Smart Tourism: Mobile Application with Augmented Reality to Promote the Use of Virtual Tourism for the Archaeological Zone of Caral, Peru

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Abstract

Due to COVID-19, the tourism sector had a loss of visitor revenue of 56%. For tourism in Caral, Peru for 2020 there was a 95% reduction in the annual number of visitors expected. Therefore, the research aims to develop a mobile application for Android with augmented reality to show 3D models and audiovisual content that allows to promote the use of virtual tourism for the archaeological zone of Caral, Peru. To this end, an applied research is developed with a quantitative approach following an experimental methodological design through the pre-experimental method for which a sample of 50 users was taken. To measure this experiment was based on the use of indicators of time of use of the application and the use of augmented reality in the application. The results obtained an average time of use of the application of 0:08:25 minutes while the average time of use of augmented reality in the application was 0:03:36 minutes. Likewise, the results show a great interest on the part of users towards the implementation of augmented reality in an application focused on tourism.

Keywords

Augmented reality, smart tourism, virtual tourism, mobile app

1. Introduction

Tourism worldwide in countries means a large percentage of GDP, reaching up to more than 20% in some of these. However, during the first period of COVID-19, the entry of tourists worldwide decreased by 56% and there were losses of 320 million dollars [1]. For example, tourism in Peru has been one of the most important economic activities, reaching 3.9% of GDP in 2019 with revenues of 4,784 million dollars [2]. However, with the appearance of the COVID-19 pandemic the country was affected, harming all economic sectors, thus causing a 75% drop at the financial level [3]. In this way it happened in the archaeological city of Caral during 2020, which had a reduction of 95% of the annual number of visitors expected which led to a loss in their income of that percentage [4]. This led the tourism sector to think about a restructuring necessary for the reopening and sustainability of the business. This restructuring focused on allowing the business to be sustainable and to be able to achieve digitalization with the use of information technologies. From this search by tourism businesses, the concept of smart tourist destinations is known. This would seek to have a cutting-edge technological infrastructure included in its processes and services, allowing to ensure that its development is sustainable [5]. In this way we have the concept of smart tourism, which can prepare a recovery of the business together with the most innovative information technologies [6]. One of the technologies that have been integrated to display information is augmented reality. Which has proven to be an innovative opportunity that focuses on user interaction [7]. Therefore, augmented reality has been part of the technologies proposed to implement smart tourism [8]. Also, part of this solution is virtual tourism, which allows greater access to tourism and technology remotely [9]. This led to the development of smart tourism in Europe and Asia. Which, in 2021, Peru reached an agreement with Spain, considered a pioneer country of smart tourism, to develop the concept of Smart Tourism in the country [10], [11]. In recent research it has been proposed to integrate augmented reality through mobile applications to display information interactively

[12], [13]. As well, develop virtual tourism as an alternative for a new experience and interest for tourists [14]. Therefore, one of the objectives of the research is focused on analyzing the current context of tourism in Caral as well as identifying the necessary requirements to develop virtual tourism through a mobile application with augmented reality. With this, it is proposed to develop a mobile application with augmented reality with the purpose of promoting the use of virtual tourism for the archaeological site of Caral. Therefore, we ask ourselves the following question: How does the development of a mobile application with augmented reality promote the use of virtual tourism for the archaeological zone of Caral, Peru?

2. State of the Art

2.1. Smart Tourism

Tourism has been experiencing continuous growth over the years due to new technologies and methods to provide services [15]. This is how the concept of smart tourism appears, which has been taking on greater relevance due to the need for new opportunities to innovate in the tourism service. With this in mind, we observe that the use of smart devices in everyday life is much more common, which makes it possible to explore ideas such as the design of smart cities or smart tourist destinations [16]. In this way, smart tourist destinations are designed to have a total approach to the business, thus allowing it to be sustainable in the long term to achieve observing the results [17]. For this, it is necessary to understand the elements that surround the concept of a smart tourist destination and that allow the project to be integrated in all its aspects [10].

2.2. Turismo Virtual

Due to the negative impact that COVID-19 had on the tourism sector, an idea was developed that allows the tourism sector to be maintained through virtual technologies [18]. Through technologies that allow a virtual immersion of the user, virtual tourism is developed that will allow tourists to be part of an experience different from that obtained in traditional tourism creating interest in it. According to studies, they have obtained positive sensations from tourists for the use of virtual tourism as a response to a crisis situation or difficulty in accessing traditional tourism. Likewise, a design of a smart tourism has been sought by applying a virtual tourism in order to obtain an immersive experience for tourists [21]. Thus, with this concept, different ideas have been developed in order to respond to a crisis that prevents them from continuing to carry out their traditional activities and moving to a virtual medium. The tourism sector had not foreseen before an option other than traditional tourism until the pandemic that led to virtual tours to maintain the tourism sector as a sustainable business [22]. However, it is necessary to emphasize that virtual tourism will not replace traditional tourism, but will complement the tourist experience for the services pro-vided by tourism [23].

2.3. Caral Tourism

Tourism in Caral has a great variety of ceramics and instruments that they used for their religious and musical ceremonies as well as their pyramidal buildings built with quincha [24]. Caral has had a constant growth over the years. The annual visits that the archaeological zone received were in continuous growth. According to the analysis of the archaeological site of Caral, there has been a significant decrease due to the COVID-19 pandemic [25]. Thus, having an economic loss compared to the years 2019 and 2020 of 87% [26].

## 2.4.   Realidad Aumentada en Aplicaciones Móviles

At present, studies related to augmented reality have seen a growth of great potential to be implemented in mobile applications. One of the studies reviewed by Spallone & Palma [13] contemplates a solution through digital innovation, which collects information for visits to the archaeological sites of Rome. This research focuses on the use of the mobile application to recognize monuments and display information about them through 3D modeling of each of them. A similar look is given with the research of Hincapié et al. [27], which sought an innovative solution that works on the experiences of tourists and its value as a tourist site of Plaza Cisneros. The use of augmented reality in the mobile application was based on showing through a map a marked guide of historical places, which attracts the curiosity of tourists.

3. Research Methodology

The methodological design of the research will follow an experimental design in order to apply measuring instruments to obtain the results. Likewise, it will be developed with the pre-experimental type because it will work with a reduced sample.

With this, to measure the use of virtual tourism, we worked with the time indicators of the use of the application with all the functionalities and the time of use of the augmented reality functionality. To obtain the results, an observation guide was developed in which the variable of the impulse of smart tourism was validated. For the first indicator, we looked for groups of users to whom to pre-sent the proposal to be part of the experiment. For the selection of the sample, it was taken into consideration that they are users among children, young people or adults of any sex who have made a visit to a tourist site. A group of 65 people were told to be part of the experiment using the mobile app. Of the total number of people, 50 users agreed to be part of the experiment. To do this, the Android Package Kit (APK) developed for research was delivered. Each of these users had a mobile device with Android operating system through which they would access the application.

For the mobile app, it started with the creation of the mobile app architecture. The software in use for the construction of the application was considered as well as the permissions that would be required for its use. (See Fig. 1).
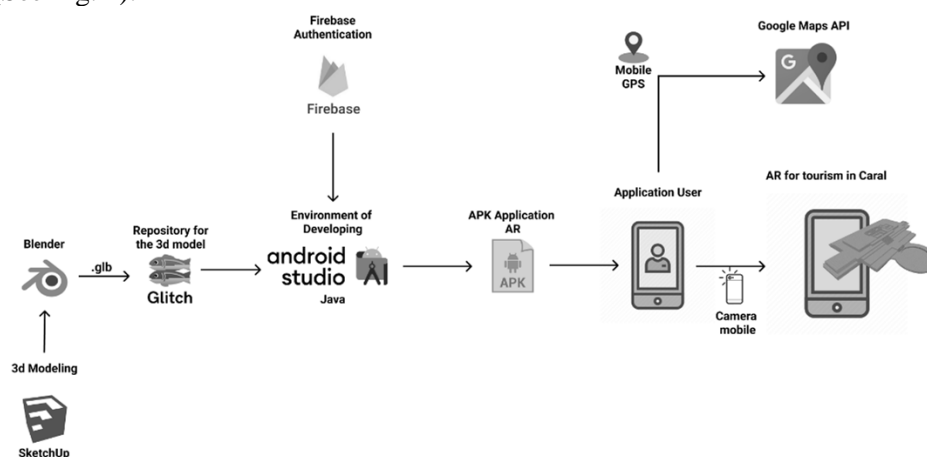
Figure. 1 Mobile App Architecture

The mobile application will consist of 10screens developed in Android Studio with the Java programming language. These screens will be the welcome screen, login screen, user registration screen, main menu screen, Caral history screen, history augmented reality screen, Caral pyramids screen, pyramid description screen, Caral Map screen, the augmented reality screen of the pyramids of Caral (See Fig. 2).
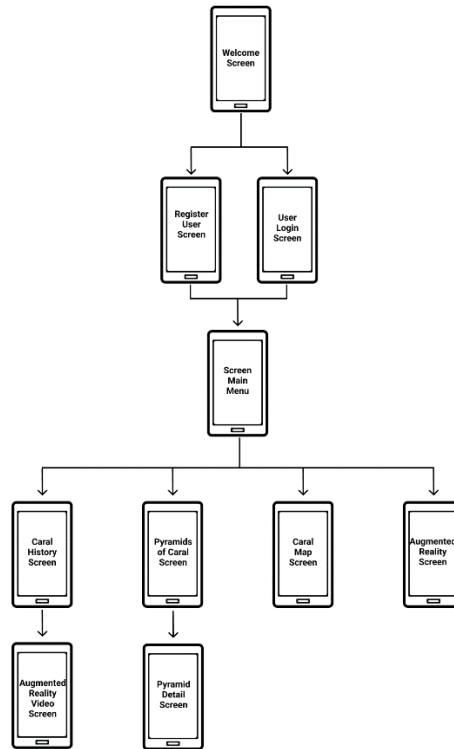
Figure. 2 Mobile app screens

For the functionality of the augmented reality screen, we work with the type of augmented reality without markers, so it is necessary to detect a flat surface with the camera of the mobile to show the 3D object and the information video. For the application we work with a 3D model of the major pyramid of Caral because it is one of the most attractive points of Caral (See Fig. 3).

Figure. 3 Augmented reality of the Great pyramid of Caral in the mobile application with a reference image and the 3D model used.

The following augmented reality functionality will show a video about the socio-environmental system model of Caral's culture. Through the sensors of the cam-era, as in the previous implementation, a flat surface will be detected on which to load the audiovisual content (See Fig. 4).
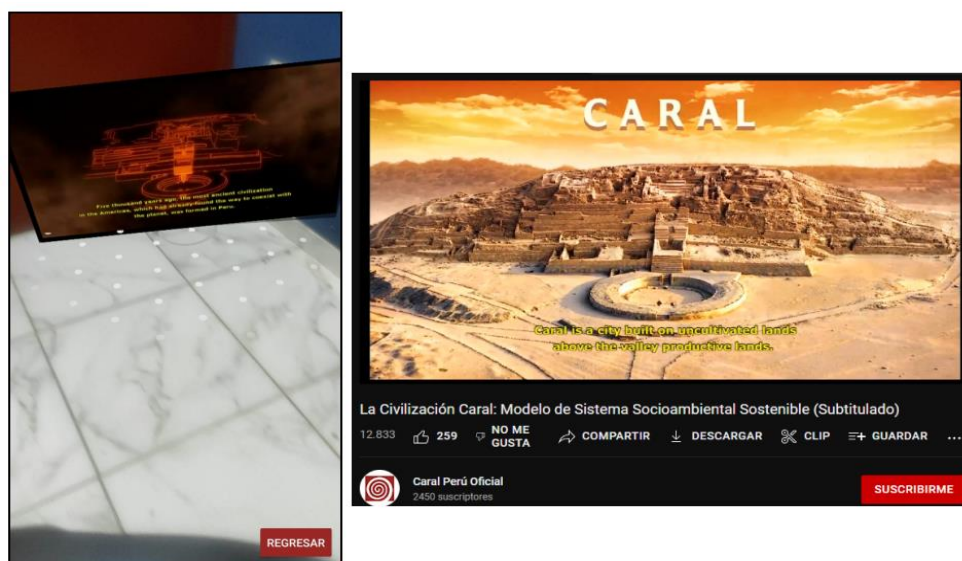
Figure. 4 Augmented reality making use of audiovisual content from Caral's socio-environmental system model.

Finally, based on the research of this new application with augmented reality to be implemented in Caral would taken 4 months. This time will focus on the 3D modeling of the 6 main pyramids of Caral and the development of the application. For the costs of the application, a minimum budget of $500 is foreseen be-tween the resources, the modelling process and the development process.

4. Results and Discussion

For the results related to the participants of the experiment, 50 users interested in carrying out the experiment were obtained, achieving a total of l 81% interest in this new mobile application (See table 1).

Table 1
Observation guide for the percentage of users who make use of the mobile application

A=Total number of users using the group application	B= Total number of users in a group	=A/B
50	65	81%

As a next point we have the results of the indicators of the time of use of the mo-bile application and augmented reality. For the result of the first indicator, an average time of use of the application of 8:25 minutes was obtained from a total of 50 users (See table 2). The evaluation was carried out with the Student T test for a sample with a test value of 0 since there is no previous record of the use of a mobile application with augmented reality in Caral. A longer time of use of the mobile application is reported (M=0:08:25, DE=0:02:08) than the normative sample with the characteristics (t (49) = 27.782, p<.001) (See table 3).

Table 2
Statistics for a sample of the indicator time of use of the mobile application

	N	Average	Deviation typ.	Error Typ. Of the average
TiempoUsoAplicación	50	0:08:25	0:02:08	0:00:18

Table 3

Student's T-test for a sample of the mobile app usage time indicator

TiempoUso Aplicación	Valor de prueba=0					
	t	gl	Sig. (bilateral)	Average difference	95% confidence interval for difference	
					Inferior	Superior
	27,782	49	,000	0:08:25	0:07:49	0:09:02

For the following indicator of the time of use of augmented reality, an average time of 3:36 minutes was had (See table 4). Student's T-test, as with the first indi-cator, reported a longer time of use of augmented reality functionality (M=0:03:36, DE=0:01:32) than the normative sample (t (49) =16,510, p<,001) (See Table 5).

Table 4

Statistics for a sample of the indicator time of use of augmented reality

	N	Average	Deviation typ.	Error Typ. Of the average
TiempoUsoAplicación	50	0:03:36	0:01:32	0:00:13

Table 5

Student's T-test for a sample of the augmented reality usage time indicator

TiempoUsoAplicación	Valor de prueba=0					
	t	gl	Sig. (bilateral)	Average difference	95% confidence interval for difference	
					Inferior	Superior
	16,510	49	,000	0:03:36	0:03:10	0:04:02

As a starting point, we have the beginning of a smart tourism through the mobile application with augmented reality. As Mohanty points out [6], the augmented reality IT tool is innovative and provides a new experience for the tourist as observed in research through the times of augmented reality use. As Neiva mentioned [10], for the concept of smart tourism to be fully applied it is necessary to continue developing the other components such as IT governance, human capital, sustainability and economic capital. We can reaffirm with research that applying a virtual tourism will be a complement service to traditional tourism as mentioned by Talafubieke [23].

Para For users who made use of the mobile application, they found this new way of making their visit to Caral interesting. They consider that it gives them a greater approach to history and that they can complement what they have learned. On the other hand, some users reflected in their observations ideas to complement the application when displaying the information or improving the functionality.

5. Conclusions

Finally, through research it has been possible to meet the main objective through the experiment executed. First, it has been possible to know what has been happening in Caral and how it is possible to promote the use of virtual tourism through the concept of smart tourism. It has been possible to take the first step through the implementation of a mobile application with augmented reality so that the tourist can experience a new way of accessing the information of the site he visits or is interested in knowing. In addition, the development of the application is fulfilled based on requirements of previous studies that had the implementation of augmented reality for different market sectors. Through the results, it was possible to obtain a high degree of interest from users to make use of a mobile application with augmented reality. For the use of the application there was an average time of 0:08:25 minutes. While for the use of augmented reality there was an average time of 0:03:26 minutes. It was able to

identify that there is an opportunity with augmented reality technology to provide a virtual tourism service and also implement it in the tours of Caral, since it is a new experience for tourists.

Based on the observations obtained from the research, the project can continue in a future development in order to realize a long-term implementation in collaboration of the archaeological site of Caral.

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