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Interactive Emergency TeleHealth Systems in Pandemic Times: a Usability Evaluation in the Interior of Brazil

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With the emergence of the COVID-19 pandemic, people had to avoid crowded places and attend hospitals, clinics, and doctors' offices only in an emergency. The authors' institution developed a telehealth platform prototype in a joint effort between Health and Computer Science researchers and students to allow the participation of medical students under the supervision of medical professors to provide emergency health advice using online remote care supported by a video and form-filling tool to support in preliminary diagnosis. This paper presents a usability evaluation of the telehealth platform prototype involving 30 participants in a medium-sized town in the interior of Brazil. Participants simulated virtual consultations about COVID-19 with health professionals. The usability evaluations were fundamental to understanding users' mental models, how to provide a better experience and measuring the system's effectiveness and acceptance. The findings show implications to the design of telehealth systems and the impact of problems related to Information Architecture, user feedback, controlling video-based interfaces. The preliminary results encountered in the present study are essential to help improve the usability of telehealth solutions, which will have a significant growth following the trend from the COVID-19 pandemic.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**.

Additional Key Words and Phrases: User tests, Usability, Health care, web application.

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1 INTRODUCTION

Due to the COVID-19 pandemic, the world population was quarantined, as shown in the news during this period. For this to be possible, it was necessary to interrupt environments with agglomerations. On the other hand, with the growing number of disease cases, hospitals have started to provide more care, and ways have been sought to prevent overcrowding so that they are not compromised.

One of the objectives of remote care systems is to reduce the crowds searching for medical appointments, as they allow such care to take place remotely. These systems can achieve those goals by using video and audio technology and digital communication media to enable contact between medical professionals and patients [14].

The telehealth platform prototype investigated in the present paper sought to solve the problem of such agglomerations in the challenging period of the COVID-19 with social isolation measures. The prototype enables users to find out more information about the disease, clearing their questions through a chat with automatic responses. The system enables users with COVID-19 symptoms to go through a service initiated by chat and then migrated to a video call with

a medical student guided by professors of the Medical degree. A form-filling tool was used to support the preliminary diagnosis.

While larger towns and cities in Brazil had some initiatives to implement telehealth platforms, smaller towns in the interior of the country had comparatively lower availability of such services offered by medical doctors.

Previous studies have examined the usability and acceptance of telehealth systems in contexts such as weight gain prevention [3], geriatrics [11, 17], paediatrics [8] and other contexts. The advent of the COVID-19 pandemic and social isolation will significantly impact the increased use of telehealth applications. The usability of such applications is fundamental for their acceptance. However, cultural factors have a strong influence on use traits. In the Brazilian context, telehealth was regulated by Law N. 13.989 [2], in April 2020 only, as an emergency measure for the COVID-19 pandemic. For this reason, it is essential to understand the usability of interactive telehealth tools and how they impact the use of the services, considering the limited experience of Brazilian people with such technology.

This study aimed to conduct usability tests with volunteer users to understand the usability and user acceptance when using a remote consultation system targeted at COVID-19 suspected cases in an interior town in Brazil. The study consisted of remote evaluations involving 30 participants. The results reveal the main types of usability problems and reflections on the implications for the design of telehealth systems, which are expected to increase following the expansion during the COVID-19 pandemic.

This paper is divided into six sections. Section 2 presents the theoretical background used for this work, as well as related work. Section 3 presents the methods for usability evaluation and data analysis. Section 4 shows the results of this research, discussing the evidence found. Finally, Section 5 presents the main conclusions and future work that may emerge from the results.

2 THEORETICAL BACKGROUND

This section presents the main concepts related to usability in medical systems, user tests to measure usability of health care systems, the concept of usability and related works.

Telehealth can be understood as using technology to help health issues, such as information, medical care, and prevention. Inside telehealth, there is telemedicine, defined by the use of technology to practice medicine remotely [15].

According to Wootton [18], telemedicine is a term that encompasses any medical activity involving distance, where the interaction between doctor and patient takes place through the use of a telecommunication system.

Wootton [19] showed a positive result in managing chronic diseases using telemedicine to help the treatment, showing results as effective as a regular treatment. Otherwise, according to DelliFraine and Dansky [5], the use of telehealth had a positive impact for specific disease categories and clinical care, but for other diseases such as diabetes, it did not work as expected.

2.1 Usability of Medical Systems

A system with good usability must allow users to navigate the system easily and practically. According to ISO 9241-11 [10], usability can be understood as "the extent to which a product can be used by users to conclude tasks with effectiveness, efficiency, and satisfaction considering a specific context of use".

Assessing the usability of systems should be an item carried out early in the development process to determine what problems have already appeared and what possible problems may arise during the development process. According to Edwards *et al.* [6], evaluating usability as soon as possible allows the final system to be efficient, effective, and valuable, bringing benefits not only to the end-user but also to those involved in the software development process.

When dealing with health systems, we need to consider the use of the system by people with the most varied types of knowledge related to computer systems. When dealing with the use of these systems by the care team, according to Khajouei, Gohari, and Mirzaee [13], when systems focused on health information are used by professionals, usability problems of these items can cause harm to the patients.

When we consider the use of systems aimed at the health area by the population, it is known that the system can be used by people of the most varied age groups and with the most varied types of knowledge related to the area of health and computing.

2.2 User tests of remote medical care systems

A study by Kaufman *et al.* [12] aimed to evaluate the usability of medical systems where users could clear their questions without leaving their homes to a standard service location. During the analysis carried out with 25 users, the task was to use the system remotely and then inform the researchers about their opinions about the system. With the results obtained through the research, it was possible to identify which usability problems faced by users were able to prevent some tasks from being completed.

According to the study by Agnisarman *et al.* [1], there was an increase in the acceptance of the use of telecommunication systems for remote assistance. However, little was done to assess the usability and degree of acceptance of the systems. The study had the collaboration of 20 participants to assess the usability of four different telemedicine systems. Nineteen of the participants completed the tasks proposed by the study. Results reported on the effort and satisfaction of the users about each one of the systems. Participants preferred systems with no installation and registration pages, as these topics brought more usability issues and more significant mental burden and fatigue for users.

A recent study investigated the usability of a telehealth system to support weight gain for new kidney transplant recipients [3]. The qualitative study with 11 patients revealed usability issues related to improvement in the quality of textual and video-based content and problems with controls and difficult-to-use interactive components.

Other studies also focused on the use of telehealth systems with older participants. [11, 17]. In the study conducted by Iyer [11], the authors analyzed the use of a telehealth system with 32 patients in the United States. Their qualitative analysis covered themes related to technology set-up and usability, satisfaction with the visit, and clinical assessment and communication. While the study pointed out that participants were satisfied with the system, there was little depth in analysing the usability problems and implications for the design of telehealth systems for elderly users. Rasheedy *et al.*'s [17] also focused on elderly participants but did not examine deeper usability issues.

Fung *et al.* [8] evaluated the acceptance of telehealth services for diabetes paediatric services with 141 respondents that used such services during the COVID-19 pandemic. The results showed that participants were satisfied, and the majority of them intended to continue using the services after the pandemic. However, the study did not investigate the usability of the services.

The related studies examined in this section show the need to investigate the usability of telehealth systems further. Many studies showed that the technology is promising and has good acceptance, in general, by users. However, it is crucial to understand better the implications for the design and improved usability.

The telehealth platform prototype was selected for evaluation because its service answers questions without the presence of a professional. With this, we sought to verify whether the system's intelligence would answer the questions and if users accepted the interaction of users with the service section of the system.

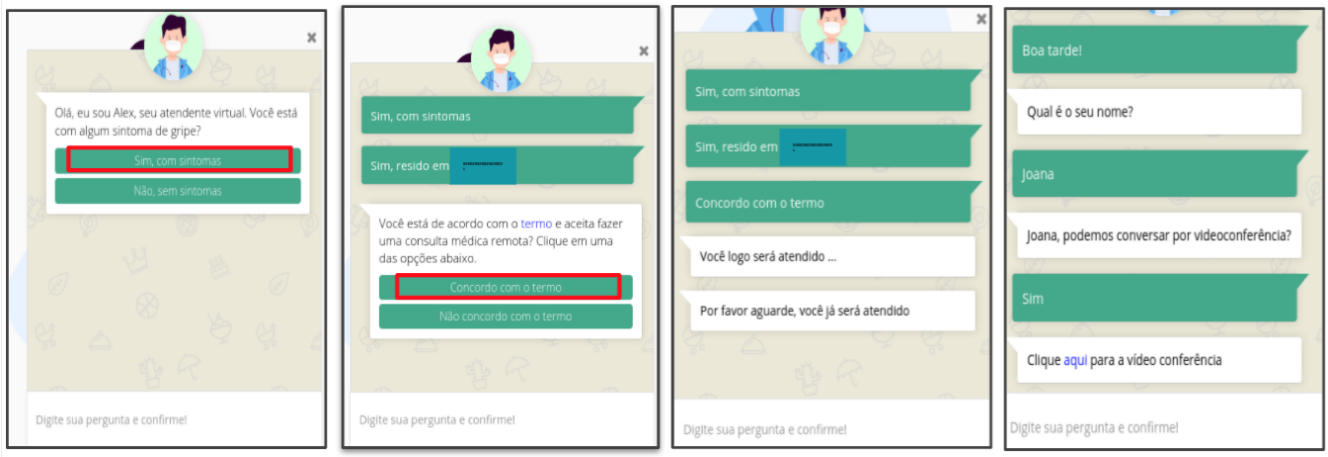

Fig. 1. 4 Screens of Telehealth Plataform Prototype, with the chatbot, and responses following user input

3 METHODS

For this research, usability tests were carried out with volunteer users. These tests sought to understand the degree of acceptance of users in using a remote consultation system and find usability issues to improve user's experience.

3.1 Study design

This paper aimed to evaluate the usability of the telehealth platform prototype, which focused on emergency telehealth to people under suspect of getting COVID-19 or those who wanted to get information about the virus.

Using the system, the user could ask questions about the disease or talk to a medicine student with supervision to analyze the symptoms and send the patient to adequate treatment.

3.2 The Evaluated Application

Students and professors created the telehealth platform prototype from the educational institution to offer the population a tool where questions about COVID-19 can be resolved, and online assistance can be provided, seeking to avoid greater agglomerations in hospitals and health posts. Some screens are illustrated in Figure 1. To use the system, the user must first accept an agreement term to release their access to the project's chat.

In the chat with the conversational agent, the system confirms whether the user lives in one of the 12 cities where the service takes place. Being from one of these cities, the next question to be asked is whether or not the user has symptoms.

If the user does not have symptoms, the system will release the option to ask questions, where their answers will be brought automatically based on the system's database.

Otherwise, the user will be invited to go through the service through chat. The user will then be seen by a medical student accompanied by a responsible physician. During the answer, the user can be redirected to a video call.

3.3 Tasks performed in the users test

During the tests, users were invited to use the Think-aloud method [7] so that they could express their views and perceptions of the system.

Users were asked to perform two tasks: first, considering the user as a person without flu-like symptoms, they should search and find in the system how to resolve their questions about COVID-19, this doubt being the user's free choice. After completing the question, the system issued an answer for the user to verify whether or not it would have been satisfactory.

In the second task, users considered that they had flu-like symptoms and needed to undergo medical care to check whether or not their symptoms were from COVID-19. With that, they should access the chat and start their service. The task was completed when the attendant (the researcher responsible for the test) sent the link to make the video call via chat.

3.4 Procedures for User Tests

Users were recruited through invitations and online communication, respecting the safety protocols established for the COVID-19 pandemic. In addition, recruited users should be over 18 years old, know how to use video calling tools, live in one of the involved cities, and have volunteered to participate in this study. The survey included 30 users aged between 19 and 31 years. The research ethics committee approved the conditions for participating in the test and its performance with CAAE 33163020.1.0000.5148.

A time was scheduled with the participants to carry out the test individually. Before starting the tests, users were informed about the test's purpose, data confidentiality, the use of the result in the research, and the focus on evaluating the system. In addition, we highlighted that it was the system that was being tested and not the user and the possibility of interrupting the test at any time, and recommendations regarding the online signing of the free and informed consent form.

For recording the videos for the analysis, users were asked to share their screen in the Google meeting room, where it was possible to record the user's interaction with the system.

At the end of the tasks, the users were invited to answer three questionnaires to expose their impressions and experiences about the system, namely:

Demographic Questionnaire: This questionnaire aimed to collect the age group of the participants, asked if the volunteer had any deficiency, their habits with the use of computers, such as hours using a computer, their experiences with smartphones, how long the user uses the internet, if the user ever used any system to solve their questions about health issues or had an online medical appointment or if the user already participated of any usability test.

Usability and Acceptance Questionnaire: This questionnaire sought to understand the degree of user satisfaction when using the system, showing statements where users could agree or disagree, based on Technology Acceptance Model (TAM) [4].

The questionnaire had 11 questions, as follows:

(1) Overall, I felt satisfied with the website.
(2) Overall, the website was easy to use.
(3) I would use the website to ask questions about prevention.
(4) I would use the website to get medical care online.
(5) I would recommend the website to friends.

(6) I believe the website interface was easy to learn and understand to accomplish the tasks.
(7) I believe the website is useful in my life.
(8) I believe the website can help me understand how to do prevention correctly.
(9) Overall, I had no problems getting the questions answered.
(10) Overall, I had no problems requesting service.
(11) Overall, I had no problem getting medical attention.

A survey study [9] revealed that the most widely used questionnaires to evaluate the usability of telemedicine - Telehealth Usability Questionnaire (TUQ) and Telemedicine Satisfaction Questionnaire (TSQ) were the most widely used in the study. However, they have a stronger focus on the performance of the medical doctor and less on the system usability. For this reason, we opted for using an adapted version of TAM to address issues more directly related to the acceptance of the technological artefact.

The results were obtained by analysing the recorded videos of the tests with the participants. The analysis identified usability problems, both through the users' comments and those observed by the researcher during the analysis.

The problems found were grouped in a table and then gathered in "unique problems", filtering the errors raised so that the same record was not made twice. With this, a survey of usability problems occurred in the system during user interaction and severity level.

Due to the COVID-19 pandemic, the tests had to be carried out remotely, making it impossible to have closer contact with users during the research. Thus, all testing procedures needed to be adjusted and migrated to use and perform the tests remotely.

In addition to this analysis, user satisfaction with the system was also assessed through the questionnaires applied. Such results are further discussed in Section 4.

4 RESULTS AND DISCUSSION

The results were obtained by analyzing the videos recorded during the tests, considering the topics observed by users, and joining them into unique problems, which means joining similar problem instances so that they are not repeated in the list, counting only the number of times each problem occurred. All participants had at least basic knowledge about how to use a computer and the internet. In addition, there were questionnaires to understand more about the perceptions and opinions of volunteers.

Table 1 presents the category of problems found adapted from Petrie and Power [16], considering the categories: Physical Presentation (PP), Information Architecture (IA), Interactivity (Int) and Content (Con). Table 1 also presents a severity rating for the problems found, considering 1 as a "Cosmetic Problem", 2 as a "Minor Problem", 3 as "Major Problem" and 4 as a "Catastrophic Problem".

Considering the results, 32 unique problems were found in the interaction with the telehealth platform prototype, mapped from a set of 60 problem instances.

One of the most recurrent usability problems shown in the tests was related to the answers given to the user. Users sometimes typed in a question about the symptoms of the COVID-19. However, they received an answer about how not to get infected with the virus. In a second attempt, the user could see information related to the virus history and how it was spread, taking some of the users to give up on the task and realize they would not find the expected result. Figure 2 illustrates an example of the answer with ways of transmitting COVID-19 when a user had requested clarification about symptoms.

Table 1. Category of problems found adapted from Petrie and Power [16]

Category	Subcategory	Problems found by users	Median Severity
IA	Structure not clear enough	5 (16%)	2
PP	Data presentation	26 (86%)	3
PP	Look and feel not consistent	2 (6%)	1
PP	Ease of use	4 (13%)	2
PP	Comfort	1 (3%)	2
Int	Input and output formats unclear	4 (13%)	3
Int	Lack of feedback	3 (10%)	2
Int	Interactive functionality expected is missing	3 (10%)	2
Int	Lack of information on how to proceed and why things are happening	2 (6%)	2
Int	Error prevention	1 (3%)	1
Int	Labels/ Instructions/ Icons on interactive elements not clear	2 (6%)	2
Con	Too much content	5 (16%)	1
Con	Loss of content	2 (6%)	2

When starting the interaction with the system, some users felt confused about the steps to follow to start sending their questions to the system, believing that agreeing with the terms, they would be redirected to talk to the medical team. Some of the users showed discomfort talking to the medical team to clarify a question, creating a sensation in the users that they would take someone else's place who might need the service more than them. We acknowledge the test was a made-up simulated situation. However, this shows the need of showing the status service status in agreement terms and possible queues. As a parallel to physical health systems, users would expect to know how busy the service would be and whether others who would be more in need of the service than them would be waiting.

These problems show that in telehealth systems, users must be informed about the status of dialogue with medical professionals and the process until they contact them. In the test scenario, situations were simulated. In real scenarios, however, users could be in much more stressful situations, and those uncertainties could have an even more significant impact on user frustration and use of the interactive telehealth system.

Focusing on the communication with the medical team, some users expressed that they could not know if the attendant was typing the answer once the system did not give this feedback. It gave them the impression that some network problem may have occurred or that the session was over and the attendant was not there anymore. In this situation, the user can abandon the conversation believing it was already over, causing problems in communication and information on how to proceed.

Design issues were also found, such as spelling errors. Some users felt comfortable expressing that they did not believe that the information on the main screen was on the right path to a complete understanding of how to proceed.

Because of it, some users expressed that they would feel better navigating in a clean page, having just the steps to be followed to access the chat.

Users also noticed problems with the lack of a place to minimize or close the chat. This problem confused users on getting back to the telehealth prototype's main page.

Likewise, some users had more positive experiences, where when asking their questions, they obtained the correct answers right away and ended up having a better experience while performing the tasks.

The results showed that conversational agents for telehealth systems have good potential for emergency support in health crises such as the COVID-19 pandemic. However, the appropriate design of conversations and consideration of users' expectancy and dialogue models is crucial to enable effective communication.

The responses provided by users to the acceptance questionnaire are presented in Table 2.

Table 2. Number of responses provided by users to TAM questionnaire

Scale of User Experience Questionnaire						
Positive attribute	**1**	**2**	**3**	**4**	**5**	**Negative attribute**
Pleasant	18	6	4	1	1	Unpleasant
Easy learning	15	11	3	0	1	Hard to learn
Meets expectation	14	7	5	4	0	Does not meet expectations
Efficient	13	15	2	0	0	Inefficient
Innovative	14	11	2	2	1	Conservative
Reliable	17	9	4	0	0	Unreliable
Interesting	21	4	4	1	0	Boring
Attractive	4	15	7	3	1	Ugly
Evident	6	12	10	2	0	Confused
Easy	15	11	2	2	0	Complicated

According to the TAM-adapted user acceptance questionnaire, 40% of users said they were satisfied with the system, while 56.7% partially confirmed the statement. Of the sample users, 66.7% believed that the system was easy to use, and 70% of users said they would use the system to answer their questions or go through online medical care.

Users stated that the system has a user-friendly interface and believe the system is helpful in their lives.

By cross-analyzing the information received by the questionnaire with the problems found in the videos analyze from a macro perspective, we can observe that users believe it is easier to interact and get to medical care than to clear up their questions. In user experience questionnaires, 61.3% of users judged the system as pleasant. Likewise, 51.6% of the participants judged that the system is easy to learn. 58.1% of users believe the system is reliable.

5 CONCLUSION

This study aimed to evaluate the usability of the telehealth platform prototype through usability tests involving 30 users with at least basic knowledge of using a computer. The systems consisted of a module with a text-based conversational agent and a video-conference platform for communication with medical staff. For the test, users were asked to perform two tasks: to clear their questions in the system and the second to go through a remote service. After performing the tests, users were asked to answer three questionnaires so that it was possible to understand more about their experience with the system and how the application could improve.

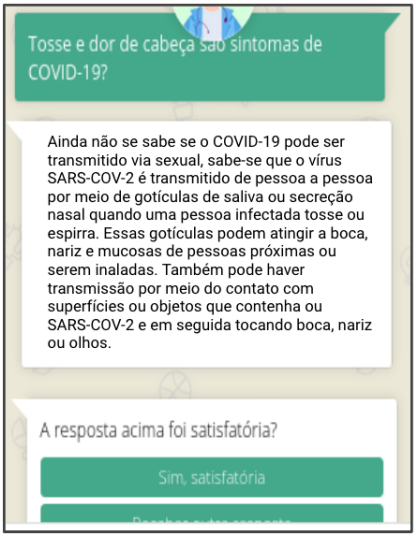

Fig. 2. Example of incorrect answer of chat

With this, it was possible to conclude that users believe it is possible to receive their care remotely, preferring to interact with a professional on the other side, receiving their diagnosis and referrals more accurately and quickly. In addition, 58.1% of users considered the system reliable, and most of them would use it in their daily lives.

The study showed important implications for designing telehealth systems, especially to attend to emergency issues such as the impacts from the COVID-19 pandemic.

For future studies, it would be interesting to evaluate the usability of the system on the attendant's side as well, since poor usability on the part of the service may also cause problems for the end-user and create problems and delays on the service side.

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