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PAPER

Design of a Mobile Application to Improve the Therapy Process in Children with Autism

Orlando Iparraguirre-Villanueva(✉), Edson Sebastián Almeyda-Saravia, Kemily Jarumy Araujo-Jayo, Dylan Huaringa-Cruzado, Aldair Fabian Palomino-Guevara

Facultad de ingeniería y arquitectura, Universidad Autónoma del Perú, Lima, Perú

oiparraguirre@ieee.org

ABSTRACT

Autism is a spectrum disorder that affects communication and social interaction. It has increased in recent decades, especially among children, and has had a significant impact on their lives, necessitating attention and appropriate support. A prototype mobile application was developed using the Scrum methodology, which allows for flexibility, adaptability, incremental delivery, and quality, as well as continuous improvement. The result obtained was a prototype with a design and features that facilitate patient and specialist access to healthcare areas. The quality of the prototype was evaluated by experts, who assessed its efficiency, usability, design, and functionality and obtained an average score of 4.61. This indicates that, according to the established quality range, it is high. In conclusion, the prototype enhances the therapeutic process for children with autism. It is efficient, easy to use, and has good functionality and an attractive design. This provides a solution that facilitates patients' access to health services for their well-being.

KEYWORDS

mobile app, autism, therapy, Scrum

1 INTRODUCTION

Autism has been on the rise in recent decades, posing a significant problem that commonly affects children [1]. The World Health Organization (WHO) states that autism spectrum disorders (ASD) encompass a range of conditions related to brain development [2]. Since its establishment, the United Nations has played a significant role in promoting and safeguarding global health [3]. In 2007, the United Nations General Assembly declared April 2 as World Autism Awareness Day to improve the lives of individuals affected by this disorder [4]. WHO aims to enhance government commitment to measures that improve quality of life, provide guidance on policies and action plans, strengthen the capacity of health personnel, and promote inclusive and supportive environments for people with autism [2].

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The United Nations safeguards the rights of individuals with autism to participate in society in accordance with the Convention on the Rights of Persons with Disabilities and the 2030 Agenda for Sustainable Development [5]. In September 2015, the Sustainable Development Goals were established [6]. Sustainable Development Goal (SDG) 3 is titled "Health and Well-being" and aims to ensure a healthy lifestyle and promote well-being at all ages [7]. Each SDG includes multiple targets that provide additional details about the goal. For instance, Target 3.d aims to enhance the capacity of all countries, particularly developing countries, in early warning, risk reduction, and management of national and global health risks [8]. SDG 4 is titled "Quality Education" and aims to ensure inclusive, equitable, and high-quality education while promoting lifelong learning opportunities for all [9]. Target 4.5 by 2030 aims to eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for vulnerable populations, including individuals with disabilities, indigenous peoples, and children in vulnerable situations [10]. A 2016 study conducted in Quito and Guayaquil found that 69 of the children studied were diagnosed with autism, while 91 children were neurotypical, ranging in age from 2 to 12 years old [11]. According to the Peruvian Ministry of Health in 2019, 81% of individuals receiving treatment for autism in Peru are male. Similarly, it indicates that 15,625 people suffer from ASD, with 90.6% being children under 11 years old [12]. With the help of interventions, we aim to alleviate the symptoms of autism spectrum disorders to improve quality of life [13], [14].

The aim of this study was to examine different viewpoints and strategies for creating innovative interventions that enhance the health and quality of life of children with autism. The main goal was to create a mobile application that enhances the therapeutic process, providing an effective tool for monitoring and improving therapy for these children.

2 BIBLIOGRAPHIC REVIEW

In [13], the Scrum methodology was used to develop the Autism Serious Games Framework (ASGF). This framework is designed to assist therapists in developing serious game interventions that target various areas, such as emotion identification through matching facial expressions and response inhibition. In the effort to decrease challenging and impulsive behavior in children with autism, mental health clinicians have been found to utilize collaborative approaches and therapeutic videos based on the current testing and AIM HI protocol [14].

Studies [15] have highlighted the presence of motor skill imbalances in children with ASD. To address this issue, implementing the Kinect game was proposed as a cost-effective solution, following the user-centered design (UCD) methodology. Similarly, a sophisticated educational game was developed in [16] for the identification and treatment of autism, with a focus on improving emotional skills. This game has proven to be effective in accurately detecting autistic children.

The automation of determining autism levels was explored in [17], where an algorithm based on the player's activity during the game was introduced. Through the utilization of fuzzy logic and unsupervised learning, an accuracy level of 85% was attained in assessing autism. In addition, [18] presented the development of web and mobile applications for the evaluation of ASD, demonstrating a high sensitivity and specificity of 80% when comparing the application results with professional diagnoses.

In the field of organizing routines and therapies, [19] developed a mobile application that generates digital schedules for children with ASD, aiding in the customization of therapies and enhancing their quality of life. On the other hand, in Indonesia,

a mobile application was developed to monitor speech therapy in children with autism, thereby improving the quality of data records [20]. Similarly, in [15], they conducted a systematic review of the implementation of mobile applications for autism.

In addition, innovative intervention strategies have been applied, such as in [21], where backward chaining and minimal stimulation techniques were combined to promote functional communication skills in children with ASD. In a study [22] related to Attention Deficit Hyperactivity Disorder (ADHD), researchers investigated the effects of a digital multitasking-based treatment compared to an educational approach in children with ASD and ADHD. The study demonstrated improvements in cognitive control.

Communication has also been explored through the use of augmented reality in [23], where its potential for cognitive therapies involving perceptual identification was evaluated. Finally, [24] identified the potential of a touchscreen mobile computing device (TSMC) to enhance skills in children with autism, providing independence in learning and therapy.

3 METHODOLOGY

3.1 Fundamentals of development

For the development of this research, an investigation into existing agile methodologies was conducted. The selection criteria included the amount of information available, the understanding of each methodology, and their adaptability and flexibility for implementation. Table 1 displays ratings from 1 to 5.

Table 1. Choice of methodologies

Methodologies	Information Management	Knowledge	Adaptation	Flexibility	Points
RUP	4	3	3	4	14
Mobile D	4	3	3	2	12
XP	3	2	3	2	10
SCRUM	5	4	4	5	18
KANBAN	2	3	3	2	10

According to the theoretical support found in the research, Scrum emerged as the preferred methodology, as indicated in Figure 1. Therefore, it will be utilized in the project.

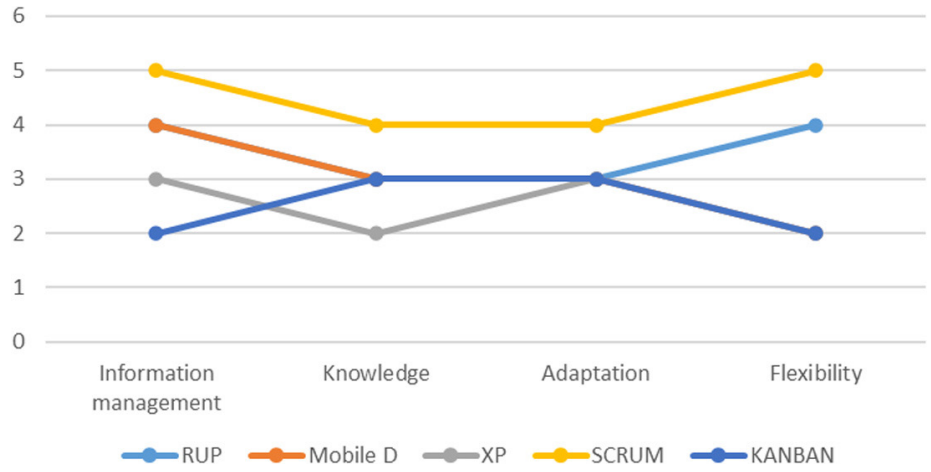

Fig. 1. Methodology chart

Currently, the Scrum agile methodology [16] is the most commonly used approach by organizations for software implementation. It is a lightweight framework that offers a set of rules and specific tasks that guide interactions based on collective intelligence.

The magazine [18] mentions that SCRUM has benefits, fundamentals and requirements, such as those detailed below:

- Delivery of results in a short and fixed time frame
- Contribution to the management of customer expectations, who assigns the value and time
- Demonstrate to the client the result obtained so that they can make the necessary decisions
- Return on investment (ROI), through which the client maximizes the benefit of the project
- Collaborative work and communication with both the team and the client [19] indicate that the Scrum methodology has five phases as follows (see Figure 2):

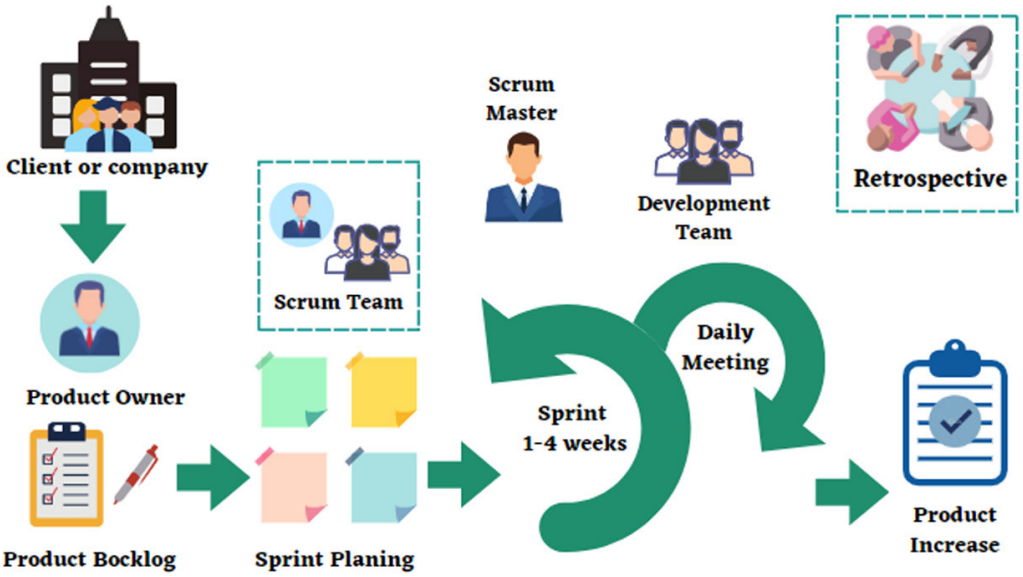

Fig. 2. Scrum phases

3.2 Case studies

At this stage, the proposed methodology has been developed, outlining the practical application of the scrum phases used in the project. To better understand the system. Figure 3 illustrates the architecture of the proposed application, depicting the intended users as patients and medical experts in autism. Additionally, it outlines the database process and its relationship to the application.

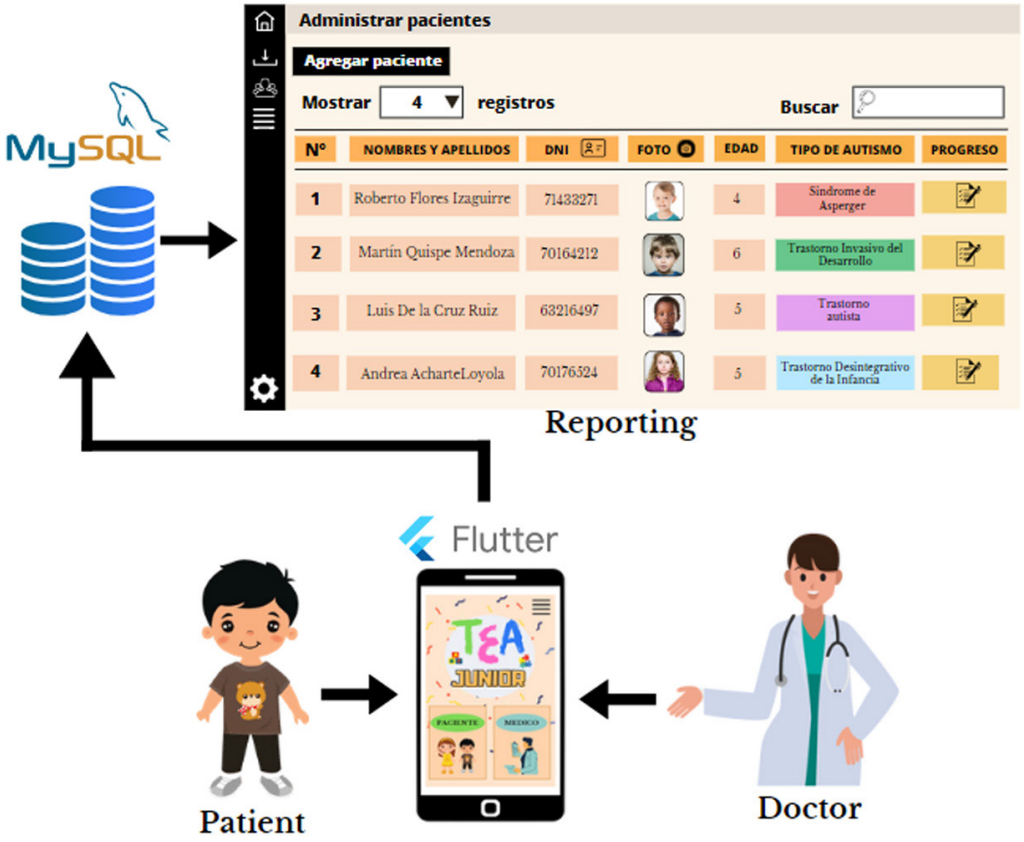

Fig. 3. System architecture

Both the doctor and the patients will have the option to log in as "TEA JUNIOR-doctor" and "TEA JUNIOR-patient" in the application developed in Flutter. This application will connect to the MySQL database to store data and generate reports in PHP for the web system.

Home. During this initial phase, the project's vision is developed, serving as the focal point and guiding direction for the project. It is characterized by the identification of three main roles [17]. Additionally, a list of priorities, or product backlog is defined, which serves as the basis for the development of the launch plan and the duration of each sprint [20].

A Scrum Team [17], [21], is typically comprised of working groups of three to nine members. Each person has different responsibilities, which are outlined as follows:

- **Scrum Master** manages the Scrum process and helps to remove impediments that may affect product delivery.
- **Product Owner** is in charge of optimizing and maximizing the value of the product. In addition, they verifies the result at the end of each sprint.
- **Developer** is in charge of developing the project increment in each sprint.

Planning and estimation. Here, user stories are specified and included in the sprints. Everything that generates value for the organization is prioritized, and time and effort estimates are made to fulfill them. These estimates are then translated into lists of tasks, with their development times defined in team meetings. Additionally, the process of defining the Sprint Backlog, which contains all the tasks to be completed in the sprint, is undertaken [20]. After establishing the backlog, the product

roadmap was developed based on the user stories, and ultimately, the project's velocity was determined.

a) Story estimation and prioritization

The stories were prioritized, beginning with the most important ones for the project. The effort required for each story was estimated using different tools [31]. We used Planning Poker, in which each team member individually estimated the user stories [32]. We then validate the estimates against the assigned historical data points to ensure accuracy.

b) Planning of deliverables

Epics were decomposed into user stories, estimated, and prioritized. Then, a sprint was initiated to develop a user story within a specified timeframe. The product backlog was organized by prioritizing and estimating stories [22], which reflected the team's interactions on the project [23]. The project consists of 10 stories, divided into five sprints. In the agile Scrum methodology, the sprints were observed and analyzed, considering that the velocity may vary.

Table 2. Product Backlog

N°	User History	Priority	Estimate
1	As an administrator I want the application to have the option to enter as a doctor or patient.	2	4
2	As a user, I want the application to allow me to log in with my ID number and give me options to choose the health area.	1	3
3	As an administrator I want the user to detail their personal data such as name, date of birth, and gender.	2	3
4	As a user I want the application to show a calendar in which I could select the day that is more feasible to go to the health area.	1	3
5	As an administrator, I want the application to have the 4 types of autism as options, considering access to the patient according to the autism that has been established in the health area.	1	7
6	As a user, I want each type of autism to provide me with information about it and have dynamic games to help me improve my therapy process.	1	5
7	As an administrator I want the application to allow me to log in with my ID number and select the health Area where I work.	1	3
8	As an administrator, I want the application to allow me to view appointments and patient progress.	2	4
9	As an administrator, I want to select patients to allow me to see the history and respective progress of each one by entering their ID number. Also, it can allow me to make a comment.	1	7
10	As an administrator, I want to visualize from the platform of the health center the report of the patients, as well as the follow-up of the therapy process of each one of them.	1	7

Implementation. In this third phase, tasks are executed, and prototypes of the application are created based on the stories that were prioritized and estimated during the planning phase [24], [25]. Product owner assignments should be completed within the following time frame [26]. The project is divided into 5 sprints, each lasting 31 days. [27] The sprints are prioritized based on the customer's needs, which improves the predictability of the project's progress [28].

a) First sprint

In the initial sprint, we tackled user stories 1, 2, and 3 from the prioritized backlogs listed in Table 2. In Table 3, we provide a detailed overview of these stories, including their estimated duration and acceptance criteria. Subsequently, in Figure 4, we show the corresponding prototypes: 4a for user story 1, 4b for user story 2, and 4c for user story 3.

Fig. 4. User story: (a) user story 1 (b) user story 2 (c) user story 3

Table 3. First sprint

Description	
User story 1	As an administrator I want the application to have the option to enter as a doctor or patient.
User – Time	Physician or Patient – 2 days
Acceptance criteria	The application must guarantee security and privacy, either when logging in as a physician or patient. It must also provide differentiated authentication.
User story 2	As a user, I want the application to allow me to log in with my ID number and give me options to choose the health area.
User – Time	Patient – 2 days
Acceptance criteria	In this case, the application displays a login, which allows patients to register with their ID card and select the health area closest to their home.
User story 3	As an administrator I want the user to detail their personal data such as name, date of birth and gender.
Usuario – Tiempo	Patient – 2 days
Acceptance criteria	The user interface must be intuitive. Likewise, it must have good navigation and accessibility.

b) Second sprint

In the second sprint, we addressed user stories 4, 5, and 6 from the backlog prioritized in Table 2. In Table 4, we provide a detailed overview of these stories, including their estimated duration and acceptance criteria. Subsequently, in Figure 5, we show the corresponding prototypes: 5a for user story 4, 5b for user story 5, and 5c for user story 6.

Table 4. Second sprint

Description	
User history 4	As a user I want the application to show a calendar in which I could select the day that is more feasible to go to the health area.
User – Time	Patient – 2 days
Acceptance Criteria	The user interface must be intuitive. Also, it must have a good navigation and accessibility.
User history 5	As administrator, I want the application to have the 4 types of autism as options. Also, only allow access to the patient according to the autism that has been established in the health area.
User – Time	Patient – 3 days
Acceptance Criteria	The patient selects the type of autism indicated by his or her physician in the health area. The interface must also provide visual feedback to indicate the selected option.
User history 6	As a user I want each type of autism to provide me with information about it and have dynamic games to help me improve my therapy process.
User – Time	Patient – 4 days
Acceptance Criteria	The application must have complete and accurate information. In the same way it should allow adaptability and customization of the games according to the type of autism of the user.

Fig. 5. User story: (a) user story 4 (b) user story 5 (c) user story 6

c) Four sprint

In the fourth sprint, we addressed user stories 7, 8, and 9 from the backlogs prioritized in Table 2. In Table 5, we provide a detailed account of these stories, including their estimated duration and acceptance criteria. Subsequently, in Figure 6, we show the corresponding prototypes: 6a for user story 7, 6b for user story 8, and 6c for user story 9.

Table 5. Fourth sprint

Description	
User history 7	As an administrator I want the application to allow me to log in with my ID number and selecting the health Area in which I work.
User – Time	Physician – 2 days
Acceptance criteria	In this case, the application displays a login, which allows physicians to log in with their DNI and select the health area in which they work.
User history 8	As an administrator I want the application to allow me to view appointments and patient progress.
User – Time	Physician – 2 days
Acceptance criteria	The application must have a secure access, in which only the physician can access the appointments and the progress of the corresponding users.
User history 9	As an administrator, I would like to select patients to allow me to see the history and respective progress of each one by entering their ID number. Also, it can allow me to make a comment.
User – Time	Physician – 4 days
Acceptance criteria	The application must have a patient search option and a real time update of the patient's history and progress. It must also have the ability to make comments.

Fig. 6. User story; (a) User story 7, (b) User story 8 and (c) User story 9.

d) Fifth sprint

In the fifth sprint, we focused on user story 10, which had been previously prioritized in the product backlog (Table 2). During this sprint, we completed one iteration. In Table 6, we provide a detailed overview of the specific user story for this iteration, including the estimated duration, the target user, and the acceptance criteria. Subsequently, in Figure 7, we present the prototype corresponding to user story 10.

Table 6. Fifth sprint

Description	
User history 10	As an administrator I want to visualize from the platform of the health center the report of the patients, as well as the follow-up of the therapy process of each one of them.
User – Time	Physician – 3 days
Acceptance criteria	The platform must have a clear and organized visualization, while providing customization options and filters. In addition, allow administrators to track the therapy process of each patient.

Fig. 7. User history 10

4 RESULTS

This section presents the results of the validation of the design quality level based on feedback from 10 experts. During the validation process, various criteria were applied, including usability, design, functionality, and efficiency. Questions were formulated based on the Likert scale to assess these criteria. This validation method was intended to measure the level of acceptance by the experts. Table 7 presents the validation criteria, the corresponding questions for each criterion, and the level determined by calculating the quality mean and standard deviation (S.D.). It also indicates that the overall mean is 4.61, indicating a final quality level of "very good."

Table 7. Expert validation

Criteria	Questions	Media	D.E	Quality
Usability	Does the application have an optimal loading time?	4.4	0.52	Good
	Is the application easy to use for users with no application knowledge?	5	0.00	Very Good
	Is the application divided into sections for better user understanding?	5	0.00	Very Good
	Does the application have a user-friendly interface?	4.6	0.52	Very Good
Design	Is the layout of elements in the interface clear and provides a good user experience?	4.9	0.32	Very Good
	Have consistent and attractive visual elements been used, such as icons, buttons and graphics?	4.9	0.32	Very Good
	Does the design of the application follow a visual identity consistent with the purpose of the application?	4.8	0.42	Very Good
Functionality	Would the app help you to improve the therapy process in children with autism?	4.4	0.70	Good
	How satisfied are you with the variety of options available from the present app?	4.8	0.42	Very Good
	Does the app allow children with autism to benefit from sensory stimulation?	4.5	0.53	Very Good
Efficiency	Does the physician take advantage of the information and data collected by the app to evaluate the child's progress?	4.7	0.48	Very Good
	Is the physician's feedback immediate?	4.2	0.63	Good
	Does it show accurate results?	3.9	0.32	Good
Total average and final quality level		**4.61 = 5**		**Very Good**

With the participation of 10 experts. Figure 9 shows that 75% of the experts rated the application as "very good" in terms of usability, while 25% rated it as "good." None of the experts rated it as "very bad," "bad," or "regular."

The quality of the prototype was determined by averaging the evaluated criteria. As shown in Figure 8, each of the criteria—efficiency and functionality—has an average score of 4.27, 4.75, 4.87, and 4.57, respectively. According to the results obtained, the quality of the mobile application is deemed acceptable. The overall average is 4.61. In addition, for the mobile application to be feasible, the overall average score must be higher than 4.00.

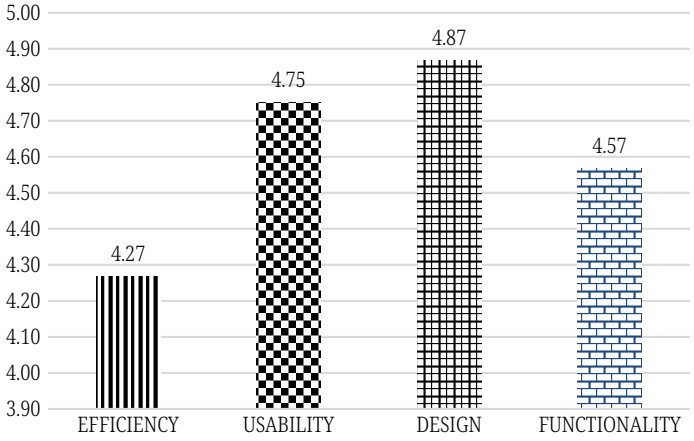

Fig. 8. Evaluation of the criteria

The summary graph reveals that “design” is the best-rated criterion, receiving 86.7% “very good” ratings. In addition, usability scored 75% as very good, followed by functionality at 60% as very good, and efficiency at 60% as good. This visual representation provides a quick understanding of the strengths and areas for improvement of the prototype in each of the evaluated criteria.

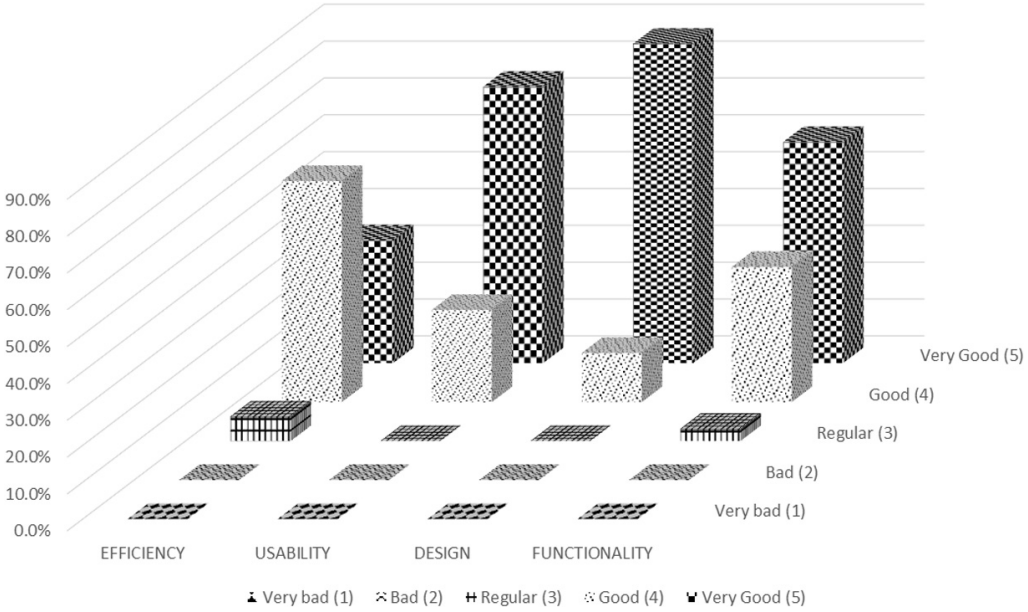

Fig. 9. Summary of criteria

5 DISCUSSION

The mobile application was designed to enhance the therapy process for children with autismusing the Scrum methodology. Additionally, [29] employs the Scrum methodology, but the mobile application enables the creation of digital agendas for children with autism spectrum disorder. On the other hand, [30] utilized the user-centered design (UCD) methodology to develop its prototypes. Similarly, the proposed mobile application features dynamic games tailored for each type of autism. However, the proposed mobile application includes dynamic games tailored for different types of autism [31], [32], as demonstrated in their research prototypes, along with general games designed for children with autism. This limits the capacity of the mobile application. The prototype was evaluated based on expert judgment. After calculating the points, the overall mean score was 4.61, which exceeded the minimum mean requirement. At [33], the screening method was used, achieving a 93% success rate. In addition, to assess the efficiency, usability, design, and functionality, the mean scores were calculated and obtained as 4.27, 4.75, 4.87, and 4.57, respectively. These results indicate that the quality of the evaluated criteria of the application is acceptable. On the other hand, in [34], an unsupervised learning algorithm was utilized, resulting in 85% accuracy. On the other hand, when comparing the screening results of the application with the diagnosis of a child and adolescent psychiatrist, it was found that the application had a sensitivity and specificity of 80%. As future work progresses, it will be important to implement the Scrum methodology, which has great potential for improving processes in the health sector.

6 CONCLUSIONS

In conclusion, this research has successfully developed a prototype mobile application designed to enhance the therapy process for children with autism, facilitating effective interaction between the patient and the physician. The primary goal of the developed prototype is to enhance social and communication skills, support therapy and follow-up by the physician, and stimulate cognition. The results obtained indicate that the design of the mobile application features user-friendly, intuitive, and essential interfaces for collecting the required data and facilitating the necessary interaction to identify each patient's process. The Scrum methodology was essential for the efficient development of the prototype, enabling proper documentation and continuous project progress. The evaluation of the prototype through expert judgments showed that it was well-received and feasible, as evidenced by an overall average score of 4.61 in the areas of efficiency, usability, functionality, and design. One of the limitations identified was the difficulty in collecting information, attributed to the absence of an autism specialist. For future projects, it is recommended to enhance the project with emerging technologies, such as artificial intelligence, to aid in diagnosing the patient's condition. In addition, there is a proposal to develop a mobile application for iOS devices, which would expand its reach and accessibility.

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8 AUTHORS

Orlando Iparraguirre-Villanueva, Systems Engineer with a master's degree in information technology management, PhD in Systems Engineering from Universidad Nacional Federico Villarreal-Peru. ITIL® Foundation Certificate in IT Service, Specialization in Business Continuity Management, Scrum Fundamentals Certification (SFC). National and international speaker/panelist (Panamá, Colombia, Ecuador, Venezuela, México) (E-mail: oiparraguirre@ieee.org).

Edson Sebastián Almeyda-Saravia is a student at the Faculty of Engineering and Architecture of the Universidad Autonoma del Peru. Escuela Académica Profesional, Industrial Engineering (E-mail: ealmeydas@autonoma.edu.pe).

Kemily Jarumy Araujo-Jayo is a student at the Faculty of Engineering and Architecture of the Universidad Autonoma del Peru. Escuela Académica Profesional, Industrial Engineering (E-mail: karaujo@autonoma.edu.pe).

Dylan Huaringa-Cruzado is a student at the Faculty of Engineering and Architecture of the Universidad Autonoma del Peru. Escuela Académica Profesional, Industrial Engineering (E-mail: dhuaringa@autonoma.edu.pe).

Aldair Fabian Palomino-Guevara is a student at the Faculty of Engineering and Architecture of the Universidad Autonoma del Peru. Escuela Académica Profesional, Industrial Engineering (E-mail: apalominog@autonoma.edu.pe).