

AUGMENTED REALITY FOR THE DEVELOPMENT OF SUSTAINABLE TOURISM IN THE CHIMBORAZO WILDLIFE PRODUCTION RESERVE

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Abstract: This work presents the application of Information and Communication Technologies (ICT), with the aim of designing a digital product for the tourism promotion of the Chimborazo Fauna Production Reserve, during the process the new trends in marketing and tourism promotion helped by ICT and their evolution over time were taken into consideration, to offer better benefits to both the promoter and the tourist. The RPFCH stands out as an emblematic site of the country thanks to its natural and cultural wealth, being considered a suitable place to apply this technology. The use of Augmented Reality in the reserve will provide more information and accessibility about the attractions it has for visiting tourists. To know the current situation of tourism in the reserve, a study of supply and demand was carried out, in the case of supply, the attractions and activities, infrastructure, tourist plant and the existing superstructure were diagnosed and analyzed; for demand, information related to visitors, market, marketing channels and promotion strategies was collected, and tourist dissemination. Regarding the creation of the augmented reality application, a comparative study was carried out on the tools, application methodologies, hardware and software, in order to determine the most appropriate for the objectives set. Subsequently, the requirements for the design of the application were analyzed, comparing the different methods to apply Augmented Reality, managing to create the application, which, through the scanning of markers will present the information that the tourist needs to know. At the end of the work, it is concluded that Augmented Reality technology is of great help, in addition to being extremely efficient, this resource transforms the way the world is seen. It is recommended to optimize the use of this computer field to know new media and methods of promotion and dissemination that are consistent with new technological trends and market preferences.

Keywords: ICT, sustainable tourism, augmented reality, environmental science, Chimborazo Wildlife Production Reserve, GIS

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1. INTRODUCTION

Tourism is a fundamental pillar in economic and social development worldwide, it is a key factor for the promotion of a country, so it requires adequate public strategies that allow it to potentiate, in this sense generate dynamism in places previously little visited, allows the development of activities previously unknown, making them attractive. According to the World Tourism Organization (2018) "Tourism includes the activities carried out by people during their trips and stays in places other than their usual environment, for a consecutive period of less than one year for leisure, business and other purposes". Indeed, it is the natural tendency of the human being to change places to benefit from the attractions of places other than the one he usually lives, resting in a pleasant and recreational environment.

At the level of Latin America, there are many countries that offer innumerable tourist attractions, such is the case of Ecuador, a country that does not dissociate itself from tourism, since it has multiple areas of great tourist attraction that stand out for its varied culture and great biodiversity, among which they have inventoried more than 920 tourist attractions, about 520 are natural, highlighting the national parks, among others (Serrano and González, 2019). Tourism activity has a great impact at the level of the Ecuadorian provinces, such is the case of Chimborazo where currently the Fauna Production Reserve (RPFCH), perceives an increase due to the declaration of this snowy volcano as the closest point to the sun since 2016, however, in its buffer zone, Although there are Community tourism centres offering various services and activities, the lack of a consolidated tourism product is evident.

Tourism has been favored by the use of information and communication technologies (ICT), internet and mobile devices, which, together, are a great multiplier of the facilities and services that a tourist attraction has. Natural and cultural resources are also part of a network of great value and wealth, which must be promoted and marketed in a sustainable way, with the aim of improving the socio-economic development of local populations in terms of destinations and conservation of resources (Orgaz and Moral, 2016), in other words, the actors involved should not be affected by the use of tourism resources, on the contrary, their dissemination should be motivated to boost the economy and boost the promotion of tourist attractions.

With the passage of time, technological innovation has significantly changed the tourism landscape of the XXI century. ICTs have become a crucial tool for the dissemination of cultural (Bernad-Conde, 2020) and natural heritage. At present it is possible to access information and have on electronic mobile devices real libraries with data previously little known and that were the privilege of certain acts, the different technologies in hardware and software are increasingly used, contribute significantly to the development of the dissemination of cultural heritage and tourism of rural and urban sectors.

Technological models are increasingly common and revolve around the sustainable development of tourism, with which they have been responsible for defining a before and after of the ways of traveling and living experiences, which generates possibilities of connectivity through different technological systems such as: the web, social networks, augmented reality, robots, artificial intelligence, among others; showing essential for the different sectors in the coming years.

Augmented reality (AR) is an important tool that has had great perception, there is a broad consensus in the academic world regarding the great potentialities presented by AR in the field of tourism (López-Mielgo et al., 2019). AR is a technological tool in which elements of the real world are combined with virtual elements, it allows a new, powerful, original and effective way to present and experience new situations. This technology gives the possibility of knowing tourist sites, with an added value and complementary information that was not available before (Smarttech Group, 2019).

The RPFCH, part of the National System of Protected Areas of Ecuador, was created on October 26, 1987 has, among its main attractions with the Chimborazo volcano (6310 m), known as the furthest point from the earth, with respect to the center of the planet (Castro, 2016). It is a site very visited by national and foreign tourists, has basic signage and information about the area, is mostly provided by guides and park rangers. However, due to the large influx of tourists, this human



contingent may be insufficient to cover the demand for information, so it is necessary to implement new technological strategies that are easy to use and freely accessible.

This research aims to identify and analyze the potential that the RPFCH can offer, making use of an AR application, as a tool that contributes to improving the tourist offer and satisfaction of tourists who visit it.

ICT and its impact on tourism

Since ancient times, ICT has transformed tourism, in terms of business practices and the structure of the industry, they also have a competitive advantage and wide potential to transform the value chain, from the moment in which it is possible for the customer to start looking for information about the tourism product to after-sales service (Rodríguez, 2018).

Tourism is a business activity that requires a diversity of information, since quality depends on the availability and management of information, allowing greater control of volume and interaction of information between seller and buyer. On the other hand, they promote changes in horizontal relations, generating an increase in incentives or support in cooperation between competitors, such as the case of entities of small tourism service providers that are grouped to develop a common website, offering a platform with lower costs for each, but with greater or greater opportunity to be visited.

On this context, Rodríguez (2018) points out the experiences in Latin America where ICTs have fostered associativity, becoming a facilitator in the construction of competitive advantages, given that the internet has revolutionized the distribution of tourist and commercial information, also has an important impact as a source of information for tourism. In addition to this, the development of social networks and ICTs have generated important changes in the models of tourism behaviour and in the way they search, evaluate, buy and consume information, products and services.

ICT and especially the internet have made tourists, well-informed individuals, less interested in tracking crowds and more willing to follow their preferences, in terms of customer participation in the design of tourism products, the rapid transmission of data on the internet has reduced the response time that positively influences customer satisfaction. and. Likewise, the behavior of the response became an essential factor for the success of small and medium-sized tourism companies, in addition online customer satisfaction has generated a positive impact on loyalty on both services of the organization and its website.

Consequently, the development of multimedia resources is becoming a key aspect for the promotion of tourism since, tourist information requires the presentation of photographs, graphics, animations and ideas to provide a tangible image, increasing the richness of information and virtual interaction with an established destination (Arrunategui, 2019), where tourists can see the information through maps with images, antenna with ANCH A band, satellite in various dimensions and even tourist attractions can be dynamically presented by virtual characters in real time

Augmented reality

AR is a type of technology that today is used in almost all environments, combines in real time, through devices with camera (cell phones, tablets, etc.), images of the environment with layers of virtual images generated by computer, creating an immersion that allows combining the two worlds (virtual and real), therefore, AR is defined as the use of a computer-generated 3D environment, called a "virtual environment" (VE), which one can navigate and possibly interact with, resulting in a real-time simulation of one or more of the users (Guttentag, 2010), consequently, AR consists of combining the real world with the virtual one through a computer process, enriching the visual experience and improving the quality of communication. (Rigueros, 2017).

AR needs 4 main elements or factors that allow its execution

- **Environment:** Device that allows to display the layers and the combined real world, can be a monitor or the screen of the mobile device.
- **Software:** allows you to interpret and combine the layers and the environment.



- **Sensor:** it is responsible for capturing the information shown by the environment and the activator, usually with cameras of electronic devices.
- **Activator:** who is responsible for triggering the execution of one or more layers that must be displayed, the most used activators are GPS, barcodes, QR codes or two-dimensional codes, among others (Rigueros, 2017).

Types of Augmented Reality

Augmented reality is grouped into two large groups, applications based on markers and without markers

Augmented reality with markeris

Marks are used that can be on cards, posters, posters, etc., which contain certain images called markers with a specific pattern, which the software recognizes, so that when the camera scans them, scenes or three-dimensional images are superimposed. This type of AR is one of the most widespread

Augmented reality without markeris

It is the one that allows to position or superimpose on reality itself without the need for markers, recognizes objects or certain characteristics such as walls, windows, intersections, among others. There are several subtypes of marker AR, which are listed below.

- **Location-based:** This technology uses the location that is recorded in the location sensors of the device used (GPS), to position the virtual object in the desired place or point of interest.
- **Projection-based:** by making use of a fixed projector and a tracking camera, you can shape objects with artificial light that may be able to receive instructions taken from this created illusion.
- **By overlay:** allows you to take an object and create multiple views, which allow the user to have a better view of the object under study.
- **Contour:** it allows to form lines that allow to orient oneself in the environment and to know distances and depths (Rigueros, 2017).

2. MATERIALS AND METHODS

Area of study

The study was carried out in the Chimborazo Fauna Production Reserve (Figure 1), is located in the provinces of Chimborazo, Bolívar and Tungurahua, in the central zone of Ecuador, in the southern hemisphere, zone 17, 742535.52 m E, 9837537.78 m S, is one of the sixty protected areas of the National System of Protected Areas of Ecuador, created in 1987, its extension is 52683 ha (Ministry of Environment, Water and Ecological Transition [MAATE], 2021), within the reserve is the Chimborazo volcano, whose height is 6310 meters above sea level as its main attraction, the Carihuayrazo and paramo territories. Its limits are:

- **North:** Páramo de Guillán, Loma Utucumuri, Loma Sumipungu, Loma Tanimullo, Quebrada Mulacorral, Loma Cóndor Samana, Loma Chaupiloma, Cerro Tangango, Cerro Sunaniza.
- **South:** Talahua, Quebrada Yuracpolvo, Minas de Cascajo in Cerro Gariquis, Cerro Razotambo Grande, upper channel of the Heart River.
- **East:** Mortiño Loma, Quebrada Cocha Podrido, Loma Chillabulla, Loma Caparina.
- **West:** Mesarrumi, Loma Quishuar, Loma Mangahurcu, upper course of the Curipaccha Creek, Curipaccha Hill, courses uperior of the Toro Huanuna Creek and Culebrillas River, Lozán Creek, Toni and Batijasacha Hills, Allpacorral Creek, Yucuviana Creek, Laihua Creek, upper course of the Yuracsha Creek, Tioginal Hill (Zhicay, 2016).

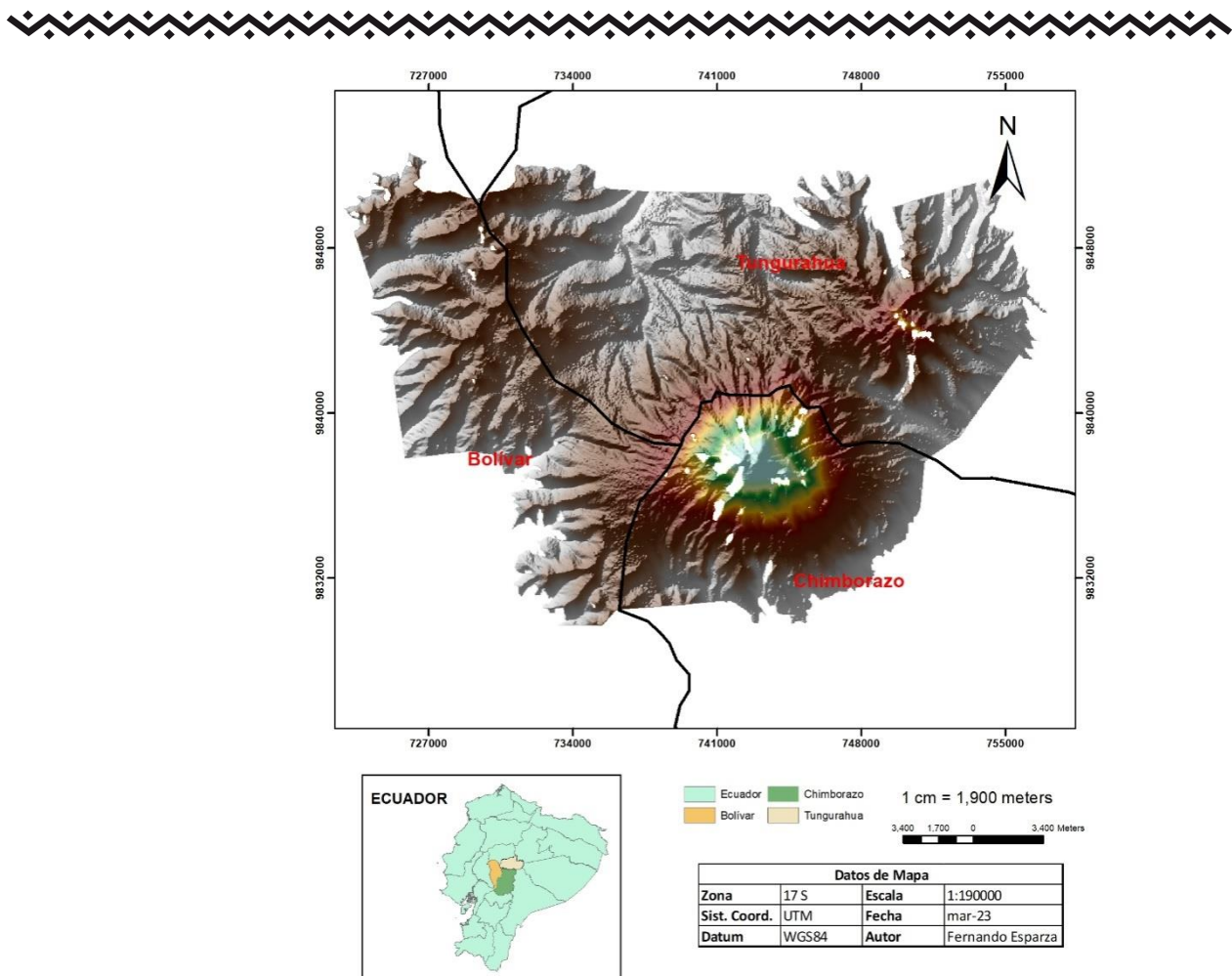


Figure 1. Chimborazo Wildlife Production Reserve. The reserve extends between the provinces of Chimborazo, Tungurahua and Bolívar

Type of research

The present research is of an applied type, not experimental, in which, for the collection of primary information, it used interviews, video recordings and production of photographic material, in addition to bibliographic archives (Arias, 2020).

Background to the investigation

For the analysis of demand in the RPFCH, the methodology proposed by Valle and González (2004) was used, in which the vision of supply and demand was considered, which includes:

Collection of information on the number of visitors and the profile of the tourist, through interviews with key actors who are in charge of the administration and operation of the RPFCH, using as an instrument the interview guide, statistical data of MAATE and the Visitor Management Plan of the reserve (MAATE, 2015).

Identification of tourist attractions of the RPFCH

Regarding the identification of the offer, the attractions, facilities, tourist plant and superstructure presented by the RPFCH were considered, using the observation technique for the identification of these, each of these attractions were georeferenced to locate the necessary markers that serve as inputs to the application of AR.

Each point was georeferenced at the site, making use of SPECTRA high-pressure GPS, configured to take data in the UTM Universal Transverse de Mercator (UTM) coordinate system, Datum World Geodetic System 1984 (WGS84), for zone 17 South.

Development of the AR tool

For the design of this AR product, to carry out a bibliographic research on the different AR tools, in search of the most appropriate ones for the application to be developed, was considered as a determining factor, the geographical area and the possible changes that this environment may suffer with the passage of time, in addition, the fact of the little or no coverage of cellular operators in this sector, This prevents users from downloading the app.

For this objective, technologies based on augmented reality applied to tourism were used, considering the activities of figure 2:

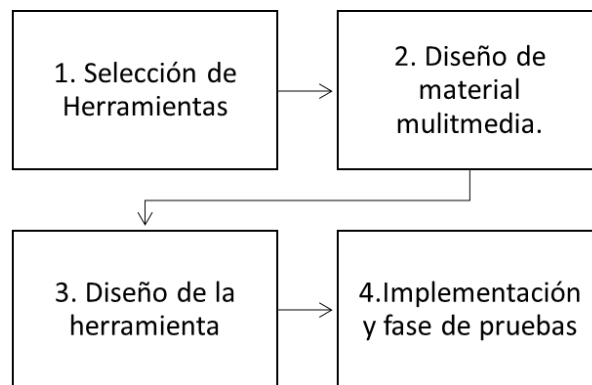


Figure 2. AR application development processes.

1. In the selection of AR tools, it was necessary a comparative analysis between tools for AR, so that the most appropriate for the objective is found (Leiva, 2014), two fundamental aspects were considered, hardware and software, analyzing the compatibility that must exist between them, in order to achieve a good performance in the development of the AR application.

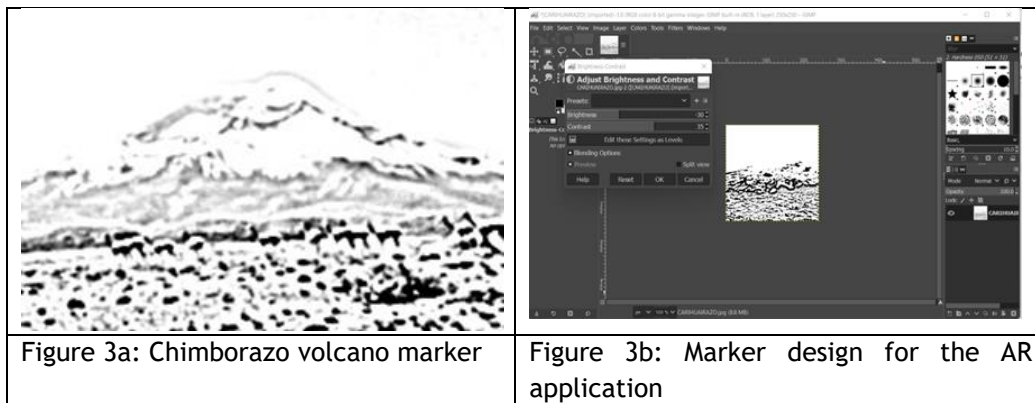
To select the AR design tool, it was necessary to consider the following parameters: Shape, Use of the Global Positioning System (GPS), Visual Search, Content of the APIs and Framework (Ferrada, 2014). To quantify the values of each parameter, the Likert scale was used, the tools compared were Aurasma, Vuforia and Layar. As a result of the tool analysis, the results shown in Table 1 were obtained.

Parameter	Aurasma	Unity-Vuforia	Sail
Platform	3	4	2
Use of the Global Positioning System (GPS).	4	4	3
Visual Search	3	3	3
API content	1	2	1
Framework	2	3	1
TOTAL	13	16	10
Total percentage (100%)	65%	80%	50%

Table 1: Software score analyzed

With the analysis carried out, it is determined that the appropriate tool for the implementation of the AR tool for this area and purpose is Unity-Vuforia, applying AR based on the use of markers (Rigueros, 2017).

2. Design of the digital product, in this section photographic material is designed with bibliographic data that are shown in the RA application, the tools used for this purpose, were Blender 3.0 for 3D images and Gimp 2.10.28 for 2D images. Images of the attractions were used and the characteristics of each site were investigated. With this material, making use of Blender, the moderate content was designed in each marker that will serve as markers and that will activate the layers to be displayed, for which the most representative tourist attractions of the Chimborazo Fauna Production Reserve were chosen, shown in Table 3.
3. The development of the AR application is based on the SCRUM methodology (Scrum Alliance, 2018), useful for rapid development. To generate markers (Figure 3a) Gimp was used, this tool allowed editing the original images, resizing and modifying contrast, brillo and image properties until obtaining the result that will be used in the AR application (Figure 3b).



With the previous inputs, the AR application was developed, and an executable file was generated for Android devices called RA Chimborazo (Figure 5), once the application is installed, the results can be verified by running it and pointing the camera to the marker, as evidenced in Figure 4.



Figure 4: Application of AR

4. Implementation and testing phase, with the development of the tool, proceeded with the on-site testing phase, for this purpose on-site tests were carried out with the tourists who were at the site, the application was installed on several mobile devices and the results were verified.

3. RESULTS

Visitor statistics

Table 2 provides the number of tourist visits in the years 2018 and 2019 in which, when compared, there is a minimal decrease in terms of visitors, but it is consolidated that the reservation is a recipient of a large number of tourists, increasing the possibility that any product that is implemented is favorable for tourism in it.

	2018		2019	
	National	Foreign	National	Foreign
January	7063	2251	578	2218
February	8636	1584	5612	2008
March	11773	1732	12868	1733
April	10373	1546	9308	1755
May	807	1931	7466	1981
June	5579	1955	5985	1566
July	9227	2845	7262	2741
August	12993	3192	11062	2945
September	7217	1923	5685	2227
October	4857	216	880	1643
November	4984	2613	6914	2549
December	7276	1979	5542	175
Subtotal	98048	25711	84364	25116
Total		123759		109480

Table 2: Visitors to the RPFCH

Table 2 mainly shows that domestic tourism gains strength compared to inbound tourism and according to the records of the reservation, the level of visitor income for the year 2018, was significantly higher than domestic visitors, corresponding to 98,048 and 25,711 foreign visitors, making a total of 123,759 visitors.

From the entry of visits generated in 2018, we proceed to detail the entry of tourists by months, deducing that in the month of August the largest movement of tourists is registered, being 12,993 nationals and 3,192 foreigners, obtaining a total of 16,185 tourists in that month.

The year 2019 registered 84,364 national visitors and 25,116 foreign visitors, making a total of 109,480 visitors.

There is an opportunity for improvement in the foreign sector, a new form of management and motivation will help the reserve move from conventional tourism to more enjoyable and interesting tourism. With a notable decrease in visitors in 2019, it is expected that, from the implementation of the AR-based application, tourists will find a stronger incentive to consider booking as a priority destination when organizing their trips.

In the same way, analyzing the visits that were generated per month in 2019, it is known that the months with the most influx of tourists were March and August, with 12,868 visits by national tourists and 2,945 visits by foreigners respectively.

Demand Profile

The tourists and visitors who frequently visit the RPFCH have the following characteristics:

- National tourists: Coming from the cities of Guayaquil, Ambato, Cuenca and Quito their age generally ranges between 20 and 50 years, they prefer to see the attractions on their own, without the direct contracting of services or packages, they choose to receive information from the web and enter the adventure.
- International tourists: They come from the countries of the United States, France, Argentina and Germany, their age varies between 25 to 60 years, their visit focuses on tours, one of their

options being the route of the refuges, that is, it starts from the main entrance to the first refuge, then to the second refuge until reaching the lagoon Condor Cocha, This being the route with the greatest reception due to its easy access. Followed by the high mountain route, several

No.	Name of Attraction	Category	Guy	Subtype
1	Chimborazo Volcano	Natural attractions	Mountain	High Mountain
2	Carihuairazo Volcano	Natural attractions	Mountain	Mid Mountain
3	Machay Temple	Natural attractions	Speleological phenomena	Caves
4	Barracks of the Incas	Cultural manifestations	Architecture	Archaeological Area
5	Casa Condor Canyon	Natural attractions	Geological phenomena	Cannon
6	Arenal Desert	Natural attractions	Forests	Moor
7	Solitary Tree	Natural attractions	Forests	Moor
8	Polylepis Forest	Natural attractions	Forests	Moor
9	The Chorrera	Natural attractions	River	Waterfall
10	Chimborazo coolers	Cultural manifestations	Cultural and Popular Heritage	Crafts and arts

Table 3. Tourist attractions of the RPFCH.

The following table shows the tourist attractions selected for the implementation and their respective georeferencing, useful for the location of the RA markers.

No.	Attractive	X	And
1	Chimborazo Volcano	743392	9838003
2	Carihuairazo Volcano	749642	9844609
3	Machay Temple	741921	9834605
4	Barracks of the Incas	744310	9829906
5	Casa Condor Canyon	741079	9829920
6	Arenal Desert	737575	9834361
7	Solitary Tree	740999	9832911
8	Polylepis Forest	740025	9836431
9	The Chorrera	741825	9830997

Table 4: Attractions that will be presented in the app

The georeferenced points are shown in Figure 5, where you can show the area that is covered with the markers to be used with the application of AR.

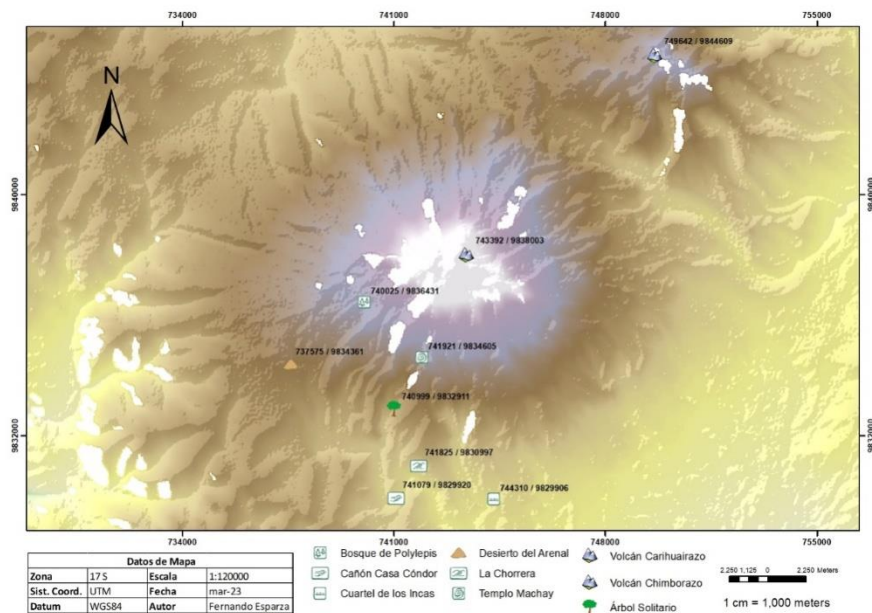


Figure 5: Map of tourist attractions of the RPFCH.

Once the markers in si tu are located, figure 6a, the use of theAR application is shown on site, the mobile device with the application installed, scans the marker shown in the signage and this shows the result on the screen of the mobile device used, figure 6b.



Figure 6a: Example of marker in RPFCH attractions.



Figure 6b: Screenshot of the RA application in use (Chimborazo Volcano)

4. DISCUSSION

Currently, Latin America has immersed itself in a globalized world, where the tourist and technological aspect is becoming more important every day, due to the constant modifications and updates by tourists in the search for new experiences that meet their needs through tourism products other than mass tourism, which oblige the East Adapting to the parameters of globalisation, which has an impact on motivations related to rest, nature protection or knowledge of local culture.

On the other hand, the cultural, economic and economic changes brought about by the development of tourism are undeniable, although it has only been highlighted from the economic capacity generated by this sector, although, in recent years, research has appeared from a point of view more related to sociology, anthropology or geographical area (Orgaz and Moral, 2016). From this context, the research will be argued through prior information that will serve as a basis to support the theory and methodology to be developed.

In the study about the "Analysis of the application of augmented reality in the tourism sector : a proposal for improvement", developed by the Spanish researchers Agüero and González (2014), they consider that the arrival of the internet and the different tools related to the new technology, have opened a new horizon in the tourism sector, for which they raised as an objective of the research, carry out a study on new technologies applied to tourism, focusing on the use of a new mobile technological tool of great potential for the sector, called Augmented Reality (AR), where they



established the impact of all its applications in the field of tourism which allowed to conclude that AR covers certain needs that may have er the tourist and, in addition, enriches their experiences in the tourist practice. However, they diagnosed the need to improve AR, as well as greater promotion by tourist destinations, because there is still a certain ignorance on the part of the final recipients of these technological tools.

For his part, Arrunategui (2019) in his research established as an objective to implement a mobile application using AR for the development of tourism in the Tumbes region by 2018. Through longitudinal methodology, with a quantitative approach, at a descriptive level and applying statistical analysis, it determined as a result that 90% do not know the tourist applications in Tumbes and 64% believe that a mobile application focused on tourism will help improve the tourist experience of the region, concluding that a digital product that uses augmented reality will greatly promote the tourist activity of the locality, as well as tourism-based businesses. Under these considerations it is important to take into account the appreciation of visitors to the RPFCH regarding the use of AR to improve tourism potential in this region, although tourist mobile applications are still unknown in similar circumstances to the reality of Tumbes, it is important to identify that for most visitors the experience of using AR can be very enriching and promote tourism. locally, nationally and internationally.


According to the perspective of Suárez (2020), new technologies constantly influence people's daily lives, and it is important to make the most of the benefits they can provide; one of these modern technologies that attracts attention is AR, its applications provide an innovative way to show a reality, which can be called mixed, since it combines the real with the virtual.

5. CONCLUSIONS

- The Chimborazo Fauna Production Reserve has several tourist facilities, in addition, institutions such as the Ministry of Environment, Water and Ecological Transition, the Ministry of Tourism and prefectures of the provinces of Chimborazo, Bolívar and Tungurahua, all this management is reflected in its variety of services, attractions and activities, noto However, by complying with the specific parameters to receive tourists, it was possible to evaluate that there was no greater increase in visits to the area, reflected in figures for 2018, 123,759 and in 2019, 109.480 tourists, between nationals and foreigners in both years, since there was no management that drives innovation in its methods of marketing, promotion and tourist dissemination that helps the reserve position itself in the market.
- When a comparison of tools is made, in this case of augmented reality, it is important to take into account the applicability that will be given, not all tools are effective in all cases, we must consider the environment and objective of potential users, for this case, it was determined that Unity-Vuforia meets the functional and development parameters, taking into account the advantages it offers.
- With the creation of the augmented reality application, it contributes to the tourism sector, offering visitors services that complement their stay, which will provide you with information you see, to avoid the overinformation they can find on the internet. In addition, this added value generates diffusion among potential tourists and at the same time, generates promotion of the RPFCH, as a collateral consequence of visitors.

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