Mobile application to promote the Malecón 2000 tourism using augmented reality and geolocation

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***Abstract* — In this work, an innovative development proposal is presented with the use of augmented reality to improve tourist motivation in an area of the city of Guayaquil, in Ecuador, known as the "Malecón 2000". A prototype of a mobile application developed in the program Unity on the platform of Vuforia SDK, which allows presenting visual and audible information about different buildings and geolocalized tourist points of the "Malecón 2000". "AG Turismo", is a mobile application that helps to promote the touristic offer of the city, for national and foreign people visiting the place, in this icon area of "Malecón 2000". This development proposal applies a Small Data analysis focused on the accessible information of each georeferenced point, of tourist interest or chosen tourist route, making it accessible from the mobile device through an informative approach with the use of the technologies of environments generated with augmented reality.**

Keywords - Augmented Reality; geolocation; small data; digital tourism.

I. INTRODUCTION

The importance of tourism worldwide has allowed various promotion strategies and, with the use of emerging technologies [1][2][3]. Tourism has managed to improve the development of countries [4][5] worldwide, generating a wide employment rate directly or indirectly[6]. Technological progress incorporates existing innovative resources, specifically the use of augmented reality, AR (augmented reality), which plays an important role in tourism of developing countries [7]. In Ecuador, a considerable number of proposals combine augmented reality, geolocation, QR codes among others, pointing its use [8][9][10][11][12], through innovative strategies to promote tourism potential from different places[13].

The techniques used in large data analysis have allowed us to handle different types of classification about the preferences or tastes that tourists have, when choosing a tourist destination[14]. The support of *small data*, in the analysis of specific data [15] points to a specific area as tourism, allows applying new technological tools to motivate or address the interest or preference in users. Adding the use of mobile devices and technological platforms to achieve it, the incorporation of support tools for the presentation of images with augmented reality is allowed [16].

Generating information in an interactive way, integrating virtuality and multimedia components, through mobile devices, replacing the classic paper guide, is the challenge of experts to be applied as a way of advertising on the network[17][18]. However, having specialized platforms available, the adequate development support and well-trained professionals to promote these technologies in the environment where we are, motivates the creation and development of a mobile application proposal for smartphones. The application presented in this work, reflects information, with which the user can interact with augmented reality, as well as showing, learning and reproducing historical data that, for some national and foreign tourists, are important when choosing a site to visit. The purpose of this work is to promote tourism in the main tourist points of the *"Malecón 2000"* area, in the city of Guayaquil, for local, national and foreign visitors, through the AG Turismo mobile application, created for Android platforms with Augmented Reality, as a way to get tourists to know the cultural heritage in that área, and in turn to increase the number of visitors to the city.

This work contributes to the set of technologies and digital spaces that stimulate and promote tourism in the city of Guayaquil [19] [20] and its attractive and relevant places, it can be a model to be followed by other cities in order to generate new forms of tourism development. The AG Turismo mobile application, created for Android platforms with Augmented Reality, is aimed at an attractive place in the city, such as the Malecón 2000, and allows local, national and foreign visitors, through a mobile device [21] and geolocalization, achieve the presentation of digital information with AR of the cultural heritage and physical structures that are in that sector and that in turn collaborate in the tourist promotion of the city.

II. STATE OF THE CURRENT SITUATION

A. Augmented reality in the tourist area

The augmented reality has taken a revolutionary turn to different fields not only in computing, but in medicine, education, entertainment, information, architecture among others[19][20][21]. In its beginnings it was seen as a good option to experiment new sensations and simulate a virtual world [22], later it appeared a diverse range of platforms in order to propose or create more applications that use the same technology.

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The boom in augmented reality has been growing day by day, improving the hardware structures of personal computers thanks to the implementation of graphics cards, memory capacity and computer accessories, which facilitates a better experience of scenarios with high quality[23].

The emergence of different smart mobile devices allowed users to have quick access to the augmented reality experience (Figure 1). Applications linked to advertising posters, catalogs or magazines, also emerged, and with them new applications and hardware devices, such as glasses or viewers for the user, which especially benefit specific businesses, including those that aim for tourism. Authors consider that the development and use of technologies, such as global positioning systems, geolocation, QR codes, metadata, among others, allow the AR to achieve a unique experience in this sector that is easy to use, distinct and efficient, contributing to the globalization of acceptance in the use of new applications [27][28][29].

Figure 1 shows the prototype of the AG Turismo application that uses AR on an object that represents an iconic building of the city of Guayaquil, metadata are integrated into the 3D object designed.

Figure 1. AG Turismo application from a mobile device

B. Small Data for the analysis of tourist preferences

The strategic use of information allows a specific treatment of all the data obtained, the impact that significant information may have to establish accurate predictions of the tastes and preferences of a client [15]. As in Big Data technology, macro data is used or a large volume of data, for Small Data, we work with small data sets that can be collected by specific applications of massive use, which medium and small organizations require to determine any change in the way of acting and understanding the client.

Objectives that determine the policies of the company or organization are established, so that the relevant information is chosen. Small Data is born as a counterpoint to Big Data, when many companies realize that they do not have the capacity to handle this large amount of information in a massive way.

However, they know that they need structured information in real time to make correct decisions [24].In the travel industry and tourist destinations, there is a set of mobile applications such as mTrip, Kayac, Travel Smart AR, among others, which provide information to users to familiarize themselves with attractive sites and places, integrating technological tools that motivate the tourism experience [31].

Several studies show that tourist preferences go along with the perception given by the information of an offered tourist location [4], and by being provided by tools [32] that improve the user experience, produce a positive effect on the intention to visit the chosen destination [33][34], that is, finding an easy to use tool with RA like this one, positively affects the tourist's preference because of the intention it creates.

C. Digital Tourism nowadays

The area with greater growth is tourism worldwide, because it provides a generous offer and demand and it helps a big number of people, contributing to the economic growth of a country.

Currently, this sector has taken a positive economic turn with the emergence of the Internet [25], incorporating digital marketing strategies in the promotion of a distinctive for the company or its own fingerprint as indicated by several authors [37] [38], it has allowed to introduce new innovations such as web portals, mobile application digital systems, smart database and online businesses into services, helping the emergence of innovative business models, causing a favorable transformation in the tourism chain and advertising.

Mobility, social networks and the internet are key elements to streamline processes and save costs for companies, at the time of disseminating data in a personalized manner based on recommendations [38] [15].

Social networks, such as Facebook or Instagram, among others, are fundamental to make the most of chain advertising, as this is an excellent way for customers to make any comment. It can be a positive or negative comment about their stay, places or more, and share their experiences[26]. Many companies exploit these tools to innovate, provide their customers with new final products and thus increase the quality of their services. In the field of tourism, the competition is based on creating innovative and attractive methods to attract the customer's attention in this way.

Mobile applications applied in tourism offer a great experience to the final user, covering a large structured content of information, which is incorporated with social networks or free download sites for mobile devices.

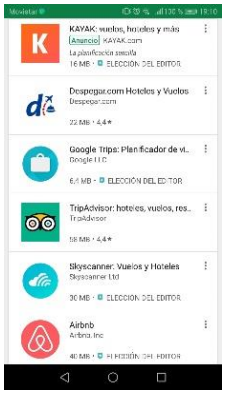

Figure 2. Mobile applications for tourist offers.

III. MATERIALS Y METHODS

This work presents a research work in two parts, the first the development of a mobile application with technological tools using AR. The second one is a study applying the quasi-experimental method through the survey procedure with a quantitative approach.

The mobile application was designed on Unity, which allows the generation of augmented images from a real one. The mobile device allows the process of capture and interaction with the user in the real world. The AR application generates a reproduction pattern by means of a marker image that, when located, projects a three-dimensional modeled object onto the marker image. The development architecture of this work is evidenced in figure 3, with the processing of the captured image and the generation of the augmented image.

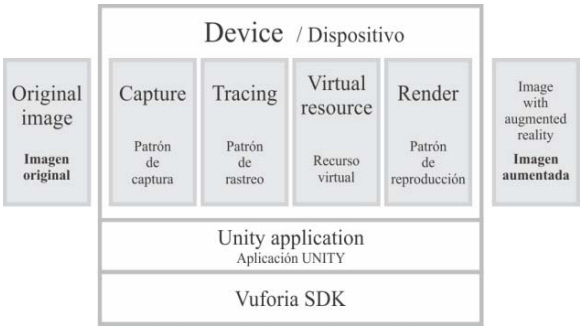

Figure 3. Development Architecture

D. Development Process

Unity with its multiplatform video game engine, allows to integrate different extensions and scripts without occupying many resources, nor memory when generating the final mobile application. The patterns generated by the markers of the captured image (QR), were processed through the algorithm of the extension called: Vuforia SDK, for the architecture of Unity.

Figure 4. *Image Targe*t based on the traditional image of QR code.

Figure 4 shows an Image Target, a reference name that is given to each of the representative images (markers) that Vuforia SDK can capture and track, also known as objective image or pattern image. The Vuforia SDK algorithm is responsible for classifying the patterns of each image of the important monuments that were presented in the application for Android.

E. Methodology

A study was carried out using the quasi-experimental method through the survey procedure with a quantitative approach. The first consultation phase is carried out by means of a survey given to a group of people (randomly selected), specifically, ten tourists located in the Malecón 2000 sector, in May 2018. The set of questions refers to the knowledge of the visitor about the cultural heritage of the Malecón 2000*"*, without having used the "AG-Turismo" application mobile, and the second survey consisted of evaluating the learning that the application granted to that person, after using it.

Figure 5 shows the consolidation of the correct and incorrect answers of the interviewees who participated in this phase:

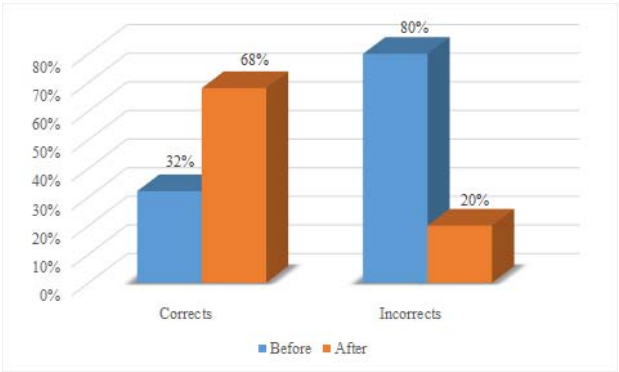

Figure 5. Results before and after using the "AG-Turismo" application

It is determined that before using the "AG Turismo" application, they had a lower percentage of remembering the important places of the *"Malecón 2000"*. It was observed that without the application there were more incorrect answers than after having used the application with augmented images, the interviewee managed to retain the image of the place with a greater retention in his memory.

As a second phase, it is surveyed online through the service called Google Forms, to 404 students from different engineering careers of the Polytechnic Salesian University, making a set of questions about the experience with the AR technology in the application. Through a poster (Figure 5), and with the prototype of the AG Turismo mobile application downloaded on a smartphone, the AR application allows an object on the poster, after positioning the mobile device, to be projected in 3D and presenting information in audio and / or video depending on the need. The development of the mobile application proposal was designed on the Android operating system due to the large number of users of it on their smartphones.

Figure 6 shows the referential poster of *"Malecón 2000"*, with the nine objective images on the specific geographic location of each one of the monuments and representative places of *"Malecón 2000"* for our research work. The geographical map was obtained from the Google Maps web application and it was edited in Macromedia Fireworks for resolution of 1200 x 2430 pixels in the original image.

Figure 6. Demonstrative Map with name and logo.

F. Development and Implementation of the project

The development of the "AG-Tourism" application began with the development of a database using Vuforia SDK, which includes 9 master images for the implementation of augmented reality. Each Pattern Image has an augmented reality rating for the value of up to five stars, this process is known as Target Manager. Figure 7 shows a Target Image with its respective adapted characteristics, therefore, the more features the pattern has, the higher the augmented reality score is, and in this way, a better response time is achieved for the recognition of the original marker image.

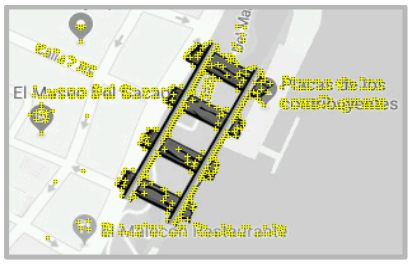

Figure 7. *Target Manager example* showing some features.

It is decided to put into practice three types of image selection to assess the score.

●By area: A portion of the original image of the area located on the map is taken.

●By logo: The original image is edited, and a corresponding logo is added to the established tourist place.

●By name and logo: The original image is edited, and a logo and the corresponding name is added to the established tourist place.

IV. SAMPLES ADQUISITION

G. Development tools

There are several types of multiplatform software that support generating the desired final application. Each software can have several add-ons or extensions, which allow relating them to the software, depending on the platform, in order to obtain a new purpose that the previous tool did not have in its default version. On table 1, Software and extensions applied in this Project are shown.

TABLE I. SOFTWARE AND EXTENSIONS APPLIED IN "AG TURISMO" APPLICATION.

Software	***Extension/Addons***
Unity 2017 64-bits	UnitySetup-Vuforia-AR-Support for-Editor-2017.3.1f1. Autofocus Script. Main Menu Script.
Vuforia SDK	AR Camera. ImageTarget. Target Manager. License Manager. logos.unitypackage.
Android Studio 3.0.1 64 bits	Android SDK Platform 27. Android API 27. Tools_r25.2.5-windows.
Java 64-bits	JDK Manager Jdk-8u161-windows-x64.
Visual Studio 2017	Visual Studio Tools for Unity Package
Google Maps	Default.
SketchUP 2018	Default.
Macromedia Fireworks 8	Default.

The choice of tools was initially based on four criteria: cost, integration, support and performance. From the very first moment of the development of the prototype. This allows taking into consideration in subsequent works, considering the ISO / IEC 25010 quality of the software product considering its quality characteristics [40].

H. Mobile Device Application

Using the Unity 2017 software, the mobile application called AG-Turismo.apk for Android is generated. This application was generated with two different scenes. Each scene represents a different instance or level within the final mobile application.

1. Scene Zero (0): Contains the application menu.
    a. Camera AR.
    b. Quit
2. Scene One (1): Contains the main scene and the models that represent the tourist places in *"Malecón 2000"*.

Once all the scenes have been finalized, each one is added in order of appearance, in the Build Settings option within Unity 2017, and also adapt the settings of Android for the construction of the mobile application. It is recommended to check the External Tools option, within the Preferences menu, to ensure the correct path of both the SDK and JDK, Android and Java respectively. Unity software is a graphical engine that allows developing simulations and video games in second and third dimension for several platforms such as Nintendo Wii U, PlayStation, Xbox, PC, Android, IOs, among others that we can find through its architecture editor.

Figure 8. Unity graphic interface showing AG-Turismo menu.

The Vuforia tool is a group of libraries that has the facility to generate a final application that uses and supports augmented reality. Vuforia specializes in the recognition of pattern images, after capturing it, rendering some type of model within its database and transforming the standard image into an enlarged image.

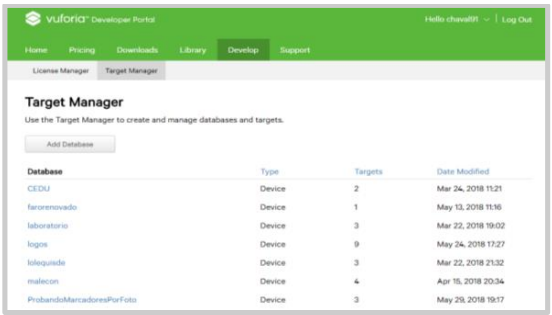

Figure 9. Vuforia Developer Portal of AG-Turismo.

I. Modeling in 3D.

An essential part of the desired final application is to show a virtual three-dimensional object referring to the tourist place indicated on the map, using the camera of the mobile phone. Figure 10 shows some examples of final three-dimensional models, in order to achieve this effect, you need to model, or make a visual schematic representation through a set of objects and properties, which when rendered, will be transformed into a 3D modeling, that in this case, in a tourist point of *"Malecón 2000"*.

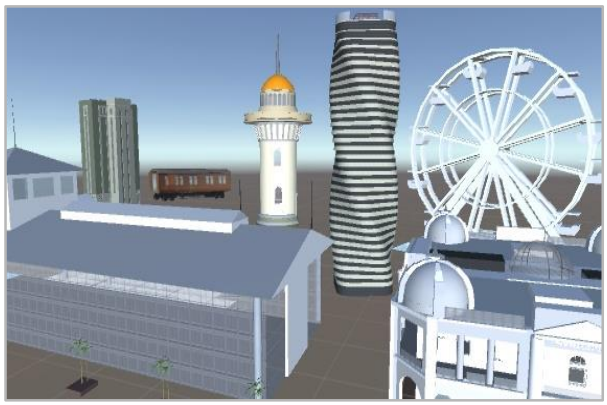

Figure 10. Three-dimensional models of the "Malecón 2000".

There are several software for 3D modeling, which allow a simple creation and edition of three-dimensional objects. Sketchup 2018, allows the design and modeling of 3D very easy to use, used by many architects, decorators, builders, engineers, carpenters managing to shape the physical world. Sketchup has the necessary tools to capture your idea in an intuitive and easy way. Sketchup is used in this work to create 3D models of the nine structures that the Malecon has, because it allows to export and share the object and its characteristics. Sketchup has many innovations and features that make it stand out from others, especially the final rendering of small size, when the final model is exported, it creates a compressed file ready to be used as a resource for Unity, without using too much memory of the mobile device.

J. Georeferencing of buildings

The technique of spatial positioning, known as Geo-referencing is used as a process of the application, to locate a point in reference to the center of the Earth, and its purpose is to represent either on a map or over time any type of information that can be attached to a position with georeferenced coordinates.

Table 2 shows the geolocation of the *"Malecón 2000"* buildings with their latitude, longitude and distance to the next objective image. When being closed to or around the geographical location of any of them, the "AG-Turismo" application mobile will show the name of the building in 3D Text Model format.

TABLE II. GEOLOCATIÓN OF MALECÓN 2000 BUILDINGS

Name of the place or building in "Malecón 2000"	*Latitude*	*Longitude*	*Distance (m) to the next Image Target*
The Point Building	-2.1863822	-79.8764175	307.40 m
Malecón 2000 Lighthouse	-2.1809938	-79.8758694	609.20 m
Noria La Perla	-2.1864176	-79.8781043	196.15 m
Jardines del Malecón	-2.1874351	-79.8772799	401.25 m
Banco Bolivariano	-2.1899334	-79.8798941	302.08 m
Hemiciclo La Rotonda	-2.1925449	-79.8793522	283.13 m
Municipalidad Gye	-2.1947823	-79.8804256	215.93 m
Morgan Ship	-2.1967576	-79.8825517	500.08 m
Cristal Palace	-2.2008109	-79.8823650	000.00 m

V. RESULTS AND DISCUSSION

One of the fundamental purposes of Augmented Reality is to immediately capture the recognition pattern and superimpose the object or model in the real world using the camera of a device and achieve the desired virtualization. For an optimal recognition of the standard images, a study was carried out, in order to understand the evaluation algorithm offered by Vuforia SDK on the characteristics of each standard image. The type of recognition image selection was put into practice, and the variation of the score of each selection is demonstrated. In each image selection, the platform throws a certain amount of different characteristics.

Table 3 shows Vuforia process and evaluation of the different types of image selection, and it was demonstrated that, for an excellent and optimal recognition of a standard image, the type of selection by name and logo, is the ideal one for our prototype of mobile application.

TABLE III. VUFORIA VALIDATION TABLE BY TYPE OF SELECTION

Image selection	Vuforia SDK Validation of Augmented Reality by number of features				
	1 Star	*2 Stars*	*3 Stars*	*4 Stars*	*5 Stars*
By área	35	62	80	115	150
By name	50	75	110	140	190
By name and logo	60	79	113	145	350

Consequently, in the sample map extracted from Google Maps, 2 types of image selection will be inserted, 44% of Image Target will be made with type of selection by name, and the remaining 56% will be made with type by name and logo referring to each of the tourist places entered in the application.

TABLE IV. TARGET MANAGER OF VUFORIA USED IN AG-TURISMO

Name of Target Image	*Type*	*Selection*	*Features*	*Score*
The Point Building	Single Image	Name and logo	355	5 Stars
Malecón 2000 Lighthouse	Single Image	Name and logo	346	5 Stars
Noria La Perla	Single Image	Name and logo	172	4 Stars
Jardines Del Malecón	Single Image	Name and logo	351	5 Stars
Banco Bolivariano	Single Image	Name	180	4 Stars
Hemiciclo La Rotonda	Single Image	Name and logo	351	5 Stars
Municipalidad Gye	Single Image	Name	183	4 Stars
Morgan Ship	Single Image	Name	185	4 Stars
Cristal Palace	Single Image	Name and logo	348	5 Stars

In the final phase of this work, the prototype of the application was released for evaluation, a survey was taken to 404 people who had access to the web, the result of the experience when using our application is shown later in this document. Figure 11 shows how convenient the developed application is, 90% of the interviewees said that it has been easy to use it.

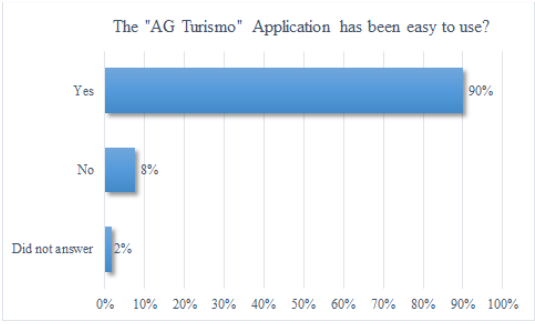

Figura 11. Question No. 3 of the survey regarding the use of the mobile application and the user experience

Figure 12 shows the percentage of interest, which users had with the application at the time of interaction with it, and how useful was the information provided by the application. 89% of those who took the survey said that they have been motivated by the information offered in its different formats.

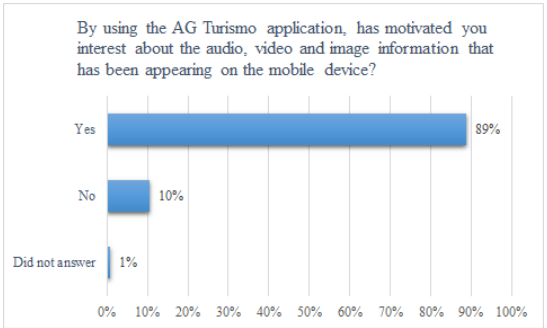

Figure 12. Question No. 4 of the survey that shows interest in the content selected for its use.

The following figure shows the opinions that users had about the mobile application, evaluating its most outstanding features, such as: the information of the found objects.

From the characteristic, information of the application, in figure 13, it is shown that 33% of the participants, indicate that the presentation is adequate, 32% indicate that is complete and 19% indicate that is consistent, being the most outstanding percentages for the application.

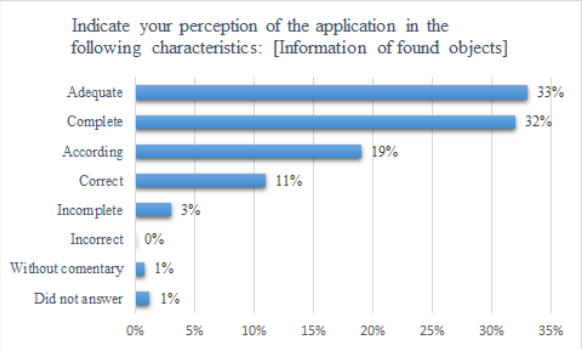

Figure 13. Question No. 6.2 of the survey, shows the perception of the user from the characteristic of the objects information found in the application.

In figure 14, we can observe the results about the opinion that the application promote the interest of tourists in visiting the Malecón 2000, the results show 51%, that is to say, that half of the interviewees see the possibility that the application could contribute in the promotion of tourism of this area of the city and with it the increase of tourists.

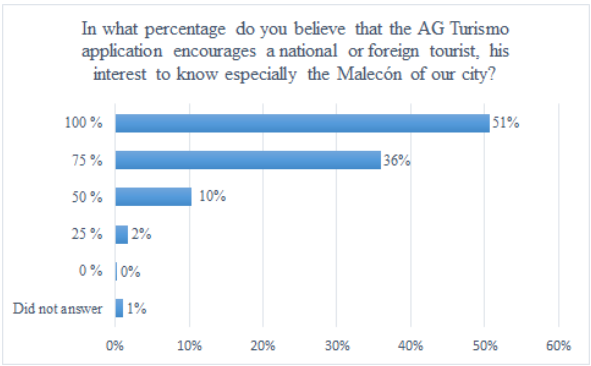

Figure 14. Question No. 7 of the survey, indicates the percentages of the different opinions of the tourist, regarding how the AG Tourism application would promote tourism in the sector.

Finally, in Figure 15, the opinion of the interviewees about the "AG Turismo" application is shown, and it shows that 50.74% indicate that this application is innovative in our environment, so it is considered in a way that meets the objectives for which it was developed. 11.88% indicate that the application is a mobile application that can create new opportunities for jobs which can be direct or indirect, and it opens a possibility for local development, thanks to the contribution that the application achieves in the people who observed the presented work.

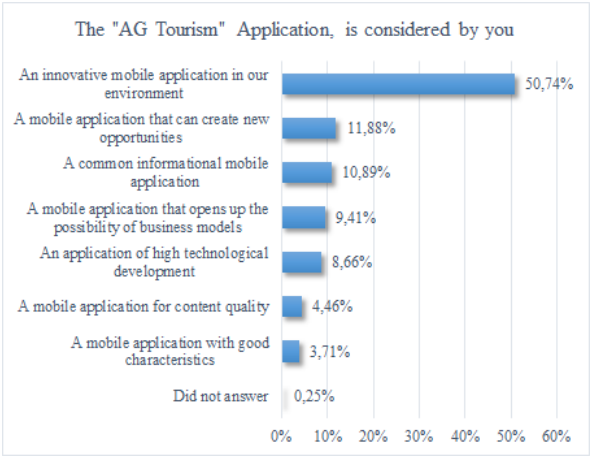

Figure 15. Question No. 10 of the survey, opinions of how the interviewees consider the presented application

It is important to indicate that the people surveyed have a degree of motivation to know attractive touristic places that would allow them to know more about cultures, heritage and history, and the AG Tourismo application, is a potential interaction tool that contributes strongly in this promotion.

VI. CONCLUSIONS

This article presents a prototype of a mobile application to promote tourism in a specific place in the city of Guayaquil, Malecón 2000. The prototype shows that the application provides users with a pleasant knowledge of the attractive places, structures and / or tourist spaces thanks to the acceptance of AR technologies, promoting a preference in their use. In addition, the mobile application promotes the knowledge of the objective touristic point and achieves a favorable experience on the part of the user when having an acceptance reaction from them when using new technologies. Increasing the knowledge on the part of the visitors thanks to the mobile application AG Tourismo will allow the increase of the number of visitors to the place. The augmented reality technology used is fundamental for the elaboration of 3D designs integrated with metadata, allowing the information of the cultural heritage of the Malecón 2000, to be presented with structured information promoting a tourist interest.

Mobile technologies with digital tools allow the application to innovative strategies for different sectors of development in a country, this work focuses on the tourism sector. The mobile application AG Turismo, manages to be a project model which using AR and geolocation can be applied in other sectors in order to impulse or motivate the population included in this study. Areas such as construction, real estate, medicine or education, can be the objects of study where the technological tools used in this work develop and facilitate the improvement of creative ideas to develop the way of presenting the information required in different stages. The augmented reality in mobile applications becomes striking on the part of the user who, by joining it with a topic of interest, such as digital tourism and geolocation, manages to attract the attention of many people.

Innovation is an important engine in the field of tourism; the appropriate improvements that a service provides are more attractive if they are facilitated with the help of technological tools that improve the relationship between the experience and the user.

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