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# EVALUATION OF THE USABILITY OF A MEDICAL ASSISTANCE SOFTWARE APPLYING HEURISTIC RULES

MIRIAM JANET CERVANTES LÓPEZ[1], GUADALUPE ESMERALDA RIVERA GARCÍA[2], JUAN CARLOS RAMÍREZ VÁZQUEZ[2], ARTURO LLANES CASTILLO[1], JAIME CRUZ CASADOS[1]

[1] Tampico School of Medicine "Dr. Alberto Romo Caballero", Autonomous University of Tamaulipas, Tampico, Tamaulipas
[2] Higher Technological Institute of Pánuco, National Technological Institute of Mexico, Pánuco, Veracruz

**KEYWORDS**

*Usability*
*Heuristic rules*
*Telemedicine*
*Medical Assistance Software*

**ABSTRACT**

*The objective of this research is to evaluate the usability of a telemedicine system developed by the authors through the RUP (Rational Unified Process) methodology, since it is a rigorous method whose purpose is to ensure the production of high-quality software. Usability was evaluated by a group of experts using an instrument based on the Nielsen heuristic rules model. The results indicate that the usability is between "very good" and "excellent" so it is very acceptable. However, some items with low value were presented as recognition before I remember, derived from the fact that the links of the system are not easily identified by the user, therefore, derived from the above, the corresponding improvements will be made.*

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## 1. Introduction

At present, software applications play a fundamental role in all organizations, since their use and application allow the automation of daily tasks and tasks, which contributes to an efficient management of the work of employees and to offer better service to customers, users and the community in general (Pinargote, Merino, Sánchez & Lucas, 2022). In the field of engineering, software development has strengthened this discipline and therefore organizations seek to acquire or build their own technological solutions to have a pleasant and adaptable work environment that allows their employees to be efficient and provide quick solutions to the demands of the environment (Laáz, Ponce, Valencia & Tapia, 2022).

One of the quality criteria that is responsible for managing these characteristics is usability, which is defined as the property that a product has to be easy to use, learn and use (Monsalve, Echavarría & Alvarez, 2020). It is a relevant factor that encompasses aspects such as ease of learning, efficiency in use, the ability to manage errors, an adequate visual presentation and user satisfaction, for which the International Organization for Standardization (ISO) has established the standard 25000, which provides guidance for the use of the series of international standards known as Software Product Quality Requirements and Assessment (Martínez et al., 2023).

In today's world, where information systems play a central role in our lives, usability has become a crucial aspect to ensure that users can effectively and satisfactorily interact with these tools, since it not only benefits users, but also to the organizations and companies that develop and maintain these systems (Méndez et al., 2023), so usability evaluation methods play a fundamental role in the identification and resolution of problems in the interface and experience. user, since good usability can lead to a higher degree of user satisfaction, greater user retention, greater efficiency in the use of the system and, ultimately, greater commercial success (Molano, Yara & García, 2015).

Nowadays, the evaluation of the usability of information systems is of vital importance to guarantee the quality of the software and ensure a pleasant, easy and intuitive interaction between the user and the system, thereby avoiding redesign and maintenance problems. According to Naranjo, Collazos & Estrada (2021), "usability evaluation is one of the most important tasks that must be undertaken when developing a user interface". The evaluation of the usability of information systems refers to the process by which the ease of use, efficiency and user satisfaction when interacting with a specific information system is analyzed and evaluated, that is, it consists of examining and measuring various aspects, related to the user experience, with the aim of identifying possible problems, deficiencies or areas for improvement in the design, functionality and interaction of the system (Melo, López, Sagñay & Gavilanes, 2023).

Usability evaluation involves the application of different methods and techniques to collect data and obtain relevant information about how users interact with the system. These methods may include observing users in real usage situations, collecting performance and response time data, analyzing interaction logs, performing user tests, and applying usability heuristics (Murillo, Novoa & Rodriguez, 2019).

There are several methods to evaluate the usability of software, among which are heuristic evaluation, user tests, analysis of metrics and records, comparative evaluation, design inspection, among others, which are detailed below (Caro et al., 2020):

**Heuristic evaluation:** this method involves the review of the software by usability experts, who apply a list of heuristic principles or established guidelines to identify usability problems; These guidelines may be based on industry standards or accumulated knowledge of good design practices. Experts review the interface and workflow of the software in search of elements that may hinder ease of use and user efficiency (Michel Garay, García & Reyes, 2021).

**User testing:** In this approach, actual users of the software perform specific tasks while their interaction is observed and feedback is collected. User tests can be conducted in a laboratory environment or in real use situations, researchers can ask users to think aloud during tasks, which provides valuable information about their thought process and the difficulties they encounter. These tests can help identify problems with navigation, interface design, confusing terminology, and other obstacles to the user experience (Marinovich & Palomino, 2019).

**Metrics and log analysis:** This approach involves collecting and analyzing quantitative data about user interaction with the software, this can be accomplished using logging tools that capture data such as response time, error rate, clicks made and shipping lanes. These data can provide an objective view of the efficiency and effectiveness of the software and help identify problem areas (Chanchí, Ospino & Campo, 2022).

**Benchmarking:** In this approach, different versions or alternatives of the software are compared to determine which is more usable, tests can be performed with groups of users randomly assigned to different versions of the software, and then the results are compared in terms of efficiency, accuracy and user satisfaction, which makes it possible to identify which design or features are most effective and preferred by users (Molano, Yara & García, 2015).

**Design inspection:** This method involves a detailed analysis of the software design, including interface design, information structure, and element organization. It seeks to identify usability problems such as lack of consistency, lack of feedback or lack of clarity in the instructions (Zapata, Zapata & Cardona, 2020)

Usability assessment is essential to ensure that information systems are intuitive, easy to learn and use, efficient in terms of time and resources, and satisfactory for users, so it is important to select the appropriate approach based on needs and requirements available resources and combine different methods to obtain a more complete and accurate assessment of software usability (Campo, Ospina & Chanchí, 2022).

## 2. Heuristic analysis

Heuristic analysis is a method used to perform expert evaluation of the usability of an interface, in order to identify problems in a digital product such as an application or a website. This approach is based on the application of heuristic principles, which are general rules or design guidelines established to evaluate the quality of the interface and the user experience, through an expert or a group of experts who review it and evaluate compliance. of these rules, such as visibility of the state of the system, consistency and standards, error prevention, and flexibility and efficiency of use (Mitjaneta & Moreno, 2022).

Some authors mention that there are various evaluation principles in the case of usability that start from analysis and synthesis, and among which are the ten usability heuristic principles for user interface design, proposed by Jacob Nielsen (Nielsen, 2020), Bruce Tognazzini's nineteen heuristic usability rules (Tognazzini, 2014), Ben Shneiderman's eight golden rules (Santos, 2018), the eleven interface design principles proposed by Arturo Chavero (Chavero, 2021) and the thirteen important usability principles proposed by Eva Brumme (Brumme, s.f.).

Jacob Nielsen (1995) developed a heuristic analysis that is based on principles that act as general guides to evaluate the usability of an interface, these principles such as visibility of the system state, consistency and standards, and error prevention, have They have been refined over the years and are widely accepted in the interface design industry. One of the key benefits of Nielsen's (1995) heuristic analysis is its ability to identify usability problems quickly and efficiently, allowing problem areas and possible improvements to be discovered before testing with real users.

Tognazinni (1994) is one of the main references in interaction design and is the author of heuristic rules that have some aspects in common with the heuristics proposed by Nielsen (1995) but have a more specific focus on user interaction with the interface. These include aspects such as immediate feedback, consistency in design, intuitive design, minimization of cognitive load, and reduced need for memorization, among others. Ben Shneiderman proposed the eight golden rules, which include aspects such as consistency, visual update frequency, providing informative feedback, designing dialogs that are easy to undo, and preventing errors (Santos, 2018).

Another researcher Arturo Chavero (2021) proposes the eleven principles of interface design, these include aspects such as clarity and simplicity in the design, visual consistency, information hierarchy, clear feedback and adaptability, to mention a few (Chavero , 2021). In the same way,

Eva Brumme raises the thirteen principles of usability, among which are accessibility, learning capacity, ease of use, efficiency, security, user satisfaction and flexibility (Brumme, s.f.).

## 3. Methodology

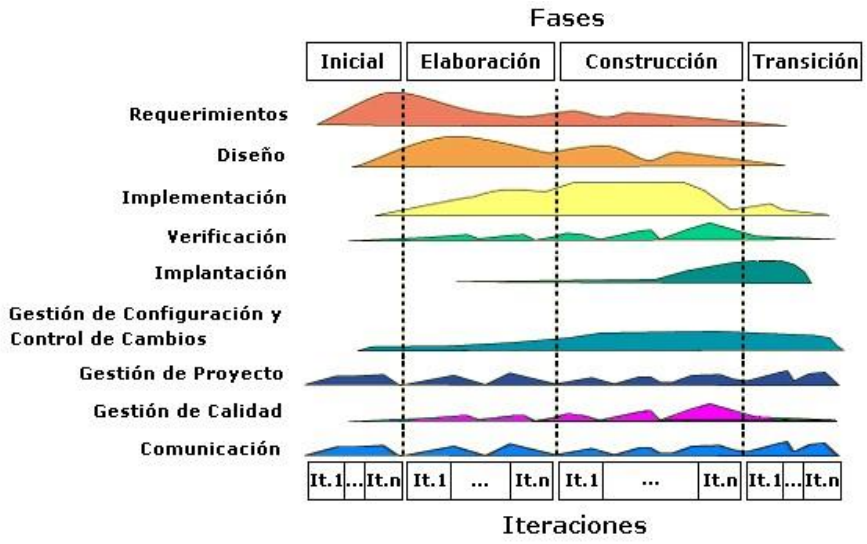
As a result of the above, after analyzing and understanding each of the methods, it was determined to use the heuristic evaluation method proposed by Nielsen (1995) since this method presents a series of heuristic principles that allow usability improvement opportunities to be detected mainly in the interface, as well as analyze the content and the interaction between the user and the design.

The information system in which the heuristic evaluation will be applied is telemedicine software, a concept that dates back to the first transmission of an x-ray over telephone lines carried out by the University of Nebraska in 1959 (Alcocer, Chávez & Cardoso, 2023). Telemedicine has been developed with the purpose of addressing the problem of access to health in Mexico, since according to INEGI (2020) around 5.8 million people in the country do not have access to health services, including emergency care. specialist doctors, in addition, 43.9% of the population lives in a situation of extreme poverty and cannot afford transfers to clinics outside their municipalities or communities (COVENAL, 2021).

In response to these problems, a telemedicine system was developed that allows medical consultations to be established through video calls between specialist doctors and patients, with the assistance of a general practitioner or social services practitioner. The development of this system was based on the RUP (Rational Unified Process) methodology; The Nielsen (1995) heuristic rules method was used to evaluate its usability to determine if the telemedicine system is intuitive, efficient and satisfactory for users, thereby contributing to the improvement of medical care in Mexico.

There are various ways of developing software, some formal and some informal. The Figueroa, Solis & Cabrera (2008) model called RUP (Rational Unified Process) was chosen, which is a formal process that provides a rigorous method whose purpose is to ensure the production of high-quality software that meets the needs of users. users, is based on use cases and uses UML as markup language. Figure 1 shows the phases of the life cycle of the RUP model.

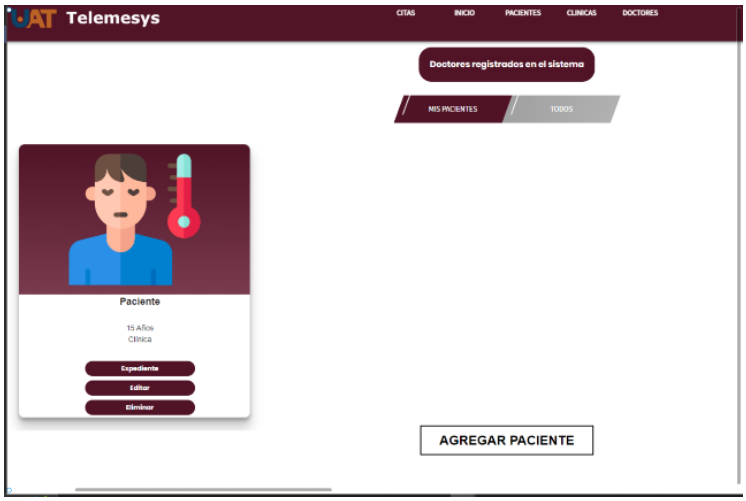
**Figure 1.** Rational Unified Process




Source(s): Figueroa, Solis & Cabrera, 2008.

Once the essential points of the system were considered, the process of its layout began, for which a web platform called Figma was used, which allows us to design interfaces for free, as shown in figure 2.

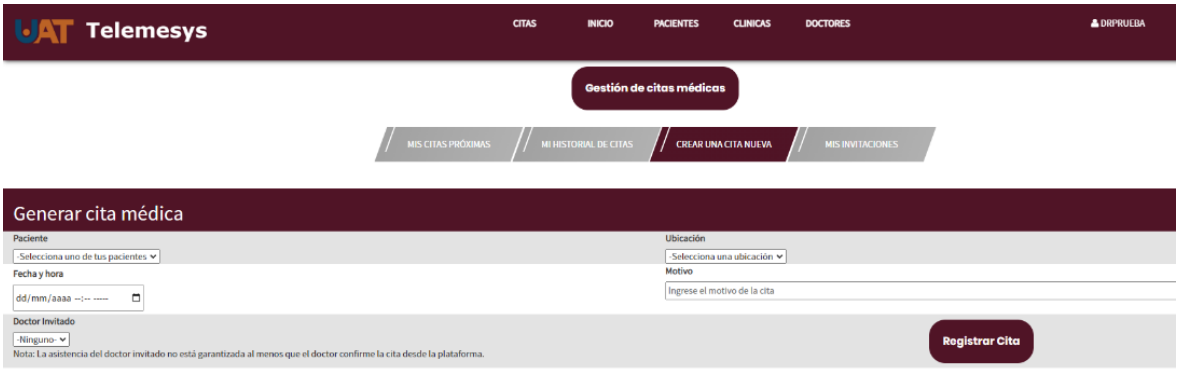
**Figure 2.** Interface design using the Figma platform




Source(s): Own elaboration, 2023.

Once the interfaces were designed, the real development of the platform was carried out, through the coding of said interfaces, as well as their functionalities, using for this the PHP, Javascript and HTML languages, attending to each of the system sections. requirements. In figure 3, a screen of the system is shown.

**Figure 3.** Telemedicine system




Source(s): Own elaboration, 2023.

To evaluate usability, the Nielsen (1995) method was used, who defined the following 10 heuristic rules:

1. Visibility of the system state
2. Relationship between the system and the real world
3. User freedom and control
4. Consistency and standards
5. Error prevention
6. Recognition before memory
7. Flexibility and efficiency of use
8. Aesthetics and minimalist design
9. Help and error recovery
10. Help and documentation.

The usability of the telemedicine system was evaluated by a group of experts who answered an instrument designed by the authors and based on Nielsen's 10 heuristic rules (1995), where each heuristic rule has 3 questions, the experts were 5 medical specialists. from the Tampico School of Medicine “Dr. Alberto Romo Caballero" from the Autonomous University of Tamaulipas. For the evaluation, a score had to be assigned to each question, for which a Likert scale of five options was used (1- Totally disagree, 2-Disagree, 3-Neither agree nor disagree, 4- Agree, 5– Strongly agree). Each evaluator performs the assessment individually, as if he were a user of the system and when the last evaluator finishes, the results of the analysis are recorded and communicated. Table 1 shows the 10 heuristic rules proposed by Nielsen (1995), as well as the 3 questions for each rule, the ratings assigned by the 5 experts, and the general percentage achieved in each heuristic rule.

**Table 1. Heuristic rules used for the evaluation of the telemedicine information system**

| |
|---|
| ***1. Visibility of the system state*** |
| 1.1. Does the design clearly show the options selected by the user? |
| 1.2. Are the possible links to explore clearly marked? |
| 1.3. Is the user always informed of the system status? |
| ***2. Relationship between the system and the real world*** |
| 2.1. Are the instructions clear and user friendly? |
| 2.2.Are the concepts and words used understandable? |
| 2.3.Are the icons and images of known meaning? |
| ***3. Freedom and control by the user*** |
| 3.1. Is navigation through the system easy and does it allow you to return to the previous point? |
| 3.2. Is it easy to return to the main page from any other page? |
| 3.3. Does it have buttons to move between the different pages? |
| ***4. Consistency and standards*** |
| 4.1. Is there congruence between the name of a link and the page to which it leads? |
| 4.2. Do all links in the system show content? |
| 4.3. Is there congruence between the title of a page and the content it displays? |
| ***5. Error prevention*** |
| 5.1. Are there warning messages that help prevent errors? |
| 5.2. Is the system clear in capturing information to prevent errors? |
| 5.3. Is the system validated against trial and error? |
| **6. Recognition before memory** |
| 6.1. Are the icons easily identifiable? |
| 6.2. Can the links be clearly identified? |
| 6.3. Does the user identify the page they are on at all times? |
| **7. Flexibility and efficiency of use** |
| 7.1. Can users select a task, by menu or by keyboard shortcut? |
| 7.2. Does the system allow novice users to use a keyword grammar and experts a positional grammar? |
| 7.3. Do the menus have words that are easy to understand and rememb |
| **8. Aesthetics and minimalist design** |
| 8.1. Is the information displayed on each page of the system relevant and useful? |
| 8.2. Is the content well distributed and classified between the pages? |
| 8.3. Does the content appear aesthetic, attractive and orderly? |
| **9. Help and error recovery** |
| 9.1. Is it easy to recognize when an information capture error occurs? |
| 9.2. After an error occurs, is it easy to return to the place of origin? |
| 9.3. Does the system show help mechanisms to solve errors? |
| **10. Help and documentation** |
| 10.1. Is the help consistent with what is requested in the sequence of user actions? |
| 10.2. After having requested help, can users continue with their activities from where they left off? |
| 10.3. Is there a visible help menu that responds to all the requested information? |

Source(s): Own elaboration, 2023.

## 4. Results

In general, the rating given by the experts was 91.60%, which represents a rating of 4.58, located between "Very good" and "Excellent" according to the Likert scale, where 5.0 is the highest rating. Table 2 presents the results obtained, it can be seen that the instrument scores were higher than the expected average, which is 3.0.

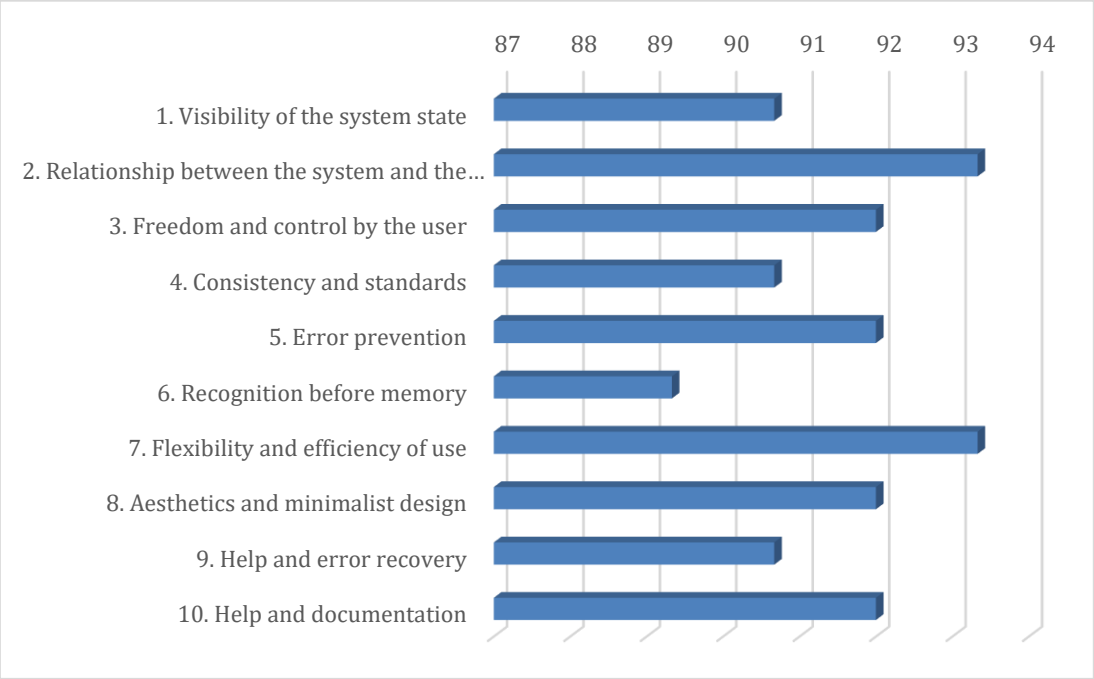
**Table 2.** Mean scores obtained in the items analyzed

| Ítem | Media | DS | Ítem | Media | DS |
|---|---|---|---|---|---|
| 1.1 | 4.80 | 0.44 | 6.1 | 4.60 | 0.54 |
| 1.2 | 4.40 | 0.54 | 6.2 | 4.40 | 0.54 |
| 1.3 | 4.40 | 0.54 | 6.3 | 4.40 | 0.54 |
| 2.1 | 5.00 | 0.00 | 7.1 | 4.80 | 0.44 |
| 2.2 | 4.60 | 0.54 | 7.2 | 4.80 | 0.44 |
| 2.3 | 4.40 | 0.54 | 7.3 | 4.40 | 0.54 |
| 3.1 | 4.80 | 0.44 | 8.1 | 4.80 | 0.44 |
| 3.2 | 4.60 | 0.54 | 8.2 | 4.60 | 0.54 |
| 3.3 | 4.40 | 0.54 | 8.3 | 4.40 | 0.54 |
| 4.1 | 4.80 | 0.44 | 9.1 | 4.60 | 0.54 |
| 4.2 | 4.40 | 0.54 | 9.2 | 4.60 | 0.54 |
| 4.3 | 4.40 | 0.54 | 9.3 | 4.40 | 0.54 |
| 5.1 | 4.80 | 0.44 | 10.1 | 4.80 | 0.44 |
| 5.2 | 4.60 | 0.54 | 10.2 | 4.60 | 0.54 |
| 5.3 | 4.40 | 0.54 | 10.3 | 4.40 | 0.54 |

Source(s): Own elaboration, 2023.

Figure 4 shows the strongest heuristic rules of the telemedicine system, such as: heuristic rule No. 2, "relationship between the system and the real world", as well as heuristic rule No. 7, "flexibility and efficiency of use. The rule with the greatest deficiencies is the heuristic rule No. 6 called “Recognition before memory”.

**Figure 4.** Results of the usability evaluation of the telemedicine system




Source(s): Own elaboration, 2023.

The reliability of the instrument was determined by applying Cronbach's alpha coefficient, obtaining a value of 0.69, which shows that the instrument has adequate values of internal consistency (Table 3).

**Table 3.** Cronbach's Alpha Consistency

| Cronbach's alpha | N of elements |
|---|---|
| .690 | 30 |

## 5. Discussion

In this research, the importance and application of the Nielsen heuristic evaluation has been analyzed as an effective and widely used method to evaluate the usability of a software through its heuristic principles that provide a solid framework to identify problems in the user interface and improve your user experience, the results of the evaluation of the telemedicine system show that it is acceptable, however, it is important to pay attention to the heuristic rules that obtained a score lower than 9.0 as "recognition before memory", since that means that the links of the telemedicine system are not easily identified and that the user does not easily locate the page where he is located in the system. In conclusion, we have that Nielsen's heuristic evaluation is a powerful tool to determine if information systems are more usable, which leads to a better user experience, greater efficiency and general satisfaction; By implementing this approach and considering the recommendations derived from the evaluation, organizations can ensure that their information systems are effective, intuitive, and meet the needs and expectations of their users.

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