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Original Article

Artificial Intelligence Chatbot to Improve Hospital Care Process

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Abstract *- Hospital care affects numerous people globally every day. It is a process that not all people can easily receive, especially in rural areas, and it critically impacts their health. This study aimed to develop a chatbot prototype with Artificial Intelligence (AI) to improve the hospital care process. The methodology applied was the agile Scrum methodology. This methodology focuses on staged development to improve software procedures. It provides speed in adaptation, flexibility, quality, and continuous improvement. This methodology focuses on step-by-step development to improve software procedures. It provides rapid adaptation, flexibility, quality, and continuous improvement. As a result, a chatbot prototype with Artificial Intelligence was obtained, whose quality was evaluated by experts who assessed the criteria of usability, design, functionality, efficiency, and security, assigning ratings of 4.87, 4.88, 4.77, 4.76, and 4.68, respectively; and obtaining an average of 4.80 on a Likert scale; these values indicate that the prototype meets high-quality standards. In conclusion, this study succeeded in developing an effective prototype to improve hospital care by incorporating features such as chat consultations to facilitate immediate interaction between doctors and patients, access to hospital services for patients from any location, as well as visualization of clinical history to improve the user experience.*

Keywords *- Artificial Intelligence, Chatbot, Hospital care, Scrum, Mobile application.*

1. Introduction

The problematic reality of hospital care worldwide shows a large gap between the quality and coverage of health services offered to people, especially the poorest and most vulnerable. According to the World Health Organization (WHO), poor quality health care increases morbidity and health costs globally. Some problems affecting the quality of care are inaccurate diagnoses, medication errors, inappropriate or unnecessary treatments, inadequate or unsafe medical facilities or practices, or providers who lack sufficient training and experience [1]. These statistics reveal that the pandemic has caused a reversal of the progress made in recent years in achieving the health-related Sustainable Development Goals, such as the reduction of maternal and child mortality, control of communicable diseases, universal health coverage, and access to essential medicines. WHO also warns that the pandemic has exposed weaknesses and inequities in health systems and that greater investment and cooperation are needed to strengthen them and make them more resilient. Also, better control and diagnostics [2] improve the quality of care in health centers. In Europe, hospital care is facing multiple challenges arising from the HIV/AIDS pandemic, the aging of the population, the scarcity of human and financial resources, inequity in access and quality of services, and the need to adapt to new technologies and user demands. According to, the impact of the COVID-19 pandemic on European primary care is both on the organization and functioning of services and on the health and well-being of professionals and patients. It also proposes measures to improve primary care's responsiveness and resilience to health crises. According to a study in Spain, 40% of patients who come to the emergency department do not require immediate attention, which implies an inappropriate use and waste of resources [3]. Lack of coordination and integration between the health system's different levels and actors leads to fragmentation, duplication, and discontinuity of care [4]. On the other hand, Latin America faces a series of problems that affect the population's quality of and access to health services. These problems include shortages of medicines and supplies, lack of capacity and infrastructure, and long waiting lines. Therefore, according to [5], more investment, better coordination, greater efficiency, and equity in hospital care in Latin America are required to improve the situation. The saturation and collapse of emergency services, which generate delays, waiting times, and risks to the health and safety of patients, is a serious problem [6]. According to a WHO report [7], integrating healthcare services can improve the quality of care for patients and professionals, as well as their efficiency and satisfaction. From the point of view of

health professionals, proper care can improve and provide comprehensive care by allowing the possibility of providing uninterrupted, free care, staff recruitment, and continuous professional development, among other benefits that help to improve the quality of primary care [8]. Poor participation and empowerment of patients and their families in the care process limits their autonomy, decision-making capacity, and treatment adherence. According to research conducted in Mexico, 70% of hospitalized patients are unaware of their diagnosis, prognosis, and the therapeutic plan assigned to them [9]. In other countries, such as Peru, it faces similar problems that affect the quality and equity of health services. In addition, according to [10], Peru has a shortage of 18,000 health professionals, which puts hospital care at risk. This shortage is intensified in rural areas of the country where the indigenous population lives in communities with difficult access. These difficulties seem to increase when the indigenous population lives in rural communities with difficult access or highly limited healthcare coverage [11] and present important challenges in terms of access to and quality of health services, especially in rural areas.

The article [12] mentioned that a chatbot was developed to recommend ICD-10 codes, which facilitates diagnosis coding for inexperienced healthcare workers. Evaluated using the AHP method, it was 82.58% preferred over a traditional application, standing out in performance and accessibility thanks to its ability to handle unexpected inputs and interpret medical terms.

Also, in [13], an immersive Augmented Reality (AR) chatbot was developed to enhance operator training using smart glass interfaces and interoperability with IIoT devices in a pilot test. The pilot test demonstrated its potential to empower operators with real-time information, thus optimising decision-making in manufacturing. In addition, in [14], an automated medical chatbot was created to provide personalised diagnostics, to reduce costs and improve access to healthcare. With 65% accuracy in symptom identification and 71% diagnostic accuracy, this chatbot shows promise as a tool to support medical care based on conversational symptom analysis. The purpose of this research is to examine multiple perspectives and alternatives to devise an innovative solution that will contribute to improving hospital care and ensuring the provision of high-quality medical care for all patients. The main objective was to create an application to optimize the hospital care process, providing a tool capable of tracking and improving patient care.

2. Methodology

2.1. Fundamentals of Development

In order to carry out this research project, an analysis of the available agile methodologies was carried out, and several factors were considered to make a decision, such as the amount of data used, the degree of understanding of each methodology and its adaptability and flexibility for implementation. Based on the theoretical foundations identified during the research, Scrum was selected as the methodology, as shown in Table 1.

- *Case Study*

In this stage, the proposed methodology is implemented, providing a detailed analysis of the practical scenario of the phases applied in the work to obtain a more complete view of the system. In Figure 1, the application's structure is visualized, where the intended users, patients, and doctors are identified. Furthermore, the interaction between the database and the application outlines how they relate.

2.1.1. Start

The project vision is formulated at the beginning of this stage, which acts as the focus and orientation point for the entire development. This phase is distinguished by identifying the three key roles: the Scrum Master, the Product Owner, and the Developers, who comprise the Scrum Team. In addition, a list of priorities is established, known as the Product Backlog, which serves as the cornerstone for release planning and determining the duration of each Sprint.

- Scrum Master: Oversees the development of the Scrum process and is responsible for overcoming obstacles that may hinder product delivery.
- Product Owner: Responsible for improving and increasing the product's value, as well as evaluating the result at the end of each Sprint.
- Developer: Responsible for creating the project's progress in each iteration (Sprint).

Fig. 1 System architecture

Table 1. Choice of methodologies

Agile methodology	Flexibility	Collaboration	Communication	Interactive delivery	Change Management	Scalability	Total
Scrum	4	5	4	4	5	4	26
Kanban	3	4	3	5	4	3	22
Lean	4	3	4	4	2	3	20
RUP	4	4	4	5	3	2	22
XP	3	3	4	3	4	3	20

Table 2. Product backlog

Sprint	Code	User History (UH)	Effort (score: 2,4,6,8)	Priority
1	UH01	As a user, I want to know the date and time of my medical appointments.	6	Medium
	UH02	As a user, I want to know about a medication.	2	Low
2	UH03	As a user, I want to know about a medical procedure.	6	Medium
	UH04	As a user, I want to know the contact information	2	Low
	UH05	As a user, I want to know the method of payment or billing for a treatment or medication.	6	Medium
3	UH06	As a user, I want to know health and wellness tips.	8	High
	UH07	As a user, I would like to ask about other types of medical consultations.	6	Medium
	UH08	As a user, I want to be given information about mental health.	6	Medium
4	UH09	As a user, I want to communicate with a real person.	2	Low

2.1.2. Planning and Estimation

At this stage, during Sprint planning, User Stories (UH) are described and specified. All activities that bring value to the organization are prioritized, and estimates are made of the time and effort required to execute them. These estimates are transformed into task lists with development deadlines established in team meetings.

A Sprint Backlog is also established, containing all tasks to be completed during the Sprint. After creating the backlog, a product roadmap is built based on user stories, and finally, the project's progress velocity is defined.

Story Estimation and Prioritization

The prioritization process started with the most critical stories for the project. Next, we estimated the effort needed for each story using various tools. One of these tools was Planning Poker, where each team member provided independent estimates for the user stories to prevent bias. Afterwards, we validated these estimates by assigning story points to ensure precision.

Planning of Deliverables

Deliverable planning involved breaking the stories into user stories, which were then estimated and prioritized. A sprint was subsequently planned to develop a user story within a defined timeframe. The product backlog was organized by arranging the stories based on their importance and estimates, reflecting the team's interactions throughout the project (see Table 2). The project consists of 9 stories distributed across 4 sprints. Sprints were observed and analyzed throughout the Scrum agile process, with attention to potential team velocity variations.

2.1.3. Implementation

In this third stage, activities are carried out, and initial models of the application are developed based on the stories that were prioritised and estimated during the planning phase. The responsibilities assigned to the product owner must be completed within an approximate time frame. The project is broken down into 4 sprints, which are approached according to their relevance to the customer, facilitating a better prediction of project progress.

First Sprint

During the first sprint, we focused on user stories 1 and 2 from the prioritized backlog. Table 3 provides a detailed breakdown of these stories, including their estimated timeframes and acceptance criteria. Subsequently, in Figures 2a and 2b, we show the corresponding prototypes, which include the development of the menu and the first chatbot options for the user to interact and to be able to consult their doubts or inconveniences.

Second Sprint

In the second sprint, the focus is on user stories 3, 4, and 5 of the prioritized backlogs. Table 4 presents the description of these stories, together with their estimated durations and acceptance criteria. Following this, Figure 3 presents one of the prototypes, including chatbot interactions. These interactions cover queries about medical procedures, contact information, and payment methods for specific medical treatments.

Third Sprint

In the third sprint, we focused on user stories 6, 7, and 8 from the prioritized backlog. Table 5 details these stories,

including their estimated duration and acceptance criteria. These tasks include interaction with the chatbot that enables the development of questions for which there is a common lack of user knowledge; they may include information and advice on health or other medical queries.

Fourth Sprint

In the fourth sprint, the focus was on user story 9, previously prioritized in the product backlog. During this sprint, one iteration was completed, and Table 6 provides specific details of this user story for that iteration, including estimated duration, target user, and acceptance criteria.

Figures 4a and 4b display the prototypes developed for situations where the user stops interacting with the chatbot and instead prefers to communicate with a real person.

Table 3. Sprint Backlog - Sprint 1

Code	User History	Tasks
UH01	As a user, I want to know the date and time of my medical appointments.	Search in the database based on your ID card for the records of your medical appointments.
		Process information and understand the context.
		Send the consulted information to the user.
UH02	As a user, I want to know about a medication.	Process information and understand the context.
		Send the consulted information to the user.

Table 4. Sprint Backlog - Sprint 2

Code	User History (UH)	Tasks
UH03	As a user, I want to know about a medical procedure.	Process information and understand the context.
		Send the consulted information to the user.
UH04	As a user, I would like to know your contact information.	Process information and understand the context.
		Send the consulted information to the user.
UH05	As a user, I want to know the method of payment or billing for a treatment or medication.	Process information and understand the context.
		Send the consulted information to the user.

(a)

(b)

Fig. 2 Sprint backlog 1: (a) Medical appointments interface (b) User interface and their interactions with the chatbot

Fig. 3 Sprint backlog 2: Interface with chatbot on a medical procedure

Table 5. Sprint Backlog - Sprint 3

Code	User History (UH)	Tasks
UH06	As a user, I want to know health and wellness tips.	Process information and understand the context.
		Send the consulted information to the user.
UH07	As a user, I would like to make other medical inquiries.	Process information and understand the context.
		Send the consulted information to the user.
UH08	As a user, I want to know information about mental health.	Process information and understand the context.
		Send the consulted information to the user.

Table 6. Sprint Backlog - Sprint 4

Code	User History (UH)	Tasks
UH09	As a user, I want to communicate with a real person.	Process information and understand the context.
		Request a search for an available real agent.
		Liaise with the agent to advise the user.

(a) **(b)**

Fig. 4 Sprint backlog 4: Interaction interface with chatbot requesting attention from real people

3. Results

This section presents the results of the design quality assessment, in which 15 experts participated. This validation applied various criteria, such as efficiency, functionality, security, design, and usability. Questions were asked and rated on a Likert scale to assess these aspects. This validation method aimed to measure the level of acceptance by the experts. Table 7 shows the criteria used in this validation, the specific questions for each criterion, and the quality level calculated using the mean and Standard Deviation (S.D.). In particular, the overall mean was 4.80, corresponding to a quality rating "Very good".

Figure 5 shows the networks created with ATLAS.ti software, according to the four criteria: Efficiency, Functionality, Security, Design, and Usability. This approach would result in a high degree of user satisfaction. ATLAS.ti is a tool used to perform qualitative analysis on large data sets that can be in the form of text, audio, images, or video. It offers advanced tools that facilitate the organization and creative and orderly management of your content [15], [16].

Table 7. Expert validation

Criteria	Questions	Media	S.D.	Quality
Efficiency	Does the application offer features that increase productivity and efficiency for users and hospital staff, such as appointment reminders or relevant notifications?	4.6	0.51	Good
	Does the application allow users to perform tasks quickly and efficiently, minimizing the time and steps required to achieve their goals, such as scheduling appointments or accessing medical information?	4.8	0.41	Very good
	Is the use of resources, such as Internet bandwidth or the processing power of the mobile device, optimized to provide a smooth and lag-free experience?	4.86	0.35	Very good
Functionality	Does the application meet all the necessary functions and features to satisfy users' needs, such as appointment scheduling or consultation of relevant hospital information?	4.86	0.35	Very good
	Are all application functions reliable and consistently performing, avoiding unexpected failures or interruptions?	4.73	0.46	Very good
	Does the application enable users to perform tasks efficiently and effectively, minimizing complexity and obstacles in its use?	4.73	0.46	Very good
Security	Are effective measures implemented to protect users' medical and personal data, ensuring privacy and compliance with health information security regulations?	4.8	0.41	Very good
	Does the application have secure authentication mechanisms to ensure only authorized users can access confidential information or critical functions?	4.73	0.46	Very good
	Are clear policies and procedures in place to ensure that the application is secure and that users feel comfortable sharing medical and personal information through the application?	4.53	0.52	Good
Design	Is the application's design appealing, and does it reflect the consistent visual identity of the hospital?	4.86	0.35	Very good

	Is the layout of information and functions in the mobile application intuitive and easy for users to navigate?	4.86	0.35	Very good
	Does the design prioritize text readability, accessibility and usability on mobile devices, ensuring a pleasant experience for users?	4.93	0.26	Very good
Usability	Is the application easy for users to use when searching for information or performing hospital-related tasks?	4.86	0.35	Very good
	Does the mobile interface allow users to interact intuitively with the application?	4.73	0.46	Very good
	Does the application consistently provide useful and accurate answers?	5	0.0	Very good
Total average and final quality level		**4.80**		**Very Good**

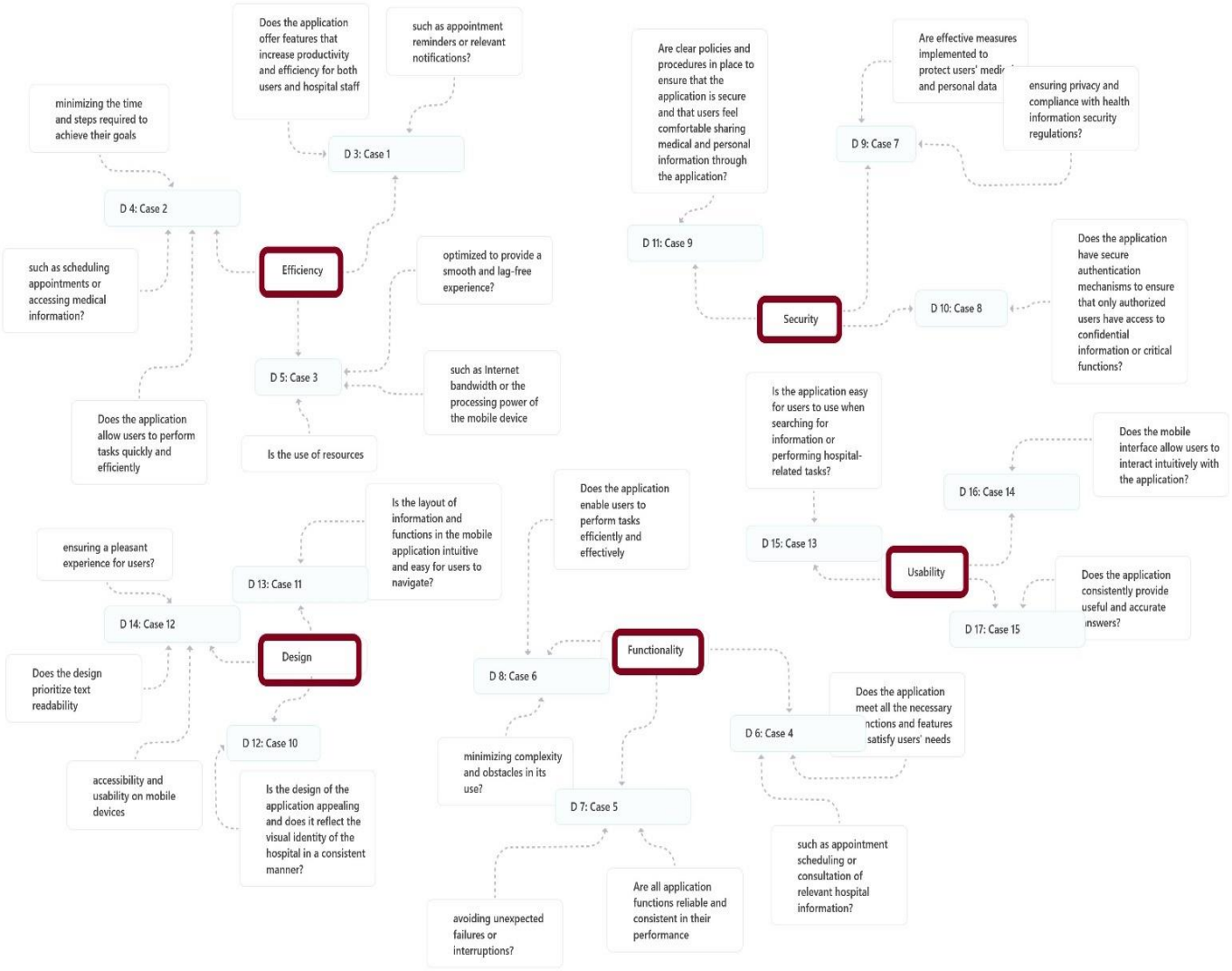

Fig. 5 Dimension of expert criteria

The quality of the application was assessed through the average of the scores considered in the criteria. As shown in Figure 6, the efficiency, functionality, security, design, and usability criteria obtained average scores of 4.75, 4.77, 4.68, 4.88, and 4.86, respectively. Based on these results, the quality is considered acceptable, with an overall average of 4.80. The summary graph in Figure 7 shows that design is the highest-rated criterion, reaching 88.90% in the "Very Good" category. In addition, usability scores 86.70% in the "Very Good" category, followed by functionality at 77.80%, efficiency at 75.60%, and security at 68.90% in the same category. This figure makes it possible to identify the strengths of the prototype and the aspects that require improvement in each of the evaluated criteria.

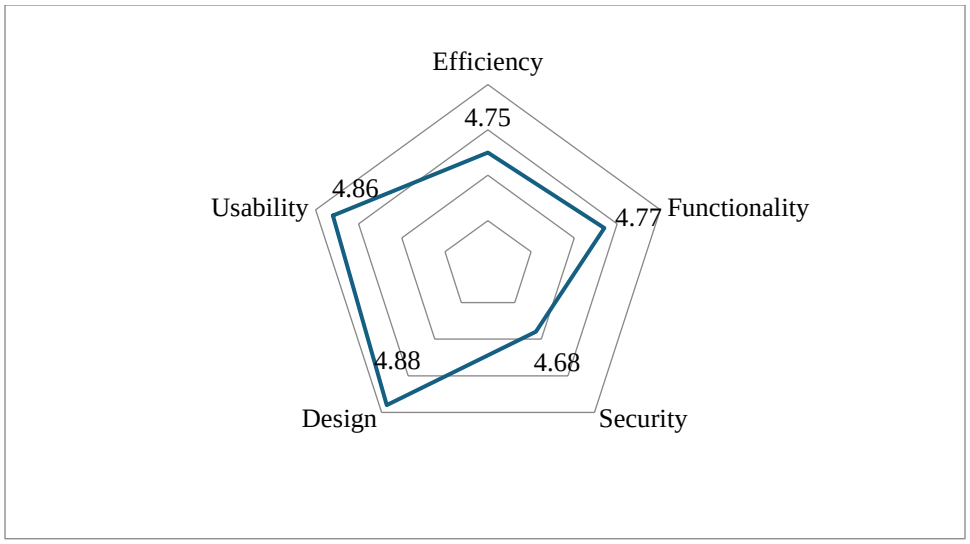

Fig. 6 Evaluation of the criteria

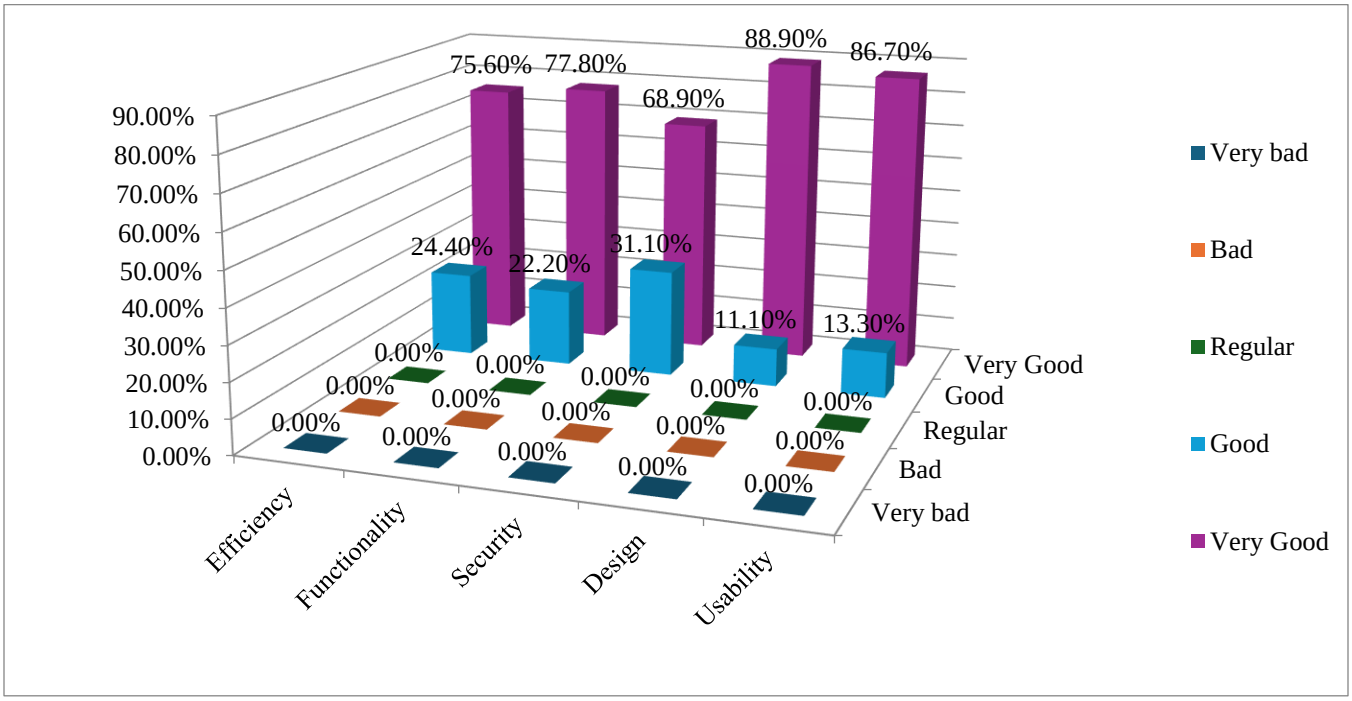

Fig. 7 Summary of criteria

4. Discussion

The project aims to design a prototype using a chatbot with AI to improve the hospital care process, which was built using the agile Scrum methodology. On the other hand, [17] uses the Waterfall methodology to develop its prototype, which also focuses on medical care for the elderly. While [18], this research was not only about hospital care but more generally focused on patient-bot interaction, his part in [19] used their application to promote adherence to home physiotherapy. Their objective was to determine the effectiveness of using a chatbot to promote the follow-up of instructions for improving rehabilitation with a total sample of 75 participants. The results determined that the people using a chatbot complied with the instructions designated to them, decreasing their recovery time considerably. They concluded that chatbots can be a powerful tool for the accompaniment of patients. The quality of the prototype was evaluated through the quality assessment of 15 experts with the parameters of Efficiency, Functionality, Security, Design, and Usability. After the evaluation, it was possible to obtain a very high percentage in the design and usability with 88.90% and 86.70%, with an overall average of 4.88 and 4.86, respectively. Likewise, in [20], The study of a web application and the evaluation of a chatbot in therapy and

emotional support, aimed at young people and adults over 18 years of age, with a qualitative approach through the evaluation of 15 users through an online questionnaire; and the results showed an average satisfaction score of 4.09 on a scale of 1 to 5. For its part [21], with its application for rural areas, achieved that, in 5 months, 42% of the people involved kept using the application constantly. Its usability, functionality and functionality criteria resulted in a total average of 4.76, 4.69 and 4.81, respectively. In [22], a comparison was made between people who did not use the chatbot and those who used it for hospital care. Based on the survey cards, it was possible to conclude that 95% of the people would use them gradually.

5. Conclusion

In summary, this study allowed the development of a prototype chatbot based on artificial intelligence designed to improve hospital care by facilitating effective communication. The prototype stands out for its functionality, efficiency, ease of use, security, and innovative design, thus contributing to better health management for its users. Its main objective is to optimize the hospital care process to improve health and quality of life. The Scrum methodology was instrumental in providing the necessary structure and approach to create a solution tailored to the needs of both patients and medical staff. Expert evaluations showed the prototype to be acceptable and feasible, with an overall average score of 4.80. However, certain limitations were identified, such as data management, information security, and user privacy. A possible restriction regarding access and availability of mobile devices in some communities was also noted. For future developments, it is suggested that support for iOS devices be included to reach a wider audience.

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