

Mobile design for medical care and minor emergencies applying telemedicine

Misael Lazo-Amado, Laberiano Andrade-Arenas

Facultad de Ciencias e Ingeniería, Universidad de Ciencias y Humanidades, Lima, Perú

Article Info

Article history:

Received Nov 21, 2023

Revised Dec 9, 2023

Accepted Jan 12, 2024

Keywords:

Medical appointment

Medical attention

Medical consultation

Mobile design

Telemedicine

ABSTRACT

The large number of patients today in hospitals or clinics shows a total collapse in the medical areas, this is reflected by the lack of available specialists and the saturation of appointments to attend patients, taking minutes and hours to get to be attended, that is why it is proposed as an objective to design a mobile application for medical care and minor emergencies applying telemedicine offering the main processes of appointment registration, video calls, medical qualification, first aid, prescription management, and emergency calls. This mobile application is made with the Design Thinking methodology that will allow the team to find the main problems or risks of the patient and find a quick solution based on design. The results give response to the 150 patients showing their satisfaction of the proposed solution, also validation by experts is performed indicating a 97% acceptance and specialist doctors indicate satisfaction, accepting that the system is efficient. In conclusion, the applied objective is shown, finding the main problems and looking for quick solutions showing efficiency and satisfaction by patients, experts, and medical specialists.

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Corresponding Author:

Laberiano Andrade-Arenas

Facultad de Ciencias e Ingeniería, Universidad de Ciencias y Humanidades

Lima, Perú

Email: landrade@uch.edu.pe

1. INTRODUCTION

Nowadays we have many patients with discomfort in their care and this is reflected in any health center in the world, medical congestion is very frequent since the long waiting list in health centers can be a delay and problem for doctors, surgeries, or consultations with specialists are a headache for patients who require short and urgent care [1]. Lack of specialists contributes to a major problem, showing patient overload and great difficulty in medical care [2]–[5]. India has a high population density in its health services which are overloaded with patients, showing a total collapse in hospitals and more so for COVID-19 diseases or similar symptoms treated in health centers [6]. In China, there is an increase in chronic diseases related to aging and a long list of patients for physicians, with chaos for medical care and even more so for people requiring specialized care for emergencies [7]–[10].

Likewise, in Latin America, hospitals and public clinics are overloaded with patient care due to their high demand as patients wait a long period to be attended with limited attention, many of the rural populations have limited access to medical care showing little efficiency in their treatments being marginalized by the lack of specialists [11]–[14]. Education is of great importance in such a way that learning first aid as well as the resolution of some emergencies is very efficient for families living in rural areas that can hardly be attended by a specialist [15], [16]. In Peru, as in other Latin American countries, scheduling appointments is complex due to long lines in person and the difficulty of coordinating the agendas of patients

and physicians who are available to be scheduled for patient care [17]–[21]. The lack of education and the use of advanced technologies for medicine are not taken full advantage of, as they would solve the problems in hospitals by providing quality scheduling and care to patients [22], [23].

The importance of these findings in the introduction is to show the main problem in patient care and the collapse of health centers allowing patients to wait long minutes and hours to be attended, they also indicate that physicians feel fatigued by the high demand of patients and cannot have a short break to continue with their work, appointment scheduling also has a strong problem as it shows the difficulty to attend long queues of patients. Likewise, the lack of specialists to solve patients' doubts and the lack of training to solve emergencies is also a problem. According to these authors, telemedicine is not highly valued but it is necessary to solve these problems.

The cited texts present in the paragraphs show the main problems with medical care and emergencies in the world showing a very poor lack of quality in the care of patients with poor treatment and stress in the queue of hundreds of patients showing an agglomeration in the medical areas. It is important to highlight that the best solution to raise in this article is to fulfill the main objective of making a Mobile Design for medical care and minor emergencies by applying telemedicine this will keep the main novelty that today is applied in hospitals and clinics helping patients to solve their problems and quick appointments, avoiding congestion and reducing unnecessary face-to-face medical expenses, as well as scheduling with specialists that are attended with telemedicine to help the patient to solve the diseases that arise with a specialist in real time, being a novel idea so that it can be accepted or developed in the future in medical centers around the world.

2. LITERATURE REVIEW

The mobile design proposes to realize innovative projects for the future helping developers to motivate themselves for the creation of the product being a very guaranteed proposal for hospitals and clinics that nowadays are familiar with technology, optimizing their medical care will help patients to get better quickly than are oriented in their moment of urgency. This author shows the impact of telemedicine and call centers in Saudi Arabia's Ministry of health providing effective remote care, recent the number of emergency visits a result in health centers optimizing their medical care showing an analysis of improvement in their medical appointments with telemedicine by 24.4% [24]. This author demonstrates that the TEAMS program optimizes their care through telemedicine showing a specific call with the physician for the control of asthma managing self-care and clinical decision-making showing as a result 80% who participated with uncontrolled asthma at 6 months of the study showed an absolute control of asthma improving their quality of life with a lung function of 4.2% ensuring their satisfaction up to 95.7% with telemedicine [25]. The e-health services is a fundamental role for remote medical care demonstrating a way to help in the emergencies of lower risks as well as the covid-19, as this author shows that telemedicine is the future indicating as a good result an excellent medical care reducing patients in person 3. The result of mobile applications with these authors shows their optimization for their medical care for patients seeking to solve the short time to attend their scheduled appointments for emergencies [26].

The development of the mobile application is a reality and even more that it is applied for telemedicine as this author indicates shows the challenges faced by hospitals and clinics for the high demand for medical care indicating as a result an Android device that is developed with Flutter, offering to receive diagnoses with specialists online facilitating their request and payment for the care of medicines, shows the options of calling ambulance services and delivery of medicinal products his proposal shows the limitation by traditional care [27]. This author develops a telemedicine and educational mobile application called OrtogApp that takes care of orthognathic surgery patients providing the patient an orientation with their surgeons with an educational video call showing an involvement about their disease showing a satisfaction of 83% in its usability. The efficiency of the development method is one of the most impactful proposals of high demand fulfilling the objective of the user with telemedicine facilitating new processes that satisfy the patient [28].

Statistical analysis is essential in research, and this author conducts a study to validate the effectiveness of telemedicine during the COVID-19 pandemic. It is highlighted that 64.2% of 2041 studies indicate the search for symptom information through online calls, is efficient for detecting suspected cases and maintaining isolation [28]. In addition, the implementation of telemedicine in the United States and China is analyzed, demonstrating efficiency in reducing virus transmission [29]. It also evaluates the scheduling of surgical appointments, showing that telemedicine streamlines the process, and saves time and costs, with a high satisfaction rate of 98% of patients [30]. This secure method of analysis uses statistical data to evaluate the usability and satisfaction of physicians and patients in telemedicine projects

The works presented by these authors [31] show their methods of development and analysis of telemedicine, but these processes are taken into account to attach and motivate the development of this project that helps us to identify the main problems and solutions to propose new processes that satisfy the patient with a friendly interface for the user, recording an appointment scheduling with real-time care and other processes. This novel proposal will help health centers to solve the problems of patients, avoiding congestion and long waiting lines, highlighting that the mobile application provides us with the facility to be used to streamline the care process and that today people have a mobile slide to schedule your appointment and be served as quickly as possible.

3. METHOD

This second section will show the design thinking methodology that will be used to design the mobile application according to the needs of the user, explaining in detail the five phases (Empathize, Define, Ideate, Prototyping, Evaluate) that will be used to complete the telemedicine project. For more details on understanding this methodology will show a process of using this methodology as shown in Figure 1. This process indicates that the development team will be in charge of the surveys. These are carried out for decision-making in such a way that the user must collaborate with answering the surveys in such a way that the work team proposes the best solutions according to the problems presented by the user to design the solution based on a mobile application. Finally, the user will decide whether he/she agrees with the design or if it needs some improvement.

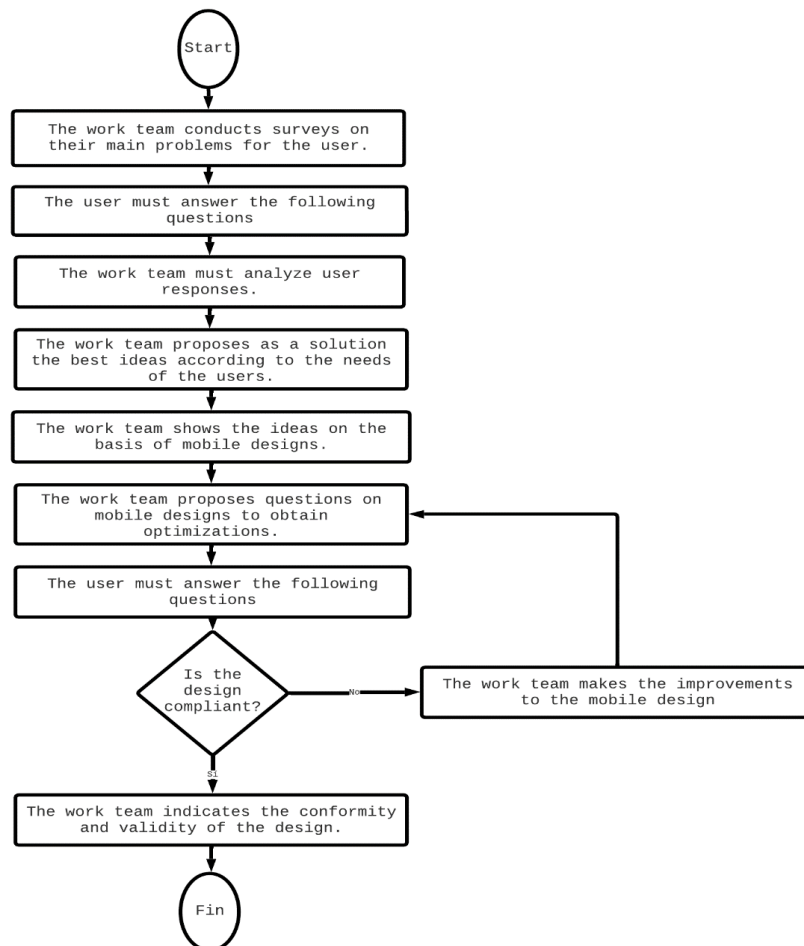


Figure 1. Methodology process

3.1. Design thinking

It is a highly creative methodology that is dedicated to problem solving and is one of the most important tools for ux/ui designers showing efficiency in the design of their products and services that

innovate each business and improve the processes suggested by customers [32], [33]. Design thinking is focused on understanding the challenges presented by the customer by understanding their main needs, desires, and concerns, this methodology requires observing the user's behaviors to obtain improvement processes constantly with a collaborative approach that experiences good design practices showing five stages empathize, define, ideate, prototype, and evaluate [34], [35]. Figure 2 shows the overall graph of the stages involved.

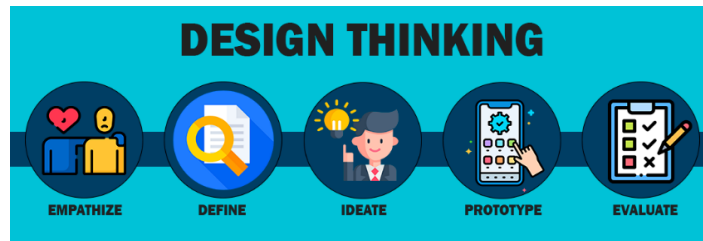


Figure 2. Methodology design thinking

3.1.1. Empathize

This is the first stage of the methodology dedicated to conducting research, interviews and observations to meet people's needs, allowing us to identify and familiarize ourselves with their main problems, to look for a main solution [36], [37]. Table 1 shows the main questions that are asked to patients who are treated in hospitals in which 10 questions were generated (Q1 to 10) to understand their main problems. The user needs to answer the questions to solve their main problems.

Table 1. Empathize

ID	Question
Q1	Have you had to travel long distances to receive specialized medical care?
Q2	Have you ever had to wait in a doctor's office waiting room for more than 30 minutes during your last few visits?
Q3	Have you ever had to seek medical care in an emergency room due to the inability to get an appointment with your doctor?
Q4	Have you experienced difficulty getting your prescriptions filled on time at the pharmacy?
Q5	Have you felt pressured to end your medical consultation before you could ask all your questions or discuss all your symptoms?
Q6	Have you had to deal with difficulties in accessing medical specialists in a reasonable amount of time?
Q7	Have you had to cancel or reschedule a medical appointment due to your doctor's unavailability?
Q8	Have you noticed a high turnover of doctors at the clinic or healthcare facility you attend?
Q9	Have you had problems obtaining medical tests or diagnoses in a reasonable amount of time?
Q10	Have you had difficulty obtaining timely and clear information about your treatment plan or medical care?

3.1.2. Define

This is the second phase of the methodology, is a crucial point for decision-making from the first stage of data collection that shows the main problems people have [38]. Table 2 shows the answers to questions in which 150 patients were surveyed so that the team could understand the patient's problems and initiated decision-making. The task force analyzes the results of the surveys for decision-making and implement new ideas in the next process.

The survey responses reveal a variety of problems among patients. A total of 75.3% of the respondents face long trips to the health center, affecting their time considerably. 89.6% experience medical delays, waiting more than 30 minutes in the waiting room. In addition, 80.3% face difficulties when approaching the emergency room due to disability or scheduling medical appointments. Obtaining prescriptions on time is a problem for 80.8%, generating congestion in health center pharmacies. 95.5% indicate that physicians seek to finalize cases quickly, while 85.7% have difficulty accessing specialists due to congestion. 81.5% cancel appointments due to physician availability, and 79.9% experience constant changes in the location of their physicians, making prompt care difficult. 70.5% face problems obtaining medical tests, and 76.6% have difficulty obtaining information about their treatment and experience inefficiency in their medical care. These identified problems will guide the team's decisions in the search for solutions.

Table 2. Define

Questions	Answers
Q1	Yes 75.3%, No 24.7%
Q2	Yes 89.6%, No 10.4%
Q3	Yes 80.3%, No 19.7%
Q4	Yes 80.8%, No 19.2%
Q5	Yes 95.5%, No 4.5%
Q6	Yes 85.7%, No 14.3%
Q7	Yes 81.5%, No 18.5%
Q8	Yes 79.9%, No 20.1%
Q9	Yes 70.5%, No 29.5%
Q10	Yes 76.6%, No 23.4%

3.1.3. Ideate

This is the third stage of the Design Thinking methodology, showing creativity on the part of the work team, indicating empathy towards the user and clearly defining possible solutions based on the identified problems to proceed to the next step [39], [40]. Table 3 shows the main ideas for solving patients’ problems, indicating 8 processes that speed up primary care and minor emergencies. The work team must indicate all your ideas to proceed to the next process.

Table 3. Ideate

ID	Ideate
I1	Patient registration for mobile application login
I2	Appointment scheduling registration for patients
I3	Video calls and live chat with scheduled physicians
I4	Physician rating to score your care
I5	First aid educational tips
I6	Prescription management
I7	Emergency calls

3.1.4. Prototyping

This is the fourth stage of the methodology which is responsible for transforming the proposed solution so that this process can be used in their presentations in the physical or digital form as a final solution to satisfy the user [41], [42]. The work team is responsible for translating their ideas in the form of design to fall in love with users. Figure 3 illustrates the initial phase of patient registration in the mobile application, providing a clear and detailed interface. In Figure 3(a), a complete form is presented with essential fields, such as name, ID number, password, and more. This comprehensive approach ensures accurate data to personalize the user experience based on their location and demographic profile. In Figure 3(b), the next stage simplifies access with the registered email and password, facilitating fast and secure access, minimizing barriers and ensuring service efficiency.

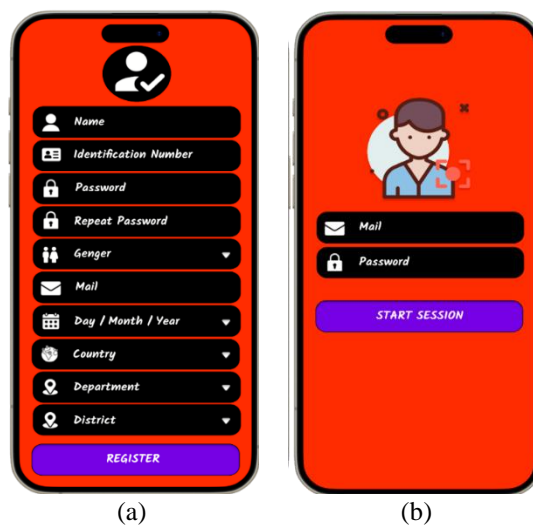


Figure 3. Patient registration for mobile application login (a) registration and (b) login

Figure 4 presents an intuitive and comprehensive menu for the patient to explore and meet their specific needs. This central menu offers a variety of functionalities to manage care in an efficient and personalized manner. It includes options designed to address specific aspects of the user's interaction with the application, such as recording appointments to keep a detailed history. Video calls and live chats with scheduled physicians facilitate communication with healthcare professionals, providing an experience close to face-to-face care. The application covers a wide range of functions, from medical assessment to prescription management and emergency calls, providing crucial information and practical tools for understanding and managing medical treatments. The ability to edit the profile and close the application adds a component of personalization and control for the user to adjust their information.

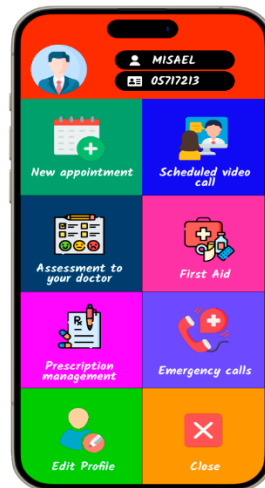


Figure 4. Patient options menu

Figure 5 is a comprehensive tool for scheduling medical appointments, simplifying the process for the user. Figure 5(a) highlights the initial step where the user registers the appointment, providing personal information and detailing the medical problem. This registration not only fulfills administrative formalities, but also ensures that the professional is informed about the consultation for effective preparation. Figure 5(b) provides additional details about the appointment, such as date, time and remarks, with the option to download the information in PDF format. This feature facilitates personal record keeping and prepares the user for the scheduled medical consultation.

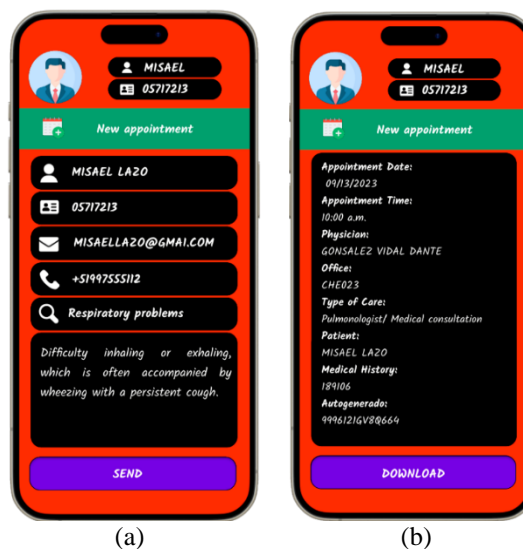


Figure 5. Appointment scheduling registration for patients (a) appointment registration and (b) appointment detail

Figure 6 details the user experience in a video consultation, offering efficient and transparent remote medical interaction. In Figure 6(a), a complete listing of scheduled consultations is shown with crucial information, ensuring that the patient is informed and actively involved. Figure 6(b) provides a detailed view of the video consultation, highlighting the interactivity between user and physician. This process allows instantaneous exchange of messages, camera and audio activation, effectively replicating face-to-face interaction, providing a live chat during the medical consultation.

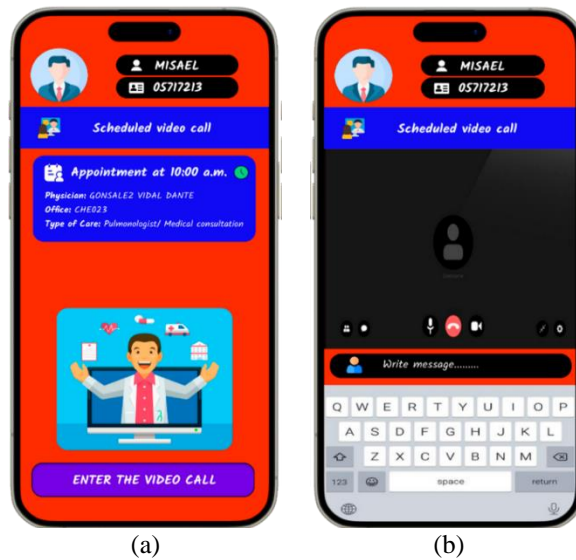


Figure 6. Video calls and live chat with scheduled physicians (a) appointment list and (b) video calls

Figure 7 is an essential tool for patient feedback, allowing the patient to evaluate the medical care received. In Figure 7(a), a complete list of physicians is presented with details on the type of case treated and the associated rating stars, giving the patient a quick overview of his or her experience with each physician. Figure 7(b) shows detailed healthcare surveys, allowing the patient to express specific opinions on empathy, the effectiveness of treatment, and overall quality of care. This detailed approach provides practitioners with valuable information to identify areas for improvement and recognize positive aspects.

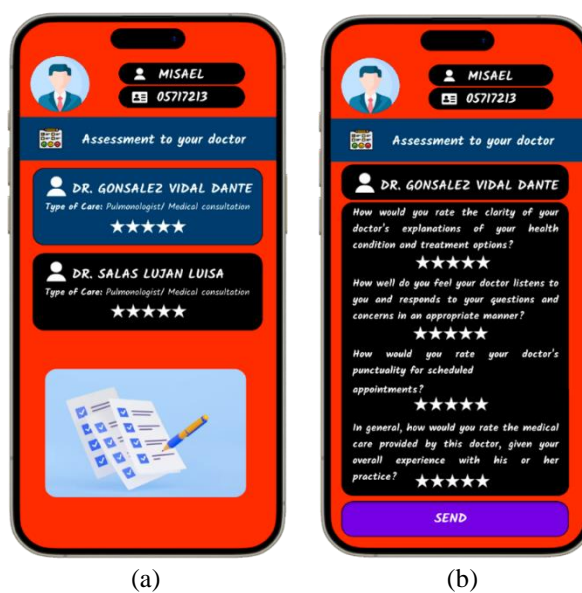


Figure 7. Physician rating to score your care (a) list of doctors and (b) doctor ratings

Figure 8 displays a valuable list of first aid procedures, allowing the patient to become familiar with the necessary treatments. In Figure 8(a), an overview of the list is presented, giving the user the opportunity to examine in detail the information associated with each available option. On the other hand, in area Figure 8(b), the visual representation offers a concise summary of the treatments, highlighting the inclusion of brief and precise information that summarizes the essential guidelines for each procedure. This summary facilitates a quick and efficient understanding of the key steps in emergency situations.

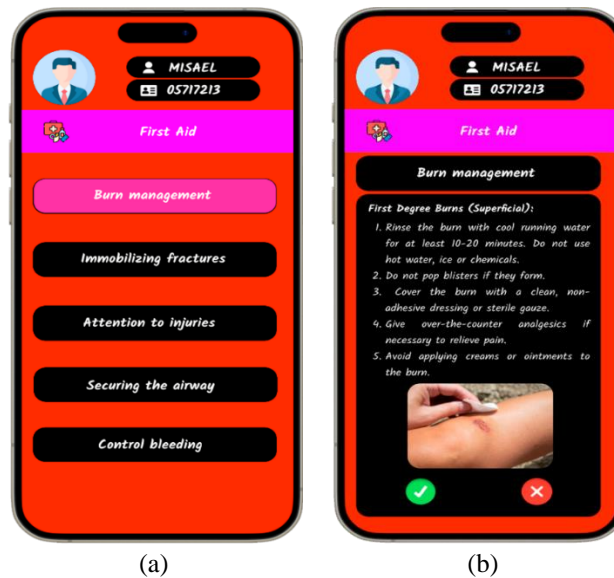


Figure 8. First aid educational tips (a) first aid checklist and (b) training sample

Figure 9 presents the medical prescriptions sent to the patient after a consultation. In the visual representation Figure 9(a), a complete list of the prescriptions is shown with details about the type of case and codes related to the medical area. This visualization allows the user to quickly access relevant information about their prescriptions. In Figure 9(b), a more detailed overview of each prescription is provided, including details such as dosage and specific instructions. In addition, it highlights the option to download the prescription, offering the user the convenience of having an easily accessible digital copy.

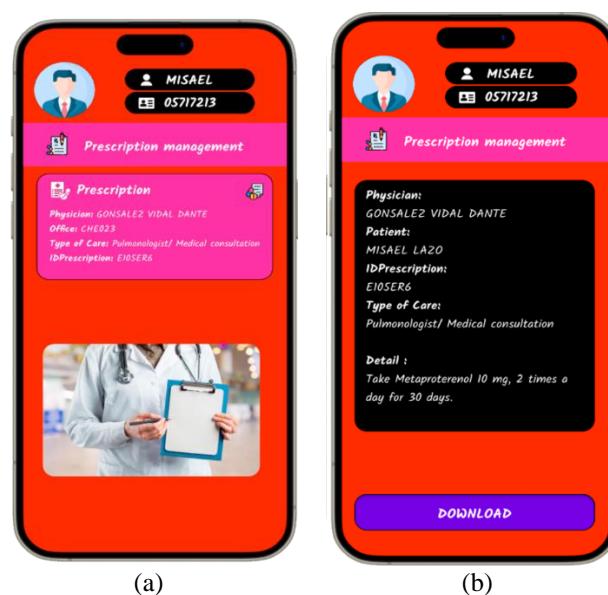


Figure 9. Prescription management (a) prescription list and (b) prescription detail

In Figure 10, the mobile application user is provided with the ability to make emergency calls related to health, police safety, and fire response. The visual representation Figure 10(a) details the call alternatives available for any emergency, covering health, police and fire response. On the other hand, Figure 10(b) displays the specific call interface, providing the user with a direct way to make the call immediately and efficiently.



Figure 10. Emergency calls (a) call options and (b) immediate call

3.1.5. Evaluate

This is the fourth phase of the methodology responsible for transforming the proposed solution so that this process can be used in its presentations in physical or digital form as a final solution to satisfy the user [43], [44]. Table 4 shows the 10 questions about the prototype (Q1 to Q10) so that the work team can evaluate and make a decision showing its approval. The team will conduct a user survey and these questions will be based on the prototype. It is necessary that the user can answer these surveys to optimize as soon as possible the proposed design.

Table 4. Evaluate

ID	Question
Q1	Does the application offer an intuitive and user-friendly user experience?
Q2	Is the registration process and access to the application simple and secure for users?
Q3	Does the app allow users to schedule medical appointments efficiently?
Q4	Does the app provide reliable and up-to-date medical information?
Q5	Does the app provide appointment and medication reminders for patients?
Q6	Is communication between doctors and patients through the app secure and private?
Q7	Does it offer the option of video consultations for a more complete diagnosis?
Q8	Is medical information presented in a clear and understandable way for patients?
Q9	Is a real-time chat function included for urgent medical consultations?
Q10	Can patients access a 24-hour online assistance service in case of medical emergency?

4. RESULTS

In this essential phase, a comprehensive evaluation of the mobile application will be carried out through the active participation of the prototype, experts, and health specialists. This process seeks to ensure the quality and effectiveness of the application in the health field. A detailed analysis of the advantages and disadvantages of the methodology used will be carried out, as well as a comparison with alternative

approaches. The results of this evaluation will be presented transparently, allowing the work to be tested and validated by specialists and stakeholders. This step is essential to ensure the feasibility and acceptance of the application, as well as to obtain the necessary support for its successful implementation.

4.1. Prototype validation

The evaluation of the responses of the 150 respondents in Table 4, validating the acceptance of the mobile design, is shown in Figure 11. Ninety-five percent of respondents found the mobile application very intuitive and easy to use, 90% considered it secure, and 91% found it efficient for scheduling medical appointments. In addition, 92% indicated that the application provides reliable and up-to-date medical information. Overall satisfaction was high, with 89% highlighting the security and privacy, 91% approving of the video consultations, and 97% praising the real-time chat and 24/7 emergency assistance.

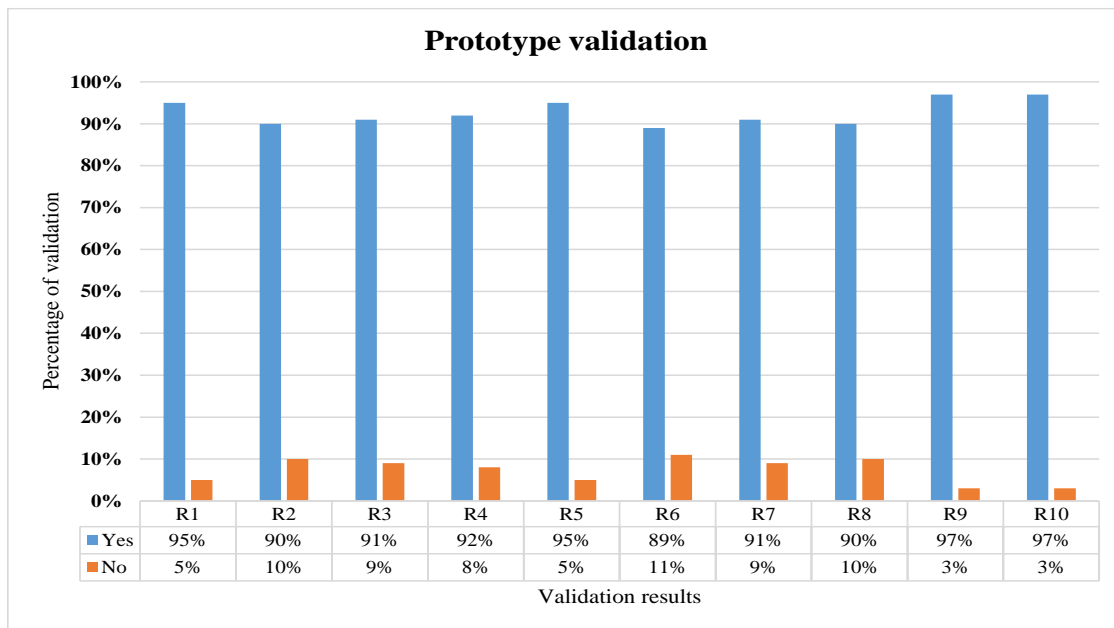


Figure 11. Weibull distribution of all filler concentrations

4.2. Expert validation

In this validation, seven experts (E) in the areas of realism, integration, adaptability, technology, innovation, functionality, and usability are evaluated, which shows an efficient guarantee of the presented product as shown in Table 5. The validation by seven experts shows a high level in all specialties indicating that realism has a total of 94%, integration has 97%, adaptability has 95%, technology has 93%, innovation has 95%, functionality has 96%, and usability has 93% showing an overall average of 97% indicating their satisfaction and efficiency in the specialties shown.

Table 5. Ideate

Validation	E1	E2	E3	E4	E5	E6	E7	Total	Level
Realism	94%	95%	94%	94%	90%	96%	97%	94%	High
Integration	99%	98%	97%	98%	97%	95%	97%	97%	High
Adaptability	93%	95%	93%	95%	95%	94%	97%	95%	High
Technology	96%	97%	91%	92%	92%	90%	96%	93%	High
Innovation	95%	95%	95%	95%	97%	95%	94%	95%	High
Functionality	97%	97%	96%	90%	97%	95%	97%	96%	High
Usability	92%	92%	95%	92%	91%	94%	94%	93%	High

4.3. Validation by health specialists

In this validation, the specialists in Nursing, Emergency Physician, Emergency Physician, Traumatologist, Cardiologist, Pneumologist, Gastroenterologist, Surgeon, Internal Medicine Physician will

be evaluated in which 4 main questions about the mobile application evaluated as shown in Table 6. After that the results will be shown by the specialists as indicated in Table 7. These results show the validation of specialists are satisfied and satisfied with the mobile application indicating the efficiency of the patient to have online medical care is 96%, the specialists indicate that the application has the necessary functionality to inform the patient about treatments for emergencies 94%. The specialists indicate that the mobile application fulfills its purpose of performing medical consultations 95% and also shows that the mobile application is in charge of prescription management with 94%, indicating that the mobile application is very effective for patients, avoiding congestion in face-to-face appointments and providing good control in health centers, affirming that telemedicine is the future.

Table 6. Evaluate

ID	Questions for specialists
Q1	Does this mobile application allow for effective online consultation with physicians?
Q2	Does the mobile application provide accurate and useful information about your treatment and emergencies?
Q3	Do you comply with making medical consultations through the mobile application?
Q4	Does the mobile application facilitate prescription management?

Table 7. Validation by specialists

Health specialty	Q1	Q2	Q3	Q4
Nursing	95%	92%	93%	94%
Emergency physician	97%	92%	95%	95%
Urgent care physician	95%	92%	94%	93%
Traumatologist	95%	95%	95%	94%
Cardiologist	96%	98%	94%	94%
Pulmonologist	97%	98%	93%	94%
Gastroenterologist	95%	97%	96%	95%
Surgeon	97%	95%	96%	94%
Internal medicine	95%	91%	96%	93%
Total	96%	94%	95%	94%

4.4. About the methodology

4.4.1. Advantages

The use of this methodology offers benefits by addressing complex problems through innovation, focused on understanding the user's needs. It facilitates teamwork by exploring solutions with creative ideas. It is characterized by being iterative and flexible, allowing continuous optimization that adjusts to changes according to user needs. In addition, it promotes the acceptance of failure as part of the process to achieve more effective solutions.

4.4.2. Disadvantages

The main limitation of this methodology lies in its potential slowness, especially depending on business needs, which can result in high costs as it requires significant time on the part of designers to complete the innovation effectively. In addition, its effectiveness is strongly linked to the capability of the team, as it seeks highly interactive, communicative and innovative individuals. It is important to note that this methodology is not considered agile and may not be suitable for large projects, although its value as a contribution to shorter processes is highlighted.

4.4.3. Comparison

The methodology is ideal for design according to user needs but also compared with other methods according to the project objective. Thus, the lean startup method has a similar approach that allows a quick validation in your ideas through experiments. With the Kanban methodology, they have a continuous improvement process similar to design thinking but more focused on optimizing their workflows showing efficient delivery in a short period.

5. DISCUSSION

Mamoun *et al.* [27] shows the development of a mobile application showing telemedicine in which shows the options that the patient can receive their diagnoses online and make their payment for medicines as the delivery of their products, instead, the project presented shows live care with an intuitive design that adapts to the client as well as shows education in first aid to train the patient to any emergency that arises.

Mammen *et al.* [25] shows telemedicine to optimize their medical care in asthma management and self-care with Teams indicating their satisfaction instead this project offers the only process for telemedicine which is video calls with their doctor presented meeting the patient's expectations for proper treatment. The analysis for the work is necessary to understand the needs of people which is why the design thinking methodology is used to show an analysis for decision-making and indicate the quick solutions for the problem presented, instead Gao *et al.* [29] does not show any methodology that applies any solution only the risks presented are observed. According to the presented authors, they show a part of equality to the project. It is also observed that the presented project indicates a complete system for the patient being of great novelty using new processes such as appointment booking, doctor's assessment, video calls with the specialist, first aid education, prescription management, and quick calls to emergencies, something that these mentioned authors do not implement these processes yet.

6. CONCLUSION

The presentation of the project responds to the needs of the patients starting from their satisfaction based on surveys and showing in its analysis an efficient utility to make their medical appointments and maintain control in the health centers due to the high demand, the methodology is the most important part of this project since it presents the analysis and decision making according to the problems encountered understanding the needs of the patient. Finally, the results show the satisfaction that indicates the validation of the prototype, validation by experts, and validation by specialists showing the efficiency that the mobile application has in solving the congestion of patients in the process of medical appointments. The motivation that gives us the project is the opportunity to provide a quick solution to patients to be attended quickly so they show a great contribution to the peruvian country especially to health centers. The limitation of the project is in the development of mobile application software since it is required to get together with a specialist in programming and establish a complete project. As a future work, this project developed with a specialist in software development should be presented and new processes such as artificial intelligence should be increased.

ACKNOWLEDGEMENTS

Thank the Faculty of Science and Engineering, University of Sciences and Humanities for providing support in the research carried out and the culmination of it can become reality.

REFERENCES




- [1] Y. Guo, H. Wu, and Y. Wei, "Nocturnal nasal congestion is associated with uncontrolled blood pressure in patients with hypertension comorbid obstructive sleep apnea," *European Archives of Oto-Rhino-Laryngology*, vol. 279, no. 11, pp. 5215–5221, 2022, doi: 10.1007/s00405-022-07352-4.
- [2] N. Aslani and A. Garavand, "Using eVisit to reduce patient referrals to clinics and physician controlling COVID-19 outbreak," *Health Scope*, vol. 9, no. 3, 2020, doi: 10.5812/jhealthscope.103769.
- [3] W. Hou, S. Qin, and C. H. Thompson, "A virtual evaluation of options for managing risk of hospital congestion with minimum intervention," *Scientific reports*, vol. 12, no. 1, p. 14634, Aug. 2022, doi: 10.1038/s41598-022-18570-5.
- [4] N. H. S. Suhaimi, A. F. Ismail, K. Badron, and Y. A. Ahmad, "Estimation of satellite link's fade margin using non-meteorological technique and worst month analysis," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 13, no. 4, p. 4136, 2023, doi: 10.11591/ijece.v13i4.pp4136-4144.
- [5] A. Odeh and Q. Abu Al-Haija, "Medical image encryption techniques: a technical survey and potential challenges," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 13, no. 3, p. 3170, 2023, doi: 10.11591/ijece.v13i3.pp3170-3177.
- [6] D. Koepfen, M. Aurich, M. Pasalar, and T. Rampp, "Medicinal leech therapy in venous congestion and various ulcer forms: perspectives of Western, Persian and Indian medicine," *Journal of traditional and complementary medicine*, vol. 10, no. 2, pp. 104–109, Aug. 2019, doi: 10.1016/j.jtcme.2019.08.003.
- [7] S. Saleh, B. Cherradi, O. El Gannour, N. Gouiza, and O. Bouattane, "Healthcare monitoring system for automatic database management using mobile application in IoT environment," *Bulletin of Electrical Engineering and Informatics*, vol. 12, no. 2, pp. 1055–1068, 2023, doi: 10.11591/eei.v12i2.4282.
- [8] A. Chandak, M. Holkar, A. Moghe, and K. Washikar, "Use of telehealth during COVID-19 pandemic in India: literature review," *International Journal of Public Health Science (IJPHS)*, vol. 12, no. 1, p. 164, 2023, doi: 10.11591/ijphs.v12i1.22059.
- [9] J. Xu and Y. Zhang, "Traditional Chinese medicine treatment of COVID-19," *Complementary therapies in clinical practice*, vol. 39, p. 101165, May 2020, doi: 10.1016/j.ctcp.2020.101165.
- [10] X. Chen *et al.*, "Perioperative management of patients infected with the novel coronavirus: recommendation from the joint task force of the Chinese Society of Anesthesiology and the Chinese association of anesthesiologists," *Anesthesiology*, vol. 132, no. 6, pp. 1307–1316, Jun. 2020, doi: 10.1097/ALN.0000000000003301.
- [11] G. Filippatos *et al.*, "Global differences in characteristics, precipitants, and initial management of patients presenting with acute heart failure," *JAMA cardiology*, vol. 5, no. 4, pp. 401–410, Apr. 2020, doi: 10.1001/jamacardio.2019.5108.
- [12] M. N. Fakhruzzaman, G. S. Palupi, and T. N. Rochmah, "Fear of missing out during a pandemic: the driving factors of telemedicine application acceptance," *Bulletin of Electrical Engineering and Informatics*, vol. 11, no. 4, pp. 2331–2338, 2022, doi: 10.11591/eei.v11i4.3848.

- [13] A. S. Arif and M. A. Jassim, "Combining 3D run-length encoding coding and searching techniques for medical image compression," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 12, no. 3, p. 2601, 2022, doi: 10.11591/ijece.v12i3.pp2601-2613.
- [14] S. Silvalena and R. A. Syakurah, "Healthcare providers' utilization and perception on telemedicine: urgency amidst COVID-19 pandemic," *International Journal of Public Health Science (IJPHS)*, vol. 11, no. 1, p. 287, 2022, doi: 10.11591/ijphs.v11i1.20978.
- [15] H. González-Pacheco *et al.*, "Clinical phenotypes, aetiologies, management, and mortality in acute heart failure: a single-institution study in Latin-America," *ESC heart failure*, vol. 8, no. 1, pp. 423–437, Feb. 2021, doi: 10.1002/ehf2.13092.
- [16] Á. A. Faccini-Martínez *et al.*, "Historical overview and update on relapsing fever group Borrelia in Latin America," *Parasites & vectors*, vol. 15, no. 1, p. 196, Jun. 2022, doi: 10.1186/s13071-022-05289-5.
- [17] J. C. Gómez de la Torre Pretell *et al.*, "Clinical characteristics associated with detected respiratory microorganism employing multiplex nested PCR in patients with presumptive COVID-19 but negative molecular results in Lima, Peru," *Tropical medicine and infectious disease*, vol. 7, no. 11, p. 340, Oct. 2022, doi: 10.3390/tropicalmed7110340.
- [18] C. Kim and H. Yoon, "Health-care networks and the impact of maternal health care projects--the cases of Peru and Bolivia," *Journal of International and Area Studies*, vol. 27, no. 2, pp. 37–53, 2020, doi: 10.23071/jias.2020.27.2.37.
- [19] I. E. Salem, H. R. Abdulshaheed, and H. M. Ghenni, "A secure telemedicine electronic platform based on lightweight cryptographic approach," *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, vol. 20, no. 5, p. 988, 2022, doi: 10.12928/telkomnika.v20i5.22662.
- [20] I. Q. Abduljaleel and A. H. Khaleel, "Significant medical image compression techniques: a review," *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, vol. 19, no. 5, p. 1612, Oct. 2021, doi: 10.12928/telkomnika.v19i5.18767.
- [21] S. A. Aziz *et al.*, "A review on region of interest-based hybrid medical image compression algorithms," *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, vol. 18, no. 3, p. 1650, 2020, doi: 10.12928/telkomnika.v18i3.14900.
- [22] J. F. Quispe-Cañari *et al.*, "Self-medication practices during the COVID-19 pandemic among the adult population in Peru: a cross-sectional survey," *Saudi pharmaceutical journal : SPJ: the official publication of the Saudi Pharmaceutical Society*, vol. 29, no. 1, pp. 1–11, Jan. 2021, doi: 10.1016/j.jsps.2020.12.001.
- [23] M. J. Valladares-Garrido *et al.*, "Clinical-epidemiologic variation in patients treated in the first and second wave of COVID-19 in Lambayeque, Peru: a cluster analysis," *International journal of infectious diseases : IJID : official publication of the International Society for Infectious Diseases*, vol. 123, pp. 212–220, Oct. 2022, doi: 10.1016/j.ijid.2022.07.045.
- [24] A. Alfaleh *et al.*, "The role of telemedicine services in changing users' intentions for presenting to the emergency departments in Saudi Arabia," *Digital health*, vol. 8, pp. 20552076221091360–20552076221091360, Jun. 2022, doi: 10.1177/20552076221091358.
- [25] J. R. Mammen *et al.*, "Going mobile with primary care: smartphone-telemedicine for asthma management in young urban adults (TEAMS)," *Journal of Asthma*, vol. 59, no. 1, pp. 132–144, 2020, doi: 10.1080/02770903.2020.1830413.
- [26] J. Crouch, K. Winters, L. Zhang, and M. W. Stewart, "Telehealth during the pandemic: patient perceptions and policy implications," *Journal of nursing scholarship : an official publication of Sigma Theta Tau International Honor Society of Nursing*, vol. 55, no. 1, pp. 141–148, Jan. 2023, doi: 10.1111/jnu.12832.
- [27] R. Mamoun, M. Nador, and S. H. Abulikailik, "Design and development of mobile healthcare application prototype using flutter," in *2020 International Conference on Computer, Control, Electrical, and Electronics Engineering (ICCCEEE)*, IEEE, Feb. 2021, pp. 1–6. doi: 10.1109/ICCCEEE49695.2021.9429595.
- [28] C. S. Sousa and R. N. T. Turrini, "Development of an educational mobile application for patients submitted to orthognathic surgery," *Revista Latino-Americana de Enfermagem*, vol. 27, pp. e3143–e3143, Jul. 2019, doi: 10.1590/1518-8345.2904.3143.
- [29] Y. Gao *et al.*, "Application of telemedicine during the coronavirus disease epidemics: a rapid review and meta-analysis," *Annals of translational medicine*, vol. 8, no. 10, p. 626, May 2020, doi: 10.21037/atm-20-3315.
- [30] S. G. Alonso *et al.*, "Telemedicine and e-Health research solutions in literature for combatting COVID-19: a systematic review," *Health and technology*, vol. 11, no. 2, pp. 257–266, 2021, doi: 10.1007/s12553-021-00529-7.
- [31] N. V. Kamdar *et al.*, "Development, implementation, and evaluation of a telemedicine preoperative evaluation initiative at a major academic medical center," *Anesthesia & Analgesia*, vol. 131, no. 6, pp. 1647–1656, Dec. 2020, doi: 10.1213/ANE.0000000000005208.
- [32] J. Kurek, L. L. Brandli, M. A. Leite Frandoloso, A. Lange Salvia, and J. Mazutti, "Sustainable business models innovation and design thinking: a bibliometric analysis and systematic review of literature," *Sustainability*, vol. 15, no. 2, p. 988, Jan. 2023, doi: 10.3390/su15020988.
- [33] V. Braun and V. Clarke, "Conceptual and design thinking for thematic analysis," *Qualitative Psychology*, vol. 9, no. 1, pp. 3–26, Feb. 2022, doi: 10.1037/qup0000196.
- [34] C. Dell'Era, S. Magistretti, C. Cautela, R. Verganti, and F. Zurlo, "Four kinds of design thinking: From ideating to making, engaging, and criticizing," *Creativity and Innovation Management*, vol. 29, no. 2, pp. 324–344, Jun. 2020, doi: 10.1111/caim.12353.
- [35] E. Knight, J. Daymond, and S. Paroutis, "Design-led strategy: how to bring design thinking into the art of strategic management," *California Management Review*, vol. 62, no. 2, pp. 30–52, Feb. 2020, doi: 10.1177/0008125619897594.
- [36] J. M. Lewis, M. McGann, and E. Blomkamp, "When design meets power: design thinking, public sector innovation and the politics of policymaking," *Policy & Politics*, vol. 48, no. 1, pp. 111–130, Jan. 2020, doi: 10.1332/030557319X15579230420081.
- [37] F. Fariyanto and F. Ulum, "Designing a village head election application using the Ux design thinking method (case study: Kuripan village) (in Indonesian)," *Jurnal Teknologi dan Sistem Informasi (JTSI)*, vol. 2, no. 2, pp. 52–60, 2021, [Online]. Available: <http://jim.teknokrat.ac.id/index.php/JTSI>
- [38] P. Cankurtaran and M. B. Beverland, "Using design thinking to respond to crises: B2B lessons from the 2020 COVID-19 pandemic," *Industrial Marketing Management*, vol. 88, pp. 255–260, Jul. 2020, doi: 10.1016/j.indmarman.2020.05.030.
- [39] M. Lynch, U. Kamovich, K. K. Longva, and M. Steinert, "Combining technology and entrepreneurial education through design thinking: Students' reflections on the learning process," *Technological Forecasting and Social Change*, vol. 164, p. 119689, Mar. 2021, doi: 10.1016/j.techfore.2019.06.015.
- [40] R. Patrício, A. C. Moreira, and F. Zurlo, "Enhancing design thinking approaches to innovation through gamification," *European Journal of Innovation Management*, vol. 24, no. 5, pp. 1569–1594, Oct. 2021, doi: 10.1108/EJIM-06-2020-0239.
- [41] N. F. Klenner, G. Gemser, and I. O. Karpen, "Entrepreneurial ways of designing and designerly ways of entrepreneuring: exploring the relationship between design thinking and effectuation theory," *Journal of Product Innovation Management*, vol. 39, no. 1, pp. 66–94, Jan. 2022, doi: 10.1111/jpim.12587.




- [42] A. B. Marful, J. A. Danquah, M. Ansah, P. Ben-Smith, and D. Duah, "Design thinking as an effective tool for architectural pedagogy: challenges and benefits for Ghanaian schools," *Cogent Arts & Humanities*, vol. 9, no. 1, Dec. 2022, doi: 10.1080/23311983.2022.2051828.
- [43] L. Przybilla, K. Klinker, M. Lang, M. Schreieck, M. Wiesche, and H. Krcmar, "Design thinking in digital innovation projects - exploring the effects of intangibility," *IEEE Transactions on Engineering Management*, vol. 69, no. 4, pp. 1635–1649, Aug. 2022, doi: 10.1109/TEM.2020.3036818.
- [44] K. Crites and E. Rye, "Innovating language curriculum design through design thinking: A case study of a blended learning course at a Colombian university," *System*, vol. 94, p. 102334, Nov. 2020, doi: 10.1016/j.system.2020.102334.

BIOGRAPHIES OF AUTHORS



Misael Lazo-Amado    holds a bachelor's degree in Systems Engineering and Computer Science and is a researcher at the University of Sciences and Humanities. He proposes technological and innovative solutions to address various problems. He has published in journals indexed in Scopus. He can be contacted by e-mail: jerlazo@uch.pe.



Laberiano Andrade-Arenas    he holds a PhD in Computer and Systems Engineering, a Master's Degree in Systems Engineering, and a Master's Degree in University Teaching and in Accreditation and Evaluation of Educational Quality (UNE). He is also a Systems Engineer (UTP) and has completed the International Course on ITILV3 Fundamentals (Zonngo-Peru/IMLAD-Mexico), as well as the SCRUM FUNDAMENTALS CERTIFIED certification. As a research professor, he has published in SCOPUS-indexed journals and has extensive experience in university teaching, giving face-to-face and blended learning classes at several universities in Lima. He can be contacted through his e-mail: landrade@uch.edu.pe.