

AUGMENTED REALITY APPLICATIONS IN MUSEUMS: THE CASE OF SAKIP SABANCI MUSEUM*

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ABSTRACT

Museums, as indispensable tourist attractions within the scope of cultural tourism, should therefore interact and communicate with visitors using up-to-date technology whilst further developing technology in order to sustain their existence. Augmented Reality (AR) is a contemporary technology that has the potential to be used in museology. This research aims to determine the evaluations of visitors to Sakıp Sabancı Museum of the use of current AR applications. For this research, 19 semistructured interviews were conducted using a convenience sampling method. The content of the interviews were analyzed using a descriptive analysis method. The results of the research reveal that most of the interviewees after the Atlı Köşk visits, in which Sakıp Sabancı Museum AR applications were used, they considered AR applications to be useful and believed they should be adopted by other museums.

Keywords: *Augmented Reality, Technology, Museum, Tourism and Museums.*

JEL Codes: *O330, Z320*

MÜZELERDE ARTIRILMIŞ GERÇEKLIK UYGULAMALARI: SAKIP SABANCI MÜZESİ ÖRNEĞİ

ÖZ

Kültür turizmi kapsamında önemli bir turistik çekim öğesi olarak kabul edilen müzelerin, varlıklarını sürdürebilmeleri açısından çağın gereklerine ve gelişen teknolojiye uygun olarak ziyaretçileri ile etkileşim ve iletişim içinde olmaları gerekmektedir. Güncel bir teknoloji olan Artırılmış Gerçeklik (AG), müzecilikte potansiyel kullanım alanına sahiptir. Bu araştırmada, Sakıp Sabancı Müzesi'nde kullanılan AG uygulamalarının faydaları ve Sakıp Sabancı Müzesi'ndeki mevcut AG uygulamalarının müze ziyaretçileri tarafından nasıl değerlendirildiği ölçülmeye çalışılmıştır. 19 müze ziyaretçisi ile yapılan yüz yüze görüşmelerin içerikleri derlenerek betimsel analiz yöntemi ile analiz edilmiştir. Araştırmanın sonuçları, görüşme yapılan ziyaretçilerin Sakıp Sabancı Müzesi AG uygulamalarının kullanıldığı Atlı Köşk ziyaretleri sonrasında, AG uygulamalarını faydalı ve diğer müzelerde de kullanılması gereken bir uygulama olarak gördüklerini ortaya koymuştur.

Anahtar Kelimeler: *Artırılmış Gerçeklik, Teknoloji, Müze, Turizm ve Müzeler.*

JEL Kodları: *O330, Z320*

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INTRODUCTION

Cultural assets are regarded as primary evidence in disciplines such as archeology and the natural sciences, and thus their contributions are significantly important. Museums, where the cultural assets of the world are preserved and stored, bring these cultural assets and people together (Lewis, 2004: 1). Museums are integrated into the tourism sector and are referred to as a tourism element. Museum investments are therefore of vital importance in order to meet the expected standard of experience within universal tourism (Woollard, 2004; Jolliffe & Smith, 2001).

AR provides an enhanced view of the real world by facilitating the interaction between additional information such as images, sound, videos generated by computers, or any other data perceived by the senses, with the real world (Azuma, 1997; Gonzato, Arcila & Crespin, 2008; Kipper & Rampolla, 2012). AR creates reality platforms where the real world is supported by virtual objects in order to make the physical world feel more like it, by combining place and network-based information technologies (Milgram & Kishino, 1994; Johnson, Smith, Willis, Levine & Haywood, 2011). AR, as a technology that enables the real world to interact with the three-dimensional virtual world (Billinghurst, Kato & Poupyrev, 2001), creates a world that allows digital information to have a big role in the real world without replacing the real world (Chang, Morreala & Medicherla, 2010; Wang, Kim, Love & Kang 2013).

The development of technology and the various applications of these developments to different areas of life have made technology a part of social life and granted it a position in the dynamic structure of the tourism sector. Continuous improvements in AR technology, in which reality and virtuality are used together, have enabled the use of many applications in different forms in the field of tourism. This research brings together the museum, as an important non-formal educational institution that contributes to the formation and development of observation, logic, creativity, imagination and appreciation (Atagök, 1999), and the current AR technology on the basis that technology has an important part to play in both social and individual life. The main aim of this study is to inspect the usage of AR applications in field of museology and evaluate the perspectives of visitors towards the AR applications of Sabanci Museum.

LITERATURE REVIEW

Augmented Reality

AR is a version of Virtual Reality (VR) and has been shaped into its current form during the development stage of VR. Early AR applications date back to the time of the image director Morton Heiling in the 1950s. In 1962, Heiling developed a simulator called Sensorama as part of a project that he described as "The Future of Cinema" in 1955; and got the technology patented in the same year. Sensorama, which is regarded as the pioneer of VR, had two side-by-side 35mm cameras that created an ambiguous reality using its sensors, including using 3D moving images, smell, stereo sound, vibration while the user is in a sitting position and feelings of wind blowing through one's hair (mortonheilig.com, 2016).

In 1966, Ivan Sutherland invented the "Head-Mounted Display", a system that could display simple graphics and was sometimes attached to the ceiling, depending on the ceiling due to the fact that it was heavy and difficult to use. In his work "The Ultimate Display," Sutherland argued that computer interactions with human beings will evolve into virtual experiences, thus anticipating the future of AR (Sutherland, 1968).

AR was first introduced in 1990 by Boeing computer system researchers Tom Caudel and David Mizell to help employees during the aircraft construction phase; discussions began then about advantages and disadvantages of AR and VR (Caudell & Mizell, 1992). This was also the first use of AR for educational purposes.

The definition of the reality-virtuality process used by Paul Milgram and Fumio Kishino in 1994 is widely recognized in the academic world and is still valid today. The relationship between reality and virtuality is defined as shown in Figure 1, which also illustrates the place of AR and the difference between the positions of AR and SR. On one side of illustration is the world that is perceived without any hardware, while the other side refers to a world produced entirely through a computer. Virtuality is closer to VR as it moves away from the real world. In the AR between the virtual environment and the real environment, the real environment is more dominant than the virtual environment, and thus the real environment is closer.

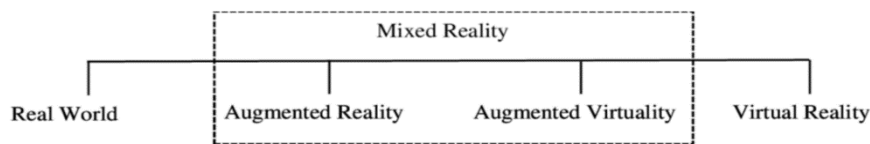


Figure 1: Reality-Virtuality Continuum

Source: Milgram and Kishino, 1994:1322.

In 1997, Ronald Azuma described the characteristic features of the AR accepted in the literature. According to Azuma, AR has three characteristic features. These are:

- 1) Combination of real and virtual reality
- 2) Real-time interaction
- 3) These elements are shown in three-dimensional environments (Azuma, 1997)

When AR applications are examined according to their technology, it is clear that different researchers use different classifications. In the classifications used in these studies, AR is essentially divided into two systems; tracking systems and imaging systems (Bimber & Raskar, 2005; Johnson, Levine, Smith & Stone, 2010; Carmigniani & Furht, 2011; Pence, 2011; Chen & Tsai, 2012).

Tracking systems are divided into two basic systems: marker-based tracking and markless tracking. Objects or images defined in unguided tracking systems are detected by cameras, and data specified by the Global Positioning System (GPS) or Wireless LAN (Wi-Fi-Wireless Fidelity) systems are used. Marker tracking systems require barcodes and other systems (Pence, 2011). QR codes, also developed as a smartphone application, are the most common marker tracking systems.

Imaging systems, on the other hand, are made by processors to place generated virtual information on to a real world image. These are systems in which AR applications

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such as computers, tablets, smart phones, and game consoles are implemented. It is established by the imaging system that the image from the user's camera and the virtual information presented by the processor are in the same environment (Carmigniani & Furht, 2011).

In the AR visualization system, virtual information and real world images should be available at the same time, three-dimensional images should be visible, the user should be free from restrictions, and there should be a common space for both virtual information and real-world images (Eitoku, Tankawa & Suzuki, 2006).

There are three main displaying systems; head mounted display, handheld display and spatial display (Carmigniani & Furht, 2011).

Head Mounted Display: Devices with optical images are attached to the top of the user's head or face, corresponding to one or both of their eyes (Kesim & Ozaslan, 2012).

Handheld Display: Mobile devices such as handheld smartphones and tablets. They are the most common and practical devices used in AR applications due to their small size and ease of access. Even in present day smartphones, having features such as a powerful processor, camera, GPS etc. and being more suitable in terms of portability, suggest that smartphones will continue to be used for AR in the future. However their small screens are a disadvantage in terms of 3D user interfaces (Carmigniani & Furht, 2011; Wagner & Schmalstieg, 2003).

Spatial Display: Spatial Augmented Reality examines the interaction between the real world and the virtual world according to the environment of the user. Unlike other AR applications, virtual information is integrated with the environment of the user rather than their field of vision. Without any equipment, the virtual world is combined with the real world by directly projecting the computer generated image onto the real world using technologies such as video projectors, optical elements and holograms. Users do not require any device to be used. In general, spatial imaging is distinguished from other imaging technologies by the inclusiveness of the users and the environment. Compared to other imaging technologies, spatial imaging technology is more advantageous in solving problems such as visualization (resolution, field of vision, focus etc.), technical features (tracking, lighting etc.), the human factor (problems using technology etc.); however it is limited to immobile applications. The decreasing cost of personal computers, graphics software and the increasing availability of projection technologies have led increasing interest in spatial AR applications among research laboratories, universities, museums, industry & art communities (Bimber & Raskar, 2005; Carmigniani & Furht, 2011).

Augmented Reality and Tourism

The ability of AR to be used almost everywhere and its increasingly widespread usage growing have enabled it to be used in many different areas (Dunleavy, Dede & Mitchell, 2009). Previously, six area of utility were being mentioned for AR applications as medical, production and repair, fact sheets and visualization, robot path planning, entertainment, and military aviation (Azuma, 1997) but nowadays, with the technological development and proliferation of mobile devices AR applications are started to be used

in many areas such as education, architecture and construction, advertising and marketing, entertainment and game, tourism, etc.

Several studies can be found within the field of education about the education related usages of AR applications such as their effects on learning process (Walczak, Wojciechowski & Cellary, 2006; Alcañiz, Perez-Lopez, Contero & Ortega, 2010; Mohana et al., 2012), achievements they provides to students (Kirner, Reis & Kirner; 2013; Wojciechowski & Cellary, 2013; Cheng & Tsai, 2012; Wu, Lee, Chang & Liang; 2013; Radu, 2014), their effects on students' understanding and problem solving skills (Núñez, Quirós, Núñez, Carda & Camahort, 2008; Jan, Noll, Behrends & Albrechti; 2012), and their comparison with the traditional learning by books. Within medical science AR applications can be used for the treatment of some phobias. Botella, Juan, Baños, Alcañiz, Guillén & Rey (2005) used AR for the treatment of cockroach phobia in their study considering the aspect of AR that offers the user full control over the artificial elements. Within the field of industrial designing, AR applications provides to engineers the possibility of designing, testing, and implementing during each step of product development. For instance, during the impact tests and calculations for automobiles AR applications are being used as a new method (Noelle, 2002).

AR applications are used to improve the visitor experience in the tourism sector (Fritz, Susperregui & Linaza, 2005). Studies within the tourism literature also have the main focus on this subject (Fritz, Susperregui & Linaza, 2005; Kounavis, Kasimati & Zamani, 2012; Rodriguez-Fino, Martin-Gutierrez & Meneses Fernqandez, 2013; Han et al., 2014; Jung, Chung & Leue, 2015; Han, Weber, Bastiaansen, Mitas & Lub, 2020). With the AR applications, tourists are able to reconstruct buildings, cities, natural areas, fields, artifacts and etc. as their former selves in their minds (Sood, 2012: 5). In addition, there are studies in which the benefits and disadvantages of AR applications in toursim are inspected (Yovcheva, Buhalis & Gatzidis, 2012), their contribuitions to learning and formation of the sense of place are evaluated (Chang, Hou, Pan, Sung, Chang, 2015), their affects on attitude and behavior are tried to be determined (Chung, 2018), their affects on user satisfaction and decision of recommendation are evaluated (Jung et al. 2015), the factors affecting the acceptability of these applications by the users and the level of interest of the users are focused (Haugstvedt & Krogstie, 2012).

AR applications have added a new dimension to cultural tourism. Some of the projects in which virtual and real-world images have been combined in cultural areas include the following. The Ancient Pompeii project provides visitors with further information about the daily life of the ancient city, to enhance their experience of the archaeological sites uncovered by the excavations. According to Papagiannakis et al. (2005), the visualization of the daily life of the ancient city with virtual images helps visitors broaden their horizons and understand and interpret ancient cities more clearly. In China, the Yuanmingyuan Imperial Garden, which dates back to 1707, was destroyed and disappeared. However, digital reconstruction has been designed with the help of AR applications to ensure that the old version of this historic area is visible to visitors (Huang, Liu & Wang, 2009). March is another example of an AR project in a cultural area that is worth mentioning. The application enables the wall writings of prehistoric times to appear in their original form. It is necessary to capture the wall writings in a picture taken with a

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cell phone camera in order to have a proper display of the realistic information generated by the computer on the mobile phone screen (Choudary, Charvillat, Grigoras & Gurdjos, 2009). Archeoquide is an Information Society Technologies (IST) project sponsored by the European Union to encourage archaeologists to transfer information about cultural sites to visitors to those sites. Instead of rebuilding historic sites, visitors can experience virtual reconstructions in the real world using mobile devices or display units (such as a head mounted indicator) (Gleue & Dähne, 2001), and acquire more detailed information and explanations about navigation and artifacts with their mobile devices via AR (Vlahakis et al., 2002).

It is aimed for this study to raise awareness for the museums and to contribute to both the related literature and future studies on this subject. Furthermore, the inspection of the AR applications of the museums is hoped to be a guide for the other museums that also wants to implement those applications. Museums that are considered as an aspect of cultural tourism are very important in regards to their ability to provide different experiences for the tourists. There is a relation between tourism and museum in terms of creating and presenting culture, and creating experience (Jolliffe & Smith, 2001: 167). While the vast majority of the visitation requirements of the museums which turned into a touristic product are being met by the people participating in touristic activities, likewise visitor attraction needs of the tourism sector are being met thanks to museums (Arslan, 2014: 24). In this age which technology is an important part of both personal and social life, for museums to progress according to the requirements of the age is vital in terms of their communications with the society. It is thought that it is an important factor for museums to adopt innovations by the help of up to date technologies in the name of answering demands and needs and continuing their existence.

STUDY SITE

The villa, the main building of the Sakip Sabancı Museum, is located in Emirgan, in one of Istanbul's oldest settlements on the Bosphorus. It was constructed by Prince Mehmed Ali Hasan for the Hidiv family of Egypt, who commissioned the Italian architect Edouard De Nari to design the building in 1925 (Uras, 2013). The villa, now the museum's main building, was used as a summer house for many years by various members of the Hidiv family before being purchased by the Sabancı family. Atlı Köşk eventually came to be used permanently by the family and in 1998 the mansion was bequeathed, along with its collections and furnishings, to Sabancı University by the Sabancı family in order for it to be transformed into a museum (sakipsabancimuzesi.org, 2016).

AR applications in are used in rooms on the lower and upper floors of the Sakip Sabancı Museum where the Sabancı Family used to lived. The AR applications within the museum operate by scanning QR codes throughout the several places of the museum with cam of ipads that is given at the entrance of the museum. On the first floor in the section which is called family rooms, the opportunity to see the photos of Sabancı Family is provided via AR technologies (Figure 2).

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Photographs of the Sabancı family are displayed digitally on the small screens in the room on the ground floor of Atılı Köşk. In addition, further information related to the family's business life, publications, philanthropy, and rewards can be acquired using the touch screen in the same room.

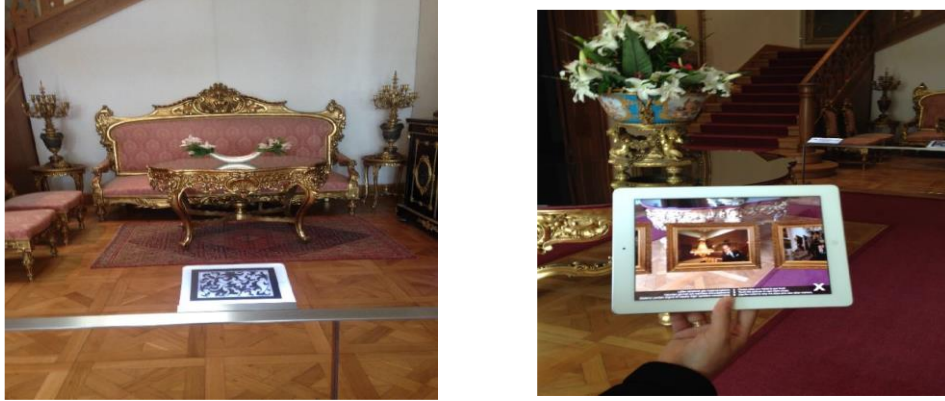


Figure 2: Family Rooms QR Code and AR Scene

On the second floor, under the title of “Golden Letters: Ottoman calligraphy and tableaux collection from Sabancı University Sakıp Sabancı Museum” there is The Arts of the Book and Calligraphy Collection section which is the first Turkish collection and private calligraphy collection being exhibited in New York Metropolitan Art Museum. Within the sections included to The Arts of the Book and Calligraphy Collection such as “Calligraphers’ Skillful Works: Muraqqa and Kit’a, Beautiful Mural Calligraphies: Levha and Hilye-i Şerif, From the Pigeonhole of a Calligrapher, Echoes of Faith: Books of Prayer with Pictures, Holy Scripture of Muslims: Kuran-ı Kerim, Treasure of Booklovers: Artistic Manuscripts”, thanks to AR applications miniatures invigorate.

Thanks to AR applications it is possible to view all pages of the rare and untouchable manuscripts of Turkish and Islamic arts (Figure 3). Those artifacts are: “The endowment document which carries the signature of Sultan Bayezid 2nd about Mevlana Şemseddin’s land properties and moveable properties within Bursa and İstanbul”, “the certificate (celi divanı hat) which carries the signature of Sultan Murat 3rd about renewal of the right to use of a land belonged to Grand Vizier Sokullu Mehmet Pasha (1579)”, “a journal of prayer dates back to 14th century”, “a pictorial book from 18th century Iran (Tarih-i Kitabı Müstetab Ahbar-ı Aliyye der Gazavat-ı Mürtezaviyye/ talih hat)”, “Kuran’ı Kerim illuminated by Hasan with the ornamentation date of 1256-1840-41 (hürde talik hat)”

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Figure 3: Turkish and Islamic Arts AR Application

METHODOLOGY

In this research, AR applications for Sakip Sabancı Museum were selected to determine the usage of the AR application in the museum and the evaluations of the visitors.

The qualitative research method of semistructured interviews were used to collect data from the museum's visitors in order to understand their views. The interview questionnaire was prepared following a literature review (Kozak, 2014). The sample in the study was selected using a convenience sampling method, based on the inclusion of those who were considered appropriate and were also present at the museum. According to Sekaran (2003), the convenience sampling method is the best way of collecting some basic information quickly and efficiently. Interviews were conducted with the visitors of Atlı Köşk, where the AR applications were used, who agreed to be interviewed between the 14th-16th of April 2016, the period for which permission was granted by the Sakip Sabancı Museum. All of the interviews were carried out in the museum.

The interviews were recorded with the permission of the participants and the voice recordings were converted into a written format; this formed 25 pages of data. The interviews were concluded when the collected data began to repeat itself (reaching saturation point) (Sekaran & Bougie, 2013). A descriptive analysis method was used for the data analysis. Main aspect of this analysis method is to keep the originality of the data as much as possible and present the data to the reader by direct quotes from the participants of the study. Direct quotations are given frequently to present the perspectives of participants in a striking way. In this regard the data and the results are very similar to each other in the narrative sense (Wolcott, 1994). The presentation of the data can be arranged according to the themes derived from the interview answers as well as it can be done by considering only the question contents (Kümbetoglu, 2015).

The names of the interviewees are coded as Participant 1, Participant 2, ..., Participant 19. In the findings section, all identifying information was kept confidential

during discussions of the interviewees' opinions. Data analysis, based on the questionnaire, was arranged under headings according nine of the questions in the questionnaire, excluding six questions related to the socio-demographic characteristics of the participants. Typically, the following introductory questions to the central issues of interest were asked:

- 1- Did you already know about the concept of AR? From where?
- 2- Did the use of AR applications in the museum affect your decision to visit the museum? Why/why not?
- 3- Have the AR applications used in the museum had a positive influence on your interest in the museum and its artefacts? In what way?
- 4- Can AR applications be used in different parts of the museum? Why/why not?
- 5- During your visit to the museum, did you experience any technological problems with the AR applications? If so, what?
- 6- Should more information be provided before you visit the museum about the AR applications used in the museum? If so, why?

Table 1: Profile of the Participants

Participant	Age	Gender	Education	Choice of Museum and Visit Frequency	Average Museum Visit Duration	Average Sakıp Sabancı Museum Visit Duration
1	40	Male	High School	All Kinds (1-2 per year)	2-2,5 hour(s)	1 hour(s)
2	37	Male	Post Graduate	Museum of Modern Art (1 per month)	2 hour(s)	1-1,5 hour(s)
3	26	Male	Bachelor Degree	Museum of Modern Art (1 per month)	2-3 hours(s)	20-25 mins.
4	28	Male	Bachelor Degree	Art and Painting Museums (2 per year)	2 hour(s)	1-1,5 hour(s)
5	31	Female	Doctorate	Art and Archeology Museums (2-3 per year)	4-5 hour(s)	1-1,5 hour(s)
6	20	Male	Bachelor Degree	Art Museums (2-3 per month)	2 hour(s)	1 hour(s) 15 mins.
7	35	Male	Bachelor Degree	Turkish Handicrafts and Islamic Works (1 per month)	30 mins. - 1 hour(s)	2 hour(s)
8	18	Male	High School	School Trip (1-2 per year)	30 mins. - 1 hour(s)	20 mins.
9	19	Female	Bachelor Degree	School Trip (1-2 per year)	1-1,5 hour(s)	1-1,5 hour(s)
10	25	Female	Bachelor Degree	Art and Painting Museums (2 per year)	1 hour(s)	30 mins.
11	30	Female	Bachelor Degree	Contemporary Art Museums (2-3 per year)	1,5-2 hour(s)	40 mins.
12	19	Female	Bachelor Degree	Museum of Modern Art (1 per month)	1 hour(s)	20-30 mins.
13	35	Female	Bachelor Degree	Art and Painting Museums (1-2 per year)	1-2 hour(s)	20-25 mins.
14	26	Female	Post Graduate	All Kinds (2-3 per year)	1-2 hour(s)	20-25 mins.

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15	36	Female	Bachelor Degree	Art and Painting Museums (1 per 2 months)	1,5-2 hour(s)	1 hour(s)
16	23	Female	Post Graduate	Art and Painting Museums (2 per year)	1 hour(s)	45 mins.
17	29	Male	Bachelor Degree	Natural History Museums (2-3 per year)	1-1,5 hour(s)	40-45 mins.
18	36	Male	Post Graduate	Contemporary Art and Technology Museums (2-3 per year)	2-3 hour(s)	40-45 mins.
19	38	Male	Doctorate	Archeology Museums	1-1,5 hour(s)	1 hour(s)

FINDINGS

During the interviews, the museum visitors were asked about the concept of AR, the AR applications used in the museum, the contribution of the AR applications to the impact of the museum and its artifacts, the possibility of using AR applications in different parts of the museum, problems encountered while using the technology, and the information shared about the AR applications before their visit. Some additional questions were asked regarding the use of AR applications in museums in order to determine their opinions and suggestions about AR applications and the impact of these on their decision to recommend - or not - Sakıp Sabancı Museum and AR applications to their acquaintances.

Awareness of the Concept of Augmented Reality

During the research, Sakıp Sabancı Museum visitors were asked whether or not they had known of the concept of AR before their visit; it was clear that very few of the museum visitors had knowledge of AR, and those that did had only ever experienced AR applications in museums outside Turkey. Accordingly, Participant 2 stated:

“In fact, it has been implemented in most museums in foreign countries. They even provide WIFI from a small square; you can directly download the applications via WIFI and when you go to a particular spot, it understands the exact spot and works out when you tapped. There is such an application. I have seen it in many museums. In addition to these, many things can be done for children in various places abroad in order to attract their interest; for instance, some things such as artistic stuff may be boring for children, so they press a button and the whole image comes alive.”

When asked whether they had come across AR applications in different areas, only three of the visitors replied favourably among those who had knowledge of the concept of AR. Participant 6 stated:

“Yes, I read a magazine called "Popular Science"; in general it is a science magazine and it has an AR application. When we bring the application up on the phone and scan the QR code on the articles in the magazine, we can access certain videos and visuals related to the topic.”

Effects of AR Applications used in Museums on Demand

When the interviewees were asked whether or not they had known that AR applications are used in museum - and if yes, did this have an impact on their decision to visit the museum - most of the visitors replied that they had not known, stating, for example, “No, I did not know, they just said that they can give you an iPad and we can visit the museum with an iPad”, “I learnt that there is an application like that when I arrived”, and “I did not know, it just came up”. The visitors who did know declared that they had heard of it through word of mouth, social media and online news. Participant 5, Participant 6 and Participant 19 stated as follows:

“Yes. There was news on Facebook about Sakıp Sabancı Museum being a must-visit museums, so I was curious and decided to visit the museum.”

(Participant 5)

“Yes, I had knowledge of AR and had used it in some areas but I had never seen it used in a museum before, I heard news on the internet of the use of AR in Sakıp Sabancı Museum so I wondered about the way the technology is used.”

(Participant 6)

“Yes, I knew, I also knew that I could examine the content of artworks with this application and so I came to examine the content of the handwritten works.”

(Participant 19)

Effects of AR Applications on Museums and Artifacts

It is clear that when the museum visitors were asked about the influence of the AR applications used in Sakıp Sabancı Museum on their interest in the museum and its artifacts, the opinions given focused on the positive effects of the technology. The AR application offers a chance to examine artifacts in close detail, appreciating their vivid colours and attractive nature, whilst accessing more detailed information. The application was described as fun, convenient, with fascinating and enjoyable features, and as supporting visualisation and making the artifacts more accessible and tangible. Several visitors also described how the application made them feel transported back to the time of the artefacts.

In Table 2, the most frequently used expressions and the frequencies with which they were repeated can be seen in response to being asked to describe the effects of the AR applications used in the museum on their interest in the museum and its artifacts.

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Table 2: The Most Highlighted Expressions to Describe the Effect of AR Applications on Interest in the Museum and its Artifacts

Expressions	Frequency
Opportunity for detailed examination	7
Interesting and impressive	5
Useful	3
Convenient	3
Close look	3
Create a lasting impression	2
Vivid and colorful	2
Feeling of being alive	2
Accessing further information	2
Fun	2
Feeling of being nested	1
Tangibility and accessibility	1
Visualisation	1
Concentration on artifacts	1

These are the some of the statements that the participants made:

“Yes, it's good to see in more vibrant colors because we do not see such detail behind the glass, but we see more detail on the tablet”.

(Participant 4)

“It was a fun museum visit that made me feel nested with the vivid miniatures. The miniatures were brought to life by the application, which touched me, and also the atmosphere made me feel like I was living in that period.”

(Participant 5)

“Yes, for example I have seen the works in more detail. It was nice to be able to see all of the pages of an artifact rather than just a book behind a glass screen or only being able to examine a single page from a distance.”

(Participant 7)

“Yes, I am very pleased with its beautiful influence; the visualization has allowed me to concentrate more on interesting artifacts.”

(Participant 14)

“Yes, it was more enjoyable. I said they had modernized, after my visit. In fact, I came with my mother and she is farsighted so I think it would be better for such people as they can zoom in and see the photos.”

(Participant 15)

However, the positive opinions of the interviewees above does not reflect a consensus among all of the visitors. Participant 3 stated:

“Frankly I'm not a fan of so much technology, I prefer to look with the naked eye instead of looking at a tablet. Of course there is a positive effect of being different, but I prefer reality. I do not want technology to penetrate art so much. There are lots of people using this and I am not so strict in my opposition, but I think it would be beneficial if some things remained without technology.”

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The opinion of Participant 16 was:

“Yes, when I zoomed in I could see easily and could read more clearly. We just talked to my friend about whether there should be a guide or applications like this; a guide would create a more permanent one-to-one relationship.”

The visitors were also asked about their opinions about the use of AR applications in different parts of the Sakıp Sabancı Museum. Almost all of the museum visitors stated that it should be used as it provided a convenient way of accessing information and examining the artifacts in detail. Participant 6 explained his view in the following way:

“It can be used in my opinion, it would be great if we could access information with an iPad about what the artist wanted to say or explain with the art pieces, especially in temporary exhibitions.”

(Participant 6)

Problems Encountered by Visitors while Using Technology

When the museum visitors were asked whether or not they had experienced any technical problems, it was revealed that almost none of them had. Nevertheless, half of them stated that there should be more information provided about the content of the application. The visitors who asked for more information stated that at first they were not interested because they did not receive detailed information about the application upon entering the museum, but when they saw people visiting the museum with iPads, they went back to the entrance and took an iPad, which they used for the rest of their visit. Some of the visitors expressed their opinions about the need to inform visitors of the AR application used in the museum in the following terms:

“At first we could not understand the application, that actually there are photos of the artifacts. In fact we thought it showed the same thing for each artifact so we stopped using it after a point. Then a friend there explained; this should be included as information.”

(Participant 10)

“It would be better to be informed that there is an application like this at the entrance. I was informed but I did not pay much attention. Later I became interested after seeing it being used by other people. I went to the entrance of the museum and took the iPad and started to explore and review the pieces again.”

(Participant 15)

Opinions of the Visitors on the Use of AR Applications in Museums

When the museum visitors were asked whether or not they would like to visit other museums where AR applications are also used, most of them replied favourably with statements such as “it is always easier than carrying a brochure”, “it is better to be nested with the artifacts”, “it is more pleasant to get information without needing a guide”, “it leads to a close connection between the artifacts and visitors”.

In addition to that, the majority of the interviewees stated that they would recommend that people they know visit museums where AR applications are used, describing AR applications as “different and should be experienced, [they are] fun,

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colorful, useful, help you have good time, make the visit practical and detailed, unlike conventional exhibitions”.

“Yes, it helps a lot to bring the artifacts to life; they’re also a bit of fun, there were miniature heroes like they were falling. It’s fun, making the color more attractive. It was nice to wait for a surprise element when we read it on the tablet.”

(Participant 5)

“I would recommend visiting. It offers both a more practical and more detailed visiting opportunity. The time is set according to the willpower and interest area of the visitor instead of a rushed guide or officer.”

(Participant 19)

Comments and Suggestions of Visitors about the Museum Visit and AR Applications

The museum visitors were also asked to share their opinions and suggestions about the museum visit and AR applications. The most common opinions stated that it is a useful application and provides for a pleasant time, and suggested that they should be used in museums located in archeological sites, somemore information about the artifacts could be included, additional information about the application should be shared at the entrance to the museum, and there should be more advertisements and promotions about the application. In this regard, these are the some of the opinions given:

“My opinions are very positive. It was not audible, I do not know whether it can be applied in here but it would be more impressive if it is audible. We also did not know about the AR applications before we arrived and that we could have visited with a tablet. There should be advertisements etc. promoting this way of visiting and examining of the Book Arts and Calligraphy Collection.”

(Participant 11)

“I especially would like to see it used effectively in museums located in archeological areas. A little bit more information about the application could be added and the description part could be expanded with visuals.”

(Participant 16)

DISCUSSION

It cannot be denied that rapidly developing technology has an important place in our daily lives. By creating new needs through new applications, technology is becoming an increasingly important component of our daily lives. Developments in information technologies have also brought a new dimension in terms of access to information. It is expected that AR technology, which is current and is used in many different areas, will play an important role in human life with continuing changes and developments in the future.

AR has different qualified applications in the field of museology. The overall outcome of this study, which examined how Sakip Sabancı Museum visitors evaluate AR applications, is that the AR applications used at Sakip Sabancı Museum are considered useful and are expected to be used in other museums by the visitors.

The interviews revealed that the museum visitors did not have adequate knowledge of the concept of AR. When the effect of AR applications on demand was examined, it was found that most of the interviewees did not know that AR applications are used at Sakıp Sabancı Museum before their visit. Thus, the AR applications did not have an impact on demand from this particular group. However, the museum visitors stated that they would like to visit other museums where AR applications are also used and would recommend this museum to their acquaintances. Jung, Chung & Leue, (2015) have also shown that AR applications have positive effects on tourist satisfaction and recommendation decisions.

The museum visitors that knew that AR applications are being used in the museum stated that they visited the museum because they were curious about this application. Cianciarulo (2015) indicated, in his study on the small museum The Muvig Museum of Viggiano (Italy), which has local importance, that this new application attracted visitors after the reopening of the museum, that people visited the museum in order to experience this innovation and that museum visits have become more interesting for children.

AR applications used in museums have positive effects both on museums and on artifacts. Expressions such as “feeling of being nested, more permanent information and concentration on artifacts, help for visualisation, practical and different from conventional exhibitions, fun, attractive, impressive” have been used to refer to AR applications. In the study by Tom Dieck, Jung & tom Dieck, D (2016) it was pointed out that AR applications help visitors make connections between artifacts whilst personalizing their learning experiences. In the Allard Pierson Museum, which is the archeological museum of the University of Amsterdam, Zöllner, Keil, Wuest & Pletinckx (2009) intended to establish a link between the archeological excavations and the artifacts of the same place through AR applications, as some argue that archaeological or cultural heritage sites cannot be presented in such an realistic and interesting way. As a result of this study, AR applications have started to be considered a fun way of presenting cultural heritage areas in museums.

Regarding AR applications, sufficient information - including practice implementation and content coverage - should be provided to people who have less interest to technology not only to prevent technical problems arising but also to ensure the efficient use of the application. This information should be considered an important issue worth discussing in future potential museum uses according to visitor profiles. In addition, it should be noted that increases in the visualization of artifacts and information about artifacts should be sufficiently aligned. Depending on the content of the museum, the enrichment of AR applications such as audio and video features should be emphasized. Written documents such as brochures and booklets may be enriched by AR applications. This research has been conducted in museum section that mostly exhibits Ottoman books and calligraphy art pieces. In future research, the use of AR applications in different museums in terms of their content may be considered, as well as the educational aspects of museums and the opinions of students, in order to increase awareness of AR among students groups.

REFERENCES

- Alcañiz, M., Perez-Lopez, D. C., Contero, M., & Ortega, M. (2010). *Augmented reality technology for education*. INTECH Open Access Publisher. doi: 10.5772/9228.
- Arslan, A. (2014). İstanbul arkeoloji müzeleri'nin turizmdeki yeri üzerine bir değerlendirme. *Journal of International Social Research*, 7(29), 24-29.
- Atagök, T. (1999). *Yeniden müzeciliği düşünmek*. İstanbul: Yıldız Teknik Üniversitesi Yayınları.
- Azuma, R. (1997). A survey of augmented reality. *Presence-Teleoperators and Virtual Environments*, 6(4), 355-385.
- Billinghurst, M., Kato, H., & Poupyrev, I. (2001). The magicbook-moving seamlessly between reality and virtuality. *Computer Graphics and Applications*, 21(3), 6-8.
- Bimber, O., & Raskar, R. (2005). *Spatial augmented reality: Merging real and virtual worlds*. Florida: CRC Press.
- Botella, C. M., Juan, M. C., Baños, R. M., Alcañiz, M., Guillén, V., & Rey, B. (2005). Mixing realities? An application of augmented reality for the treatment of cockroach phobia. *Cyberpsychology & Behavior*, 8(2), 162-171.
- Carmigniani, J., & Furht, B. (2011). Augmented reality: An overview. In B. Furht (Ed.), *Handbook of augmented reality* (pp. 3-46). Berlin: Springer Science & Business Media.
- Caudell, T.P., & Mizell, D.W. (1992). Augmented reality: An application of heads-up display technology to manual manufacturing processes. *Proceedings of the 25th Hawaii International Conference on System Sciences*, 659-669.
- Chang, G., Morreala, P., & Medicherla, P. (2010). Application of augmented reality systems in education. In D. Gibsonand & B. Dodge (Eds.), *Proceedings of society for information technology and teacher education international conference*, (pp. 1380-1385). Waynesville: Association for the Advancement of Computing in Education (AACE).
- Chang, Y. L., Hou, H. T., Pan, C. Y., Sung, Y. T., & Chang, K. E. (2015). Apply an augmented reality in a mobile guidance to increase sense of place for heritage places. *Journal of Educational Technology & Society*, 18(2), 166-178.
- Chen, K. H., & Tsai, C. C. (2012). Affordances of augmented reality in science learning: Suggestions for future research. *Journal of Science Education and Technology*, 22(4), 449-462.
- Choudary, O., Charvillat, V., Grigoras, R., & Gurdjos, P. (2009). MARCH: Mobile augmented reality for cultural heritage. In *Proceedings of the 17th ACM International Conference on Multimedia*, 1023-1024. doi: 10.1145/1631272.1631500.
- Chung, N., Lee, H., Kim, J. Y., & Koo, C. (2018). The role of augmented reality for experience-influenced environments: The case of cultural heritage tourism in Korea. *Journal of Travel Research*, 57(5), 627-643.
- Cianciarulo, D. (2015). From local traditions to "Augmented Reality". The MUVIG museum of Viggiano (Italy). *Procedia-Social and Behavioral Sciences*, 188, 138-143.

- Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of Science Education and Technology*, 18(1), 7-22.
- Eitoku., S., Tankawa, T. & Suziki, Y. (2006). Display composed of water drops for filling space with materialized virtual three-dimensional objects. *In Proceeding of the IEEE Conference on Virtual Reality*, 159-166. doi: 10.1109/VR.2006.51.
- Fritz, F., Susperregui, A., & Linaza, M. T. (2005). *Enhancing cultural tourism experiences with augmented reality technologies*. Paper presented at the 6th International Symposium on Virtual Reality, Archaeology and Cultural Heritage (VAST), Pisa, Italia.
- Gleue, T., & Dähne, P. (2001). Design and implementation of a mobile device for outdoor augmented reality in the archeoguide project. *In Proceedings of the 2001 Conference on Virtual Reality, Archeology and Cultural Heritage*, 161-168. doi: 10.1145/584993.585018.
- Gonzato, J.-C., Arcila, T., & Crespín, B. (2008). *Virtual objects on real oceans*. GRAPHICON'2008, Moscow, Russia.
- Han, D. I., Jung, T., & Leue, M. C. (2014). *A user experience model for augmented reality applications in the urban heritage context*. Paper presented at the 12th APacCHRIE Conference, Kuala Lumpur, Malaysia.
- Han, D. I. D., Weber, J., Bastiaansen, M., Mitas, O., & Lub, X. (2020). Blowing your mind: a conceptual framework of augmented reality and virtual reality enhanced cultural visitor experiences using EEG experience measures. *International Journal of Technology Marketing*, 14(1), 47-68.
- Haugstvedt, A. C., & Krogstie, J. (2012). *Mobile augmented reality for cultural heritage: A technology acceptance study*. Paper presented at the 2012 IEEE international symposium on mixed and augmented reality (ISMAR), Atlanta. doi: 10.1109/ISMAR.2012.6402563.
- Huang, Y., Liu, Y., & Wang, Y. (2009). AR-View: an augmented reality device for digital reconstruction of Yuangmingyuan. *In 2009 IEEE International Symposium on Mixed and Augmented Reality-Arts, Media and Humanities*, 3-7. doi: 10.1109/ISMAR-AMH.2009.5336752.
- Jan, V.U, Noll, C. Behrends, M., & Albrechti, V. (2012). mARble – augmented reality in medical education. *Biomed Tech*, 57, 67-70.
- Johnson, L., Levine, A., Smith, R., & Stone, S. (2010). *The horizon report 2010 edition*. Austin, Texas: The New Media Consortium.
- Johnson, L., Smith, R., Willis, H., Levine, A., & Haywood, K. (2011). *The 2011 horizon report*. Austin, Texas: The New Media Consortium.
- Jolliffe, L., & Smith, R. (2001). Heritage, tourism and museums: The case of the North Atlantic Islands of Skye, Scotland and Prince Edward Island, Canada. *International Journal of Heritage Studies*, 7(2), 149-172.
- Jung, T., Chung, N., & Leue, M. C. (2015). The determinants of recommendations to use augmented reality technologies: The case of a Korean theme park. *Tourism Management*, 49, 75-86.

Augmented Reality Applications in Museums: The Case of Sakip Sabanci Museum

- Kesim, M., & Ozaslan, Y. (2012). Augmented reality in education: Current technologies and the potential for education. *Procedia – Social and Behavioral Sciences*, 47, 297-302.
- Kipper, G., & Rampolla, J. (2012). *Augmented reality: An emerging technologies guide to AR*. Waltham: Elsevier.
- Kirner, T.G., Reis, F.M.V., & Kirner, C. (2012). Development of an interactive book with augmented reality for teaching and learning geometric shapes. *Information Systems and Technologies (CISTI)*, 1-6.
- 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.
- Kozak, M. (2014). *Bilimsel araştırma: Tasarım, yazım ve yayın teknikleri*. Ankara: Detay Yayıncılık.
- Kümbetoğlu, B. (2015). *Sosyolojide ve antropolojide niteliksel yöntem ve araştırma*. İstanbul: Bağlam Yayıncılık.
- Lewis, G. (2004). The role of museums and the professional code of ethics. In P. J. Boylan (Ed.), *Running a museum: A practical handbook* (pp. 1-16). Fransa: International Council of Museums.
- Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE(The Institute of Electronics, Information and Communication Engineer) Transactions on Information and Systems*, 77(12), 1321-1329.
- Mohana, Z., Musae, I., Tahir, M.A., Parhizkar, B., Ramachandran A., & Habibi, A. (2012). Ubiquitous medical learning using augmented reality based on cognitive information theory. *Advances in Computer Science, Engineering & Applications*, 167, 305- 312.
- Noelle, S. (2002). *Stereo augmentation of simulation results on a projection wall by combining two basic ARVIKA systems*. Proceedings International Symposium On Mixed And Augmented Reality, Darmstadt, Almanya. doi: 10.1109/ISMAR.2002.1115108.
- Núñez, M., Quirós, R., Núñez, I., Carda, J. B., & Camahort, E. (2008). *Collaborative augmented reality for inorganic chemistry education*. Paper presented at the IASME International Conference on Engineering Education, Heraklion, Greece.
- Pence H. E. (2011). Smartphones, smart objects, and augmented reality. *The Reference Librarian*, 52(1-2), 136–145.
- Papagiannakis, G., Schertenleib, S., O'Kennedy, B., Arevalo-Poizat, M., Magnenat-Thalmann, N., Stoddart, A., & Thalmann, D. (2005). Mixing virtual and real scenes in the site of ancient Pompeii. *Computer Animation and Virtual Worlds*, 16(1), 11-24.
- Rodriguez-Fino, E., Martin-Gutierrez, J., & Meneses Fernandez, M. D. (2013). Enrique Armas Davara, interactive tourist guide: Connecting web 2.0, augmented reality and QR codes. *Procedia Computer Science*, 25, 338–344.
- Radu, I. (2014). Augmented reality in education: A meta-review and cross-media analysis. *Personal and Ubiquitous Computing*, 18(6), 1533–1543.

- Sakıp Sabancı Müzesi, (2016). *Müze tarihi*. <http://www.sakipsabancimuzesi.org/tr/sayfa/muze-tarihi> adresinden 8 Mayıs 2016 tarihinde edinilmiştir.
- Sekaran, U. (2003). *Research methods for business a skill-bulding approach* (4th ed.). New York: John Wiley & Sons.
- Sekaran, U., & Bougie, R. (2013). *Research methods for business: A skill building approach*. New York: John Wiley & Sons.
- Sood, R. (2012). *Pro android augmented reality*. New York: Apress.
- Sutherland, I. E. (1968). *A head-mounted three dimensional display*. In Proceedings of the December 9-11, 1968, Fall Joint Computer Conference. New York: United States. doi: 10.1145/1476589.1476686.
- Tom Dieck, M. C., Jung, T. H., & Tom Dieck, D. (2016). Enhancing art gallery visitors' learning experience using wearable augmented reality: generic learning outcomes perspective. *Current Issues in Tourism*, 1-21.
- Uras, B. (2013). Boğaz'da bir kültür kampüsü sakıp sabancı müzesi'nin mimari özellikleri. A. Anadol (Ed.), *Sakıp Sabancı müzesinin 10 Yılı. içinde* (ss. 131-156). İstanbul: MAS Matbaacılık.
- USC School of Cinematic Arts (2016). Morton Heilig: The father of virtual reality. <http://www.mortonheilig.com/InventorVR.html> adresinden 10 Şubat 2016 tarihinde edinilmiştir.
- Vlahakis, V., Ioannidis, N., Karigiannis, J., Tsotros, M., Gounaris, M., Stricker, D., & Almeida, L. (2002). Archeoguide: An augmented reality guide for archaeological sites. *IEEE Computer Graphics and Applications*, 22(5), 52-60.
- Yovcheva, Z., Buhalis, D., & Gatzidis, C. (2012). Smartphone augmented reality applications for tourism. *E-review of tourism research (ertr)*, 10(2), 63-66.
- Wagner, D., & Schmalstieg, D. (2003). First steps towards handheld augmented reality. *Proceedings of the Seventh IEEE International Symposium on Wearable Computers*, 127-135.
- Walczak, K., Wojciechowski, R., & Cellary, W. (2006). Dynamic interactive VR network services for education. *In Proceedings of the ACM Symposium on Virtual Reality Software and Technology*, 277-286. doi: 10.1145/1180495.1180552.
- Wang, X., Kim, M.J., Love, P. E., & Kang, S. C. (2013). Augmented reality in built environment: Classification and implications for future research. *Automation in Construction*, (32), 1-13.
- Wojciechowski, R., & Cellary, W. (2013). Evaluation of learners' attitude toward learning in ARIES augmented reality environments. *Computers & Education*, 68, 570-585.
- Wolcott, H. F. (1994). *Transforming qualitative data: Description, analysis and interpretation*. Newbury Park, CA: Sage.
- Woollard, V. (2004). Caring for the visitor. In P. J. Boylan (Ed.), *Running a museum: A practical handbook* (pp. 105-118). Fransa: International Council of Museums.
- Wu, H.K., Lee, S. W. Y., Chang, H. Y. and Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers and Education*, 62: 41-49.

Augmented Reality Applications in Museums: The Case of Sakip Sabanci Museum

Zöllner, M., Keil, J., Wuest, H., & Pletinckx, D. (2009). An augmented reality presentation system for remote cultural heritage sites. *In Proceedings of the 10th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST*, 112-116.