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Usability evaluation of the Doctor Saina online consultation application using the think-aloud method

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A B S T R A C T

Introduction: The rapid advancement of technology and economic growth has created both opportunities and challenges in healthcare accessibility. The unequal distribution of medical resources, which disproportionately favors economically developed regions, has led to a decline in the quality and efficiency of healthcare services in rural and underdeveloped areas, highlighting the urgent need for innovative solutions. Telemedicine effectively overcoming geographical barriers and improving access to medical care. However, usability issues in some of these applications present significant challenges, potentially compromising service quality and user experience. This study aimed to evaluate the usability of the Doctor Saina application, identifying key factors that influence its effectiveness, user satisfaction, and overall success.

Material and Methods: In this study, digital health application Doctor Saina which facilitate online medical consultations, making healthcare services more accessible, was examined. A laboratory-based usability evaluation was conducted using a predefined scenario-driven approach and the think-aloud method with 15 participants. The identified usability issues were categorized using the Van den Haak classification framework, and their severity was assessed based on Nielsen's heuristic evaluation model.

Results: The average duration of the usability evaluation per participant was 22.08 minutes. During the evaluation process, 23 issues were identified by the users, 5 of which had a severity greater than 2. The most frequent usability issues identified by users were in the Comprehensiveness category (43.5%). During the evaluation process, 9% of the issues were resolved by users without facilitator intervention.

Conclusion: Among the identified usability challenges, layout and comprehensiveness were reported as the most significant barriers affecting user experience. Addressing these issues is crucial for enhancing the overall usability, accessibility, and effectiveness of the Doctor Saina application.

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INTRODUCTION

With the advancement of socioeconomic conditions and the development of science and technology, healthcare and medical treatment have significantly improved. However, due to disparities in economic development between regions and urban-rural areas, the distribution of medical resources has been skewed toward economically developed regions [1–3].

This unequal distribution of medical resources has led to inadequate medical conditions and a decline in the quality and efficiency of healthcare services in various areas. Consequently, access to medical care remains a significant challenge for many people. Addressing the issue of medical resource allocation and ensuring the effective sharing of these resources is crucial for improving healthcare services and enhancing the quality of medical care, particularly in

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underserved regions [4].

Telemedicine has been defined by the World Health Organization (WHO) as "the delivery of healthcare services by healthcare professionals using information and communication technologies." This technology facilitates the remote exchange of reliable information for diagnosis, treatment, and disease prevention [5].

The emergence of telemedicine, which leverages telecommunication technologies to deliver and support remote healthcare, has ushered in a new era in healthcare provision. It offers numerous opportunities for improving patient outcomes and expanding access to medical care. Its applications include real-time video consultations, remote monitoring, and mobile health applications, all designed to bridge the gap between patients and healthcare providers. Telemedicine's potential for enhancing patient outcomes and healthcare access is multifaceted, addressing longstanding challenges such as geographical barriers, provider shortages, and the need for timely medical interventions. Additionally, it eliminates the necessity for long-distance travel for patients in rural or underserved areas, reducing both the time and costs associated with accessing healthcare. Furthermore, it provides a platform for continuous monitoring and follow-up care, which is essential for managing chronic diseases and improving overall health outcomes. The convenience and flexibility of telemedicine also contribute to increased patient engagement and adherence to treatment plans [6].

Telemedicine-based solutions are among the most effective approaches for improving patient care quality and promoting self-management in patients [7, 8]. According to the WHO, "self-care" is defined as the ability of individuals, families, and communities to promote health, prevent disease, maintain well-being, and cope with illness and disability, with or without the support of a healthcare provider [9]. Access to technologies such as telemedicine enables patients to take a more active role in their health-related activities, thereby increasing their opportunities for self-care [10, 11].

In this regard, the widespread adoption of mobile technology is being leveraged to enhance healthcare delivery. A broad range of health applications has been introduced for monitoring, planning, and achieving health-related goals. Given these advancements, smartphones have gradually become an integral part of daily life, offering immense value in routine tasks. Today, compared to the past, smartphones provide a wider array of functions and features [12].

With the widespread use of smartphones and the expansion of telemedicine, accessing medical services has become significantly easier. Individuals can now conveniently obtain medical appointments, receive online consultations, and manage their electronic health records [13].

As self-care and telemedicine gain traction among patients, the number of e-health applications has increased exponentially in recent years [14]. However, there is a growing body of reports indicating that various usability deficiencies in these applications, as well as in the environments where they are deployed, may ultimately affect the quality of patient care [15].

Among the various factors contributing to the abandonment or failure of an application, poor usability remains one of the most critical barriers to its widespread adoption [16-18].

Usability refers to the ease with which users can learn, interact with, and efficiently use a system, encompassing factors such as learnability, efficiency, memorability, error prevention, and user satisfaction. Therefore, evaluating the usability of health information systems is essential for ensuring their effectiveness and user adoption [19-23].

A crucial component of self-care is the ability of individuals to actively participate in their health management through healthy lifestyle choices [24]. Studies suggest that 60% of diseases can be prevented through effective self-care [25].

Chronic diseases pose a significant challenge to healthcare systems, and self-care behaviors play a crucial role in managing and treating chronic conditions [26]. Research has shown that when patients have access to health technologies that empower them to take an active role in their healthcare, their engagement in self-care significantly improves [27].

Over the past few centuries, the sharing of medical knowledge and telemedicine have evolved through technological advancements, including the printing press, telegraph, telephone, and the internet [28].

Today, mobile technologies are more accessible than ever and have been widely adopted in both the public and private sectors. One of the most promising applications of mobile technology is its role in health monitoring and management. Mobile health (mHealth) refers to any health-related service that utilizes mobile devices, including phones, tablets, and wireless technologies [29].

Through mobile health technologies, patients can monitor their treatments, manage health-related concerns, and receive timely medical assistance. These technologies are rapidly evolving, transforming how healthcare services are delivered and accessed worldwide [30-32].

While smartphone applications have the potential to enhance healthcare quality and accessibility, studies

have identified usability challenges that hinder effective user interaction with these applications. Issues such as poor user-centered design, privacy concerns, and lack of reliability in emergency situations have been cited as barriers to adoption [33].

The International Organization for Standardization (ISO) defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [14].

As usability becomes a critical factor in the adoption of digital health applications, ensuring that these technologies are well-designed and tailored to the needs of end-users is essential. This requires robust usability evaluation methodologies to guarantee a seamless user experience.

Conducting usability assessments for digital health applications offers substantial benefits, including enhanced efficiency, improved user well-being, reduced stress, increased accessibility, and a lower risk of user errors [34].

Usability evaluations help identify and address design flaws that may negatively impact user interaction with web applications and digital health platforms [35]. A well-designed health information system with high usability can significantly improve healthcare delivery, reduce errors, increase efficiency, and enhance user satisfaction [36]. Previous studies have demonstrated that usability issues—such as unclear system messages and inefficient workflows—can reduce user efficiency and hinder successful system interactions [37].

Various usability evaluation methods exist, depending on factors such as the design phase, system complexity, target users, budget, and time constraints [38, 39].

MATERIAL AND METHODS

Participants

The participants in this study were categorized into three groups: users, facilitators, and technical support staff. The user group consisted of 15 health information technology students from Varastegan Institute for Medical Sciences. These individuals possessed knowledge of mobile health application design, analysis, and user interface principles, but had no prior experience with the Doctor Saina application. These users could potentially serve as future system users. This study was conducted in compliance with the ethical standards outlined in the Helsinki Declaration. Before the evaluation commenced, participants were briefed on the study's objectives and general framework. Written and verbal informed consent was obtained from all participants. Furthermore, their personal information was handled confidentially, ensuring anonymity. Each user was accompanied by a facilitator, who did not interfere with the evaluation process. Facilitators only intervened if users encountered difficulties during usability testing, reminding them to verbalize their thoughts. These facilitators were health information technology specialists with experience in usability assessment. To address potential technical issues during the evaluation, a software specialist was also present as technical support.

Evaluation Tool

The evaluation was conducted in a quiet environment with adequate lighting, a table, two chairs, and an Android smartphone with internet access. Various tools were utilized to record user interactions, including:

- Vidma REC (ver 2.6.14) to capture user interactions with the application and verbal feedback.
- A microphone and a video camera to record participants' voices and facial expressions.

A 15-part scenario comprising 10 usability tasks was developed based on the application's features (Appendix 1). These tasks included:

1. User registration and profile editing
2. Accessing online medical consultations
3. Diagnosing conditions using the symptom checker
4. Assessing health status through the health checker
5. Reviewing the app's health magazine
6. Exploring the at-home laboratory services
7. Accessing mental health services
8. Interacting with the health bank section

A widely accepted usability evaluation approach involves real-user testing. In this study, the Think-Aloud method was employed, which is an empirical approach focusing on observing users as they interact with the system in real-time. This method gathers cognitive interaction data by requiring participants to verbalize their observations, thoughts, emotions, and decision-making processes while using the system.

Before the evaluation began, users received a 10-minute training session on the Think-Aloud method, where they were instructed on how to articulate their thoughts, emotions, and decisions in detail. After completing the evaluation, participants were asked to provide suggestions for improving the Doctor Saina application, which were documented in a structured

report form.

Analysis of Results

Following the completion of the assessments, the researcher analyzed the recorded interactions, including Vidma REC files, audio recordings, and user feedback reports. An independent review was conducted to compile a comprehensive list of usability issues, along with their severity levels.

Any discrepancies among researchers were resolved by reviewing the recorded data.

For categorizing usability issues, the classification method proposed by Van den Haak et al. was employed. According to this approach, issues were grouped into four main categories:

- Layout-related issues
- Terminology-related issues
- Data entry issues
- Comprehensiveness issues

Apart from these four categories, users occasionally encountered technological constraints, such as network connectivity problems. Since these were not usability-related issues, they were excluded from the analysis.

To assess the severity of usability problems, Nielsen's Heuristic Evaluation method was applied.

The Nielsen Questionnaire, developed by Jakob Nielsen, includes ten fundamental principles for evaluating application usability:

1. System status visibility (awareness of navigation and transitions);
2. Match between the system and the real world (use of familiar terminology);
3. User control and freedom (easy navigation and exit options);
4. Consistency and adherence to standards;
5. Error prevention (minimization of incorrect data entry);
6. Recognition rather than recall;
7. Flexibility and efficiency of use;
8. Help users recognize, diagnose, and recover from errors;
9. Aesthetic and minimalist design;
10. Help and documentation.

Using this heuristic framework, usability issues were identified, and their potential impact on the user experience was assessed. This method is widely recognized as an effective and cost-efficient approach for evaluating clinical information systems and is extensively utilized in usability assessments of user interfaces. According to Nielsen's classification, the severity of usability issues was categorized into five levels (Table 1). However, issues ranked with a severity level of "0" were excluded from the final list based on consensus among the researchers. Data analysis was performed using SPSS (ver 26).

Table 1: Severity classification of usability problems

Description	Severity
No usability problem	0
Cosmetic problem	1
Minor usability problem	2
Major usability problem	3
Usability catastrophe	4

RESULTS

The user group in this study consisted of 15 participants, including 3 males (20%) and 12 females (80%), with an average age of 20 years. The mean duration of the evaluation process for users was 22.08 minutes. The evaluation time for each user is illustrated in Fig 1.

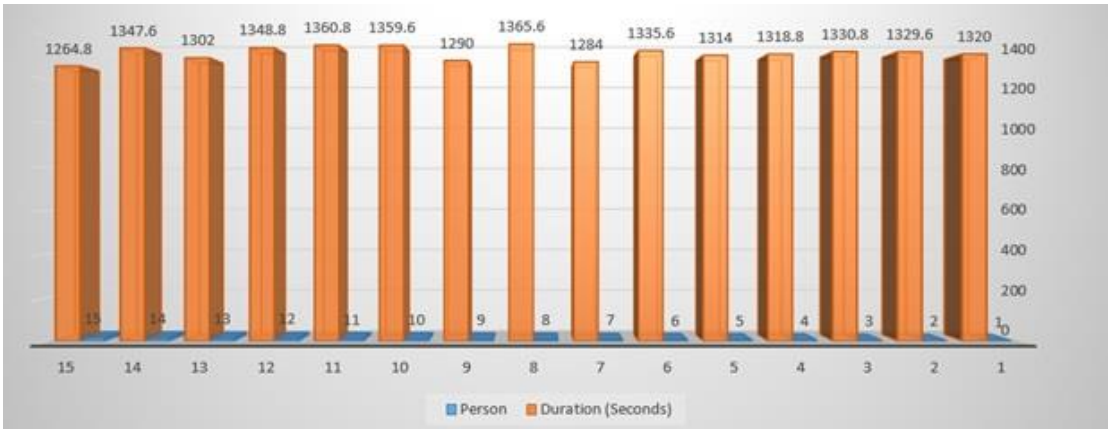


Fig 1: The evaluation time for each user

A total of 23 usability issues were identified by users during the evaluation process. The categorization and severity levels of these issues are presented in Table 2.

Among the identified issues, those related to comprehensiveness were the most frequent, accounting for 10 cases (43.5%). As shown in Table 2, approximately 40% of the issues in this category were classified as minor (severity level 2).

The most frequently reported issue in this category was the inability to enter miscellaneous symptoms in the disease diagnosis section (Task 4), which was highlighted by 10 users. This was followed by the lack of coordination for consultation regarding laboratory tests (Task 8), reported by 9 users.

As indicated in Table 2, layout-related issues accounted for 4 cases (30.4%). Among these, 2 issues were rated as severity level 4. The most frequently reported problems in this category were the absence of a confirmation message after data entry (Task 3), reported by 10 users, and the lack of proper categorization for physicians, reported by 8 users.

Table 2: Classification and Severity of Usability Issues Identified by Users

Variables		Layout N (%)	Terminology N (%)	Data entry N (%)	Comprehensiveness N (%)
Usability Problem		7(30.4)	3(13.0)	3(13.0)	10(43.5)
Severity	1	4(57.1)	2(66.7)	2(66.7)	5(50.0)
	2	1(14.3)	0	0	4(40.0)
	3	0	0	1(33.3)	1(10.0)
	4	2(28.6)	1(33.3)	0	0

Fig 2 illustrates how usability issues were addressed by users during the evaluation process.

According to this figure:

- 2 issues (9%) were resolved by users independently, without facilitator intervention.
- 6 issues (26.0%) were resolved with facilitator assistance, without interrupting the evaluation process.
- 15 issues (65.2%) remained unresolved after user attempts and were bypassed, allowing the evaluation process to continue without completing the associated tasks.

A summary of all identified issues by users and specialists is presented in Table 3.

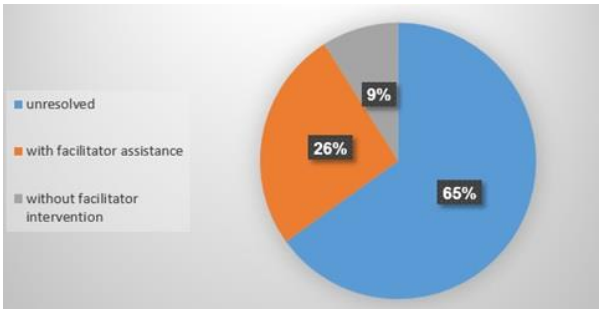


Fig 2: Illustrates how usability issues were addressed by users during the evaluation process

During the 15 evaluations using the think-aloud method, 23 issues were identified, none of the users utilized the system's help feature. Additionally, 8 users provided suggestions for improving the system's performance. The most common suggestions were related to improving the design of the doctor classification section and enhancing the notifications for operations within the application's service sections.

DISCUSSION

Usability studies of the Doctor Saina application in the healthcare domain require serious attention. Usability is a crucial part of developing this application, especially when the goal is to improve the physical health of the patient. In this study, the usability of the Doctor Saina application was evaluated using the think-aloud method. During the evaluation process, 23 issues were identified by the users, 5 of which had a severity greater than 2. While the participants generally assessed the usability of the application as good, some issues remained that could be addressed to improve the user experience. The most frequent usability issues identified by users were in the Comprehensiveness category (43.5%). The two most common issues were: the inability to record symptoms other than those listed in the disease diagnosis section and the lack of a time frame for scheduling phone consultations after a test request was made. These issues may have arisen due to the limited options available in the symptom list, which may not be comprehensive or aligned with user needs, and the lack of clarity in scheduling physician availability.

During the evaluation process, 9% of the issues were resolved by users without facilitator intervention. Additionally, 65% of the issues remained unresolved, and 26% of the remaining issues were resolved with

the facilitator's help.

Table 3: Identified Usability Issues

Issues	Users
Layout	1- The diagnostic tool lacks a symptom search feature. (5 users / Severity: 4) 2- The psychological assessment section does not include a back-navigation option. (6 users / Severity: 1) 3- Healthcare facility locations are not integrated with navigation applications. (3 users / Severity: 1) 4- After completing registration and updating their profile, users do not receive a confirmation message (e.g., "Registration Successful"). (10 users / Severity: 1) 5- The specialty selection menu for choosing a physician for medical consultation would be more user-friendly if presented as a dropdown menu. (8 users / Severity: 4) 6- The active/inactive status of physicians is not clearly visible to users. (3 users / Severity: 2) 7- The health database and medical journal sections primarily contain text-based information, lacking engaging graphical content. (3 users / Severity: 1)
Data entry	1- When applying filters to find physicians, the results do not accurately reflect the selected filters. (7 users / Severity: 3) 2- Comments and reviews are not restricted to patients who have had a consultation—any user, even without a prior visit, can submit a review. (1 user / Severity: 1) 3- The validation process for user profile data is not sufficiently robust. (2 users / Severity: 1)
Terminology	1- Instead of displaying an error message when accessing the herbal medicine section, the system should provide a message indicating the activation date. (15 users / Severity: 4) 2- The meaning of an "active" or "inactive" physician was unclear to users. (4 users / Severity: 1) 3- The medical conditions section within the health database is overly technical and not suitable for general users. (2 users / Severity: 1)
Comprehensiveness	1-The physician recommendation system is solely based on response time and frequency, without considering physician experience or patient satisfaction. (1 user / Severity: 1) 2-The diagnostic tool lacks high accuracy in identifying diseases. (8 users / Severity: 3) 3-Users cannot input symptoms that are not already listed in the diagnostic section. (12 users / Severity: 1) 4-The recommended physician at the end of the diagnosis process does not necessarily match the probable diagnosis. (6 users / Severity: 2) 5-The search and filter functions in the health database allow searches only by location, not by medical specialty or condition. (3 users / Severity: 1) 6-Information regarding healthcare service centers within the health database is not fully accurate. (1 user / Severity: 1) 7-The reliability of psychological assessments and their sources is not clearly stated. (2 users / Severity: 2) 8-The application does not include a section for submitting and tracking laboratory test requests. (1 user / Severity: 1) 9-No time frame is provided for scheduling a follow-up call after requesting an at-home lab test. (9 users / Severity: 2) 10-The integration of medical consultation payments with insurance is problematic due to limited agreements with different insurance providers. (7 users / Severity: 2)

The goal of usability testing is to identify usability problems in the system and provide solutions for addressing these issues. In this context, users made several suggestions to improve the system's performance. Most of these suggestions focused on improving the design and categorization of certain fields, such as creating a more user-friendly classification of doctors in the online medical consultation section.

One critical aspect that requires further review and attention is for users who may face equipment limitations. It is recommended that telephone-based support be provided for these users. Another consideration is for users with visual, auditory, or physical impairments, for whom the application's features do not currently provide solutions. In the future, solutions such as voice guidance, vibration, or non-verbal solutions could help address these limitations.

One limitation of this study was that the evaluation sessions were conducted in a laboratory setting. Users might interact with the application more comfortably in a real-world environment, possibly having different opinions on the issues and their severity. On the other hand, one of the key strengths of this study was the precise think-aloud usability test

of the Doctor Saina online medical consultation application. Moreover, this study is one of the few conducted in this area in Iran.

Question 1: What is the severity of issues related to receiving online medical consultations in video, phone, and text formats?

This service is accessible in the "My Health" section of the Doctor Saina application under the medical consultation section. The most frequent usability issues encountered by users in online medical consultations were in the Layout category. Two of the most common issues were related to the categorization of doctors in the initial online medical consultation section. It might be more effective to align the doctor categorization with the system used for selecting treatment centers in the Health Bank section to allow for easier specialization-based doctor selection.

Question 2: What is the severity of issues related to receiving online laboratory services?

Access to this service is available in the "Tests at Home" section of the Doctor Saina application. The most significant issue in this section was related to Comprehensiveness. The user reported that after submitting a test request, there was no time frame provided for coordination. The application only stated that the user would be contacted "as soon as possible," but the user was not informed about the time range for the call. Another issue was related to the inability of the user to use their supplemental insurance due to the lack of an agreement between the application and the user's insurance company. This issue arose from the limitations in contracts with different insurance companies. Since users prefer to use their supplementary insurance over the free-market prices, this is a significant factor.

Question 3: What is the severity of issues related to receiving health and disease diagnosis services online?

Access to this service is available through the "My Health" section of the Doctor Saina application. The most significant usability issues in the health and disease diagnosis section were also in the Comprehensiveness category. The first issue was related to the search and selection of disease symptoms, where users could not find their symptoms in the available list. Another issue was the inaccuracy of disease diagnosis based on the symptoms entered by the users. Lastly, there was a mismatch between the doctor and the disease according to the symptoms entered. This may have been caused by inadequate categorization of the symptom, diagnosis, and specialty information.

Question 4: What is the severity of issues related to receiving general information from the Health Magazine?

This section of the application is accessible through the Health Magazine section. This section had the fewest issues for users, with the only complaint being related to the lack of visual appeal and graphics, which is a Layout issue.

Question 5: What is the severity of usability issues in the Doctor Saina web application?

Users reported several significant issues with the Doctor Saina application. One issue was the limitation of the symptom list in the disease diagnosis section, which prevented users from entering symptoms outside the predefined list. Additionally, most users experienced issues with not receiving confirmation after editing and saving their profile information, which was ranked with a severity of 1. Other common issues included the inability to cooperate with different insurance companies and inaccuracies in disease diagnosis, which were ranked with a severity of 2. The most frequent issue related to the lack of access and awareness of the time for resuming access to the pharmacy and herbal medicine sections of the Health Bank, as well as the lack of proper categorization of specialties in the online medical consultation section, both of which were identified as critical issues with a severity of 4.

If, after this study, the application management and support team address these issues, it can enhance the accuracy of disease diagnosis for users. Furthermore, if the application collaborates with various insurance companies, users would no longer have to chase insurance claims after consultations. Additionally, reducing the time users spend navigating the application would lead to a more efficient and user-friendly experience.

CONCLUSION

The user evaluation of the Doctor Saina application revealed that despite being a new application designed with attention to user needs and established standards, several usability issues remain. The most frequent issues were identified in the Comprehensiveness category. If these problems are not addressed, they may negatively impact user performance, leading to fatigue, confusion, wasted time, and, ultimately, user dissatisfaction. This dissatisfaction could escalate into errors, reduced treatment quality, and potentially jeopardize patient health.

The findings underscore the importance of adhering to established human-computer interaction standards to prevent such issues. Addressing the 23 identified usability issues and making the necessary improvements will enhance the overall user experience. The management team of the Doctor

Saina web application has been notified of these issues, with recommendations for improvement to ensure a more efficient and user-friendly system.

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AUTHOR'S CONTRIBUTION

FR: Data acquisition, analysis, and interpretation of data, drafting the work; FM: Acquisition, analysis, and interpretation of data, drafting the work; ZS: Drafting the work, revising it critically for important intellectual content; HMR: Drafting the work, revising it critically for important intellectual content; MRMH: Design of the work, revising it critically for important intellectual content.

All authors contributed to the literature review, design, data collection, drafting the manuscript, read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

ETHICAL APPROVAL

This study was approved by the ethical committee of Mashhad University of Medical Sciences (approval number IR.MUMS.REC.1402.034).

FINANCIAL DISCLOSURE

No financial interests related to the material of this manuscript have been declared.

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APPENDICES

Appendix 1

1. Usability Evaluation Scenario of the Doctor Saina Application
2. In the first task, the user must open the application and register as a user by providing their personal information.
3. In the second task, the user accesses their profile section and completes or edits their personal information.
4. Additionally, in the profile section, the user encounters several items related to their user profile, which we asked them to review. These items include: My Conversations, My Doctors, My Appointments, Favorites, Financial Transactions, Support Requests, Frequently Asked Questions, Referral to Friends, and Rating Doctor Saina.
5. In the third task, the user proceeds to the "My Health" section to initiate an online medical consultation.
6. In this section, based on the user's selection of a specialty or doctor, they can choose to receive a consultation either by phone, urgent phone call, text, or video, according to various criteria such as user reviews, the doctor's medical background, and successful consultations.
7. If the selected doctor is available, the user proceeds with the consultation by choosing their primary and supplementary insurance and making the payment.
8. If the doctor is unavailable, the user can either select an alternative doctor or be notified when their chosen doctor becomes available.
9. In the fourth task, the user must use the "Disease Diagnostician" section within the "My Health" section to begin the diagnostic process for a potential illness based on their symptoms.
10. After completing the diagnostic steps, the possible diagnosis is presented, and the user can schedule a consultation with a doctor for further confirmation if necessary.
11. In the fifth task, the user is required to complete information in the "My Health" section to receive a body health analysis.
12. In the sixth task, the user must check useful and categorized health-related articles in the "Health Magazines" section of Doctor Saina's services.
13. In the seventh task, the user can view their medical consultation history in the "Conversations" section, categorized as: All, Pending Payment, and Completed.
14. In the eighth task, the user can request an in-home laboratory test service through the "Home Testing" section, and receive an interpretation of their test results with the assistance of doctors.
15. In the ninth task, the user can take a psychological test and receive analysis and counseling in the "Psychological Testing" section.
16. In the tenth task, the user can utilize the "Health Bank" section to access information on medical centers, health services across the country, as well as information on medications, herbal drugs, and diseases.