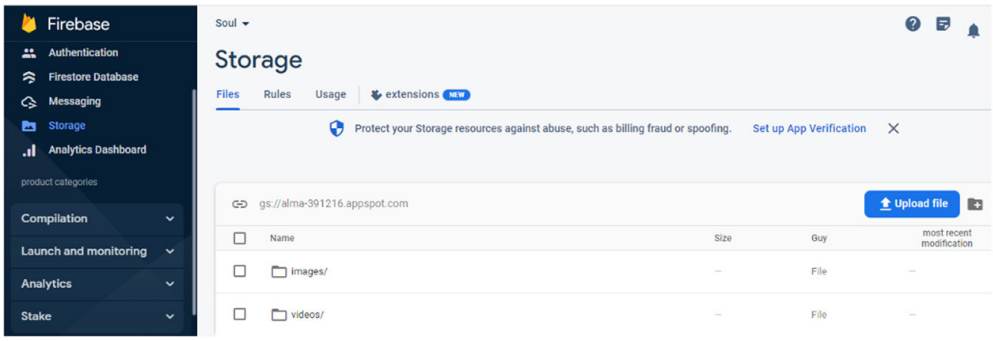

Fig. 6. Firebase dashboard

4 RESULTS

The evaluation of mobile application usability holds paramount importance for older adults, those in their 60s to 80s, as this demography often encounters distinctive hurdles when navigating technology due to age-associated factors. These challenges underscore the necessity for comprehensive usability testing, a strategy that pivots on the user's experience, aiming to uncover and solve potential difficulties within app design and operation. This commitment to a tailored user experience seeks to ensure that the emerging applications address the explicit requirements and tastes of this age bracket. The focal point of this approach is to forge a digital tool that transcends basic utility, embodying an intuitive design that bolsters user contentment and confidence. This emphasis on the user's interaction enhances the likelihood of the app's acceptance, continual engagement, and integration into everyday routines, significantly impacting the quality of life and independence among the elderly community [64]–[66].

In our approach, we conducted a thorough comparative analysis of our application against findings from previous usability studies targeting the older population, as detailed in Table 3. This review allowed us to pinpoint common usability impediments and user preferences typical of this age group, informing the customization of our prototype to avoid such issues and accommodate these preferences. Consequently, our application is uniquely positioned to provide a user-friendly, effective, and integrated digital experience for older adults, enhancing their daily lives through technology that respects and addresses their specific needs. The outcome of this process positions our application in a realm of its own, offering a seamless, efficient, and amalgamated digital interface for older individuals. This app stands as a testament to the power of technology that is sensitive to and considerate of the nuanced demands of its end-users, thereby elevating their daily experiences and interactions with the digital world.

Table 3. Comparison of usability studies of mobile applications for older adults

Reference	Contribution	Evaluation Method
[67]	Accuracy of dietary data collection	Input time and accuracy evaluation
[68]	Efficacy of mobile health applications in personalized dietary record keeping	System Usability Scale (SUS)
[69]	Usability evaluation of "HeartAround", an integrated home care solution	(SUS), along with in-depth interviews and qualitative analysis
[70]	Evaluation of motivational mobile applications to support fall rehabilitation in elderly patients.	Semi structured interviews and focus groups.
[71]	Evaluation of a mobile application to promote social participation of community-dwelling older adults.	SUS
[72]	Usability evaluation of the BioAssist" System, an integrated home care platform.	SUS, The User Interaction Satisfaction Questionnaire (QUIS)
[73]	User-centered development and testing of a monitoring system that provides feedback on physical functioning to older adults.	Post-Study System Usability Questionnaire (PSSUQ)

Importantly, our application takes an innovative approach by incorporating emotional support and the promotion of active aging, two topic areas that have received little attention in the previously reviewed studies and in the Panamanian context. This novel perspective distinguishes our study from previous research and adds an inventive dimension to our investigation. While many previous studies have focused on specific aspects such as dietary habits and cardiovascular disease through usability testing, we have broadened our focus to include these dimensions that are important to the quality of life of older adults. This helps to create an application that

is not only technically effective, but also adds significant value to the well-being and quality of life of this population.

Therefore, our application underwent usability testing using Nielsen's heuristic metrics along with evaluation techniques, testing, user satisfaction evaluation and validation [74], [75]. To evaluate the design and ease of use, we conducted an experiment described in detail below.

4.1 Attendees

To carry out the tests, an experimental study was conducted using quantitative techniques. Through interviews, we obtained the main demographic data. The participants were 15 people from Panama who belong to the Association Betania Edad III, a non-profit organization in Panama. Of these, 2 participants were under 60 years old, 7 were between 60 and 69 years old, 3 were between 70 and 79 years old, and 3 were 80 years old or older. This demographic distribution is supported by the data in Figures 7 and 8, which present the results of a preliminary survey of the participants. The survey revealed a gender distribution of 6 males and 9 females among the participants, which improves the consistency of the text.

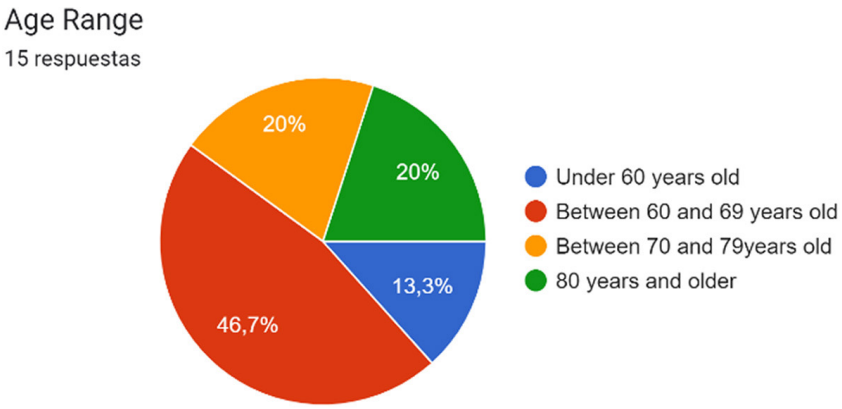

Fig. 7. Age count

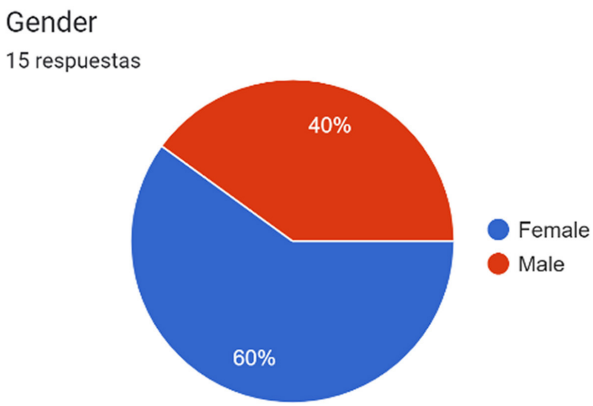

Fig. 8. Participant gender

4.2 Measuring instrument

For our usability study, we chose to use the System Usability Questionnaire (SUS), as shown in Table 4 [76], [77]. The SUS is a widely accepted standard tool for assessing

how users perceive the usability of a system. It consists of statements that are rated on a Likert scale from 1 to 5, where 1 means "strongly disagree" and 5 means "strongly agree". The use of this tool is essential as it provides us with comparable quantitative data on user experience and the effectiveness of our system in terms of usability.

Table 4. User satisfaction validation method using the System Usability Scale (SUS)

	The System Usability Scale Standard Version		Strongly disagree				Strongly agree
			1	2	3	4	5
1	I think that I would like to use this system.		O	O	O	O	O
2	I found the system unnecessarily complex.		O	O	O	O	O
3	I thought the system was easy to use.		O	O	O	O	O
4	I think that I would need the support of a technical person to be able to use this system.		O	O	O	O	O
5	I found the various functions in the system were well integrated.		O	O	O	O	O
6	I thought there was too much inconsistency in this system.		O	O	O	O	O
7	I would imagine that most people would learn to use this system very quickly.		O	O	O	O	O
8	I found the system very cumbersome to use.		O	O	O	O	O
9	I felt very confident using the system.		O	O	O	O	O
10	I needed to learn a lot of things before I could get going with this system.		O	O	O	O	O

For the interpretation of the results obtained in the SUS questionnaire, we will use the adjective scale shown in Figure 9. This scale includes the following terms: "awful", "poor", "okay", "good", and "excellent". Each term on the scale provides a qualitative representation of the perceived usability of the system, allowing us to classify and understand the level of user satisfaction more clearly.

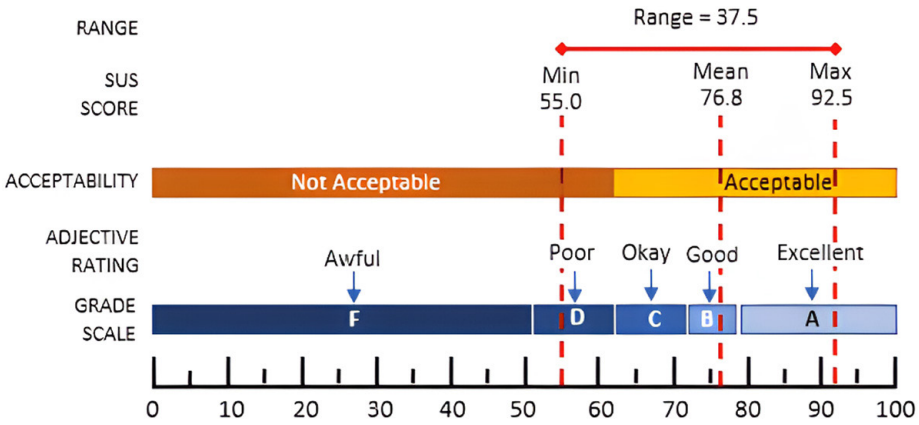

Fig. 9. Adjectives used in the SUS questionnaire scale [78]

4.3 Findings

In this section, we present the results of our scientific study. We have carefully examined the data collected to draw meaningful conclusions. We will then describe the main findings and discuss their significance in the context of our research.

Our mobile recommender system consists of several key features designed to enhance the user experience and wellbeing, as shown in Figure 10, the aesthetic aspect, and Figure 11, the work environment in which the prototype was developed.

- Registration and login system: The application has a secure registration and login system implemented using Firebase authentication and storage services. These services use highly reliable encryption techniques to ensure the protection of user data.
- Emotional State Identification: In the interaction screen, the application tries to identify the emotional state of the person. This is essential for providing more appropriate and personalized content recommendations. Through analysis and evaluation techniques, the application attempts to understand the user's emotions and tailor the experience accordingly.
- Useful and varied content: The application aims to provide a diverse range of content that is both informative and practical, with the goal of improving the overall quality of life for its users. Whether it's guidance on maintaining a healthy diet, managing medications, or engaging in physical activity and relaxation techniques, the app offers a wealth of resources to help users on their journey to better well-being.
- Eating Right Guides: The application recognizes the importance of diet in maintaining good health. It provides users with tips and recommendations for a balanced and healthy diet that is tailored to their specific needs. From meal planning ideas to suggestions for incorporating more fruits and vegetables, the app provides valuable guidance to help users make informed decisions about their diet.
- Personalized Agenda: Allows users to schedule and organize various tasks and activities, such as medical appointments, reminders of important events, and more.
- Medication reminders: Helps users remember and take their medications efficiently, preventing forgetfulness and ensuring proper treatment compliance.
- Exercise Activities: Provides routines and physical exercises adapted to different levels and needs, promoting an active and healthy lifestyle [79]–[81].
- Music Therapy: The app recognizes the power of music to promote relaxation and wellbeing. It offers a selection of soothing and therapeutic music that users can listen to during moments of stress or as part of a relaxation routine. By incorporating music therapy into their daily lives, users can reduce stress levels, improve mood, and enhance overall mental and emotional well-being [82], [83].
- Sleep Enhancement Techniques: Provides tips and techniques for achieving restful, quality sleep, including bedtime routines, meditation, and relaxation [84].

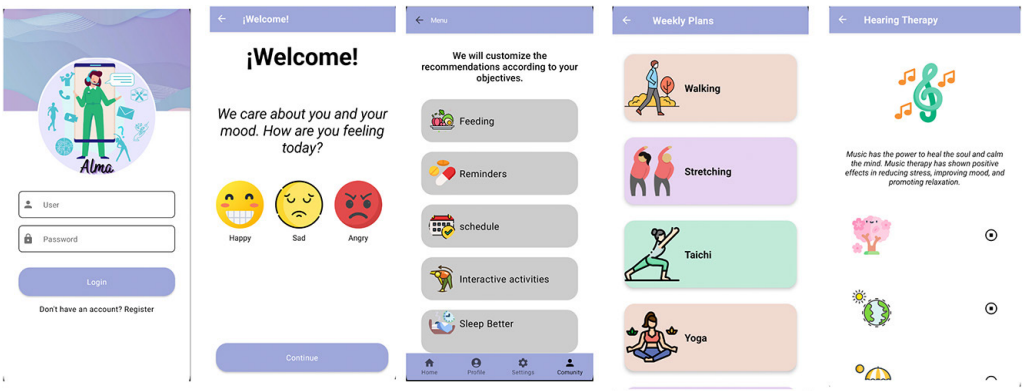

Fig. 10. Mobile recommendation system

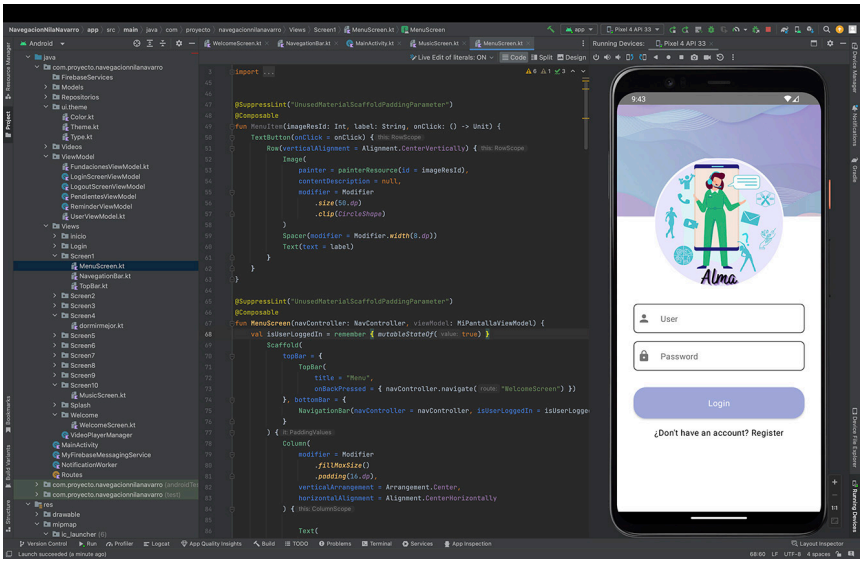

Fig. 11. Development environment

On the other hand, in our study we used the SUS questionnaire with a Likert scale from 1 to 5 to measure the usability of our prototype, as mentioned above. This questionnaire allows us to obtain values that support the evaluation of the usability of the system.

To calculate the SUS questionnaire scores, we follow the following procedure. For odd questions (1, 3, 5, 7, 9), we subtract 1 from each answer received. On the other hand, for even questions (2, 4, 6, 8, 10), we subtract 5 from the answer. Then we add the scores obtained in both cases.

Figure 12 shows a vertical bar graph summarizing the System Usability Scale (SUS) questionnaire scores of users of a mobile application. In the graph, questions 7, 8, and 9 are particularly notable as they have the highest mean scores, all of which were rated as 5. This indicates that users found the application extremely easy to use, comfortable, and did not require additional training to fully utilize all its features.

The different colors used in the graph represent the different score levels on the rating scale, and the height of each bar indicates the average of user responses for each specific question.

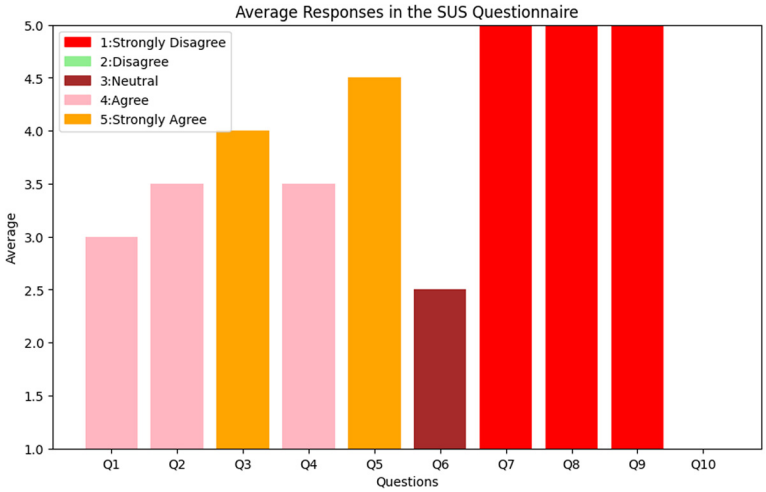

Fig. 12. Percentage of responses for each question in the questionnaire

Figure 13 shows a graph of the System Usability Scale (SUS) scores of different participants, labeled on the X-axis as "P1," "P2," and so on. Each bar on the graph represents the SUS score of a particular respondent.

The colors of the bars are related to the level of acceptability of the SUS scores. Lighter bars closer to green represent higher scores and thus better usability of the system, while darker bars closer to red represent lower scores and poor usability.

The dotted horizontal lines on the graph are boundaries that help interpret the SUS scores. The red line at 55 marks the boundary between "unacceptable" and "acceptable" based on the interpretation scales discussed earlier. Any score below 55 is considered unacceptable, meaning the system needs significant usability improvements. The green line at 56 marks the beginning of the "Acceptable" category, indicating that scores above this threshold are considered acceptable usability.

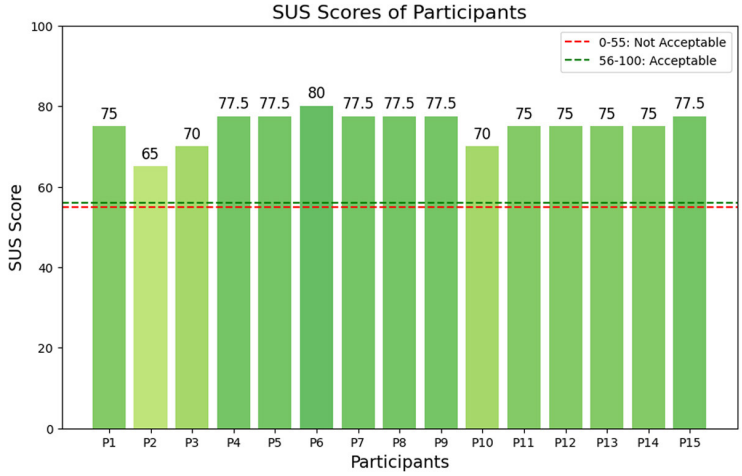

Fig. 13. SUS scores of participants

On the other hand, Figure 14 shows a pie chart indicating the average acceptance level of the system, which was 93.3%, which is very positive and indicates a solid acceptance by the users. This indicates that the mobile application was well received and appreciated by most of the users who participated in the evaluation. The high acceptance rate is an indication of the effectiveness and usefulness of the application in meeting user needs, thus supporting the quality of the system design and implementation.

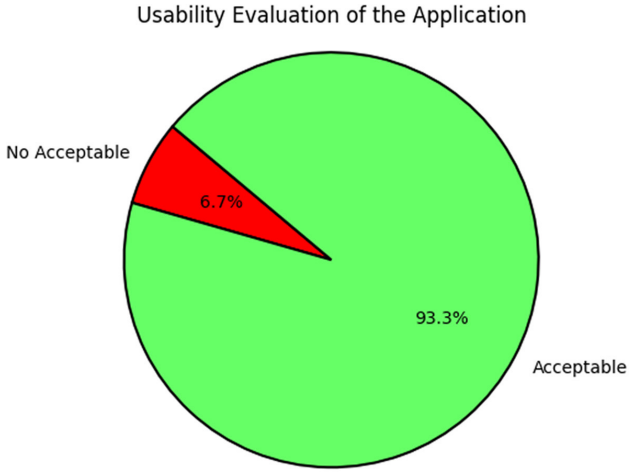

Fig. 14. Level of application acceptance

5 DISCUSSION

The results obtained by applying the System Usability Scale (SUS) questionnaire provide valuable insights into the perceived usability of the system under evaluation. Usability is a critical factor in the user experience and plays a fundamental role in the acceptance and adoption of technological solutions. In this section, we discuss the key findings and their implications in the context of our study.

Participants rated the system on the ten fundamental aspects represented by questions Q1 through Q10 of the SUS questionnaire. The average scores for each question reflect an overall positive perception of the system's usability. However, variability in individual scores was observed, suggesting that certain aspects of usability may have resonated more strongly with users than others.

Questions related to task completion efficiency (Q4, Q6, and Q10) received notable scores, indicating that users perceived the system as enabling smooth and quick execution of required actions. This can be attributed to the intuitive interface layout and ease of navigation.

On the other hand, the lowest scores were observed for questions related to the level of complexity and confusion (Q2 and Q8). This suggests that certain design elements may need to be reviewed and simplified to avoid ambiguity and improve clarity of available functionality.

An important aspect highlighted by the participants is the consistency of perceived usability, as the scores vary within a relatively narrow range. This suggests that users tend to have consistent usability experiences, which is essential for a positive and predictable user experience.

Furthermore, a comparison of our scores with previously established standards in the literature indicates that our system falls within an acceptable range of usability. These results provide additional validation of the quality of the system design and implementation.

In summary, the results obtained reinforce the positive assessment of the usability of the system under study and highlight areas for improvement that could lead to an even more effective and transparent user experience. These results play an important role in concluding this phase of analysis in our scientific work, providing fundamental insights to guide future research and refinement of the system design. They are of paramount importance as they allow us to improve our prototype to ensure that it meets the preferences of the intended users when it is released.

6 CONCLUSIONS

Research has clearly demonstrated the value of mobile technology in improving the well-being of older adults. Mobile computing provides convenient and easy access to health and wellness information and services. In addition, the development of specific mobile applications can have a significant impact on the quality of life of this population.

The mobile recommendation system developed in this study focuses on promoting healthy aging and is positioned as a tool to encourage the adoption of healthy lifestyles among the elderly. The proposed application provides information on nutrition and physical activity, as well as suggestions for maintaining optimal mental and emotional health. Interactive features such as challenges and games motivate users to participate in healthy activities and interact with other seniors.

In addition, the user interface designed specifically for senior comfort, with large buttons, clear and legible icons, and intuitive navigation, improves accessibility and usability for this population.

The importance of an interface adapted to the comfort of the elderly is magnified when considering the reality of this population in the Republic of Panama.

In this context, the results not only confirm the significant relevance of the application in promoting the well-being of the older adult population, but also point to promising directions for future research. These include areas of study ranging from the long-term evaluation of the effectiveness of the application in the sustained adoption of healthy habits to the personalized adaptation of the application to the individual needs of users. In addition, the exploration of new methods to promote social interaction and mutual support among the elderly in the Republic of Panama through this app is promising. The integration of these strategies would not only enrich our understanding, but also strengthen our commitment to promoting the well-being of this population.

In terms of future recommendations, it is important to consider strengthening the app in terms of content and functionality to further improve the user experience. In addition, the app could benefit from further dissemination and promotion among the older adult population in Panama to ensure that it reaches those who need it most.

When considering the practical implications, this app has the potential to make a significant difference in the lives of older people, improving their well-being and quality of life. It can be used in both healthcare and educational settings to promote healthy habits in this population. These results can be effectively applied in real-world settings and have a significant impact on the health and well-being of the older adult population in Panama and beyond.

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Informed Consent: All participants received an informed consent form that clearly stated that their participation in the study was completely voluntary.

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9 AUTHORS

Nila Navarro graduated in Systems and Computer Engineering from the Technological University of Panama, Chiriquí Campus, in 2020. She is currently in the last year of her Master's degree in Mobile Computing and is a research student.

Her research areas include artificial intelligence, e-health and machine learning (E-mail: nila.navarro@utp.ac.pa).

Denis Cedeno-Moreno received a Ph.D. in Project Engineering from the Technological University of Panama in 2019. She is a professor of programming and database at the Technological University of Panama. She also dedicates her time to research in mobile technology, artificial intelligence, natural language processing and machine learning (E-mail: denis.cedeno@utp.ac.pa).

Víctor López is a Master and Professor at the Technological University of Panama with extensive experience as Director of Research, Innovation and Development in the software industry. He has a solid background in Computer Science, Management Information Systems, Global Software Development, Social Robotics and Telemedicine. He is also a full-time researcher and lecturer at the university (E-mail: victor.lopez@utp.ac.pa).

Ericka Matus is a Ph.D. candidate in Education from the Specialized University of the Americas, is a professor and researcher. Her research areas include social psychology, sports psychology, and attitudes (E-mail: Ericka.matus@udelas.ac.pa).

Ivonne Nuñez graduated in Systems and Computer Engineering from the Technological University of Panama, Chiriquí Campus, in 2020. She is currently in the last year of her Master's Degree in Mobile Computing and is a research student. Her research areas include IoT, Smart City, Smart Grids (E-mail: Ivonne.nunez@utp.ac.pa).

Dimas H. Concepción graduated in Systems and Information Engineering from the Technological University of Panama, Chiriquí Campus, in 2020. He is currently in the last year of his Master's degree in Mobile Computing and is a research student. His research areas include Mobile Computing, Augmented Reality (AR) and Artificial Intelligence (E-mail: dimas.concepcion@utp.ac.pa).