UNIVERSITY OF MACEDONIA

School of Economic and Regional Studies

Department of Economics

Bachelor Thesis

The Role of Augmented Reality in Tourism Sector: Mobile AR App for Cultural Heritage Monuments

Author: Maria Karagianni
Eco19129
Supervisor: Prof. Economides Anastasios

Thessaloniki, February 2023

Acknowledgements

First and foremost, I would like to express my sincere gratitude to my supervisor Prof. Anastasios Economides for his invaluable guidance and support that led to the substantial improvement of this paper, as well as for his interesting lectures and assignments during my undergraduate studies that inspired me to identify my inclinations. Furthermore, I would like to thank Prof. Theodore Panagiotidis for accepting the position of second assessor in this thesis, as well as Mrs. Theano Hatzidaki for the technical skills she helped me to acquire through her laboratory courses.

I'm also thankful to my friend and colleague Konstantinos for his unparalleled support and feedback during the preparation of this thesis. Likewise, I'm deeply grateful to my family and my friends Betty, Marialena and Theodora for being by my side and encouraging me during my undergraduate journey.

Lastly, I would like to acknowledge the valuable help of all people who participated in the survey and expressed their genuine opinions on the topic, as without them this paper could have never been accomplished.

Maria Karagianni

Table of Contents

List of Figures

List of Images

List of Tables

1. Abstract

The increased usage of mobile phones and continuous access to internet has influenced, among other things, the travel habits of the modern human, increasing his knowledge and demand. Therefore, in order to remain competitive, it is imperative that tourism sector businesses and organizations incorporate new technologies. One such technology is that of augmented reality (AR). This research intends to investigate the impact of AR applications on the visitor experience of cultural heritage sites and the willingness to pay for such a service. This is sought to be achieved through the research strategy of Case Study for Culture App, an augmented and virtual reality travel app for tour guides and cultural travelers. Specifically, the research is based on the showcase of Culture App for Olympieia monument in Greece and people's observations after watching related material. Data collection was achieved through questionnaires and a total of 236 observations was gathered. The study finds out that the more familiar with technology a user is, the more useful he finds an AR app and the more important interest he develops for the monument. This leads to him being also more encouraged to visit a monument that has such an app available, compared to a monument that has not. Willingness to pay was not found correlated with any of the variables leading to doubts about the accuracy of the answers in this field or even thoughts about the use of the app as a way to attract more visitors and not a direct source of revenue. By analyzing participants' answers to open-ended questions, a positive impression of the app was indicated, while the disadvantages and suggestions about further functionalities that participants suggested, unfold new opportunities for further improved designs of AR applications in tourism sector.

Keywords: Augmented Reality, AR, Virtual Reality, VR, Tourism, app, Cultural Heritage, Archaeological Sites

2.   Introduction

When it comes to developed countries, the tertiary sector, i.e. services, constitutes the heart of the economy as it is growing rapidly and represents the largest share of gross domestic product. In most cases, this growth is achieved through the tourism sector, which is the most important service category. However, in addition to direct effects such as stimulating growth and increasing GDP, tourism is also responsible for other indirect benefits such as the revitalization of cultures and the preservation of traditions (Gursoy et al., 2002; Ko and Stewart, 2002).

In the case of Greece, it is widely known that tourism services are an extremely important component of the economy. According to the World Travel and Tourism Council, the total contribution of tourism services to GDP amounted to 20.8% for the year 2019, before the devastating effects of the COVID-19 pandemic, with total inbound tourism revenues reaching €17.7 billion. (World Travel & Tourism Council (WTTC) | Travel & Tourism Representative Council, n.d.) In addition, 21.7% of total employment, was also held by the tourism sector and served 31.3 million tourist arrivals. In 2021, the tourism sector in Greece faced a rebound, as the number of arrivals and the sector's revenue reached 55% and 43% of the 2019's numbers respectively, which is the reporting year. The dynamic rebound continued on 2022, while it is quite important that the rebound was also observed in non-peak periods such as September and October (EY, Industry Pulse Report: Travel & Tourism). At the same time, a total of 1,154 monuments have been inscribed on UNESCO's World Heritage List, located in 167 different countries around the world. Greece is among the countries hosting a - relatively to the country's size - large number of them, with 18 monuments concentrated in the territory of the country (UNESCO World Heritage Centre, 1992-2023).

Nowadays, technology has become an intimate part of people's everyday life. The usage of internet and smart mobile devices on a daily basis has had a significant impact on the way modern man communicates, socializes, entertains and acquires information (Wang, Kim, Love, & Kang, 2013 cited in Cranmer, 2019). As a direct consequence, the use of technology affects, among other things, their travel habits. The increased usage of mobile phones and the instant internet access has radically changed the tourism industry, creating many benefits, allowing visitors to search for tourist information, purchase products and consume tourism services at great ease. Meanwhile, many challenges are arising for tourism businesses raising the urgent need to find new methods of operation. Competition is now more intense than ever, and several factors have created a different type of traveler, more dynamic, demanding, and informed. It appears, therefore, imperative for tourism-related businesses to react and adapt immediately to the demands of modern reality, in order to remain competitive and continue to attract visitors (Jung & tom Dieck, 2017 cited in Cranmer, 2019). As has been articulated, tourism organizations should incorporate technologies that will bring additional value to the tourism experience in order to remain competitive in the future (Carlsson and Walden, 2010; Cranmer et al., 2016; Deloitte, 2013).

One such technology that could be used by businesses and tourism organizations is augmented reality. Augmented reality is a technology that introduces digital objects into the real world in real time. It is a type of reality-based interactive environment that uses the capabilities of screen, audio, text, and computer-generated effects to enhance the real user experience. "Gartner Inc" is a US technology research company that conducts and publishes annual surveys. According to Gartner Inc, augmented reality technology appeared in the hype cycle of emerging technologies from 2005 to 2018 as one of the top emerging technologies. From 2019 it stopped appearing on these charts, indicating its maturity (Herdina, 2020). The increase in computing power and consequently the maturation of this technology leads to a reduction in barriers to entry, making it now ready to be used by the wider market, improving business processes, and bringing innovation to modern 'business'.

Figure 2.1: Augmented reality evolution in the Gartner Hype Cycle from 2005 until 2020. Produced by Wikitude.
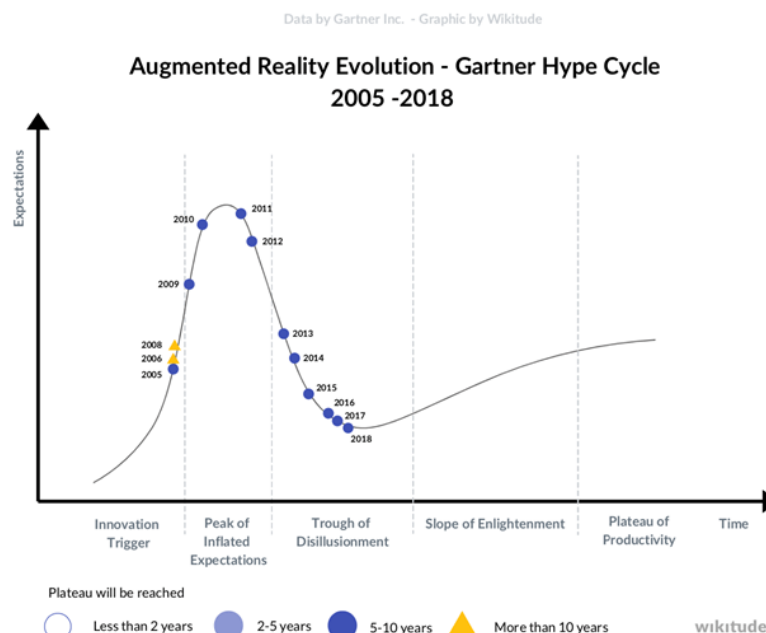
For all the above stated reasons, this paper is attempting to investigate the behavior of the modern traveler and specifically his/her reaction to efforts to integrate augmented reality applications in cultural heritage monuments. The aim is to investigate both the added value that this technology creates to the experience of tourists as well as their willingness to pay for it and thus the possible effect on the revenues of the relevant organizations.

3.   Literature Review

The purpose of this section is to explain the concepts of augmented and virtual reality and to provide a clear overview of how this technology works, through the existing literature. In addition, the implementation of this technology in tourism sectors and the benefits that can be gained by the relevant organizations are examined.

3.1. Augmented Reality Definition

According to Furht & Carmigniani (2011) "Augmented Reality (AR) is defined as a real-time direct or indirect view of a physical real-world environment that has been enhanced/augmented by adding virtual computer-generated information to it". Milgram's Reality-Virtuality Continuum, which is depicted in the following figure, is defined by Paul Milgram and Fumio Kishino as a continuum that extends between the real and the virtual environment. Augmented Reality and Augmented Virtuality (AV) stand in between the two edges, with AR being closer to the real world and AV standing closer to a strictly virtual environment.

Figure 3.1: Milgram's Reality-Virtuality Continuum
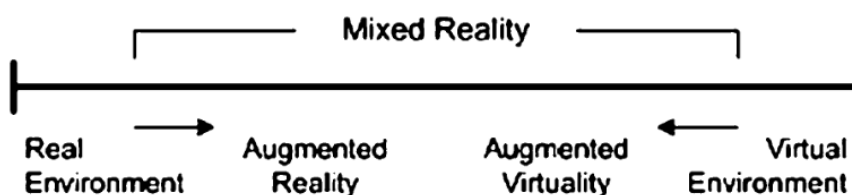
3.2. Augmented Reality and Virtual Reality

Virtual Reality (VR) is also a popular technology that provides users with an interactive, virtual environment. However, as a main drawback remains the fact that VR has no association with the real world and the surroundings, as it requires complete absorption in the simulated environment (Kounavis et al., 2012). Therefore, a crucial point in which AR and VR technology differ is the connection with the real environment. On the one hand, VR creates a whole digital world with exclusively virtual components such as an environment, characters (avatars) and the user gets fully absorbed in it. On the other hand, AR attempts to implement digital elements in the user's real perception of the environment, by adding layers of information in order to assist him in gaining a better understanding of what he sees (e.g., AR for archaeological sites), guide him in an unfamiliar place (e.g., AR tour guides) or even help him in his decision to buy products online that otherwise would not decide to buy easily (e.g., AR in retail, try on eyewear frames, lipstick color, accessories via camera). Consequently, as in AR, virtual elements attempt to increase the value of what the user perceive of the real environment, what matters the most is

the information content. Due to this, using an AR system typically involves retrieving information rather than manipulating or editing virtual content (objects), as is the case in a normal VR or 3D CAD environment (Wang et al., 2013).

3.3. AR Technology - How it works

In Augmented Reality (AR), digital information is being superimposed into a mainly real-world projection as an overlay of computerized information (tom Dieck & Jung, 2015). Its development has been aided by marker-based localisation toolkits (e.g. ARToolkit, ARTag), which are used to determine tracking and registration (where digital content will be shown) and media content (what digital content will be shown) (Wang et al., 2013). When it comes to AR applications in tourism, it is very common that they are either location-based or marker-based. In Location-based AR, a gyroscope and a GPS system helps to identify the location and direction of the user, and afterwards information about the user's surroundings are being presented (Han et al., 2018). On the other hand, marker-based AR uses a Quick-Response (QR) code system, that user has to scan in order to access information (Emaldi, Lázaro, Laiseca, & López-deIpiña, 2012 cited in Han et al., 2018). The types of media that the real environment can be augmented with, may be text, symbols, indicators, 2D image/video, 3D wireframe, 3D data, 3D model, and animations. Moreover, a hybrid representation is when more than one types of media are used together in the same display (Wang et al., 2013).

The type of content being displayed can be divided into acoustic, visual, tactile, etc. Virtual graphic objects and overlays have been the primary focus of almost all applications of augmented reality until today. However, all other senses might also be enhanced through this technology. For instance, in the case of auditory displays, computer-generated signals are being combined with the original sounds the user hears in the real environment (Wang et al., 2013). Wang et al. (2013) also mention that "Haptic displays (that is, information pertaining to sensations such as touch and pressure) are typically presented by means of some type of hand held master manipulator (e.g. Brooks, et al. or more distributed glove type devices (Shimoga)."

The devices needed for AR technology are called displays, input devices and tracking. As for displays (also mentioned as "output mechanisms" – Wang et al., 2013) they can be head mounted (HMD), handheld and spatial (Furht, 2011). HMD devices are worn on the head (e.g., helmet or glasses) and combine real and virtual elements in the user's perspective. On the other hand, handheld devices are "small computing devices" that users can keep with hands while virtual graphics are being superimposed on the real environment by "video-see-through techniques" (Furht, 2011). In order this process to be achieved, different types of tracking sensors are being used, such as digital compasses and GPS. Examples of handheld devices used for such reasons are smartphones and Tablet PCs. Lastly, Spatial Augmented Reality (SAR)- as evinced by its name – makes use of larger spaces, and the tracking technologies it may use, varies from video-projectors and holograms to radio frequency tags. This enables users to have access to the AR technology without wearing or carrying a display device being necessary (Oliver Bimber, Ramesh Raskar, Masahiko Inami, "Spatial Augmented Reality", SIGGRAPH, 2007 Course 17 Notes, 2007). Devices used for tracking are -among others- digital cameras, optical sensors, GPS,

accelerometers, compasses, and wireless sensors. The level of accuracy depends on which technology is used (Furht, 2011). Wang et al. (2013) claimed that "Accurate registration and positioning of virtual objects in the real environment require accuracy in tracking the user's head as well as sensing the locations of real objects in the environment. The biggest single obstacle to building effective AR systems is the requirement of accurate, long-range sensors and trackers."

3.3.1. Mobile Augmented Reality

Mobile Augmented Reality (MAR) as a term was firstly introduced in the mid-1990s, when augmented reality (AR) was adapted to mobile interfaces. MAR begins with the actual environment and attempts to augment it by superimposing digital items on top of the real world, rather than creating a completely virtual representation (Kourouthanassis et al., 2015). Therefore, MAR is a relatively recent developed technology that enables new capabilities for interactivity between the app and the user, aiming to enriching user's experience (Bolter et al., 2013, cited in Kourouthanassis et al., 2015). Users have the opportunity to see a vivid picture of the real world enriched with digital observations, graphics, and other information, through a device such as a smartphone or a tablet, by simply opening the camera and tending the device towards a specific point of interest (POI) – in our case historical monument. The type of information that is being superimposed, varies from "names of buildings visible on the skyline" (Kourouthanassis et al., 2015) - or historical data in the case of cultural heritage monuments - "to real- time alerts about location and current events such as menu discounts in restaurants" (Kourouthanassis et al., 2015). Consequently, the fundamentals of augmented reality are applied in the features of MAR-enhanced systems: they integrate real and virtual objects in a real time, interactive environment, and associate real and virtual elements with each other (Azuma et al., 2001, cited in Kourouthanassis et al., 2015). This process has an immediate effect on reducing multi-tasking and decreasing distractions (Liu et al., 2012). As a logical consequence, industry experts are attempting to implement this technology in their operations.

3.4. Use of AR in Tourism and Cultural Heritage Monuments' Branding

Digital transformation is the process of using digital technologies to create new — or modify existing — business processes, culture, and customer experiences to meet changing business and market requirements. This reimagining of business in the digital age is digital transformation (What Is Digital Transformation?, accessed 2023).

According to Kotane et al., 2019,

> *"Digital transformation does not refer to only digital technologies, it involves the integration of digital technologies into all areas of entrepreneurship, which contributes to significant changes in enterprise operation and generates value added for consumers. Digital transformation also affects the development and application of digital marketing instruments." (Kotane et al., 2019).*

At the same article, a thorough research regarding the development trends of digital marketing has been conducted through the research methods of monographic descriptive method, analysis, synthesis, and statistical methods based on scientific publications, statistics, and other sources of information. The authors come to the conclusion that in the year 2019 digital marketing tools that are most "actively used" were artificial intelligence / augmented reality / machine learning; video marketing; chatbots, virtual assistants (Kotane et al., 2019). Therefore, as augmented reality is becoming more and more approachable, it is the right time to consider its role to the digital transformation of the tourism industry. For instance, AR travel guides keep appearing on the market, attempting to provide access to travel-related information to tourists during their visit, displayed in a multimedia-rich way (Kourouthanassis et al., 2015). As cited in Huertas & Gonzalo (2020), according to various studies, AR applications have the ability to enhance the tourist experience (Jung et al. 2015; Leue et al. 2015; Yovcheva et al. 2013), create additional value to heritage (Cranmer et al. 2016; tom Dieck and Jung 2017; Tscheu and Buhalis 2016), and also increase the economic value of a destination. Since travel and leisure are considered as "intangible goods that are consumed on an ad hoc basis", efficient presentation of travel content is crucial not only for the travelers, but also for tourism industry stakeholders themselves (Kourouthanassis et al., 2015). One way that augmented reality (AR) can help professionals in the tourism industry and tourist organizations reach a wider audience is through the usage of appealing multimedia content and mobile applications that are tailored to a variety of knowledge levels. These kinds of information systems are able to customize the way multimedia content is delivered based on the characteristics of the user and the use context, which makes it possible to use them in a variety of situations (Kounavis et al., 2012). Because information can be organized and transmitted in layers or upon request, AR can significantly assist museums, heritage sites, cities, and tourist professionals in general (Kounavis et al., 2012).

These positive aspects that AR technology can bring to the tourist experience should also be communicated to decision makers of organizations concerning cultural monuments, or city administrations, the so-called stakeholders. As cited in Cranmer (2019), as a stakeholder in tourism industry is identified "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Sautter & Leisen, 1999, p. 313). It is quite important for stakeholders to understand the visitors' needs and perspective so as to express a complete opinion on the design process of a technology that is intended for use by the people they aim to attract.

4. CultureApp: An augmented and virtual reality travel application for tour guides and cultural travelers

Culture App is a travel mobile application managed by the Greek company under the name "Digital Culture Monuments DCM IKE", which is activated in the field of providing services to tour guides and visitors of archaeological sites and other historical monuments and buildings. It is currently available for free download in both App Store and Google Play Store, and the content is available in two languages – English and Greek. The app is attempting to bring the past to life through the implementation of AR technology, as well as 3D representations, enabling digital tours of archaeological sites in Greece. Those technological tools, accompanied with current illustrations and historical information are displayed on platform and on application in order to achieve a true visitor's experience enhancement, either by physical presence or remotely (CultureApp - Brings Cultural Heritage to Life, n.d.).

4.1. Description of User's Interface

Upon launching the application, a map of Greece is displayed, on which users can zoom in and out, while location symbols indicate a specific point of interest (POI). Users can also choose between 6 different map styles including Satellite view, Physical, Watercolor, terrain 1&2 and Voyager.

Image 4.1: Menu that appears when launching CultureApp
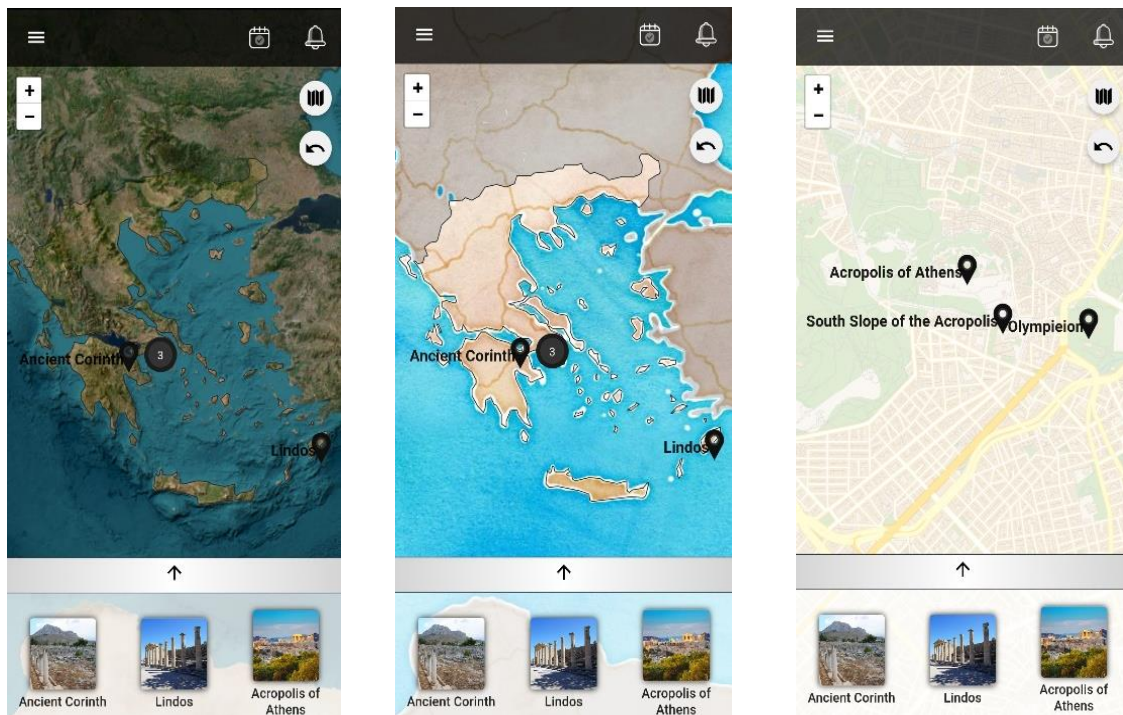
Below the map there is a menu, which allows user to scroll left and right and select the monument he/she is interested to navigate in. Alternatively, this same menu can be dragged upwards to display more information about the available monuments as shown in the images.

Image 4.2: Menu of CultureApp with all the available archeological sites
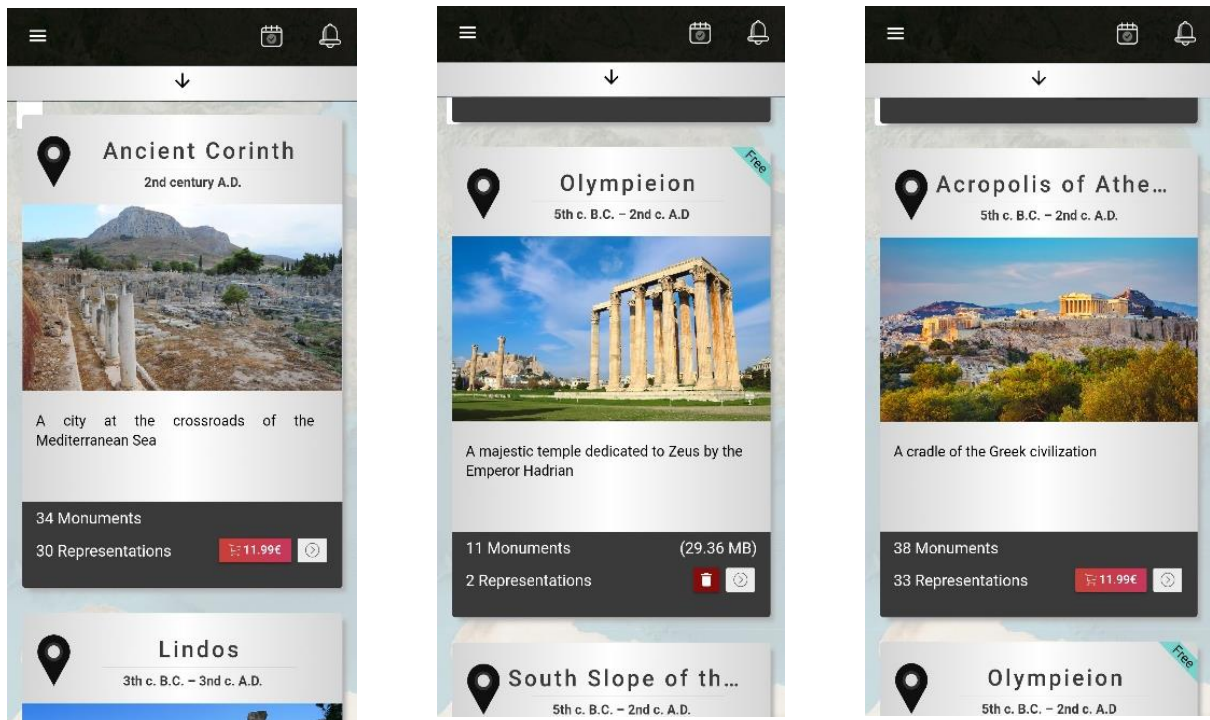
For the time being, the app provides users with the opportunity to explore five different archeological sites located in the Greek territory as follows:

Table 4.1: Archeological sites that are available in CultureApp

Archeological Site	Short Description	Time Period	Num of Monuments	Num of Representations	Price
Ancient Corinth	The rich and powerful city of Corinth at the crossroads of the Mediterranean Sea	2nd century A.D.	34	30	11.99 €
Lindos	The great sanctuary of Athena and the island of Rhodes	3th c. B.C.- 3nd c. A.D.	20	14	11.99 €
Acropolis of Athens	The virtual surroundings of the Sacred Rock of the Acropolis	5th c. B.C – 2nd c. A.D.	38	33	11.99 €
South Slope of the Acropolis	The foothills of the Acropolis, adorned with glorious public buildings and monuments.	5th c. B.C – 2nd c. A.D.	29	12	11.99 €
Olympieion	A majestic colossal temple dedicated to Zeus by the Emperor Hadrian	5th c. B.C – 2nd c. A.D.	11	2	FREE

After selecting a specific archaeological site, a panoramic contemporary image of the site and a map with the various specific monuments of the site are visualized. At the bottom left of the screen there is a button that the user can use to alter the panoramic image from present to past and vice versa. In addition, there are labels indicating the names of each monument, which users can click on to be transferred to the rest of the tools and learn more information about them.

Image 4.3: Menu after selecting an archeological site - Map and 360 View of the past as well as present
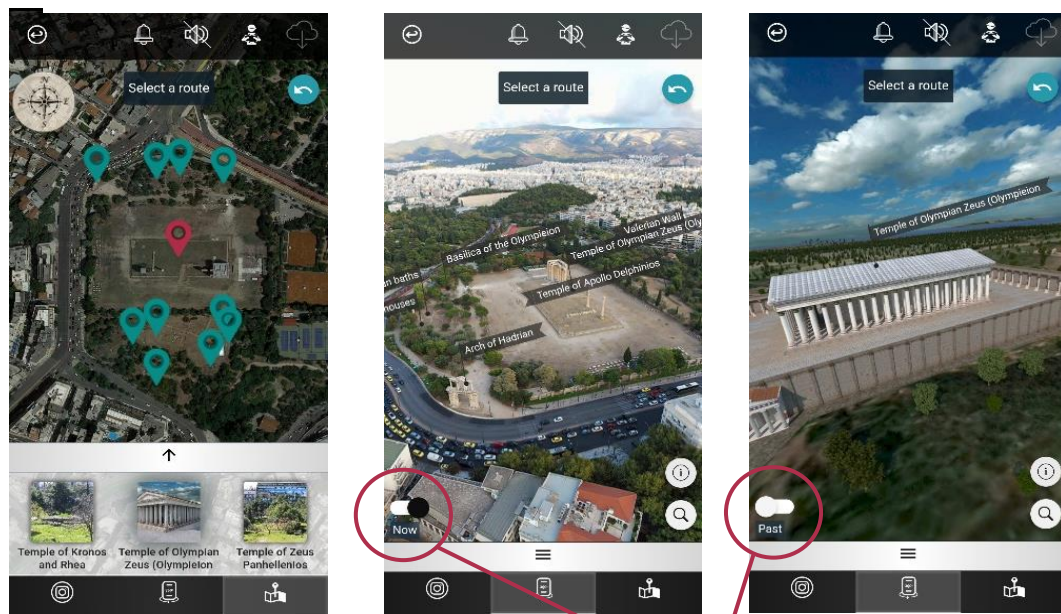
Button to switch panoramic image to present/past

4.1.1. App Tools

Once a specific label is selected, the app provides the below list of tools for most available monuments:

- **Camera AR View:**
  Tool that allows visitors to turn on the camera of their smartphone and point the device in the direction of the monument. The app augments the real picture received from the camera with digital elements and offers visitors the opportunity to see the appearance of the monument in past, in its primary form.

- **360° View in comparison to present photos:**
  Panoramic photos of present situation of the specific selected monument of the archaeological site and the around area, real photographs of the monument in the current era, as well as panoramic representation of the monument and the around area in past.

Image 4.4: Screenshots of the tool "360 View" in comparison to present photos
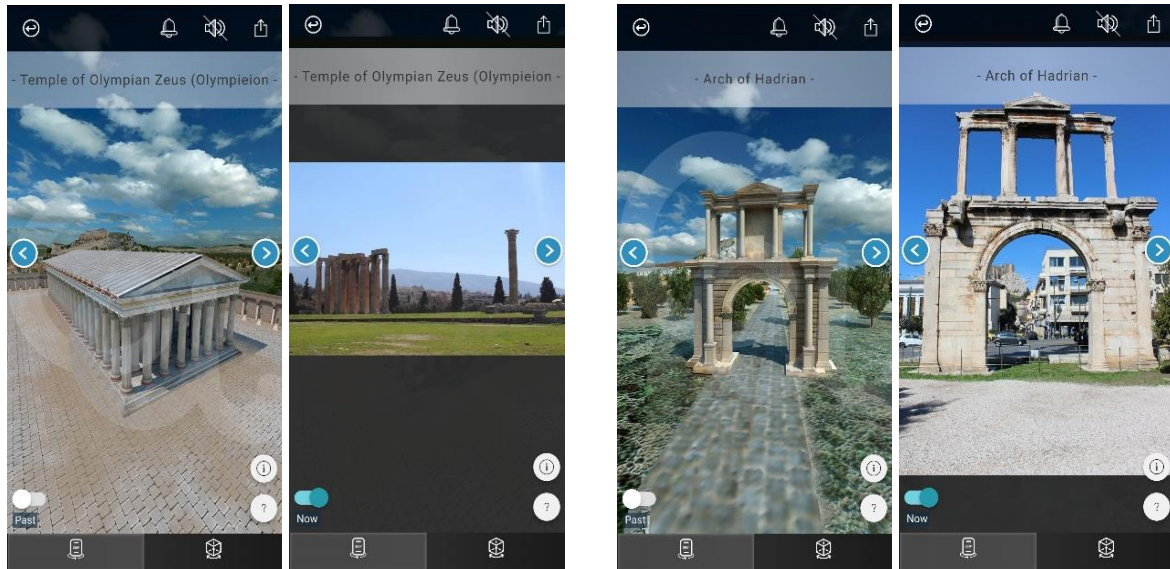
- **3D models**:
  App users can view three-dimensional representations of the structures in their primary form. There is also the capability to zoom in and out in order to observe details, as well as shift the angle of view to see, for example, a floor plan of the structure.

Image 4.5: Screenshot of the tool "3D representation"
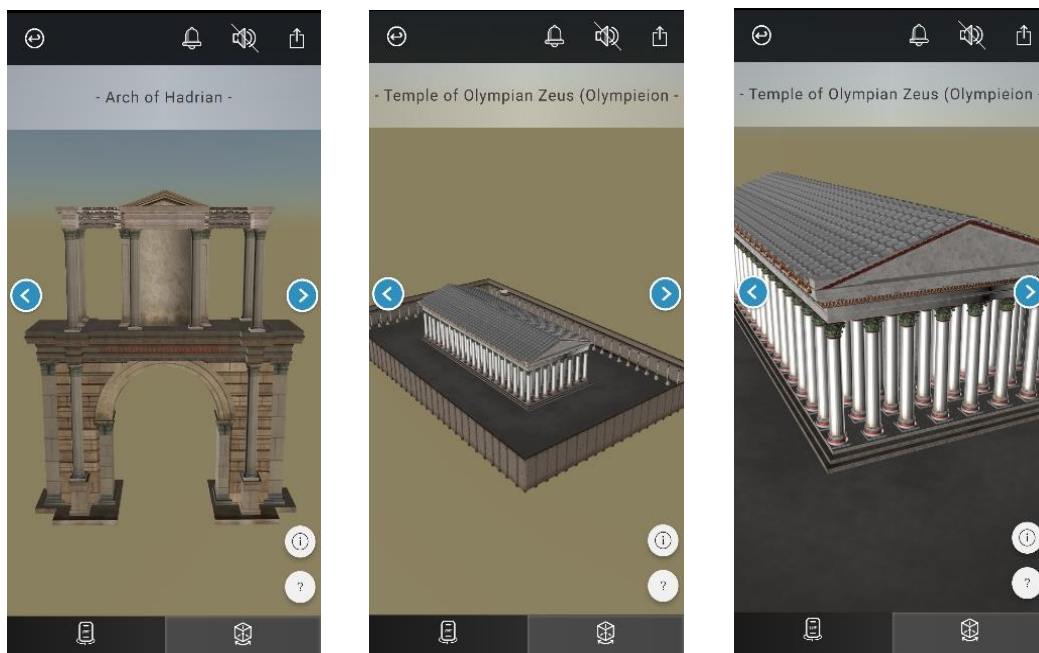
- **Written Information**:
  For each monument historical data and other related information are available in written form. A recording of the text is also available as a sound.

Image 4.6: Screenshot of the tool "Written information"
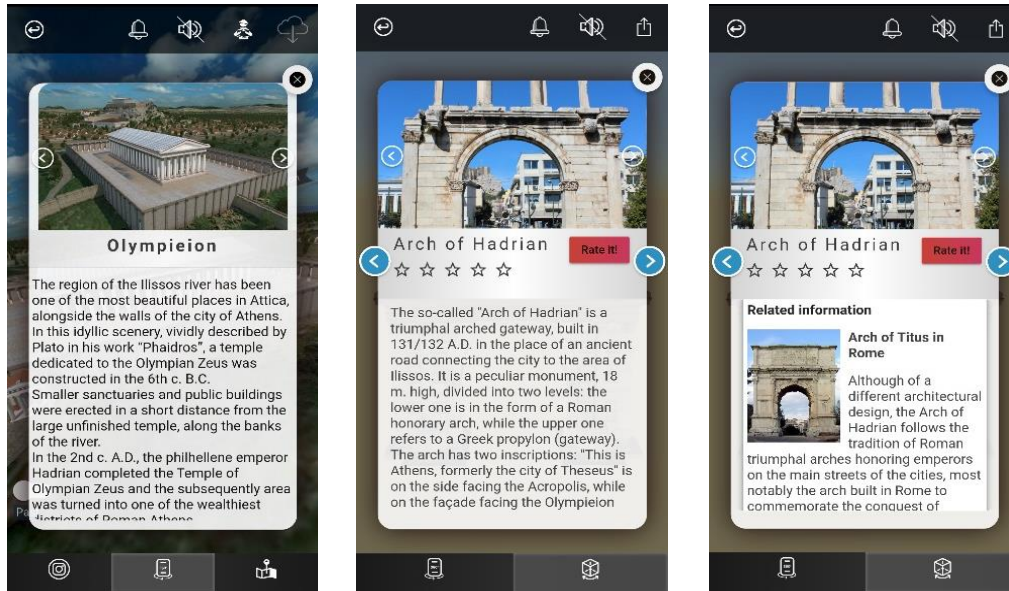
Furthermore, the app provides the opportunity to download the material of each site through Wi-Fi connection, so that users are able to access the content offline. Along with all the tools that was previously mentioned, CultureApp offers a variety of properly configured services, ideal for Professional Tour Guides and their groups. Group members can locate their guide through the app, receive SMS with all the required information or 3D representations. Members can also export photos, send postcards, and share moments in social media, thus increasing the visibility of the cultural monument to the general public.

Image 4.7: Extra features of the app for connectivity, tour guides and groups
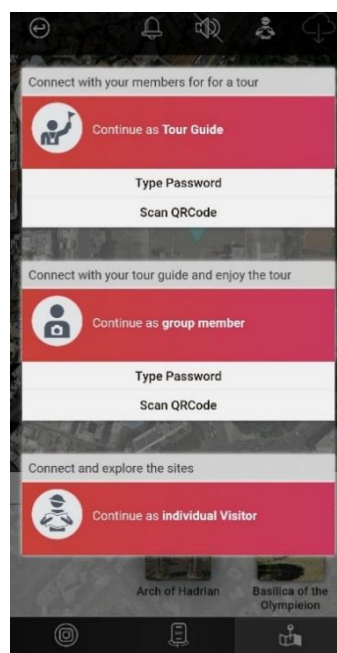
5. Methodology

This section describes the methodology employed in this paper. Section 5.1, outlines in detail how the survey was conducted, and explains the questions that were included in the form as well as the variables that were constructed. Section 5.2 includes the basic descriptive data of the sample and illustrates them in corresponding graphs such as histograms and pie charts.

5.1. Survey details

The survey was conducted through online Google Forms answered by participants anonymously. For the better understanding of the concepts by the participants, and since the questionnaire was distributed in Greece, it was considered appropriate to write the questionnaire in the Greek language.

The questionnaire is divided into 4 sections based on the themes of the individual questions. The transition to each section was made in sequential order and after the respondent had answered all the compulsory questions in the previous section. In most questions of sections B, C, D, a Likert scale anchored from 1 (disagree) to 5 (agree) was used to collect individual item scores.

The sections in the survey were:

A. Demographic characteristics (gender, age, educational level, type of employment)

B. Participant's relationship with technology

> With the purpose to understand the participant's background and their relationship with technology, a previously established measurement factor was used, reflecting "Personal Innovativeness" (Agarwal & Prasad, 1998). For simplicity, the equally weighted mean of the answers in those three statements was used in order to form the variable "User Innovativeness". Additionally, an extra variable was used (hours_spent) regarding the hours each participant spends in his smartphone daily, with the aim to understand his familiarity with mobile apps.

17

Measurement factor	Questions / Statements	Greek Translation	Reference
Personal Innovativeness	I like to experiment with new technologies.	Μου αρέσει να πειραματίζομαι με νέες τεχνολογίες.	*(Agarwal & Prasad, 1998 cited in Kourouthanassis et al., 2015)*
	If I heard about a new technology, I would look for ways to experiment with it.	Αν μάθαινα για μια νέα τεχνολογία, θα έψαχνα τρόπους να πειραματιστώ με αυτήν.	
	Among my peers, I am usually the first to explore new technologies.	Στον κύκλο μου, είμαι συνήθως ο πρώτος που εξερευνά τις νέες τεχνολογίες.	

C. Representation of the CultureApp application and views on each feature

For this section, videos and screenshots were used to demonstrate the operation of the application for each tool. Screen recording of the app features were performed on a mobile device, running an Android operating system. The videos were available within the questionnaire form and the respondent was asked to watch each of them and then answer the corresponding questions under the specific video. Those videos showcased the below tools:

- Written information
- VR Panoramic View of present & past
- 3D Model of the monument
- AR Camera tool
- Short advertisement of the app

For the AR tool, short clips, depicting its operation were used, all of which have been uploaded on CultureApp's official YouTube channel in the form of YouTube shorts. In the clips, users are in the archaeological site and turn on their mobile camera to see a reconstruction of the primary form of the cultural monument. The clips were collected, stitched together via video editing software and then used within the form.

For the purpose of this research, material related to the archeological site named "Olympieion" was showcased to participants, due to the fact that it is the only free of charge available option in the app, accessible from all internet users. "Olympieion", which was the sanctuary of Olympian Zeus, is located in southern Athens, between the Acropolis and the Ilissos River. Historical data regarding the archeological site can be found in the official website of the Greek Ministry of Culture and Sports. As the archaeologist Th. Kyriakou writes, *"According to Vitruvius, here stands one of the greatest ancient temples of Zeus, and one of the most famous marble buildings ever*

constructed. The sanctuary's foundation is attributed to mythical Deukalion. It was constructed in ca. 500 BC." (Th. Kyriakou, Ministry of Culture and Sports | Olympieio, n.d.).

The application showcases 11 monuments of the Olympieion archaeological site and provides tools for each one of them as shown in Table 5.2. The app provides all four tools (360 Panoramic View, 3D Model, Camera AR View & Written Info) for the monuments of "Temple of Olympian Zeus" and "Arch of Hadrian". Eventually, we used the tools for those two monuments and created screen recording videos and screenshots, showcasing each one of them. Regarding the AR Camera tool, clips from the functionality of the tool, published on CultureApp's official YouTube channel in the form of YouTube shorts, were used. In the clips, visitors of the archaeological site opened their mobile phone camera to see a representation of the primary form of the cultural monument. The clips were collected, joined together through video editing software, and then used within the form. All the material was included in survey and participants ought to watch it and proceed by answering the relating questions in the form.

Table 5.2: The individual monuments that consist "Olympieion" archaeological site and the tools the app provides for each one of them

	Monuments	360° View	3D Model	Camera AR View	Written Info
1	Arch of Hadrian	✓	✓	✓	✓
2	Temple of Olympian Zeus (Olympieion)	✓	✓	✓	✓
3	Basilica of the Olympieion	-	-	✓	✓
4	Gates of the Themistoklean Wall	-	-	✓	✓
5	Lawcourt at the Delphinion	-	-	✓	✓
6	Roman Baths	-	-	✓	✓
7	Ruins of houses	-	-	✓	✓
8	Temple of Apollo Delphinios	-	-	✓	✓
9	Temple of Kronos and Rhea	-	-	✓	✓
10	Temple of Zeus Panhellenios	-	-	✓	✓
11	Valerian Wall	-	-	✓	✓

D. Overall experience

Respondents were asked to fulfill this section after watching all the above stated material and evaluate the overall experience of the app. Previously established measurement factors were used to form the variables "Affective Destination Image" and "Awareness about Destination". A Likert scale anchored from 1 (disagree) to 5 (agree) was used to collect individual item scores. However, it should be noted that for the variable "Affective Destination Image" bipolar format questions were used, with the more positive emotions standing on level 1, and the more negative emotions ending up on level 5. For simplicity, the equally weighted mean of the individual answers of the related groups was used in order to form the variables "Affective Destination Image" and "Awareness about monument" respectively. Table 5.2 contains a more detailed explanation of the variables and the questions used to form them.

Table 5.3: Explanation of variables and questions in survey

Measurement factor	Bipolar format questions / Likert questions	Greek translation	Reference
Affective Destination Image	Pleasant ←→ Unpleasant	Ευχάριστη ←→ Δυσάρεστη	*(Martínez and Alvarez, 2010 cited in Griffin et al., 2017)*
	Relaxing ←→ Stressful	Χαλαρωτική ←→ Αγχωτική/ Έντονη	
	Entertaining ←→ Boring	Διασκεδαστική ←→ Βαρετή	
	Friendly ←→ Unfriendly	Εύχρηστη ←→ Μη εύχρηστη	
Awareness about monument	Intention to visit monument.	Μέσω της εφαρμογής CultureApp έχεις τη δυνατότητα να "περιηγηθείς" σε ένα από τα διαθέσιμα πολιτιστικά μνημεία από την άνεση του σπιτιού σου. Κατα πόσο θα σε παρακινούσε να επισκεφτείς δια ζώσης το συγκεκριμένο μνημείο;	*(Griffin et al., 2017)*
	Intention to seek information on destination.	Πόσο πιθανό είναι να αναζητήσετε πληροφορίες για τος συγκεκριμένο μνημείο;	
	Intention to suggest destination to others.	Πόσο πιθανό είναι να προτείνετε σε άλλους το συγκεκριμένο μνημείο;	
Interest about the app[1]	Intention to use the app in next 1 year.	Πόσο πιθανό είναι να χρησιμοποιήσετε τη συγκεκριμένη εφαρμογή μέσα στον επόμενο χρόνο;	*(none)*
	Intention to suggest the app to others.	Πόσο πιθανό είναι να προτείνετε σε άλλους τη συγκεκριμένη εφαρμογή;	
Impact on the visiting decision	Would you prefer to visit a cultural monument that has such an app over one that does **NOT**?	Θα προτιμούσατε να επισκεφθείτε κάποιο πολιτιστικό μνημείο που διαθέτει αντίστοιχη εφαρμογή έναντι κάποιου άλλου που **ΔΕΝ** παρέχει αυτή τη δυνατότητα;	*(none)*
Willingness to Pay		Τι ποσό θα διαθέτατε για τη χρήση της εφαρμογής σε κάποιον αρχαιολογικό χώρο που θα επισκεπτόσασταν;	*(none)*

---

[1] The category **"Interest about the app"** was accompanied by the official advertisement video of the app and remains available on the official YouTube channel of CultureApp

5.2. Sample Description

The sample of the survey consists of 236 observations, the majority of which were derived from females in approximately 60-40 ratio. It is also significant that the sample was concentrated around the age of 20 to 29, and consequently this led to a substantial proportion of the employment type being students (59,3%). As for education, respondents were asked to select the maximum educational level that they had completed. Below can be found the table that presents the detailed description of sample demographics and figures depicting each dimension. (Table 5.3)

Table 5.4: Sample Demographics

Dimension	Value	Total (N)	Percentage
Gender	Female	147	62%
	Male	89	38%
Age	Under 20	7	3%
	20-29	154	65%
	30-39	12	5%
	40-49	20	8%
	50-59	40	17%
	60+	3	1%
Education	Primary Education	2	1%
	Secondary Education	84	36%
	Vocational/ Technical Education	14	6%
	Higher Education	93	39%
	Master's Degree	35	15%
	PhD	8	3%
Employment Type	Student (non-working)	73	30,9%
	Student (working)	67	28,4%
	Freelancer	40	16,9%
	Private Sector Employee	27	11,4%
	Civil Servant	18	7,6%
	Retiree	10	4,2%
	Unemployed	1	0,4%

Figure 5.2: Pie Chart of Gender
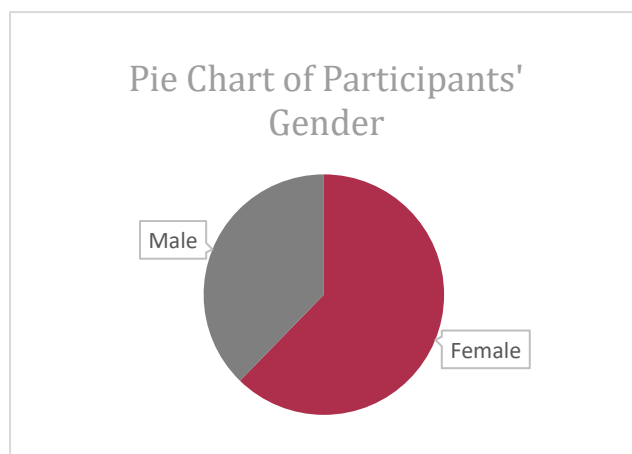
Figure 5.1: Histogram of Age
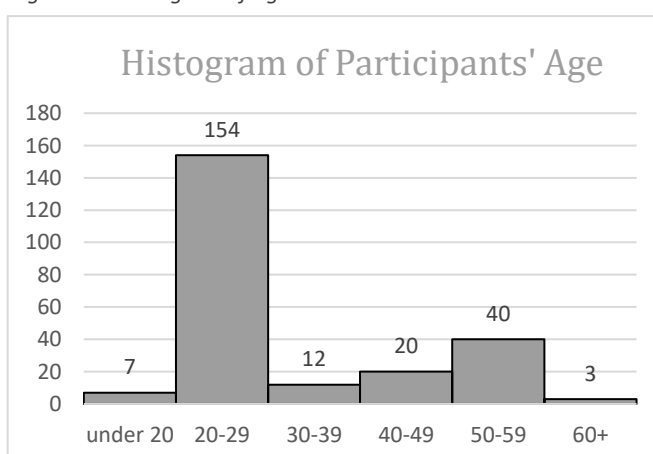
Figure 5.4: Histogram of Educational Level
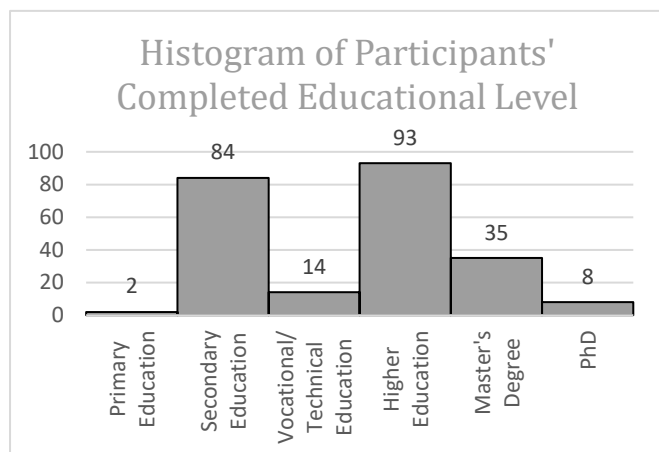
Figure 5.3: Histogram of Employment Type
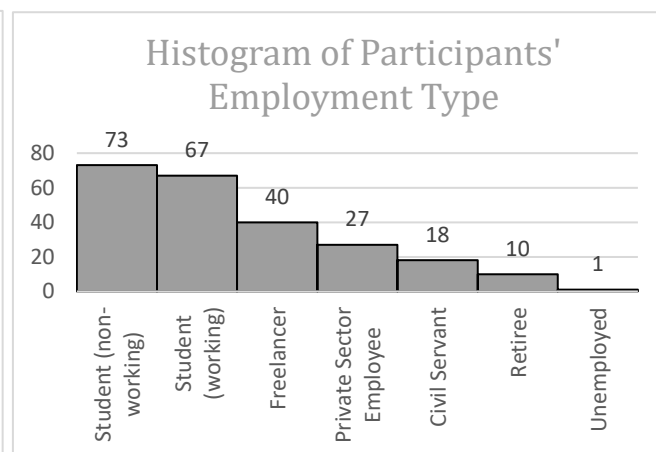
6. Results

This section is divided in three parts. Subsection 6.1 aggregates the responses as a percentage of all observations into summary tables and enables us to understand where the majority of responses were concentrated. Following, subsection 6.2 shows the correlations found between the variables formed and analyses their significance. The results are also summarized in tables and illustrated in graphs. Lastly, subsection 6.3, consists of a thorough analysis of the answers on open-ended questions which were grouped, and are shown in tables. Some selected answers of participants are also recorded translated from Greek to English, in a way that maintains the meaning consistent.

6.1. Summary tables of answers

Starting off, we examine the opinion of the respondents regarding the various tools CultureApp provides. As seen in Table 6.1, half of the sample found the tools Written Info, 360 View and 3D model to be extremely useful, while the AR tool was found to be extremely useful by more than 70%.

Table 6.1: Percentages of participants' assessments for each tool on Likert scale questions

	"How useful do you find each tool?"				
	1	**2**	**3**	**4**	**5**
Written Info	0,4%	3,4%	13,1%	30,5%	**52,5%**
360 View	0,4%	1,4%	9,7%	34,3%	**54,2%**
3D model	0%	2,5%	13,1%	30,5%	**53,8%**
AR tool	0,4%	1,3%	6,8%	19,1%	**72,5%**

Secondly, participants were asked to characterize the overall experience of the app based on the clips they had already watched, on a Likert scale from 1 to 5, with 1 representing the most positive emotions and 5 the most negative ones. Nearly 60% found the experience to be

extremely pleasant as well as friendly (easy to use). Additionally, most of the respondents agreed that the experience was just mildly relaxing and entertaining. It should also be noted that the difference between the percentages that found the experience to be mildly and extremely relaxing as well as entertaining is quite small. (Table 6.2)

Table 6.2: Percentages of participants' answers for the overall experience of the app on a Likert scale

"Based on the clips you watched, characterize your experience of the app".						
	1	**2**	**3**	**4**	**5**	
Pleasant	**64,4%**	13,6%	5,1%	13,6%	3,4%	**Unpleasant**
Relaxing	31,8%	**34,3%**	26,7%	5,1%	2,1%	**Stressful**
Entertaining	34,7%	**36%**	19,9%	6,4%	3%	**Boring**
Friendly	**58,9%**	18,6%	8,1%	11,9%	2,5%	**Unfriendly**

Lastly, some questions were used in the survey, to find out the interest of each participant on the showcased monument after watching the related material and the interest about the application. By looking at table 6.3, we observe at the last row that for most of the participants the existence of the app for a monument was unrelated to their visiting decision. This means that their decision to select a monument to visit is not affected by whether it has or has not such an app (Impact on visiting decision). The showcase of "Olympieion" through the survey affects moderately their intention to visit and seek information about the site for most participants. Regarding the app, participants after the showcase are quite likely to use the app in the next 1 year along with suggesting it to others.

Table 6.3: Percentages of participants' answers after watching all clips

Interest about monument & Interest about the app					
	1	**2**	**3**	**4**	**5**
Intention to visit	0,8%	4,2%	25%	**41,9%**	28%
Intention to seek info	1,7%	8,5%	25,4%	**38,1%**	26,3%
Intention to use app in next 1 year	3,4%	8,5%	32,6%	**33,1%**	22,5%
Intention to suggest app to others	3,4%	5,5%	29,2%	**35,2%**	26,7%
Impact on visiting decision	14%	9,7%	**32,6%**	26,3%	17,4%

6.2. Correlations

Moving on, we examine the correlations between the variables. The correlation values are measured using the Pearson Correlation Method, while the significance of the dependence is examined using the Pearson chi-squared test. The estimations are presented in Tables 6.4, 6.5, 6.6.

As shown in Table 6.4, User Innovativeness affects significantly and positively the perception of usefulness of the application's tools. Therefore, the more innovative and familiar to technology the person is the more useful finds the app's tools "Written info", "360 View" and "3D model". All the values are close to 15%. It should also be noted that the "AR tool" has a similar value but is found to be independent with User Innovativeness by Pearson chi-squared test. Moreover, User Innovativeness has significant positive correlation with Impact on Visiting decision with a value of 22%. Consequently, the more innovative a person is , the more he will select a monument with such an app available over a monument without. Finally, User Innovativess significantly affects the Interest for the monument. The more familiar with technology users have a higher chance to seek information about the monument and suggest it to others, with values of 19% and 22% respectively. It is also noteworthy that user's characteristics (gender, age, educational level, frequency of smartphone use, User innovativeness) does not affect the user's experience of the application.

Following, Table 6.5, illustrates some interesting facts about the "Attitude towards the application". The Attitude towards the application is measured using questions about the "Intention to use the app in the next one year" and the "Intention to suggest the app to others" which are found to be significantly correlated with each variable examined. "Usefulness of Application", "Impact on visiting decision" and "Interest for monument", all have positive correlations with the Intention to use and suggest the app. It is important to mention that the 'Experience of Application' is negatively correlated with the attitude towards the app, due to the fact that the survey included statements regarding the emotions after the experience of the app, sorted from the most positive emotion to the most negative one (e.g. [1] pleasant ←→unpleasant [5]), while the rest of the questions were sorted from the most negative attribute to the most positive (e.g. [1] not likely to visit ←→very likely to visit [5])

Finally, Table 6.6, which examines the Willingness to pay for the application finds no significant correlation apart from the tool "Written Info", which is significant only for a 10% level of significance. This might be due to the question of the survey about the maximum price point not representing accurately the true willingness to pay.

Figure 6.1: The model used depicting the correlations
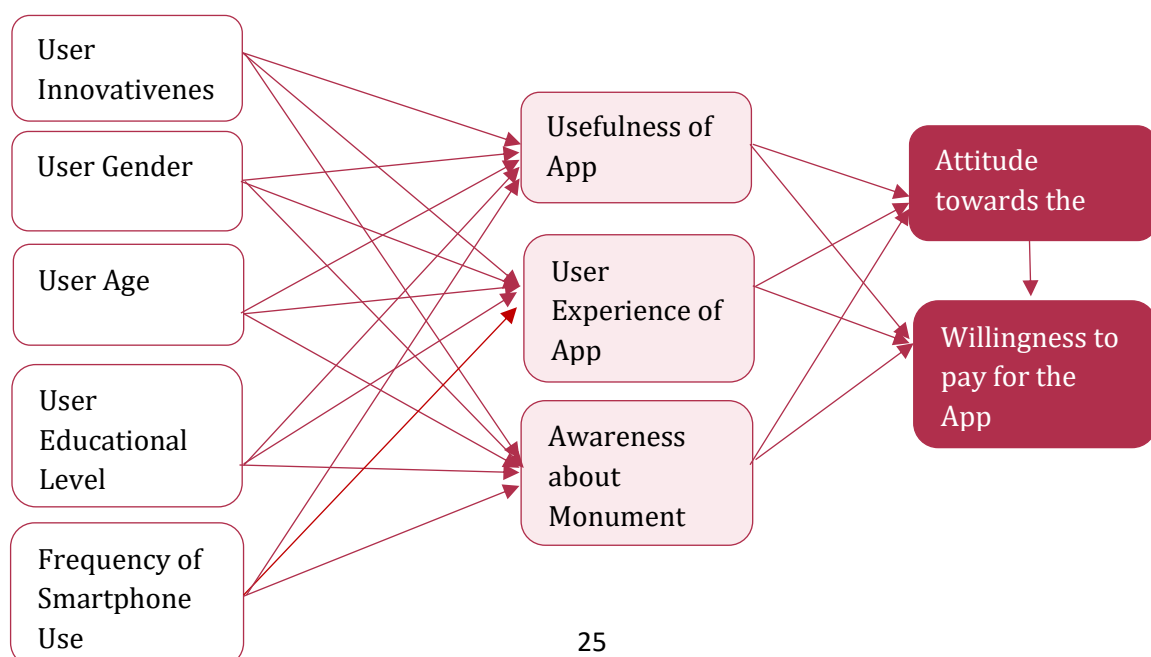
Table 6.4: Pearson Correlation Coefficients

	Variables	User Innovativeness	User Gender	User Age	User Educational Level	Frequency of Smartphone Use
Usefulness of Application	**Written Info**	0.15*** (≈ 0)	-0.07 (0.647)	0.08 (0.580)	0.04*** (≈ 0)	-0.05* (0.061)
	AR Tool	0.12 (0.769)	-0.08 (0.538)	0.00 (0.897)	0.07* (0.076)	0.02** (0.019)
	360 View	0.16*** (0.005)	-0.12** (0.020)	0.11 (0.145)	0.09*** (0.001)	-0.07** (0.033)
	3D Model	0.13* (0.086)	-0.07 (0.461)	0.18 (0.139)	0.12 (0.344)	-0.08 (0.874)
User Experience of App		-0.11 (0.119)	0.18 (0.205)	-0.18 (0.971)	-0.04 (0.868)	0.07 (0.481)
Impact on Visiting Decision		0.22*** (0.006)	0.02 (0.790)	0.07 (0.287)	0.00** (0.010)	-0.09 (0.182)
Interest for Monument	**Intention to Seek Information**	0.19** (0.039)	0.03 (0.860)	0.19 (0.401)	0.17 (0.260)	-0.13 (0.206)
	Intention to Suggest Destination	0.22*** (0.003)	0.00 (0.999)	0.20 (0.699)	0.12** (0.028)	-0.15 (0.219)

Note: The numbers in parenthesis are the p-values of the Pearson's chi squared tests

Table 6.5: Pearson Correlation Coefficients

Variable		Usefulness of Application				Experience of Application	Impact on Visiting Decision	Interest for Monument	
		Written Info	AR Tool	36O View	3D Model			Intention to seek information	Intention to suggest destination
Attitude towards the Application	Intention to use the app in the next 1 year	0.49*** (≈ 0)	0.41*** (≈ 0)	0.45*** (≈ 0)	0.43*** (≈ 0)	-0.43*** (≈ 0)	0.52*** (≈ 0)	0.59*** (≈ 0)	0.57*** (≈ 0)
	Intention to suggest the app to others	0.46*** (≈ 0)	0.39*** (≈ 0)	0.46*** (≈ 0)	0.42*** (≈ 0)	-0.43*** (≈ 0)	0.57*** (≈ 0)	0.55*** (≈ 0)	0.64*** (≈ 0)

Table 6.6: Pearson Correlation Coefficients

Variable	Usefulness of Application				Experience of Application	Impact on Visiting Decision	Interest for Monument		Attitude towards the Application	
	Written Info	AR Tool	36O View	3D Model			Intention to seek information	Intention to suggest destination	Intention to use the app in the next 1 year	Intention to suggest the app to others
Willingness to pay	0.07* (0.07)	-0.03 (0.936)	-0.03 (0.740)	-0.01 (0.711)	-0.05 (0.782)	0.06 (0.394)	0.06 (0.830)	0.05 (0.128)	0.18 (0.375)	0.17 (0.106)

Note: The numbers in parenthesis are the p-values of the Pearson's chi squared tests

Figure 6.2: Correlation Plots produced in Rstudio

Intention to suggest destination to others

	Intention to suggest destination to others
Personal Innovativenes	0.22
Gender	
Age	0.20
Education	0.12
hours spent	-0.15
Intention to suggest destination to others	1.00

Intention to seek info on monument

	Intention to seek info on monument
Personal Innovativeness	0.19
Gender	0.03
Age	0.19
Education	0.17
hours spent	-0.13
Intention to seek info on monument	1.00

Willingness to Pay

	Willingness to Pay
Affective Destination Image	0.05
Written info	0.07
360 View	0.03
3D model	
AR tool	0.03
Impact on visiting decision	0.06
Intention to seek information on destination	0.06
Intention to suggest destination to others	0.05
Intention to use the app in next 1 year	0.18
Intention to suggest the app to others	0.17
Willingness to Pay	1.00

Intention to suggest app to others

	Intention to suggest app to others
Affective Destination Image	-0.43
Written info	0.46
360 View	0.46
3D model	0.42
AR tool	0.39
Impact on visiting decision	0.57
Intention to seek information on destination	0.55
Intention to suggest destination to others	0.64
Intention to suggest the app to others	1.00

Intention to use app in next 1 year

	Intention to use app in next 1 year
Affective Destination Image	-0.43
Written info	0.49
360 View	0.45
3D model	0.43
AR tool	0.41
Impact on visiting decision	0.52
Intention to seek information on destination	0.59
Intention to suggest destination to others	0.57
Intention to use the app in next 1 year	1.00

29

6.3. Analysis of answers on open-ended questions

Lastly, participants were given the opportunity to optionally answer three open-ended questions and give their opinion. It was considered important that these responses remain optional in order to keep the questionnaire short and not to discourage people from submitting their responses.

The three questions included in the survey were:

1. Which do you consider as the most important advantages of the app?
2. Which do you consider as the most important disadvantages of the app?
3. What additional functionalities would you recommend being included in the app?

The answers of each question where gathered, analyzed and categorized, as many of the answers had similar meanings. The following tables include the summations of answers that were evaluated as similar and framed in the same category. Furthermore, there are some answers quoted unchanged. These answers were selected based on the fact that they include many statements that were also mentioned by other people, in a comprehensive and quite explanatory form. The respondent's number (R.N.), as well as their main demographic characteristics are mentioned before each answer.

6.3.1. Answers regarding advantages

A total of 89 participants answered the optional question:

"Which do you consider as the most important advantages of the app?"

A quite important percentage of the total people who answered this open-ended question, mentioned that the application helps them to better understand the spatial layout of the monument, the details of the site and the degradation that it has undergone over time, taking a full picture of its original form. This, as mentioned, helps in understanding both the architectural and historical significance of the monument. Moreover, participants find helpful the fact that the app provides comprehensive, accurate information about the monument and this makes understanding easier and faster, as they do not have to search through many sources to gather information, which would be extremely time-consuming, especially once they are physically at the monument. There is also a number of people expressing that, through this technology, the visiting experience becomes more interesting and they believe that this will encourage people of all ages to visit archaeological sites. Some also suggested that such an application might act as a tool to identify monuments of their interest and subsequently plan to visit them. It is also significant that some respondents, thinking in more depth about the positive aspects of such an application, mentioned the general promotion of cultural heritage, the deeper understanding of the importance of monuments for the society of the ancient world and the easier dissemination of all this knowledge to foreign tourists.

Table 6.7: Summations of answers grouped together, in the question regarding main advantages of the app

Main Advantages		
GROUP	EXAMPLE	SUM
Better perception of the area	*"It helps a lot in perceiving the details of the area and observe ravages of time. "*	**47**
Information	*"Gives insight and information without having to search very hard."*	**29**
Easy to use	*"Easy to use for everyone."*	**23**
Dissemination of cultural heritage	*"You can see the original form of the monument and discover the magnificence of the ancient Greek civilization."*	**18**
Moves the interest / Interesting	*"It's an interesting experience."*	**18**
Remote Access	*"Gives access to the ancient monuments of our country even from thousands of kilometers away."*	**8**
Graphics Quality / Aesthetically Pleasant	*"Aesthetically pleasant, useful for the visitor of a monument."*	**5**
Encourages for a visit	*"Preview of the monument and preparation for a visit."*	**5**
Attracting young people	*"The attraction of young people to the archaeological sites."*	**3**
Does not require a tour guide/ good for lone travelers	*" The non-intervention of third persons in the transfer of information."*	**3**

R.N.29, Female, Age: 20-29

"It is easier for the user to understand the spatial layout of the monument because it gives the user an image of its original form. Thus, in combination with the information provided by the guide or the printed descriptions, the visitor acquires a more complete visitor experience through an optimal understanding of the architectural and functional/historical significance of the monument."

R.N. 47, Female, Age: 20-29

"The app helps to preserve and at the same time protect cultural heritage through technology, encouraging young and old people to visit monuments and museums."

R.N. 49, Female, Age: 20-29

"It motivates the interest of the citizen so that they want to visit the monuments in person, once they have got to know them through the application. It helps to acquire more or complete knowledge about each monument. It is pleasant to use, original and very interesting that you can so easily see the primary state of a monument in just a few minutes, but also learn the whole story behind it. It also enables people to get to know and form an opinion about monuments that they may not easily get to know in person. It is also interesting that the information is collected in a single app exclusively for such use and one does not have to consult various sources to put the information together and end up forming this comprehensive view that this app provides."

R.N. 120, Male, Age: 20-29

"I consider as an important advantage the opportunity for the visitor to perceive the image of the monument in its original state through the AR. Through the three dimensions provided he can have various perspectives as a person of the time would have had."

R.N. 153, Female, Age: 40-49

"You can see the original form of the monument and discover the magnificence of the ancient Greek civilization."

R.N. 170, Male, Age: 50-59

"The attraction of young people to the archaeological sites and the provision of accurate information without the use of a tour guide."

R.N. 174, Female, Age: 30-39

"It stimulates the imagination. It arouses interest especially when the site itself is not impressive enough."

R.N. 177, Male, Age: 50-59

"The fact that I can immediately understand the image I see, in its complete form, excites me."

R.N. 181, Male, Age: 20-29

"It combines the lived experience of visiting an archaeological site with the fun side of technologies."

R.N. 201, Female, Age: 20-29

"(1) the remote knowledge about the cultural monuments, (2) the picture of the current state of the monument and the original one, (3) a helpful application for visitors travelling individually (and not with a group)."

R.N. 204, Female, Age: 40-49

"It gives the opportunity to those of us who already know some of our monuments, but also to people from abroad to feel that they are living in the era when the monument was built and to learn useful information about the monument, without having to search too much."

R.N. 233, Female, Age: 20-29

"Highly informative, modern, educational, and entertaining. We always have our phones on us, so the app is very easy to use."

6.3.2. Answers regarding disadvantages

A total of 59 participants answered the optional question:

"Which do you consider as the most important disadvantages of the app?"

Given that the answer to this question was not mandatory, it was considered important to mention that nevertheless, a total of 14 people wrote that they did not find any disadvantage in the application, indicating that they are not just indifferent but actually do not find negative aspects in the app. Several respondents stated that they would prefer more modern graphics, design of the buildings and surroundings as well as an overall easier to use user interface as the existing one reminds them of an "old" application. Respondents are also concerned about poor resolution due to poor signal as well as limitations due to older mobile devices with limited capabilities. There are also many who report age limitations or even problems due to unfamiliarity with technology that people of all ages may face. It was also stated that using a mobile phone during the in-person visit can reduce the quality of the experience, or even be distracting. Another concern is that viewing the archaeological site from home and learning all the information through one's

smartphone may discourage one from visiting the site. Three respondents also mentioned that the app provides for the time being, only a small number of monuments of the Greek territory, while one respondent was concerned about the lack of a real person, e.g. a tour guide, that could solve real-time questions and provide more accurate information during the visit.

Table 6.8: Summations of answers grouped together, in the question regarding main disadvantages of the app

Main Disadvantages		
GROUP	**EXAMPLE**	**SUM**
None	*"I do not see any disadvantages."*	**14**
Not modern design and graphics	*"The graphics could be richer and more vivid."*	**8**
Device/ Signal Restrictions	*"We need a high-end smartphone." / "Possible bad resolution due to bad or poor signal"*	**7**
Not good User Interface	*"Further work is needed on the interface."*	**6**
Age restrictions / Difficult for older age groups	*"I don't know whether it would be pleasant for the elderly."*	**6**
Discourages live visit	*"I think it would reduce the number of visitors to the monuments."*	**5**
Increases dependence on smartphone / Degrades the visiting experience	*"It requires internet usage and increases addiction to smartphones."*	**5**
Familiarity with technology	*"Not everyone is familiar with technology."*	**4**
Limited number of monuments available	*"It would be good to be extended to other archaeological sites."*	**3**
I haven't tested it, I can't answer	*"I haven't tested it."*	**2**
Absence of human guided tour	*"Absence of a human tour and of the feeling that someone qualified will help me to better understand the monument."*	**1**

R.N. 41, Female, Age: 20-29

"It needs advertising to get it into the hands of foreign tourists, who need it most. Also, not everyone is familiar with the technology."

R.N. 49, Female, Age: 20-29

"Perhaps some percentage of the population seeing the complete picture provided by the application, may not be interested to see it in person knowing that they saw in detail all the information of the monument through the application. However, I believe that this percentage will be small."

R.N. 53, Male, Age: 20-29

"Needs further work on the user interface, not to look like an old application, at the same time it needs development of the graphics of the monuments, to be at the most advanced levels of polygons."

R.N. 107, Female, Age: 20-29

"Requires the use of a smart phone so it automatically reduces the entertainment during the visit."

R.N. 120, Male, Age: 20-29

"I think the existence of an independent application is the main disadvantage. Personally, if I were in front of a monument, I would resort to a quick google to get the information I want, rather than downloading the app."

R.N. 124, Female, Age: 40-49

"Unfortunately, no app can transmit the vibe that each archaeological site gives you when you are there."

R.N. 164, Male, Age: 20-29

"It requires internet access and increases dependence on mobile."

R.N. 181, Male, Age: 20-29

"It's one more app that makes you look at your smartphone."

R.N. 174, Female, Age: 30-39

"It may prevent people from visiting less impressive sites. Of course, if someone is engaged to such an extent that they use the app, they will be such a lover of ancient civilization that not only will the app not discourage them from visiting the site, but it will enhance the thrill and awe they will feel during their visit. Also, the response to navigation of the reconstruction of the archaeological site is slow."

R.N. 188, Male, Age: 50-59

"Absence of human guidance, clarification of questions and the feeling that someone qualified will help me to better understand the monument...In a few words, the visitor will have to be satisfied with (and limited to) the information that the application will give him."

R.N. 201, Female, Age: 20-29

"(1) it is helpful for every visitor but beyond that everyone (every user of the app) should enjoy the experience of visiting a cultural monument and not be limited to the use of technology (general comment on the use of technology, not exclusive to the specific app) (2) it works in a limited number of regions (5 regions listed on the official site)."

R.N. 233, Female, Age: 20-29

" If there is no signal, there will be no good connection. Maybe there's some limitation on the age group - for example some 60+ don't know how to use smartphones."

R.N. 235, Female, Age: 40-49

" The limitation through the smartphone's screen, I don't have the whole sense of space."

6.3.3. Additional Functionalities

A total of 50 participants answered the optional question:

"What additional functionalities would you recommend being included in the app?"

A significant number of the sample would like the application to also include other useful information about the operation of the archaeological site such as opening hours, ticket prices, parking spaces and public transport connected to the destination. Several people also stated that the app could provide suggestions with multiple monuments of an area and schedules that combine visits to many monuments on a day. As they claimed, this could help them to easier organize activities on their trips and save time and effort. Many also suggested that the app should provide more information about how people in ancient times used to live, use these buildings and interact with the environment, while many also mentioned audio augmentations such as music or sound of the ancient environment. Some participants also highlighted the need to include audio descriptions of the information and other functionalities in order the app to be accessible to people with visual impairments or other disabilities. Furthermore, respondents in the age groups "under 20" and "20-29" noted the possible existence of quizzes, games and other interactive educational content that would help in the deeper understanding of history. Therefore, gamification would be a way to attract younger visitors. It was also argued that the content should be translated into more languages, in order for visitors to be able to enjoy the app in their mother tongue. Lastly, there were also participants claiming that they would prefer the app to be used through another device provided in the archaeological site (e.g., AR glasses), while others wished that the app included chatbots where they could ask questions and receive answers, or even share content of the app (e.g., 3D representations) to other social media.

Table 6.9: Summations of answers grouped together, in the question regarding additional functionalities

Additional Functionalities		
GROUP	**EXAMPLE**	**SUM**
Information about visiting *(e.g. opening hours, contact details, ticket costs and public transport)*	*"As many details as possible about the museums, such as opening hours, ticket prices etc."*	**10**
Audio Function	*"Audio description (some kind of e-guide) giving information about the history of each archaeological site."*	**8**
More information on life in ancient times / interesting facts	*"References of various historical events related to the site."*	**6**
Translation into more languages	*"To offer information about each attraction and in different languages."*	**4**
Gamification, Quizzes, Interactive Content	*"Quizzes about archaeological sites that help users learn about them in a fun way."*	**3**
Ability to book tickets	*"To be able to save the museum tickets in electronic form."/ "Booking a ticket for the visit."*	**3**
Use through another device (e.g., glasses)	*"Use of the application with devices that will be given to the visitor, not his/her personal smartphone."*	**3**
Interactive chat with other users/ ability to share content to friends	*"Ability to share in other applications e.g. I share the acropolis to a friend via Facebook."*	**3**
Suggestions for tours to nearby monuments / visiting schedule	*"Suggestions for nearby places to visit and services And Automatic creation of a visiting schedule."*	**2**
Personalized answers to user's questions	*"Ability to retrieve information based on user questions."*	**2**

R.N. 4, Male, Age: 20-29

"At a later stage it could also show people of the time and how they gathered in the space e.g., in a theatre, at a meeting etc."

R.N. 8, Male, Age: 50-59

"Better representation and ability to provide information based on user questions."

R.N. 29, Female, Age: 20-29

"To provide, in addition to the panoramic image, some information about each part of the monument, e.g., by clicking on the frieze of the Parthenon, the user receives 1-2 sentences with the key information."

R.N. 41, Female, Age: 20-29

" Ability to create routes connecting nearby monuments."

R.N. 50, Female, Age: 20-29

"To be able to save the museum tickets in electronic form. To have information audio-recorded so that a person walking through the site doesn't have to read and get distracted, but rather listen."

R.N. 65, Female, Age: 20-29

"Sound, moving images (e.g. people around), the ability to see how it was being constructed step by step."

R.N. 84, Female, Age: under 20

"Settings for people with disabilities -blind, deaf- (audio function), language switching function for tourists, etc. and quizzes about archaeological sites that help users learn about them in a fun way."

R.N. 95, Female, Age: 20-29

"Voice description of the image for people with visual disabilities and more generally providing information for users with difficulties in hearing, vision, etc."

R.N. 115, Female, Age: 30-39

"Use of the application in the archaeological site with devices that will be given to the visitor, not his/her personal smartphone."

R.N. 167, Female, Age: 20-29

"Surely it could be developed and apart from monuments to be able to give information about paintings which of course requires a lot of time and money."

R.N. 201, Female, Age: 20-29

"(1) to include in the list other cultural monuments of the country, (2) there would be extra useful information for the visitor of each cultural monument (such as restaurants, kiosks, parking spaces, distances from the central points of the areas where the monuments are/ perhaps this will help the planning process of the visitor to the site and in this way there will be a higher satisfaction rate, as the user has all the information he needs through an application (reduction of time consumption through an application)."

R.N. 206, Female, Age: 20-29

"Linking and categories of monuments e.g. oracles or Acropolises. Ability to share in other applications e.g. sharing the Acropolis to a friend via Facebook. Day/night view of the monument. Providing more languages (if not already available). Adding real time photos by users after approval (like in Google maps)."

R.N. 212, Female, Age: 20-29

'There could be a chat room where you can chat with people or friends with same interests. There could also be some kind of collaboration with museums to allow the user to book tickets for a visit directly through the app."

R.N. 212, Female, Age: 40-49

"It could include suggestions for walks/food/drink/cultural events around each monument, so that with the ad revenue the app could be free. That is, not to be purely "archaeological", but to be a complete tourist experience."

6.3.4. Answers about willingness to pay

Although there was no open-ended question regarding willingness to pay- only a multiple-choice question- two participants expressed their opinion on price through the "extra functionalities". Since they took the initiative to write their opinion even though there was no relevant field, it was considered important to include these views on the survey.

R.N. 174, Female, Age: 30-39

"In terms of functionality it works fine, but I couldn't say the same for the cost. (While I understand the cost in labor hours to create the graphics, collect the information, build and maintain the app, etc., it is not possible for an app to cost as much as a ticket to the site). I would suggest an annual subscription, although ideally, it should be incorporated into the ticket price of all archaeological sites. The creators would work on a percentage of the tickets and visitor attendance at the site would be boosted because of the alternative experience offered. I wrote it here because there was no other open-ended question."

R.N. 49, Female, Age: 20-29

"I will answer something related to the following question (willingness to pay). I think that such applications which focus on knowledge and education should be free of charge for the citizens. However, since I understand the work behind this application to design and formulate it, I will of course select a price that I consider affordable to the citizen, keeping in mind that there should also be a profit for the people that create this application."

7. Conclusions

The purpose of this research was to investigate the use of augmented reality applications in tourist sites of interest and specifically archaeological sites. The main objective was to identify whether the existence of such an app can enhance the tourist experience and create added value that tourists may also be willing to pay for. This was achieved through field research for the "Culture App", an app for smartphones which enables users to see the original form of various monuments and find information and historical data about them with various tools. Participants were asked to watch relevant material and then answer multiple-choice as well as open-ended questions, in which they could express their thoughts and opinions in more detail.

The Usefulness of the various tools of the app, the impact on visiting experience as well as the interest in monument were found significantly positively correlated with the Personal Innovativeness of a user. This means that the more familiar with technology a user is, the more useful he finds the app and the more important interest he develops for the monument. This leads to him being also more encouraged to visit a monument that has such an app available, compared to a monument that has not. No demographic characteristics (gender, age, educational level etc.) were correlated with the User's Experience of the App. Furthermore, the Attitude towards the app, which represents the intention to use the app in the next 1 year and the intention to suggest it to others, was positively correlated with the usefulness and the experience of the app, the Impact on visiting decision and the interest in monument. Against expectations, willingness to pay was not found correlated with any of the variables. This may be an outcome of a wrong used method to capture the true willingness to pay of the users or even an indication that the cost of such an app should be integrated to the ticket price, so as to act as a way to attract more visitors and not a direct source of revenue. As a suggestion for future research, may be exploring more appropriate methods to measure the true willingness to pay.

Through the answers on the open-ended questions, we gained a deeper understanding of people's views on the app, the advantages, the disadvantages, and the additional functionalities that they suggested. All answers indicated a positive impression for the app and the tools. However, through the proposals and the disadvantages highlighted, opportunities arise for further improvement and modernization of the service, adapted to the requirements of the modern traveler.

8.   References

- Centre, U. W. H. (n.d.). UNESCO World Heritage Centre—World Heritage List. UNESCO World Heritage Centre. Retrieved January 13, 2023, from https://whc.unesco.org/en/list/
- CultureApp—Brings Cultural Heritage to Life. (n.d.). Culture App. Retrieved January 13, 2023, from https://cultureapp.eu/
- Cranmer, E. E. (2019). Designing Valuable Augmented Reality Tourism Application Experiences. In M. C. tom Dieck & T. Jung (Eds.), Augmented Reality and Virtual Reality (pp. 73–87). Springer International Publishing. https://doi.org/10.1007/978-3-030-06246-0_6
- Furht, B. (Ed.). (2011). Handbook of Augmented Reality. Springer New York. https://doi.org/10.1007/978-1-4614-0064-6
- Griffin, T., Giberson, J., & Hwan, S. (n.d.). Virtual Reality and Implications for Destination Marketing.
- Guttentag, D. A. (2010). Virtual reality: Applications and implications for tourism. Tourism Management, 31(5), 637–651. https://doi.org/10.1016/j.tourman.2009.07.003
- Han, D.-I., tom Dieck, M. C., & Jung, T. (2018). User experience model for augmented reality applications in urban heritage tourism. Journal of Heritage Tourism, 13(1), 46–61. https://doi.org/10.1080/1743873X.2016.1251931
- Huertas, A., & Gonzalo, J. (2020). THE ROLE OF AUGMENTED REALITY IN DESTINATION BRANDING. Tourism and Hospitality Management, 26(2), 419–436. https://doi.org/10.20867/thm.26.2.8
- Kotane, I., Znotina, D., & Hushko, S. (2019). ASSESSMENT OF TRENDS IN THE APPLICATION OF DIGITAL MARKETING. Scientific Journal of Polonia University, 33(2), 28–35. https://doi.org/10.23856/3303
- Kounavis, C. D., Kasimati, A. E., & Zamani, E. D. (2012). Enhancing the Tourism Experience through Mobile Augmented Reality: Challenges and Prospects. International Journal of Engineering Business Management, 4, 10. https://doi.org/10.5772/51644
- Kourouthanassis, P., Boletsis, C., Bardaki, C., & Chasanidou, D. (2015). Tourists responses to mobile augmented reality travel guides: The role of emotions on adoption behavior. Pervasive and Mobile Computing, 18, 71–87. https://doi.org/10.1016/j.pmcj.2014.08.009
- Ministry of Culture and Sports | Olympieio. (n.d.). Retrieved January 13, 2023, from http://odysseus.culture.gr/h/3/eh351.jsp?obj_id=2488
- Rauschnabel, P. A., Babin, B. J., tom Dieck, M. C., Krey, N., & Jung, T. (2022). What is augmented reality marketing? Its definition, complexity, and future. Journal of Business Research, 142, 1140–1150. https://doi.org/10.1016/j.jbusres.2021.12.084

- tom Dieck, M. C., & Jung, T. (Eds.). (2019). Augmented Reality and Virtual Reality: The Power of AR and VR for Business. Springer International Publishing. https://doi.org/10.1007/978-3-030-06246-0
- Agarwal, R., & Prasad, J. (1998). A Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology. Information Systems Research, 9(2), 204–215. https://doi.org/10.1287/isre.9.2.204
- Wang, X., Kim, M. J., Love, P. E. D., & Kang, S.-C. (2013). Augmented Reality in built environment: Classification and implications for future research. Automation in Construction, 32, 1–13. https://doi.org/10.1016/j.autcon.2012.11.021
- What is Digital Transformation? Why Is It Important. (n.d.). Salesforce.Com. Retrieved January 21, 2023, from https://www.salesforce.com/products/platform/what-is-digital-transformation/
- Yung, R., & Khoo-Lattimore, C. (2019). New realities: A systematic literature review on virtual reality and augmented reality in tourism research. Current Issues in Tourism, 22(17), 2056–2081. https://doi.org/10.1080/13683500.2017.1417359
- World Travel & Tourism Council (WTTC) | Travel & Tourism Representative Council. (n.d.). Retrieved February 13, 2023, from https://wttc.org/
- Herdina, M. (2020, September 25). Augmented Reality Disappeared From Gartner's Hype Cycle - What's Next? | ARPost. https://arpost.co/2020/09/25/augmented-reality-gartners-hype-cycle/
- EY, Industry Pulse Report: Travel & Tourism | https://www.ey.com/el_gr/real-estate-hospitality-construction/dynamiki-anakampsi-gia-ton-elliniko-tourismo-to-2022
- Han, D.-I., tom Dieck, M. C., & Jung, T. (2018). User experience model for augmented reality applications in urban heritage tourism. Journal of Heritage Tourism, 13(1), 46–61. https://doi.org/10.1080/1743873X.2016.1251931
- Liu, C., Huot, S., Diehl, J., Mackay, W., & Beaudouin-Lafon, M. (2012). Evaluating the benefits of real-time feedback in mobile augmented reality with hand-held devices. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2973–2976. https://doi.org/10.1145/2207676.2208706