

Mobile Application with AR as a Strategy to Improve the Marketing Process in a Dental Center

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Abstract—The post-pandemic period brought new challenges for businesses and private health centers, many of which were affected by the loss of customers. In the case of dental centers, many were affected by the distrust of customers, since activities performed in the oral cavity exposed them to the contagion of Covid-19. This research work proposes the implementation of a mobile application with Augmented Reality (AR) as a strategy for digital marketing immersion, to achieve a dynamic approach to the services provided in the dental center to customers, this is through the use of this technology in conjunction with social networks, contributing to the improvement of the business and building trust with customers. The application was developed under the Mobile-D methodology with a layered system development architecture, having as indicators the time of elaboration of the advertisement, the cost of information material, the time to inform the services, and the level of customer satisfaction. Finally, the results revealed that the time of elaboration of the advertisement decreased from 25 hours to 14 hours, the cost of informative material was considered "low" since the implementation of the application turns out to be economic, and the time to inform the services in its marketing process went from 30 min to 19 min with the use of the application, finally, the customer satisfaction increased being considered in 87% between "Good" and "Excellent".

Keywords—dental center, augmented reality, covid-19, digital marketing, mobile-d

1 Introduction

Marketing, which consists of promotion, service, price, and place, contributes to the economic activities of businesses, and among them are the dental centers, evolving about the needs of customers [1]. Currently, most of these marketing features are not being handled correctly in these establishments, whose good development is important for customer loyalty [2], in addition to the fact that

advertising campaigns in newspapers, magazines, brochures, television, and more, are usually quite costly and often without return [3].

In Peru, many dental offices have had to adjust to the new post-pandemic context, making it necessary to rethink their marketing strategies to get closer to their customers [4]. According to [3] an informed patient who has been able to perceive the service provided by the dental professional is the one who will have generated trust, allowing the treatment to be carried out. In this context, service learning proves to be an effective method for e-commerce [5].

In the current XXI century where the internet, social networks, and electronic devices are part of our daily life having information within the reach of a single click, the creation of the experience becomes an important point to be considered by users [6], unfortunately, within it, we are usually attacked by redundant ads through social networks, advertisements on the websites of different types of business. For some businesses or brands, this creates an obstacle, so users may start to lose interest in acquiring any service. Therefore, in these times companies must get creative and reach their end user.

In that sense, thanks to new technologies and the constant use of smartphones, it becomes possible to make use of Augmented Reality (AR) technology through these mobile devices allowing users to interact with the real world and integration computer-generated 3D images [7], therefore, it is necessary to know the benefits that our devices and tools have to use them properly. According to Ref. [8], many companies are showing interest in AR and its implementation is increasing, therefore, the development of innovative applications is being complemented with this technology, leaving behind traditional or standard paper-based advertising. Considering that marketing is very important for companies, it is interesting that AR is implemented to give an innovative perspective, making users more knowledgeable more creatively, and interactively, being one of the reasons why dental health centers should complement the use of digital marketing to build a stronger business and more users [1].

The above, object of study in this research is the Anqa dental center in Peru, which has been affected by this problem and has suffered considerable losses from its clients. Therefore, the objective of this research work is to develop a mobile application based on Augmented Reality, which aims to improve the marketing process of the dental center to be implemented, achieving a dynamic approach to the services provided to customers through the use of this technology in conjunction with social networks and contributing to the improvement of the business. Allowing the generation of new digital marketing alternatives that provide impact dental centers, provide information, and achieve trust with their customers.

This research is organized as follows. Section II, the literature related to the research previously conducted and the impact that businesses have had on Covid. Section 3 describes the methodology to be used and details the development of the project. Section 4 is the phase of results and discussions where the results obtained through the statistical graphs made concerning Pre and Post-implementation tests of the application are analyzed, based on the indicators studied. Finally, section V contains the conclusions and future works that enhance the proposed objective.

2 Bibliographic study

Nowadays, companies have been inclined to adopt digital marketing as an attempt to improve communication with their customers, this has been due to the uncertainty generated after the COVID-19 pandemic [9], and as a consequence, innovative ideas based on the use of technology have arisen [10], a considerable increase of virtual stores has been seen, followed by the implementation of virtual marketing. The objective of the implementation of these innovative ideas in companies has been to make the brand known and generate trust among its customers, this is due to the lack of strategies that generate business continuity when going through difficult situations such as the pandemic [11].

Communication tools such as social networks are supposed to be a great advantage applied to brand advertising, besides being fast and economical to implement in the business strategy, in this sense at present, companies are influenced by the use of technological tools [12] and consumers prefer mostly to be informed through the Internet. A study on the use of social networks, applied as a marketing strategy for a coffee shop [13], found that these have become a powerful tool to disseminate the promotional information of the business to customers visually through pre-attendance photos to the establishment, focusing on the young audience to emotionally attract the customer. The results evidenced the benefits obtained from effective marketing with the use of digital tools.

Therefore, the research [14] developed a model for streamlining sales through digital marketing by using a web platform for a grocery retailer to obtain more customers through the implementation of a technological strategy, to mitigate the impact caused by the pandemic and to support the improvement of their sales. This research proposes for future work the implementation of AR as an improvement to the visualization of products, as well as to obtain greater proximity to customers.

2.1 Status of dental centers post COVID-19

La The post-pandemic stage brought with it new biosecurity measures imposed by the Peruvian government and implemented in different public establishments [15], these measures in dental health centers were refined and became essential to safeguard the health of patients and medical staff [16], however, despite the precautions adopted, patients are very suspicious since the activity is carried out in the oral cavity, which is presumed to be one of the potential sources of contagion by aerosol [17]. All these events have caused dental activity to be limited.

The use of digital media for health (e-Health) has become the technological means that allows the control and approach of patients to health services from home [18]. Ref [19] mentions that digital health has had great relevance in the pandemic, as well as the education of the population about health [20], being frequent the use of telemedicine, not being the exception the case of tele-odontology, allowing to bring the patient closer to dental services, especially preventive services to improve oral health, this is how educational information can be provided to the patient in various ways [19][21]. In that sense, AR is being used in various fields, providing favorable

benefits in remote learning in a dynamic way [22], which applied as a marketing strategy in stores aims not only to promote the brand allowing the exploration of their products or services in a virtual way achieving the feeling of being present in the physical environment [23], but also to convince and inspire the customer to keep him [24].

The analysis of several research works allowed us to have a broad perception of the problems that businesses, including dental centers, have had to face after the pandemic, such as a reduction in customers and sales, and having to look for economic technological solutions that allow them to excel.

3 Methodology

This research work presents an experimental research design, complemented by the use of the Mobile-D methodology, which consists of five phases: exploration, initiation, production, stabilization, and testing of the system [25].

3.1 Phases of the methodology

Each of the phases is made up of stages, tasks, and practices (see Figure 1). The purpose of this methodology is to achieve very fast development cycles in small teams, working in the same space. However, in this method, fully functional products must be achieved.

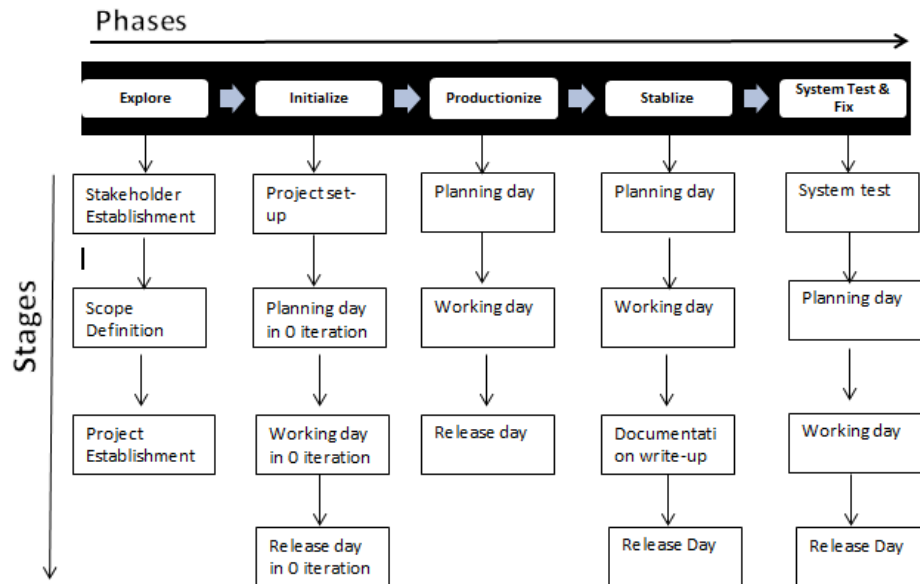


Fig. 1. Life cycle of the Mobile-D methodology [26]

The exploration Phase is aimed at planning and establishing the project. This phase is important for the establishment of the bases of the project architecture, the implementation of the system, and the choice of the environment.

The initialization Phase aims to determine the success of the other phases of the project and to verify the problems that arise during the development of the project so that all problems are corrected promptly. In addition, the project architecture, the preparation of the technological means, and communications for the activities of the production phase are specified.

The production Phase is aimed at implementing the functionality required by the product, through the application of the development cycle in an interactive way. The development of the project is based on tests for the implementation of the functionality.

The stabilization Phase aims to ensure the quality of the project implementation. The interaction of processes and documentation is reviewed.

System Testing verifies that the product complies with the implementation of the required functionalities and that the errors found are correctly corrected.

3.2 Population and sample

The population was considered to be the entire community of the Anqa dental center; it is appropriate to consider an indeterminate population, which means that the data will occur in unknown quantities. The type of sample used was non-random, by which we will obtain the sample to be used with criterion, this was confirmed with a value of 30 marketing processes in the Anqa dental center. This value turns out to be adequate and standard, being used in different research processes.

3.3 Methodology development

Before the development of the methodology, business processes were identified, which was helpful for the development of marketing. This section shows the development of the stages of the Mobile-D methodology.

Exploration. in this stage the project stakeholders were identified and their tasks, roles, and responsibilities were established. The scope of the project was also defined, whose main objective is the development of a friendly, light, interactive and dynamic design for the client. Therefore, after the interviews conducted with the stakeholders, the requirements shown in Table 1 were identified.

Table 1. Requirements

ID	Description
RF01	The Anqa Dental Center logo will be displayed at the beginning of the application.
RF02	The main menu will be displayed with four options: information, contact us, services, and animation.
RF03	The first information option will show the mission and vision of the dental center.
RF04	The second contact us option will show the phone number, Facebook, and location of the dental center. Clicking on the Facebook image will display the dental center's profile.

ID	Description
RF05	The third option of services will show the list of services that the dental center has, in which clicking on the services will display animated videos through the use of a target.
RF06	In the fourth animation option, a visual simulation of the denture shapes with animations will be shown and the corresponding audio will be played.
RF07	The camera of the mobile device must be activated for target recognition.
RF08	When focusing on the target, a video of the dental center's services should be displayed, as well as 3D models.

Initialization. in this phase the architecture was developed, as well as the project planning.

Project architecture and the development of the system were worked in layers. Table 2 shows the description of the layers of the project architecture, as well as the project design, as shown in Figure 2.

Table 2. Project architecture

Layer Type	Description
Presentation Layer	It is where the way the application is displayed to the user is created, it is in charge of performing the user's actions and then sending them to the presentation layer.
Business Layer	It is where all the logical action is located according to the processes established in such a way that it establishes the communication with the requests of the presentation layer.
Data Layer	This layer contains all the necessary information, which stores and supplies the requests requested by the Business Layer that interacts with the Presentation Layer.

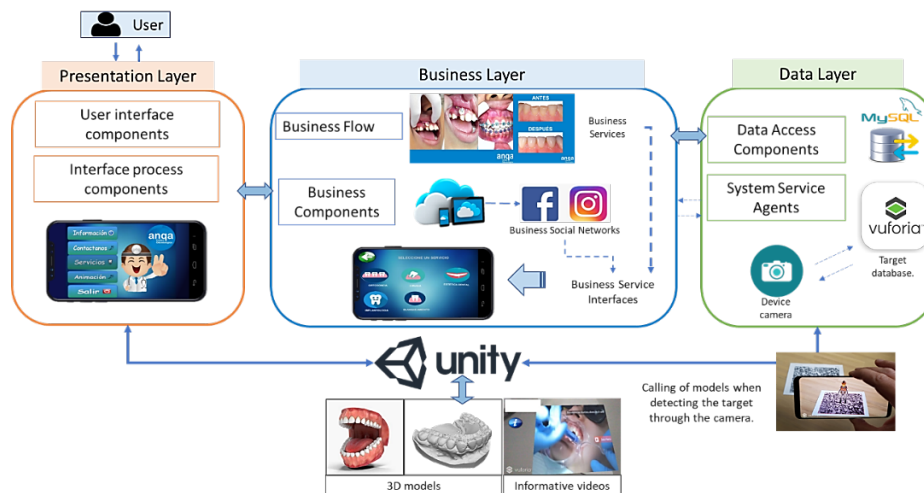


Fig. 2. System architecture design

Figure 2 shows the technological components implemented for the development and proper functioning of the system, which required the use and installation of Unity (software for game development) and its SDK, the programming was performed in

the Visual Studio environment making the connection with the MySQL database for the navigability of the application. It was also necessary the use Vuforia software which is the platform for the development of applications with AR and RM [27], this platform also works as a database of the targets (reference points for the camera), and after that, the 3D models and videos implemented in Unity can be visualized.

Phase planning. Table 3 shows the project phase planning.

Table 3. Planning project phases

Phase	Iteration	Description
Exploration	Iteration 0	Identifying the points of interest, establishing the project and scope, and identifying the modules.
Initialization	Iteration 1	A phased plan is drawn up indicating the technological, service, and communication resources, including the development of the team.
	Iteration 2	This part includes the functional requirements for the "Home Module". Making the interfaces that have been defined in the planning. Generating the acceptance tests.
	Iteration 3	Implementation of functional requirements of the "Services Module". Improvement and update of user stories.
Production	Iteration 4	Integration of the functional requirements of the "Information Module". Improved and updated interface planning.
	Iteration 5	Implementation of the functional requirements of the "Video Module". Making the improvement and updating of the interface of information.
	Iteration 6	Implementation of the functional requirements of the "AR Animation Module". Making the improvement and updating of the interface of information.
	Iteration 7	Implementation of the functional requirements of the "Target Module". Improved and updated interface planning.
	Iteration 8	Implementation of the functional requirements Audio Module" Improvement and update of the user stories realizing the interface.
Stabilization	Iteration 9	Implementation of the functional requirements of the "Connection Module". Improved and updated interface planning.
System Testing	Iteration 10	The corresponding tests and analysis of the results are carried out.

Production. in this phase, the development of the application and its respective interfaces began.

Interfaces, we started by making simple 2D sketches to later develop the interfaces within the Unity platform. Figure 3 shows the interfaces and the development of the home interfaces menu Figure 3(a), company information Figure 3(b), and contact us Figure 3(c) where you can see their social networks.



Fig. 3. Start-up interfaces

Subsequently, Figure 4 shows the external interfaces, the links connected to the application as social networks shown in Figure 4(a), and the location of the facility in Figure 4(b).

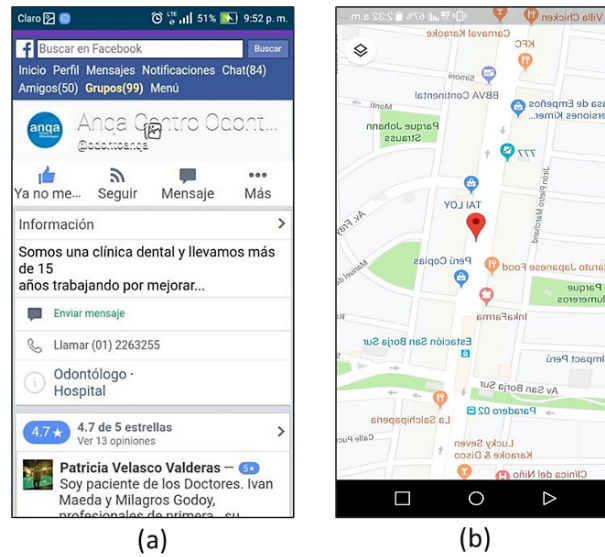


Fig. 4. External interfaces

Finally, Figure 5 shows the business service interfaces, in this section, the service menu interface shown in Figure 5(a) was developed, and the connection with Vuforia is established for the display of videos, audio, and 3D objects within the environment, Figure 5(b) and Figure 5(c).

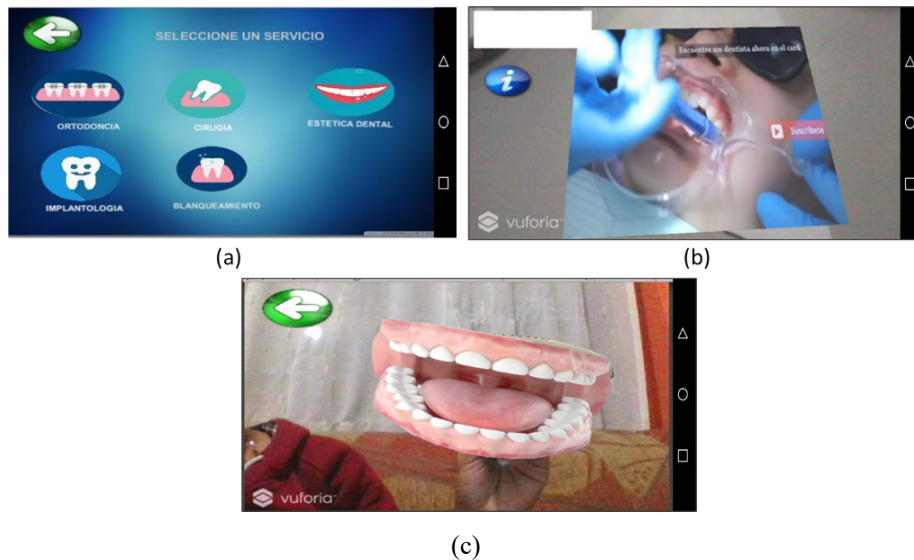


Fig. 5. Service interfaces

Stabilization. for this purpose, the mobile application and the Unity database created in MySQL were synchronized to allow the interaction of the images and the recognition of the targets in Vuforia for the development of the project. Figure 6 shows the Unity virtual environment and the Vuforia database respectively. Figure 6 (a) shows the Android development environment; Figure 6 (b) shows the Vuforia development environment.

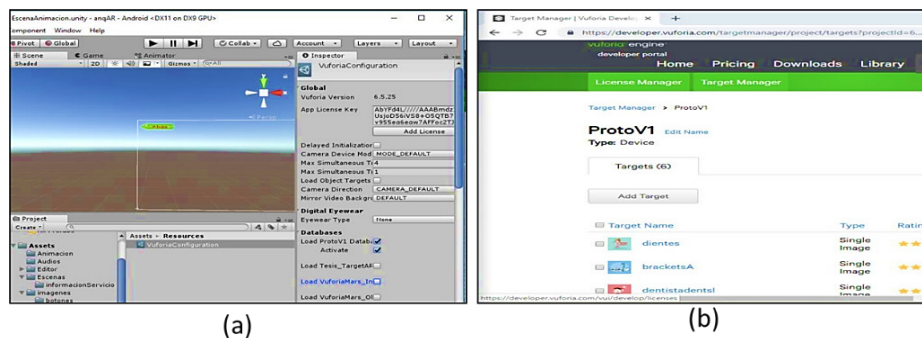


Fig. 6. Application synchronization

System testing. after testing the 8 interfaces developed, it was found that their interconnection was satisfactory. In addition, it was identified that, for the correct operation of the system, the mobile device must meet certain specifications, such as Android system version 4.1 or higher, 4-core processor, 13MP camera, 5.7 Max Vision screen, HD resolution, and finally, internet access.

4 Results and discussion

Table 4 shows the results of the descriptive statistics of the established indicators.

Table 4. Average of the pre-test and post-test indicators

Indicator	Pre-Test	Post-Test
Time to develop advertising	24.71 hours	13.82 hours
Cost in the provision of informative material.	Upper	
Time to report services.	0.30 min	0.19 min
Customer satisfaction level.	Lower	

Normality tests were performed with Minitab on indicators I1 and I3 to identify whether the data had a normal distribution [28].

I1- Time to produce advertising. Figure 7 shows that the p-value is greater than the α value, confirming that the data used have normal behavior. In both Pre-Test Figure 7 (a) and Post-Test Figure 7 (b).

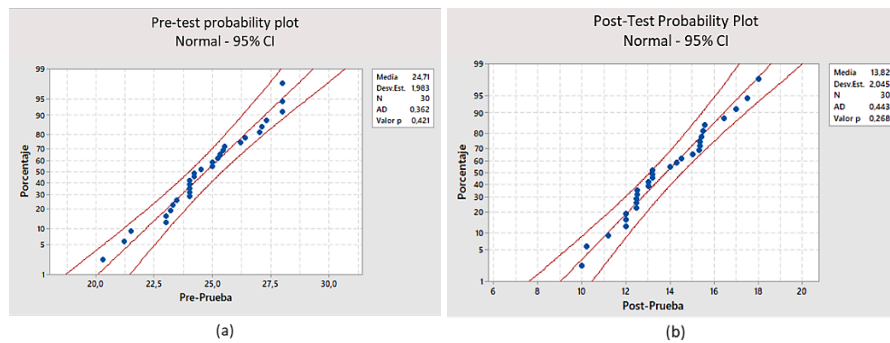


Fig. 7. Pre and post-normality test I1

It is shown in Figure 8 that the data have a normal behavior because the p-value $(0.268) > \alpha (0.05)$ are close values, which is confirmed by observing that the confidence intervals of the mean and median overlap. From the obtained results it can be affirmed that around 95% of the Times in making the elaboration of the Advertising of 2 standard deviations of the mean, that is to say, between 13,054 and 14,581 hours.

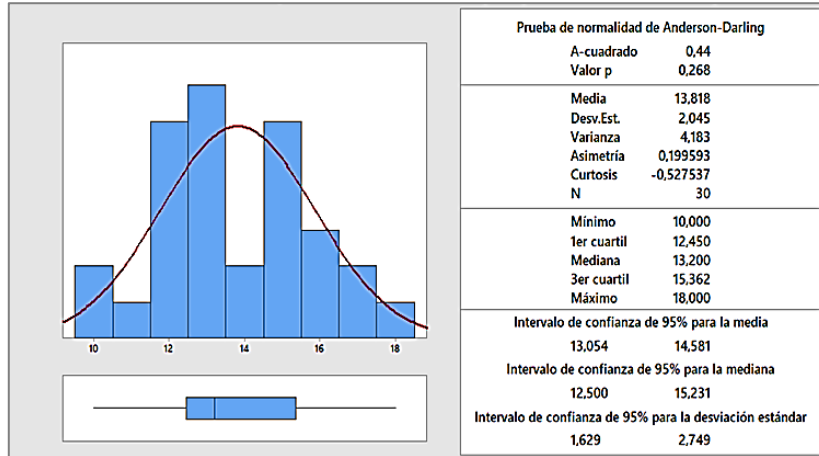


Fig. 8. Post-test I1 summary report: time to develop the advertisement

Kurtosis = -0.527537 indicates that there are values of times with very low peaks.

Skewness = 0.199593 indicates that most of the times to render the evaluation are high. The 1st Quartile (Q1) = 12.450 hours indicates that 25% of the times to produce the advertisement are less than or equal to this value. The 3rd Quartile (Q3) = 15,362 hours indicates that 75% of the time to produce the advertisement is less than or equal to this value.

I2 - Cost in informative material. Figure 9 shows the results obtained from Indicator I2 Material Cost. As shown in Figure 9 (a) in the pre-test 63% of the time the cost of information material is rated as Superior and 37% of the time the cost of information material is rated as Inferior as mentioned by the manager. It is shown in Figure 9 (b) that in the post-test 10% of the time the cost of information material is rated as Superior and 70% of the time the cost of information material is rated as Inferior as mentioned by the manager.

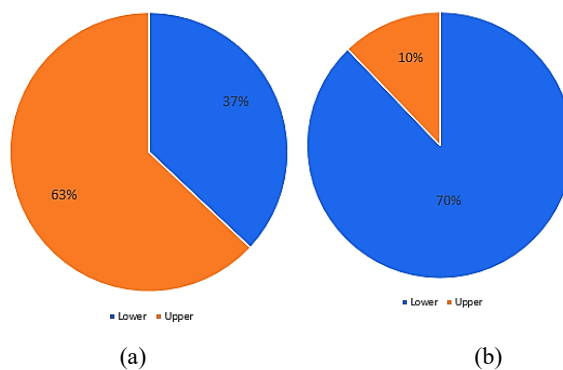


Fig. 9. Results from indicator: Material cost

I3 - Time to Report Services. Figure 10 shows that the p-value is greater than the α value, which confirms that the data used have normal behavior. In both Pre-Test Figure 10 (a) and Post-Test Figure 10 (b).

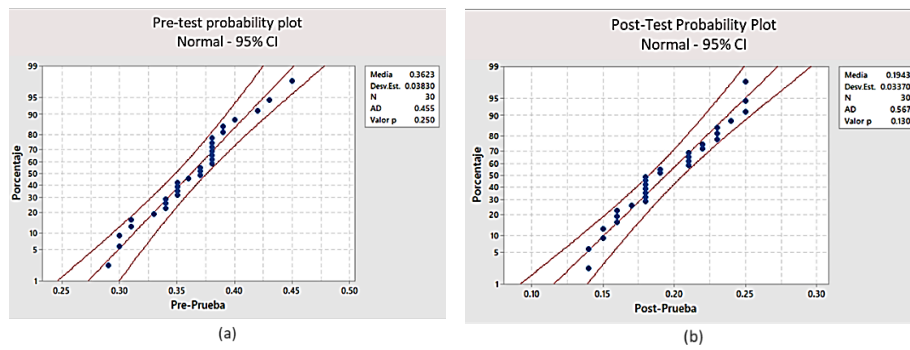


Fig. 10. Pre and post normality test I3

Figure 11 shows that the data have a normal behavior because the p-value (0.130) $> \alpha$ (0.05) are close values, which is confirmed by observing that the confidence intervals of the mean and median overlap. The "average" distance of the individual observations of the time to report services from the mean is 0.03 minutes. About 95% of the Staff amount to 2 standard deviations from the mean, i.e. between 0.18175 and 0.20692 in minutes.

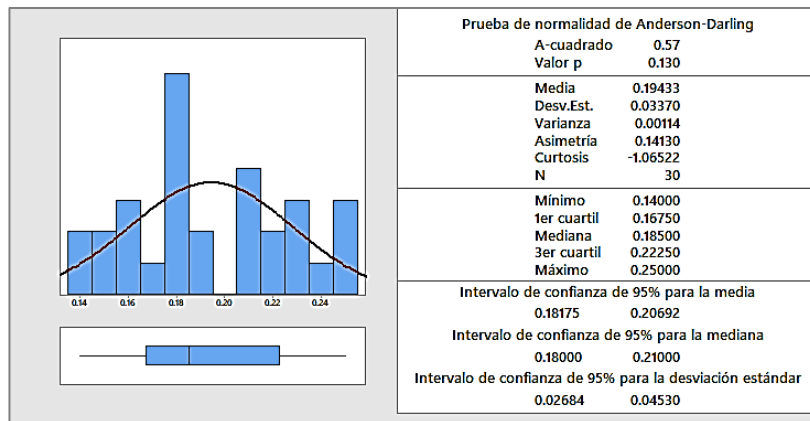


Fig. 11. Post-Test summary report I3: Time to report services

Kurtosis = -1.06522 minutes indicate that there are values of time to report services with very low peaks. Skewness = 0.14130 indicates that the majority of the time to report services is high. The 1st Quartile (Q1) = 0.16750 minutes indicates that 25% of the time to report services is less than or equal to this value.

The 3rd Quartile (Q3) = 0.22250 minutes indicates that 75% of the time to report services is less than or equal to this value.

14 - Customer satisfaction level. Figure 12 shows the pre and post results of the Customer satisfaction level indicator. In Figure 12 (a), 37% were mentioned as Poor by the Customer. 33% was mentioned as Fair. 20% was found to be Good and 10% was mentioned as Excellent.

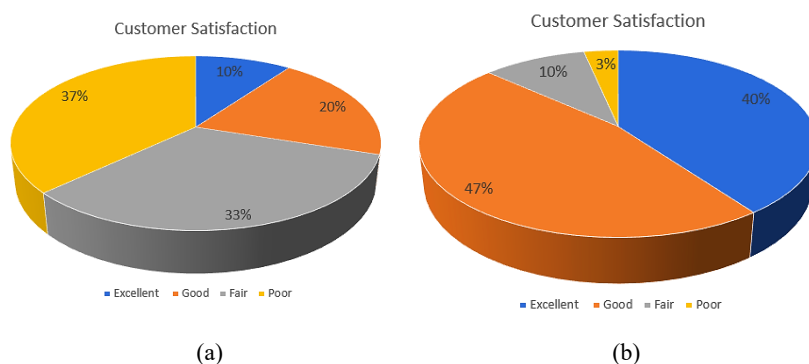


Fig. 12. Customer satisfaction pre-test

It is shown in Figure 12 (b), after the post-test survey that 3% was mentioned as Poor. 10% was mentioned as Fair. 47% was mentioned as Good. 40% was mentioned as Excellent by the Customers.

5 Conclusions and future work

The application was implemented in the Anqa dental center proposing the use of digital marketing incorporating Augmented Reality technology in conjunction with the use of social networks to reach more customers by dynamically approaching them, seeking to generate confidence in their services through the information provided in the application.

It was possible to prove through the analysis of the results that, by incorporating Augmented Reality technology compared to the traditional marketing used in the dental center, using Mobile-D Methodology, this process was improved in the Anqa Dental Center. In addition, it was observed that by using the developed application, the advertising time for the center was reduced. It was observed that using the augmented reality mobile application reduced the costs of informative material as a means of advertising, and also reduced the time it takes to provide information on services to customers. Finally, it was found that customers using the application improved their satisfaction with the services of the business, gaining knowledge of their services in a simpler and more fun way.

It is suggested to implement artificial intelligence through a "chatbot", to solve the doubts in real time of customers interested in the services, thus allowing them to solve doubts and schedule appointments without the intervention of the marketing staff of the establishment.

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