Mobile application for care and health control of camelids

Roberto Demmis Muñoz Villacorta, Carlos Manuel Oscco Aguero, Laberiano Andrade-Arenas
Faculty of Science and Engineering, University of Sciences and Humanities, Lima, Perú

Article Info

ABSTRACT

Due to the events caused by COVID-19, several activities were paralyzed, such as the export of camelids. In the present study, it was observed that many of the camelids that are located in the highest of the Andes, are exposed to diseases that originate from climatic changes or from the infrastructure in which they are inhabiting. For this reason, the veterinary mobile application for camelids was implemented, which will help care as well as sanitary control, this application was developed through the agile scrum methodology, since it adapts to the various modules used, which would be consulta of diseases, recommendations for breeding and contacts with veterinary experts. As a result, the optimal mobile application was obtained for the needs of the people who live in that sector. In addition, it made it easier for the farms, as well as for the people who are in the frozen areas, so that they have better care and control of this species of animals, since the camelids are part of the fauna of the Andes and above all all its fiber and its derivatives are exported, which generates great economic sustenance for that sector.

Corresponding Author:

Laberiano Andrade-Arenas
Faculty of Science and Engineering, University of Sciences and Humanities
University Avenue 5175, Lima, Peru
Email: landrade@uch.edu.pe

1. INTRODUCTION

The COVID-19 disease had a great impact on the world, which caused countless human losses. Each country focuses its efforts to control and take preventive measures in the face of the difficult situation. In addition, public health policies were implemented, which was necessary to avoid a resurgence in each city [1]. Despite this, the virus managed to spread, which caused the different states to make the decision to paralyze all activities. This action had the objective of putting a stop to the rapid spread. However, great economic losses were generated, not only for the state, losses were also generated for citizens who register income day by day.

In Peru, the agricultural and irrigation development sectors, as well as tourism, are considered the most essential, due to the large amount of income they produce [2]. With the announcement of the sanitary measures established by the government, these sectors were affected, since, being considered a highly contagious area, they were forced to close their activities. This generated a great mass of unemployment and lack of care in the facilities of these sectors [3]. The alpaca sector was affected by the closure of the industries, since one of the essential activities they carried out was the export of materials, as in this case of camelids. These activities were based on the extraction of its fiber, skin, among other derivatives, but due to the stoppage, a great loss of jobs was recorded, which represents 2.85% of the global economically active population and 30.2% of the population economically active industrial [4]. When unemployment was generated, the alpaca families suffered great economic losses to the point of becoming poorer. The big alpaca fiber sales days are between the months of March and June, therefore, there is no demand due to social isolation and the market does not have fixed sales. There are more than 82,000 families of alpaca and llama breeders in the country, who produce 4,500 tons of alpaca fiber and 16,000 tons of meat per year (75% alpaca and 25% llama) [5], [6].

This fall has affected the income of families and the entire alpaca fiber value chain, as well as producers, micro and small fiber processors, as well as weavers and artisans. While all activity is paralyzed, the camelids face various climatic changes, and this can cause the animals to be affected by multiple diseases, in the presence of strong frosts in the Andean zone of the Lima region. For this, control and prevention actions of infectious diseases in camelids are developed, since the animals are displaced to the Andes, in very cold areas and especially high, in certain places where other animals would not survive, approximately 4000 masl [7]. Although it is true, actions were taken for good care and health control of camelids, but due to the current situation, it can be a bit complicated, at a sanitary level, camelids can suffer from malformations, as well as various associated infections to Sarcocystis, in addition to suffering from endo and ectoparasites due to the infrastructure or natural environment in which they live [8]-[10]. Camelids are considered a source of medical studies, for which, in complicated stages created by the coronavirus, different experts observed the positive reactions of this species [11]. for which this species is considered of utmost importance, that is why it is necessary to be in constant care of these animals either by a specialist or a trained breeder, otherwise it could cause economic losses, as well as research.

In this research, the implementation of a mobile application is proposed as a tool for the care and health control of camelids to improve their productivity and export in Peru, in such a way that it helps the farms, since, in this difficult stage due to social isolation due to the pandemic, fiber and leather sales activities, among others, were paralyzed. While the activities are uncertain, the camelids that are in the high and icy parts can suffer various diseases due to climate changes. This mobile application will provide solutions and follow-up to diseases that may originate in camelids, and in the same way that it can provide recommendations for better care of these animals. In case expert attention is required, the application will provide the attention of a veterinarian who will give information about the treatment in order to achieve improvements in the camelid.

In the present investigation, a perspective on mobile applications and web systems will be carried out, as well as the functions in veterinary specialties. With the implementation of the mobile system, oriented to the care and sanitary control of camelids, it is proposed to improve productivity and exports in Peru. Related to research, it would not be the first time that applications have been made, both on the web and mobile, for the care and health control of animals.

Mwabukusi *et al*. [12] mentions that due to the difficulties of filling out disease forms, either due to the environment or any other difficulty related to the infrastructure, it was decided to use various digital services as well as short-range messaging, such as such as mobile or web services. This project had the purpose of capturing and transferring disease data to the different health sectors, both for animals and humans. It is for this reason that the server-to-client transmission model was used, resulting in a disease surveillance system, which is useful for providing data in real time, in addition to providing remote facilities in rural areas. In another case, mention could be made of another project of a mobile application that is also for web platforms. Being designed as a remote telemedicine learning tool to help farmers get immediate support and reach out to veterinary care experts. The project resulted in a tool capable of providing help to different breeders, providing them with recommendations on the management of animals [13]. Mention can also be made of a web application that can be very helpful for a breeder of certain species of animals. In this case, a system capable of diagnosing goat disease was implemented, whether it be a mild, moderate or severe disease level, in addition this system is capable of providing treatment for said diseases. Therefore, the application consists of effective treatments, for which the intervention of expert doctors is not necessary [14]. On the other hand, mention can also be made of the project: "DVet Utmach". This project presents a module for veterinary diagnosis, as well as for frequent diseases, and another that is capable of indicating which medical laboratories are nearby. The application was developed through the agile scrum methodology, which resulted in a tool capable of providing communication and data transfer with veterinarians [15]. Based on the comments, different authors contributed to the development of both mobile applications and web systems that are oriented to the animal health sector. Each author shows a different section, but with the same purpose, in which essential modules for animal care can be mentioned. However, the mentioned applications are limited to showing a specific functionality, they do not usually cover other points, in addition, with the constant technological change, they usually lack innovation, as well as new functions in their platforms, for which, in this work, it was decided to take some functionalities as a reference and add new functions to generate value to the dedicated sector.

2. METHOD

This section specifies in detail the steps that were developed throughout the project based on the agile scrum methodology. This methodology was selected due to the flexibility it offered us when establishing the different parts of the project, such as the designation of work, meetings, among others. On the programming side, the Android Studio tool was used, as well as Firebase, which provided us with an improvement in the administration of the mobile application database [16].

2.1. Scrum

In this section, the aforementioned will be detailed, the agile methodology that was applied for the implementation of the mobile application is the agile scrum methodology, because it provides the flexibility to control and manage the requirements that are presented, as well as the development of the software [17]. It should be noted that scrum has many processes and they are divided into 5 phases (initial stage, planning stage, implementation, review and retrospective and launch), for this project, we chose to visualize the essential phases. The project is divided into sprints, a sprint is the smallest block of scrum that has a small team that works on the assigned task over the course of 1 to 3 weeks [18], in the course of the sprints, meetings are established in in case there are changes, or any other incidence.

2.2. Case study

At this point, the proposed methodology was developed, detailing the case study of the scrum phases used in the project. The implemented mobile application is a care and health control tool for camelids. This system adds value to farms, whether they are new to the care sector or those who already have experience, and also improves the productivity and export of these animals. To have a better understanding of the system, Figure 1 shows the architecture of the proposed application, in which the users who will use it are displayed, which would be breeders and expert veterinarians in camelids, on the other hand, it is also displayed the database process and how they are related to the application.
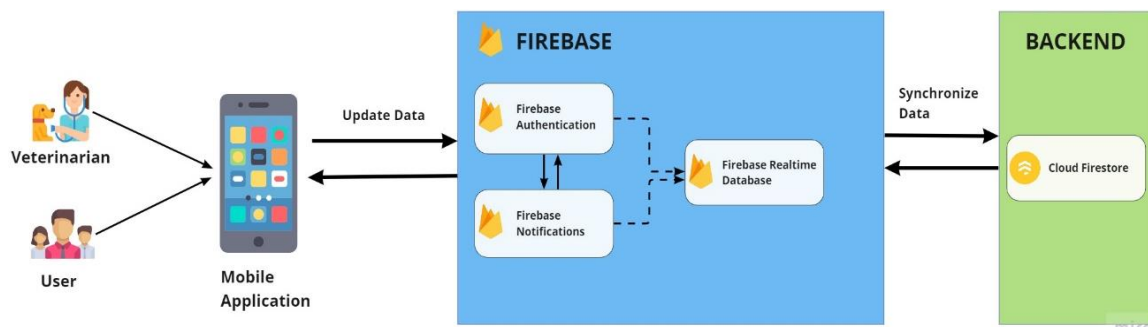

Figure 1. System architecture

2.2.1. Initial stage

In this first phase, scrum is characterized by the identification of the 3 main roles, in which there is the product owner, as well as the scrum master and the members who develop the project, called the scrum team [19]. Although it is true, there are also other secondary role roles, such as users, sponsor and stakeholders, but these roles do not necessarily have to be in the project, since the development can continue without the need for them [20]. In this phase, the participation of the 3 main roles was chosen, which, if necessary due to their importance in the project, also carried out the elaboration of the requirements, which is aligned to the fulfillment of the objectives established by the project. client. In addition, in this phase, the requirements were converted into user stories.

2.2.2. Planning stage

After holding meetings with the team to brainstorm ideas to convert the requirements into user stories, the product backlog and the risk backlog were refined. To establish the backlog, various estimates and prioritizations were established, as well user stories, tasks, among others. For the estimates, various tools were taken into account, such as planning poker, shirt size, analogous estimation or affinity estimation [21]. After establishing the backlog, the product map was created through the stories and in the end the speed with which the project would go was established.

a. Story estimation and prioritization

The prioritization of the stories was carried out starting from the most important for the project or also called what is of value. On the other hand, it was estimated by means of different tools measuring the effort required by each story [22]. After estimating and prioritizing the user stories, a validation was established according to the story points assigned in the estimate, in order to ensure that a correct estimate was established.

b. Planning of deliverable

After breaking down the epics, estimating and prioritizing the user stories, the result was grouped, generating the sprint, in which the designated user story was developed in the team meeting in an approximate time. Then the product backlog is established as shown in Table 1, in which the user stories will be ordered by priority and estimate [23], it also represents the different interactions by the team in the project [24]. The project is divided into 36 history points, for which it was divided into 3 sprints, with this the sprints of the project were observed and analyzed, in the agile scrum methodology the speed varies. For that reason, the first sprint has an initial speed of 12, the second sprint the speed increases and has a quantity of 17 and the third and last sprint has a lower speed of 7.

Table 1. Product backlog

Nº	User Stories	Priority	Estimate
1	As an administrator I want the system to have a login to allow user access.	2	3
2	As an administrator, I want the system to have a data registry to store information on new users.	1	4
3	As a user, I want each module of the system to have a help guide to know its functionalities.	9	3
4	As a user, I want the system to show me information on disease care for better health control of camelids.	4	5
5	As a user, I want the system to allow me to consult about the disease of camelids to obtain information on a possible treatment.	3	5
6	As a user, I want the system to have a search history to access past queries.	8	4
7	As a user, I want the system to provide me with recommendations to have a better breeding of camelids.	5	3
8	As a user, I want the system to have a list of specialists in camelids to be able to contact them.	6	3
9	As a user, I want the system to allow me to establish communication with the specialist through a chat to receive expert advice.	7	7

2.2.3. Implementation

In this third phase, it is where the creation of the deliverables is used, where the different assigned tasks are executed, as well as the creation of the system prototypes, which were established by modules according to the stories, prioritized and estimated during the planning [25], [26]. At this point, the assignments given by the owner of the product must be fulfilled, in an approximate time [27]. In this phase, the implementation of the prototypes of the user stories of the mobile application is shown, which was divided by sprints.

a. First sprint

For the first sprint, user stories 2, 1, and 5 found in the backlog of the prioritized product in Table 1 were taken into account. In this first sprint, an iteration was carried out, so in Table 2, you can view the user stories that make up the iteration, as well as the time it takes to complete each story, in addition to mentioning which user will use it and what criteria the story needs to be accepted. After the iteration, in Figure 2, by means of Figure 2(a) the prototype of user story 2 is shown, in Figure 2(b) the prototype of user story 1 is shown, and in Figure 2(c) user story 5 prototype shown.

Table 2. First sprint

| Description	
User story 2	As an administrator, I want the system to have a data registry to store information on new users.
User	Breeder.
Estimated time	2 days.
Developer	Muñoz Roberto and Oscco Carlos.
Acceptance criteria	In order to enter the application, the user must provide certain personal data.
User story 1	As an administrator I want the system to have a login to allow user access.
User	Breeder.
Estimated time	2 days.
Developer	Muñoz Roberto.
Acceptance criteria	In this case, the application shows a login, which allows registered people to enter the application.
User story 5	As a user, I want the system to allow me to consult about the disease of camelids to obtain information on a possible treatment.
User	Breeder.
Estimated time	3 days.
Developer	Muñoz Roberto.
Acceptance criteria	The application shows different search filters for queries on diseases and their possible treatment.
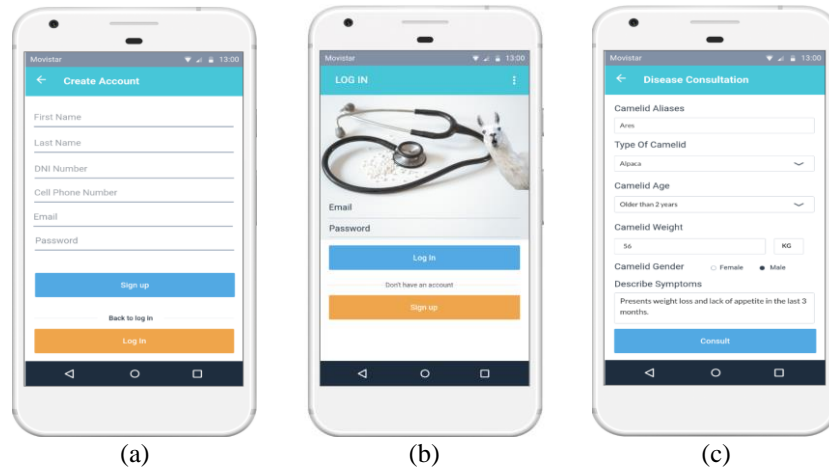
Figure 2. User story; (a) user story 2, (b) user story 1, and (c) user story 5

b. Second sprint

For the second sprint, user stories 4, 7, 8 and 9 were taken into account, which are found in the backlog of the prioritized product in Table 1. In this second sprint an iteration was carried out, for which in the Table 3, you can see the user stories that make up the iteration, as well as the time it takes to make each story, in addition to mentioning which user will use it and what criteria the story needs to be accepted. After the iteration, in Figure 3, through Figure 3(a) the prototype of user story 4 is shown, in Figure 3(b) the prototype of user story 7 is shown, in Figure 3(c) the prototype of the user story 8 is shown and in Figure 3(d) the prototype of the user story 9 is shown.

Table 3. Second sprint

	Description
User story 4	As a user, I want the system to show me information on disease care for better health control of camelids.
User	Breeder.
Estimated time	3 days.
Developer	Muñoz Roberto.
Acceptance criteria	The application shows information related to the care of camelids.
User story 7	As a user, I want the system to provide me with recommendations to have a better breeding of camelids.
User	Breeder.
Estimated time	1 day.
Developer	Oscco Carlos and Muñoz Roberto.
Acceptance criteria	The application shows recommendation on raising camelids.
User story 8	As a user, I want the system to have a list of specialists in camelids to be able to contact them.
User	Breeder.
Estimated time	1 day.
Developer	Muñoz Roberto.
Acceptance criteria	The system must show a list of camelid care specialists.
User story 9	As a user, I want the system to allow me to establish communication with the specialist through a chat to receive expert advice.
User	Breeder.
Estimated time	4 days.
Developer	Muñoz Roberto.
Acceptance criteria	The system displays a chat with different message options to establish communication.

c. Third sprint

For the third sprint, user stories 3 and 6 found in the backlog of the prioritized product in Table 1 were taken into account. In this third and last sprint, an iteration was carried out, so in Table 4, you can view the user stories that make up the iteration, as well as the time it takes to complete each story, in addition to mentioning which user will use it and what criteria the story needs to be accepted. After the iteration, in Figure 4, by means of Figure 4(a) the prototype of user story 3 is shown, and in Figure 4(b) the prototype of user story 6 is shown.
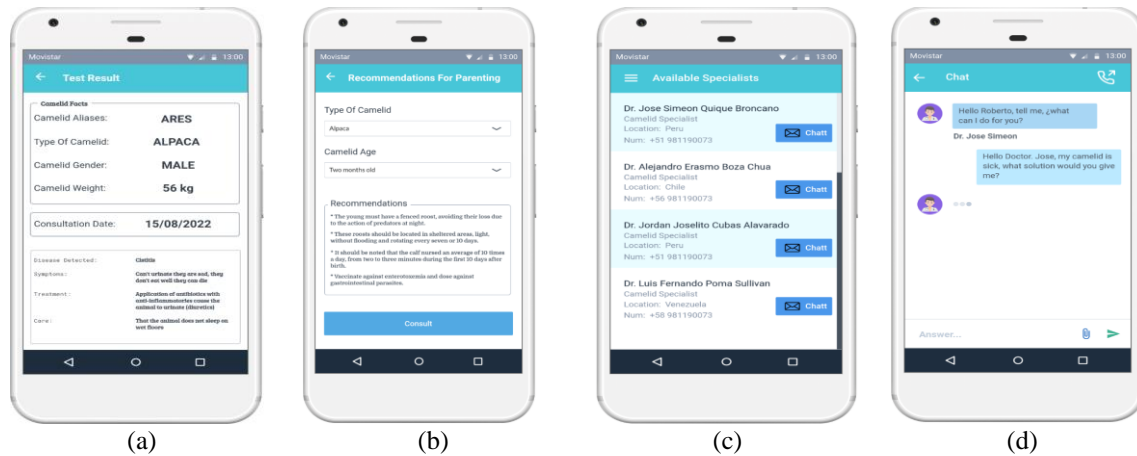
Figure 3. User story; (a) user story 4, (b) user story 7, (c) user story 8, and (d) user story 9

Table 4. Third sprint

	Description
User story 3	As a user, I want each module of the system to have a help guide to know its functionalities.
User	Breeder.
Estimated time	1 day.
Developer	Muñoz Roberto.
Acceptance criteria	The application has a tutorial guide for each section of the application.
User story 6	As a user, I want the system to have a search history to access past queries.
User	Breeder.
Estimated time	3 days.
Developer	Oscco Carlos and Muñoz Roberto.
Acceptance criteria	The app stores a history of past searches.
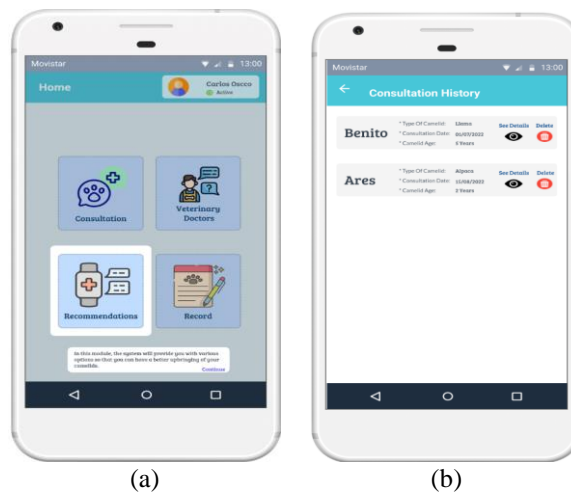
Figure 4. User story (a) user story 5 and (b) user story 8

3. RESULTS AND DISCUSSION

In this section, mention was made of the results obtained in the implementation of the project, as well as the different discussions reached during the course. On the part of the results, the general operation of the project was commented in detail through different graphs, in which the validations by both experts and users are shown. As part of the discussions, a comparison was made between different agile methodologies, such as the one that is being used in the project, which would be the agile scrum methodology, and another that was not used, such as the agile extreme programming (XP) methodology, in which show the advantages and disadvantages of both methodologies.

3.1. Regarding the agile methodology

In this section, mention is made of the differences in the application of agile methodologies scrum and XP in project management. While it is true, these agile methodologies mention various techniques that help the development team to be optimal, and to show how a software project is progressing quickly. There are multiple agile methodologies used in the market, in this case, two methodologies were investigated. In the first place, we can mention the agile scrum methodology, it is a framework in which people can solve complex problems that can be adapted, while delivering products of the highest possible value [28]. Scrum is also considered as a work method, by which all kinds of existing problems in the development of a project are minimized. This methodology is specialized for various local environments, in which changes are made constantly, that is why a final delivery is not made, rather the project is delivered in parts on a regular basis.

On the other hand, extreme programming or also known as XP methodology, was developed to guide software development teams whether they are large or medium-sized, which can be made up of two or up to ten project developers. This methodology is oriented to different environments in which the requirements are not precise or are constantly changing [29]. In other words, it is an agile methodology based on enhancing relationships between collaborators as a key to success in software development, promoting teamwork, worrying about the learning of developers, and fostering a good work environment. XP is based on continuous feedback between the client and the development team, fluid communication between all the participants, simplicity in the implemented solutions and courage to face changes [30]. XP is highly suitable especially for projects with imprecise and rapidly changing requirements, and where there is a high technical risk, but the necessary collaborators are available to cover those needs. For a better understanding, Table 5 shows the advantages and disadvantages of the agile methodologies mentioned.

Table 5. Comparison of agile methodologies

Advantages of scrums	Disadvantages of scrum
You can view the results for each stage, without having to wait until the end.	The groups must be divided into small teams, since the effect of the method would be lost.
It provides flexibility and adapts to different management contexts.	The definition of quick tasks and deadlines are essential, since it is fundamental to the methodology.
Clients can intervene at each stage to propose ideas or solutions for the development of the project.	You cannot continue with the other tasks if there are pending tasks in the project.
The risks that may appear during the project are solved quickly and efficiently due to the intervention of the team.	
Advantages of Extreme Programming (XP)	Disadvantages of Extreme Programming (XP)
Allows close communication with the project stakeholder.	Depending on the number of processes, it can be relatively expensive.
The software is optimized due to continuous testing.	Too long a time is needed for the elaboration of the project.
Fewer development bugs on the project due to duo collaboration.	The client usually intervenes a lot in the work causing delays.
Absence of work and unnecessary hours in the project.	

3.2. Validation of the design model with experts

This section shows the results of the design quality level validation, based on 15 experts who are trained in camelid health issues, as well as experts in health system application design issues. In the validation, different criteria were applied (usability, innovation and technology), of which questions were established based on the Likert scale, with the response option being 1=very low, 2=low, 3=regular, 4=high, and 5=very high. This means of validation had the purpose of measuring the degree of acceptance by the experts. Table 6 shows the criteria used in this validation, as well as the different questions used in each criterion, and the level of quality obtained by calculating the mean and standard deviation (S.D). It is also noted that the total average is 4, so the final quality level is Tall.

3.3. Validation of the design model with users

In addition to validating the application by experts in the field, a system usability study (SUS) was also carried out, through this validation, possible errors based on the operation of the system were mitigated, as well as the acceptance of the application by part of the users. For this, the collaboration of 30 people was needed, in which camelid farms stand out, as well as part of the population affected by the stoppage of activities. The measurement of performance and acceptance was carried out for each sprint, for the validation of performance, the Likert scale was used, having as response option: 1=very low, 2=low, 3=Regular, 4=High, and 5=very High. On the other hand, for the measurement of the degree of acceptance, the parameters of "Complies", "Does not Comply" were used, with the aim of analyzing how accepted the application is.

Table 6. Validation by experts

Criterion	Questions	Mean	S. D	Quality
Usability	The application has an optimal loading time.	4.10	0.56	High
	The application is easy to use for users who do not have knowledge about applications.	4.30	0.67	High
	The application is divided into sections for a better understanding of the user.	4.10	0.56	High
	The application is compatible with any mobile version or system.	4.20	0.78	High
	The application has a nice interface for users.	4.70	0.67	Very High
Innovation	Make a quick diagnosis of camelid diseases.	4.50	0.70	Very High
	Continuously transmit knowledge.	4.20	0.78	High
	Provides recommendations for raising camelids.	4.10	1.10	High
Technology	A specific programming language was used for mobile applications.	4.00	0.47	High
	A transactional database in the cloud was used for queries and local storage.	4.00	0.47	High
	A framework capable of adding more functionalities to the mobile interface was used.	4.30	1.05	High
	Total Average and Final Quality Level	3.5 = 4		High

3.3.1. First sprint

In the validation of the first sprint, both the functionality and the degree of acceptance of the mobile system were evaluated with the participation of 30 users. In Figure 5, it is observed that 13 users determined that the functionality of the first sprint is "Very high", as well as 8 users qualified as "High", another 5 users determined the function as "Regular", 2 users qualified as " Low" and 2 other users rated it "Very Low". On the other hand, in terms of acceptance, in Figure 6, it is shown that 93% of those evaluated, highlighted the implementation of the application, indicating that it "Complies", instead 7% were not satisfied, indicating that "No complies" with the degree of acceptance.
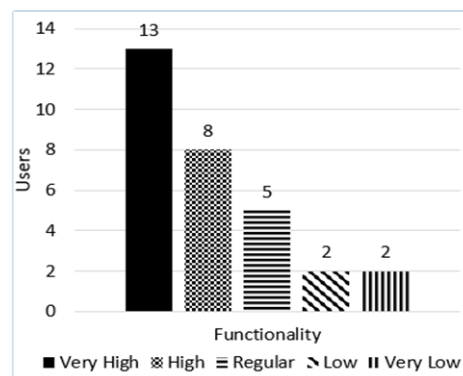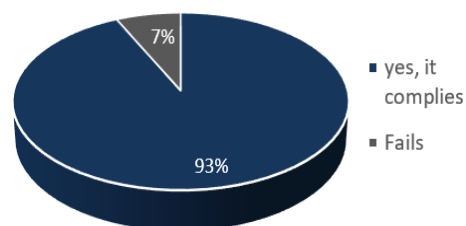

Figure 5. Sprint 1 functionality validation

Figure 6. Acceptance of sprint 1

3.3.2. Second sprint

In the validation of the second sprint, with the intervention of 30 users, the functionality of the system was evaluated, as well as the satisfaction of the users with the mobile application. In Figure 7, it can be seen that 14 users determined that the functionality of the first sprint is "Very High", as well as 9 users qualified as "High", another 4 users determined the function as "Regular", 2 users qualified as "Low" and one user rated "Very low". On the other hand, in Figure 8, it is shown that 94% of those evaluated, highlighted that the implementation of the application if "Complies" with the degree of satisfaction, instead 6% were not satisfied indicating that "It does not comply" with the degree of satisfaction.
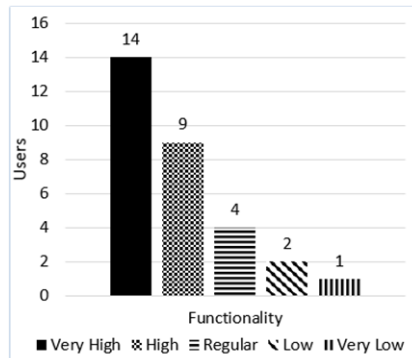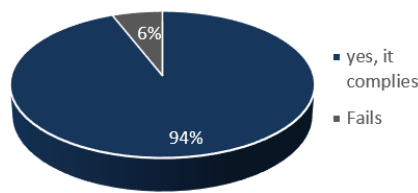
Figure 7. Sprint 2 functionality validation

Figure 8. Acceptance of Sprint 2

3.3.3. Third sprint

In the validation of the third and last sprint, with the participation of 30 users, the functionality of the system was evaluated, as well as the satisfaction of the users with the mobile application. In Figure 9, it can be seen that 12 users determined that the functionality of the first sprint is "Very high", as well as 10 users qualified as "High", another 5 users determined the function as "Regular", 2 users qualified as "Low" and one user rated "Very low". On the other hand, in Figure 10, 92% of those evaluated highlighted the implementation of the application, pointing out that if it "Meets" the degree of satisfaction, on the other hand, 8% were not satisfied, stating that "It does not meet" the degree of satisfaction. degree of satisfaction.
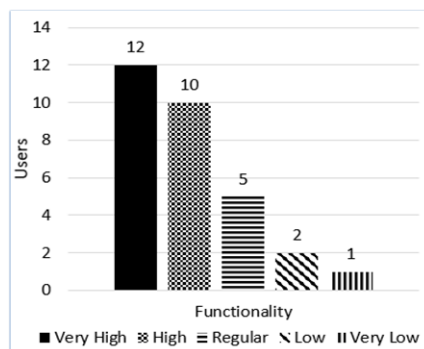
Figure 9. Sprint 3 functionality validation
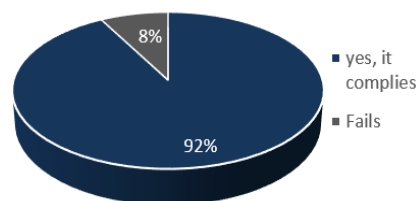
Figure 10. Acceptance of Sprint 3

4. CONCLUSION

In summary, the implementation of the mobile application for the care of camelids was successfully completed, the objective was to develop a system capable of providing care through recommendations, as well as a sanitary control for camelids. Likewise, the application provided help to the people who are in charge of caring for the camelids in the highlands of the Andes, through the processes of the application, the people of those areas were able to find out about the diseases that these animals can reach. suffer, and what recommendations they would need for good care and upbringing, in case they have needed other information, through the application the users communicated with a specialist to reach a better care and control of camelids. The mobile application was developed through the agile scrum methodology, which allowed meeting the requirements established by users, which contributed to the development of various points necessary for the project, such as sprints, product backlog, the prioritization and estimation of user stories, among others. On the other hand, for future deliveries of works related to the subject, it is recommended to investigate in more detail about agile methodologies, as well as the implementation of more functions, because the application will be constantly updated according to the advancement of new technologies, such as such as artificial intelligence or machine learning, which could be implemented in the application to give it more value.

REFERENCES

[1] E. K. Ponce, M. F. Cruz, and L. Andrade-Arenas, "Machine learning applied to prevention and mental health care in Peru," *International Journal of Advanced Computer Science and Applications*, vol. 13, no. 1, pp. 823–831, 2022, doi: 10.14569/IJACSA.2022.0130196.
[2] Ministerio de Desarrollo Agrario y Riego, "Peru remains the leading exporter of alpaca fiber in the world due to its high quality (in Spanyol: *Perú se mantiene como primer exportador de fibra de alpaca en el mundo por su alta calidad*)," Noticias, no. 022, pp. 8–10, 2021, [Online]. Available: https://www.gob.pe/institucion/midagri/noticias/348402-peru-se-mantiene-como-primer-exportador-de-fibra-de-alpaca-en-el-mundo-por-su-alta-calidad.
[3] O. V. Liulov *et al.,* "The link between economic growth and tourism: COVID-19 Impact*," International Business Information Management Association (IBIMA)*, no. November, pp. 8070–8086, 2020, [Online]. Available: http://polcyn.pl/publikacje/61/61.pdf.
[4] ADEX, "Impact of COVID-19 on Peruvian Exports (in Spanyol: *Impacto Del Covid-19 En Las Exportaciones Peruanas*)," 2020, [Online]. Available: https://www.congreso.gob.pe/Docs/comisiones2020/Turismo/files/1_adex.pdf.
[5] R. Marquina, "Arequipa: The pandemic in the alpaca sector (in Spanyol: *Arequipa: La pandemia en el sector alpaquero*)," *La revista agraria*, 2021.
[6] FAO, "Current Situation of South American Camelids in Peru (In Spanyol: *Situación Actual De Los Camélidos Sudamericanos En Perú*)," *Fao*, no. Situación actual de los camélidos sudamericanos en Perú. Proyecto de Cooperación Técnica en apoyo de la crianza y aprovechamiento de los Camélidos Sudamericanos en la Región Andina TCP/RLA/2914. Organización de las Naciones Unidas para la Agricultura y la, pp. 1–62, 2005.
[7] A. R. R. Vargas, G. A. G. Reynoso, and M. Wurzinger, "Characterization of llama rearing in the Pasco region, Peru," *Revista de Investigaciones Veterinarias del Peru*, vol. 32, no. 3, p. e18030, 2021, doi: 10.15381/RIVEP.V32I3.18030.
[8] J. Sumar, "Reproductive patology in alpacas and llamas," *Libro de resumenes de Investigaciones XLII Reunion Cientifica Anual de la Asociacion Peruana de Produccion Animal*, no. 1, pp. 27–33, 2019.
[9] L. Velásquez, J. Soncco, and A. Valderrama, "Sarcocystis aucheniae in South American camelids and risk factors in the province of Lucanas (In Spanyol: *Sarcocystis aucheniae en camélidos sudamericanos y factores de riesgo en la provincia de Lucanas*) ," *Salud y Tecnología Veterinaria*, vol. 7, no. 1, pp. 8–13, 2019, doi: 10.20453/stv.v7i1.3562.
[10] S. Neubert, A. von Altrock, M. Wendt, and M. G. Wagener, "Llama and alpaca management in Germany—results of an online survey among owners on farm structure, health problems and self-reflection," *Animals*, vol. 11, no. 1, p. 102, Jan. 2021, doi: 10.3390/ani11010102.
[11] N. Te *et al.*, "Type I and III IFNs produced by the nasal epithelia and dimmed inflammation are features of alpacas resolving MERS-CoV infection," *PLOS Pathogens*, vol. 17, no. 5, p. e1009229, May 2021, doi: 10.1371/journal.ppat.1009229.
[12] M. Mwabukusi, E. D. Karimuribo, M. M. Rweyemamu, and E. Beda, "Mobile technologies for disease surveillance in humans and animals," *Onderstepoort Journal of Veterinary Research*, vol. 81, no. 2, 2014, doi: 10.4102/ojvr.v81i2.737.
[13] P. Johnson et al., "An innovative new approach to animal care," in *2018 IEEE Global Humanitarian Technology Conference (GHTC)*, Oct. 2018, pp. 1–5, doi: 10.1109/GHTC.2018.8601912.
[14] P. Sukmasetya, F. Nurhidayati, I. Permatasari, A. Rahmah, D. I. Sensuse, and H. Noprisson, "Developing mobile expert web-based system using brainstorming method: Case: Tetanus and botulism diagnosis and treatment in goat," in *2017 International Conference on Information Technology Systems and Innovation (ICITSI)*, Oct. 2017, vol. 2018-Janua, pp. 303–308, doi: 10.1109/ICITSI.2017.8267961.
[15] L. Aguilar, D. Torres, J. Armijos, and O. Cárdenas, "Development of a mobile application prototype as a diagnostic aid tool in veterinary medicine (in Spanyol: *Desarrollo de un prototipo de aplicación móvil como herramienta de ayuda diagnóstica en medicina veterinaria*)," *Investigación UTMACHALA*, vol. 2, no. 2, pp. 123–128, 2018, [Online]. Available: http://investigacion.utmachala.edu.ec/proceedings/index.php/utmach/article/view/269.
[16] Y. Ochante-Huamaccto, F. Robles-Delgado, F. Sierra-Liñan, and M. Cabanillas-Carbonell, "Internet of things based mobile application to improve citizen security," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 27, no. 1, p. 386, Jul. 2022, doi: 10.11591/ijeecs.v27.i1.pp386-394.
[17] E. R. Rajan and V. A. Santhosh, "Adoption of agile methodology for improving it project performance | Усвајање агИлне методологИје за побољшање перформансИ Ит пројекта," *Serbian Journal of Management*, vol. 16, no. 2, pp. 301–320, 2021.
[18] A. Tupia-Astoray and L. Andrade-Arenas, "Implementation of an e-commerce system for the automation and improvement of commercial management at a business level," *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 1, pp. 672–678, 2021, doi: 10.14569/IJACSA.2021.0120177.
[19] E. J. Kcomt-Ponce, E. L. Huamaní, and A. Delgado, "Implementation of machine learning in health management to improve the process of medical appointmentsin Perú," *International Journal of Emerging Technology and Advanced Engineering*, vol. 12, no. 2, pp. 74–85, 2022, doi: 10.46338/ijetae0222_09.

[20] A. Boza-Chua, K. Gabriel-Gonzales, and L. Andrade-Arenas, "Inclusive education: implementation of a mobile application for blind students," *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 11, pp. 785–795, 2021, doi: 10.14569/IJACSA.2021.0121189.

[21] B. G. Sudarsono, "Adopting SCRUM framework in a software development of payroll information system," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 9, no. 3, pp. 2604–2611, Jun. 2020, doi: 10.30534/ijatcse/2020/17932020.

[22] A. Srivastava, S. Bhardwaj, and S. Saraswat, "SCRUM model for agile methodology," in *2017 International Conference on Computing, Communication and Automation (ICCCA)*, May 2017, vol. 2017-Janua, pp. 864–869, doi: 10.1109/CCAA.2017.8229928.

[23] A. Ramos-Romero, B. Garcia-Yataco, and L. Andrade-Arenas, "Mobile application design with IoT for environmental pollution awareness," *International Journal of Advanced Computer Science and Applications,* vol. 12, no. 1, pp. 566–572, 2021, doi: 10.14569/IJACSA.2021.0120165.

[24] K. Kaur, M. Khurana, and Manisha, "Impact of agile scrum methodology on time to market and code quality – a case study," in *2021 3rd International Conference on Advances in Computing, Communication Control and Networking (ICAC3N),* Dec. 2021, pp. 1673–1678, doi: 10.1109/ICAC3N53548.2021.9725375.

[25] V. Gomero-Fanny, A. Ruiz, and L. Andrade-Arenas, "Prototype of web system for organizations dedicated to e-commerce under the SCRUM methodology," *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 1, pp. 437–444, 2021, doi: 10.14569/IJACSA.2021.0120152.

[26] P. Setialana, M. N. Ardiansyah, and N. Suparmanto, "Development and performance analysis of the Gunungkidul cultural potential application based on progressive web apps," *Journal of Engineering and Applied Technology*, vol. 2, no. 1, 2021, doi: 10.21831/jeatech.v2i1.39525.

[27] F. Hayat, A. U. Rehman, K. S. Arif, K. Wahab, and M. Abbas, "The influence of agile methodology (Scrum) on software project management," in *Proceedings - 20th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing, SNPD 2019*, 2019, pp. 145–149, doi: 10.1109/SNPD.2019.8935813.

[28] C. P. Godoy, A. F. Cruz, E. P. Silva, L. M. Santos, R. S. Zerbini, and C. A. L. Pahins, "Blueprint model: a new approach to scrum agile methodology," in *2019 ACM/IEEE 14th International Conference on Global Software Engineering (ICGSE),* May 2019, pp. 95–99, doi: 10.1109/ICGSE.2019.00014.

[29] O. Sohaib, H. Solanki, N. Dhaliwa, W. Hussain, and M. Asif, "Integrating design thinking into extreme programming*," Journal of Ambient Intelligence and Humanized Computing*, vol. 10, no. 6, pp. 2485–2492, Jun. 2019, doi: 10.1007/s12652-018-0932-y.

[30] L. Alsaber, E. Al Elsheikh, S. Aljumah, and N. S. Mohd Jamail, "Perspectives on the adherance to scrum rules in software project management," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 21, no. 1, p. 360, Jan. 2021, doi: 10.11591/ijeecs.v21.i1.pp360-366.

BIOGRAPHIES OF AUTHORS

Roberto Demmis Muñoz Villacorta 🔲 he is an engineering student; he is also a junior researcher with some scientific articles published in different journals indexed in Scopus. He is currently studying the tenth cycle of systems engineering and computer science at the University of Sciences and Humanities, which is focused on innovation in order to make a continuous contribution to the problems of society. He can be contacted at email: robmunozv@uch.pe.
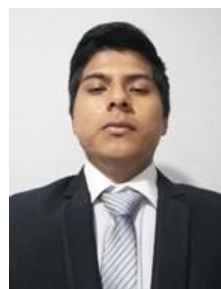
Carlos Manuel Oscco Aguero 🔲 is an engineering student and a semi-superior programmer. He is currently studying the tenth cycle of systems engineering and computer science at the University of Sciences and Humanities, which is focused on development with the aim of making a continuous contribution to the problems that arise in society. With publications in journals indexed in Scopus. He can be contacted at email: carosccoa@uch.pe.

Prof. Dr. Laberiano Andrade-Arenas 🔲 is Doctor in Systems and Computer Engineering (UNFV). Master in Systems Engineering (UNFV). Graduated from the Master's Degree in University Teaching (UNE). Graduated from the Master's degree in accreditation and evaluation of educational quality (UNE). Systems Engineer (UTP). ITILV3 Fundamentals International Course (Zonngo-Peru/IMLAD-Mexico). SCRUM FUNDAMENTALS CERTIFIED, Research Professor with publications in SCOPUS indexed journals. He has extensive experience in the University Chair in face-to-face and blended classes at different undergraduate and postgraduate universities in Lima. He can be contacted at email: landrade@uch.edu.pe.