Preservation of Heritage Sites through Virtual Museums

User Study of Stonehenge Virtual Tour

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Abstract

Heritage sites have been facing conservation issues due to pollution, tourist activities and other human-caused interventions. One example of a heritage site under conservation threats is the Stonehenge in Great Britain. Over the past few years Stonehenge has been facing several conservation problems including overcrowdedness. Stonehenge virtual tour is a virtual guide for visitors to learn more about the heritage site. An empirical study was conducted to evaluate the user experience and to learn if the virtual tour provides a sufficient enough user experience for the users not to visit the place in person. The results showed virtual tour needed several visual as well as functional improvements to create a fulfilling user-experience for the visitors. Due to several limitations like lack of senses such as smell and touch, users consider the Stonehenge virtual tour as providing an insufficient replacement of a physical visit, but despite those limitations the virtual tour can be improved visually to provide a satisfactory user experience for visitors around the world.
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1. Introduction

Preservation of historical sites and buildings has become an increasingly daunting task as they are under the threat of obliteration due to growing urbanization and industrialization in various parts of the world (Holtorf & Kristensen, 2014). Which is unfortunate, as cultural heritage not only plays a crucial factor in the economic development of a country but also provides a reflection of its old age traditions (Sánchez-Aparicio, Del Pozo, Ramos, Arce, & Fernandes, 2018). Policies from international charters such as Venice Charter 1964 (“Venice Charter,” 1964) urge to protect heritage sites through interdisciplinary approaches. These approaches focused on conserving and restoring old monuments and sites such as Stonehenge.

Stonehenge is a British archaeological site and one of the most important monuments in the world (White, 2016). Stonehenge is controlled by British Heritage, which is a registered charitable organization (“About us | English Heritage,” n.d.). Professor Geoffrey Wainwright is a former head of Archeology in English Heritage and the author of ‘The Stonehenge We Deserve’ (2000). In his research, Wainwright states that Stonehenge is facing severe preservation issues. One of the causes of preservation issues is the location of visitor facilities such as car parking and lavatories. These facilities are located extremely close to the monument. Such proximity may cause damage to the 5000-year-old archeological site because of the constant number of motorists and tour coaches who use the free parking of the monument as a roadside stop for refreshments and lavatories(Wainwright, 2000). To preserve the site, English Heritage has surrounded the stones with a fence. A group of only 30 people is allowed to visit the ‘stone circle’ through online booking. The tour is not guided, and the reservation cost 38.5 Pounds for adults and 23 Pounds for children from the age of 5-15 and even then touching the stones is prohibited (“English Heritage Home Page | English Heritage,” n.d.) Despite all these efforts made by the English Heritage, the stones still suffer from preservation issues because of A303 trunk road that cuts through the heritage site property and carries around 26,000 average vehicles a day. Another road A344 which runs nearby the Stones separates them from the ceremonial avenue and the car park. Every year many visitors risk their lives trying to cross the busy A344 to get inside the fence and touch the stones. (Wainwright, 2000). Altogether, this indicates that Stonehenge is under preservation threat and the efforts to preserve it are limiting people’s ability to visit it. Preservation efforts such as high ticket prices, not only lower the opportunity for people to experience the heritage site in person but it also raises a democratic question as people are not able to access their history.

English Heritage has built a virtual site to encourage visitors to learn more about the Stonehenge, (“Virtual Tour - Inside The Stones | English Heritage,” n.d.). The virtual tour offers an interior view of the ‘stone circle,’ which is otherwise inaccessible. Each stone is represented by a hotspot that gives a detailed description of the site in the form of either videos or text. The tour provides a 3D visual for the user to explore the place through various navigational methods, one of the methods to navigate the website is through the widgets at the bottom of the screen.
In the light of the above discussion, virtual tours can be considered a possibility for the preservation for numerous heritage sites, including Stonehenge. Currently, heritage sites are under a constant threat of destruction. Overcrowdedness is not only one of the significant threats heritage sites are facing but also a cause of nuisance for the visitors visiting those places. For instance, visitors cannot go near or touch the stones at Stonehenge, and that including a crowd of people blocking the sight of the stones might leave a negative touristic impression on a visitor visiting that place. Stonehenge virtual tour might act as a personal tour for visitors trying to connect with thousands of years of history.

Hardly any research has been done to examine the user experience of those people who visit heritage virtual sites. To bridge this gap, an empirical study was conducted to gain insight into the user experience of the Stonehenge Virtual Tour, and to investigate how this tour discouraged or encouraged users to visit the heritage site in person. More specifically, the purpose of this study was to find what is required of the virtual tour to act as a sufficient replacement for the actual trip, considering that visitors can only view the stones from a distance. Therefore, by studying an existing virtual tour of a heritage site which is in critical danger, we can learn how current virtual tours are experienced and how the user experience provides a link between virtual and physical location. The results from this study can hopefully provide a base for future development of virtual tours for heritage site.

2. Literature Background

2.1. Preservation of Heritage Sites as a Research Focus

The importance of conservation can be drawn from the fact that it aims to preserve the heritage site, from the current human practices that are considered harmful and protect it, to maintain a connection between the future generations and the humans of the past. In case of intervention such as human-made disasters and global warming a form of disruption is created between past and present (Poulios, 2014). Heritage conservation is also defined as a discipline “devoted to the preservation of cultural property for the future” (Munoz-Vinas, 2012, p.13). The main approaches for heritage conservation since the advent of this discipline are: “material based,” “value-based” and “a living heritage approach” (Poulios, 2014, p.16). Poulios (2014) in his research discusses all these approaches for heritage conservation. Together with the use of technology such as virtual sites and digital archives these approaches are all applicable till this date.

According to Winter (2014) heritage conservation and governance are entering a new phase with the shifting flows of globalization. The research states that the world is entering a new phase concerning how past information and its preservations are “framed, conceptualized, and practiced.” This rapid globalization has resulted in tourists who not only expect to have the same level of comfort and quality in all destinations they travel but also seek experiences that are unique and authentic (Maksin, 2010).

Natural and human-made disasters such as global warming, tourists activities and pollution continue to destroy the heritage sites of the world. (Allan et al., 2017). A well-known example of highly weathered and vulnerable site is the Temple of Esna in Egypt. This heritage site has been facing preservation
problems mainly because of urbanization and poor management. For the sustainability of heritage places like Esna, the research proposed, raising awareness among authorities and the local population about the conservation of heritage sites (Ghanem & Saad 2015). Another example of a heritage site which has been destroyed as part of human-made disasters like terrorism is Palmyra in Syria. While work is being done to reconstruct the demolished site, archaeologists believe, that it will be difficult to restore the heritage site to its full glory (Buffenstein 2017). Having virtual archives of these endangered heritage sites could not only help preserve the site in the digital world for future generations but can raise awareness among masses to protect them physically. Similarly, a survey conducted on castles and post-medieval landscapes in England by Corbishley et al. 2008 stressed the importance of heritage conservation in the school curriculum (Corbishley, Fordham, Walmsley, & Ward, 2008). They listed the charts of the program to effectively assist teachers to train learners on the significance of preserving heritage sites.

In a study conducted by Lin et al. 2006, it was stated that museum websites could offer great enjoyment by enabling people to virtually access and learn about various artifacts in heritage centers (Lin & Gregor, 2006). The study identified the guidelines and requirement that museum websites should follow and meet to teach methods of online learning effectively. This research explores how virtual museums could be used as a medium for learning and enjoyment without being instructional. According to the research, for the website to be an enjoyable learning experience for the users, it should be ‘interactive,’ ‘simple’ and ‘easy-to-use’ (Lin & Gregor, 2006). History is an essential aspect of a heritage site; therefore it is crucial that the information represented in the virtual heritage site is not only accurate, but it should also be engaging as well.

### 2.2. Digital Tools as a solution to improve Heritage sites

A survey conducted by (Styliani et al., 2009) explored various virtual museums and their limitations across the globe. The research concluded that museums should digitize their collection to be accessible to the public (Styliani et al., 2009). It highlights the prominence of emerging technologies, such as virtual and augmented reality in creating interactive kiosks on World Wide Web. The user experience of these technologies was measured on the basis of factors such as interactive design and the variety of possibilities for the user to connect with the technology in a seamless manner. In an agreement, Frykman, 2009 observed that the role of museums in imparting quality education is primal in this era (Frykman, 2009). Narrative web-based tools were to make history more exciting and interactive. A detailed framework was devised to study Skansen, the Swedish Museum of Natural History. The power of narration and descriptive analysis has been emphasized in the work (Frykman, 2009).

On the other hand, Jung and Dieck have proposed a method of 3D printing to enhance the visitor experience in places of cultural heritage in the United Kingdom. The research suggests a holistic approach using virtual reality and 3D printing to improve overall user experience (Jung & Claudia tom Dieck, 2017 p. 40). In the same way, (Luis et al., 2011) have proposed a novel approach of integrating 3D laser scanning, thermography, and photogrammetry. Their methodology is based on usage of terrestrial laser scanning (TLS), thermal imagery, and close range photography to accurately record World heritage sites. The study aims at providing both metric and non-metric data to create interactive 3D models of heritage sites on the internet to enable people virtually visit the sites. Jones et al. 2002 have explored the possibilities of the virtual online museum using 3D technology at an affordable cost.
Lerma et al. 2011 have used a combination of multispectral photography and thermography to assess the state of conservation of monuments. Their approach uses infrared filters instead of gelatin fibers to nullify hotspot effect in the captured image. The texture results of the terrestrial laser scanner and in-shelf digital camera are compared, leading to the conclusion that the latter can cope up with single pictures without overlap. Thermal sensor photography presents a unique advantage over near-infrared photography in obtaining information in sandstone monuments (Lerma et al. 2011. 236). The research focused at thorough analyses of the archeological sites for cultural documentation in a non-destructive way to avoid further deterioration. Possibilities like these could be considered, while physically analyzing heritage sites such as the Stonehenge to provide for a better implementation user experience to the visitors in the virtual world.

### 2.3. Other Examples of Virtual Heritage Sites

Much work has been done in digitizing ancient art and museums in various parts of the world. Ever since 2009, UNESCO and Google have collaborated on multiple projects to digitize heritage places and museums, including France’s Palace of Versailles. Google Earth and Street views provide a virtual tour of heritage sites and museums in countries from South America, Europe and Asia (“Google and UNESCO team up to provide virtual tours of World Heritage sites,” 2009).

The ‘Interactive Documentary’ of ‘The Garden of Earthly Delights’, a painting from Late Medieval Period by Bosch, is another such example of a digitized artform. The art which is on display in Museo del Prado in Madrid has a virtual version (“Jheronimus Bosch - the Garden of Earthly Delights,” n.d.) and provides a detailed tour of the different aspects of the painting.

Similarly, Komianos et al., 2014 developed a large-scale virtual environment of the Ionian Islands, Greece. This large-scale virtual environment was developed as part of promotion and preservation of the Ionian Islands. According to the research, virtual environment included a realistic display of the cultural heritage objects and provided the users with a comprehensive and holistic view of the represented virtual environment.

### 2.4. Website Evaluation Based on Kabassi 2017

While the above research work explains different example and ways of implementing physical places in the virtual world, there also needs to be a way of evaluating those virtual environments. It is important to evaluate websites to improve user-experience for the users. 3D worlds need to be ‘intuitive’, ‘easy-to-use’ and ‘immediate’ so it can provide an ‘immersive’ and ‘realistic’ user-experience (Komianos, Kavvadia, & Oikonomou, 2014).

Over the years Human-Computer Interaction (HCI) has introduced various ways for the evaluation of websites to provide better user-experiences. Evaluation tests the usability and functionality of the web as well as mobile applications to ensure they are working according to the requirements (Bias, Kortum, Sauro, & Gillan, 2013). There are various ways of evaluating a website and interviews are one of them. Interviews are one of the query techniques used in HCI, the most significant advantage of interviews is that issues within the application are explored more thoroughly, and they elicit user views that can shed light to unidentified problems (Benyon, 2013).
For virtual museums much work has been done in ways to evaluate websites and empirical method is one of them (Marty, 2007; Tsaih & Han, 2016). In empirical method, end users (visitors), evaluate the website using questionnaires, interviews and data logging, on the other hand, there is inspection method which is conducted by experts (Lewis & Rieman, 1993).

Kabassi (2017), in her research discussed various methods of evaluations that researchers have adopted in evaluating multiple museum sites. According to the paper, empirical method mainly focuses on ‘over-all-presentation design’ and usability. Based on her research Kabassi, 2017 created a table of criteria for the empirical method where she listed standards such as usability, interactivity, content quality and natural engagement as one of the top focus points of this method (Kabassi, 2017).

3. Research Aim

According to (Goldman & Schaller, 2004) “The hardest part about developing an understanding of museum audiences, both physical and virtual, isn't understanding who is visiting, but understanding what visitors take away with them from their visit” (p.1). The paper states that current museum websites need to be updated with the constant evolution of technology to attract new visitors. Museums and developers in technology can make a fulfilling experience for the online visitors by providing a link between meaning-making and motivation. This concept of linking meaning-making and motivation can also be applied in evaluating the visitors of Stonehenge Virtual Tour. The results from this study can help in building a bridge between the current heritage site conservation practices and providing a meaningful user experience to the tourists of this globalized world.

Museums in this day and age are using the internet to connect with their visitors virtually. Therefore many museums have been working on making their ‘online’ presence better (Fotakis, Economides 2008). For example, Theocharidis-Nerantzaki et al. (2014) analyzed 53 museum websites in Greece and categorized them in 6 Dimensions: “Contact-Communication, Visit to the museum, Website features and Use of social media” to design better website (Theocharidis et al. 2014 p.15-16). While this was useful in developing a website it is also essential to test the implementation of various museum websites. (Wang et al., 2016) have used different evaluation methods to examine the application of virtual museums. The study evaluated the service quality of a tourist area through questionnaires and measured the results in terms of reliability and interactivity. These factors determined user satisfaction and the users’ decision to visit the physical site (Wang et al., 2016).

The main aim of this study is to examine the user experience of visitors who have visited the Stonehenge Virtual Tour through empirical studies to find how this tour discouraged or encouraged users to visit the heritage site in person. By studying the user experience of the visitors through the Stonehenge Henge Virtual Tour, it can be examined how the users felt about the virtual tour. Based on this user experience, it can also be explored what is required of the Stonehenge Virtual Tour to discourage a physical visit or be considered an adequate substitute for a physical visit. Studying these factors could consequently help in reducing the number of visitors that visit the Stonehenge as well as providing people without any means of visiting the heritage site an opportunity to interact with this site visually.
4. Methodology

Various study methods have been implemented in previous research in accordance with the requirements of the virtual museums being evaluated. For example (Goldman & Schaller, 2004) formulated a study based on the theory of learning and motivation which was applied on an online survey to understand the motivation behind why people visited museums and what they learned from that experience. Another study was conducted by (Marty, 2008) to compare a physical visit in a museum with the museum's virtual site in order to understand how a visit to virtual museum motivated users’ decision to visit the actual place. The study consisted of 1200 participants at nine different museums in order to identify the roles of museums in the life of museums visitors.

Stonehenge digital tour is a virtual website, where the visitor’s digital experience needs to be evaluated to understand the influence of user experience behind the user’s decision to visit the actual site or not. For the virtual websites, user interface and aesthetics play an essential role in the overall impression of a website (Pallud & Straub, 2014). For this reason, inductive approach was considered the most suited evaluation method for this research. As mentioned previously empirical methods like interviews, questionnaires and data logging are used to evaluate the quality of websites (Lewis & Rieman, 1993). The empirical methods in this research comprise of semi-structured interviews and inductive approach which are used in design centered projects to develop an understanding of design problems (Weston, 2013).

Semi-Structured Interviews

As mentioned previously, empirical methods are implemented with the participation of potential users which in our case are the visitors to Stonehenge virtual site. Video recordings, observations, online/offline observations, interviews, and questionnaires are some of the many techniques used to implement empirical methods (Wen-Chih et al., 2010). In this research, semi-structured interviews are the most appropriate empirical method as they capture the users' beliefs and the interviewer can also note the user reaction not just their answers (Kabassi, 2017). As part of their research on museum programs evaluation before 2013, a survey conducted by (Nelson & Cohn, 2015) showed that 79% of the museum programs used interviews for data collection, 60% used observation, 55% used survey and 3% used audio recordings. However according to (Kabassi, 2017) a combination of all these methods is used to gather data effectively. Consequently empirical study conducted in this research was a combination of interviews, audio-recordings and observations.

4.1. Participants

The research used convenience sampling to select bachelor and graduate students from Uppsala University. Request for volunteers was posted on HCI Masters students’ Facebook page of Uppsala University and by the students of HCI Masters program on their respective Facebook profiles. In total 11 students volunteered for the interview.
One of the participants was a high school student, while the rest were students from University of Uppsala. They were all from the age-range of 23-30. Two Uppsala University student were undergraduates while the rest of the students were postgrads. One of the participants had visited the Stonehenge while the rest had not. The entire data gathering process took two and a half weeks as sessions had to be scheduled based on the availability of participants, interviewer, and the HCI lab.

4.1.1. Limitations

One of the most significant drawbacks of convenience sampling is that it can be biased and creates homogenous results which might not be an accurate representation of the entire population (Etikan, 2016). To minimise biases, the recruited participants were acquaintances of interviewer’s acquaintances and did not know the interviewer before the sessions. Although four of the students did belong to the HCI department, none of them had met the researcher before and provided a variety of different opinions. The rest of the ten students from Uppsala University belonged to the following apartments: Computer Science (two students volunteered, one undergraduate and the other was masters student), Economics, Micro-Biology, Physics and Political Science departments. Having students from different departments helped in gaining a different perspective on user-experience and create a less homogenous results. These participants were later divided into two groups, where one group was interviewed with a pre-tour discussion and the other was interviewed without one. The group with pre tour discussion shared their previous interests and experiences in museums, which influenced how they perceived their user-experience with the virtual tour.

4.2. Data gathering

Semi-structured interviews were prepared based on the empirical method criteria for the evaluation of museum websites (Kabassi, 2017). These necessary criteria of empirical methods covered user experience, Interactivity, content quality, and natural engagement. The criteria included the following prompts to elicit participants views and experiences (1)Have they been to Stonehenge? (2)How was their user experience (3)Did they find the tour interesting? (4)Regarding feature, what was their favorite and least part of the tour? (5)Based on the experience would they want to visit the actual place? (6)If yes/no, did the user experience of the digital museum play any role? (8) Was there anything they thought about during the tour that they would like to add? The purpose of these questions was to enable exploration of participants response and views using a flexible and responsive approach.

The interviews were audio-recorded with participants permission and the sessions were conducted one person at a time in HCI lab at Ekonomikum Uppsala. The web tour was shown on a laptop. Distractions like poor internet quality, and in some cases participant’s refusal to turn off the phone did impact the user experience as the participant seemed visibly distracted every time the video took a long time to load or when they received a text on their phones.

The participants were asked to sign a consent form, where the details of the study and background of the research were written. The consent form also stated that the participant’s participation in this study is voluntary and the participant can terminate the evaluation at any time. The participants were informed that their quit this study at any time also informed through the consent form that their real names will not be
used in the study to protect their identity. Once the participant had agreed to participate, he/she was asked to explore the Stonehenge digital tour on their own, after that, the participant was interviewed about their user experience. (Appendix 1)

The overall session, including the interview questions, went through a series of improvements. In a pilot interview, it was observed that the participant had difficulty navigating the website, as she used the widgets at the bottom of the screen to browse through the virtual site which distracted her from the actual tour. So, for the later sessions, the participants were informed about the different ways to navigate through the site beforehand which made the experience relatively smoother.

The technique of interview questions had to be improved as well. Initially, in the first six interviews it was observed that after the virtual tour, the answers of the participants were short and had little information on how their user experience went. The entire session was 10-15 minutes long, and the interviews only lasted for 5-6 minutes, in some cases the participants just replied yes and no without sharing any further explanations. Another problem with the interviews was that the first question about whether the participant had visited Stonehenge or not triggered a one worded reply which broke the flow for the rest of the answers.

Based on this it was decided to have a ‘pre-interview’ with the participants so they could share their views with the following semi-structured questions (1) What was their experience with museums? (2) What was their area of interest in museums or heritage sites? (3) Does money play a role in their decision to visit a museum or heritage site? (4) What was their experience with the virtual museum? (5) What did they expect from it? (6) What does Stonehenge mean to them? (7) Have they been to Stonehenge and if not do they plan on visiting it? These questions enabled the participants to share their area of interests in museums and their experiences and expectations from virtual museums. This pre-discussion helped immensely as the participants were able to give in-depth replies about their experience with the virtual tour as they were able to compare their current user experience with the heritage site from their previous experiences. The problem with previous interviews without pre-discussion session was that the post-tour questions did not give them a chance to recall their prior experiences and that resulted in lack of content, which gave rise to another problem that the interviewer did not have enough material to ask more questions. With the pre-discussion interviews, the interviews after the session turned into discussions rather than strict question and answer session and this helped gain a deeper insight into how the participant’s user experience went. For the rest of the 4 participants, the interview with the pre-discussion lasted for 40-50 minutes each.

The interviews were transcribed using the trial versions of online automated transcription tools like Sonix and Trint. Otranscribe was used to transcribe the interviews manually.

5. Data Analysis

Based on empirical methods criteria (Kabassi, 2017) and the research hypothesis the data sorted into the following main categories: user experience and the intention to visit the actual place. As a result of the semi-structured interviews and pre-tour discussions further analytical categories were identified in the data using an inductive approach: enjoyment, realistic and engaging representation of the virtual
environment and suggestions on making the tour more immersive. A combination of both deductive and an inductive analytical approach was thus used for coding and analyzing the data (Saldaña, 2013). The categories formed from these analytical approach were assigned further sub-categories. The results of this analysis are presented below under their respective headlines in the result section.

6. Results

Picture 1: Landing page of the Stonehenge virtual tour, with hotspots and navigational widgets at the bottom

6.1. User experience

In user experience, the participants shared their impression of Stonehenge from the virtual site. Following subcategories were derived from this section.

6.1.1. Learnability

As more digital museums are being developed, the number of visitors on the virtual museums have started to outgrow that of physical museums; therefore it is critical that the museum professionals explore the museum information resources in-house and online (Marty, 2008).

One of the significant parts of the virtual tour was the information presented in the hotspots through texts and videos when the participants were asked about their impression of Stonehenge, their responses mainly consisted of how they were able ‘learn’ something new about the stones.
“I understood the purpose behind the stones. There are details of what summer solstice is. Sun in summer and sun in winter that you can see and maybe it has some functions like I guess you can stand in the middle of it and see when the sun is the highest in a day. And you can find can tell what season it is. The explanation of the purpose of the stones was really good. I mean like how to see the sun. I learned something about this. and I think the knowledge is quite complete.” -Participant 10

The participants were able to explore and learn about the purpose of the Stonehenge from this virtual tour. One of the participants found the information related to stones ‘interesting.’ This is especially useful because for archeological sites, history is one of the most critical aspects of the entire experience and needs to be presented and explained in a way that connects the user with its past without being overwhelming. (Komianos, Kavvadia, & Oikonomou, 2014)

“I didn't know the stone had so much meaning Especially the little things on the stones like the color and how they viewed the sunset It's kind of opened my mind about that place. How the stones were placed on top of each other. I didn't know that rocks had anything like that because it's like 4000 years old they were built in a very impressive way. “-Participant 6

Some of the participants thought that the tour could have been made better if the information about the stones had been explained in more detail. Not only this, according to Participant 1 who had been to Stonehenge, the information in the virtual tour was ‘limited’ as well, which consequently affects the user experience as one of the most important aspects of an archeological site is its history, which needs to be captured and presented well, in order to provide an engaging user-experience. (Martijn van Welie, 2004) reiterates the importance of information display by stating that if the online version of museums does not replicate the information in their ‘offline’ or physical museum. The online experience ends up being a ‘teaser’ for the visitors, leaving them unsatisfied by the entire experience.

This limited display of information, was also noticed in Stonehenge virtual tour as evident from the quotes below from both Participant 1, who had been to Stonehenge and Participant 5 who had not.

“As I said I think that the information that you get here is kind of limited. And I would wish for maybe more videos or more little texts or whatever. Like when I went there with my dad I remember that the museum was really really big. And I remember that we spent there. I think the entire day just reading through everything and walking around. And I think that there are more things to know about Stonehenge that you can see in the video.” Participant 1

“My least favorite part. Maybe the information that was about stones here should have had better explanations about some topics. I think both of the videos and text were pretty good but sometimes complicated. Sometimes it became hard to understand the information she(the guide) was used in the videos” - Participant 6

For some participants, it was hard to access and understand all the information because of the language barrier as mentioned in the comment below.
“I don't have an archeology background, so I think in the videos, and the texts, sometimes they mention. Maybe, if you're a native English speaker, that would be fine. I feel like there are some words that I don't understand. What is this, in its entirety? What is it for? When was it discovered? Things like that- it's just loose bits and pieces. I can't really, you don't see how they connect.” -Participant 5

6.1.2. Information Presentation

Presentation of the information is an essential factor in influencing the participants' overall user experience. The presentation of the information should be ‘intuitive’ and ‘simple’ for the participant to be able to navigate through the virtual tour easily (Marty, 2008; Martijn van Welie, 2004).

As explained previously, information on the virtual site was presented in the form of hotspots through texts and videos. While navigating through the tour, some of the participants preferred knowledge through text while the others preferred videos. Personal choice of the participant also affected how they chose to gain the information i.e. reading or watching.

“I preferred videos over text. Because I don't like reading so much. But also the reading was okay because it was not too long and there was enough information and so I did also read those which I found interesting “- Participant 7

Participant 11 stated that the video experience could have been made even better if it had subtitles, the participant further shared the reason why she liked videos more than text was because she prefers listening to audio books rather than reading them, which shows that personal preference on getting information also influences participants choice of information display.

“I enjoyed it(videos) I think I liked the videos more than text and probably for inclusiveness it would have been nice to have some subtitles so people can actually read well.”

“Probably because its(watching videos) less of an effort like I personally always prefer listening to reading. I also usually prefer audio books to reading, so it's more relaxing to me it feels like I don't need to do more to focus. But I was also good with the mixture of text and video, so I don't think this was a problem that they had the text and the video.”- Participant 11

Participant 8, 9  and 10 thought videos were not engaging enough, and it took ‘time’ to watch them, there was no way to preview the videos and they had to watch the entire guide to know what it was about, and that created a sense of impatience among the participants as they felt compelled to do something, which they had already lost interest in.

“but most of the information is shown in video, and it takes time to watch the whole thing so for example what I like about the painting 'Garden of Earthly Delights' most of the information is written, I can see in a glance what can be interesting to me or not but with the video, watch like 10 seconds or more to decide whether I want to know about it more or not”-Participant 8

In the tour when a user clicks on a hotspot which shows a video, the background becomes dull and the information is displayed in the middle of the screen, Participant 10 found this feature of the tour
distracting, as he was not able to replicate exploring the virtual screen when the video was being played. This behaviour was also observed in Participant 5.

Participant 10 also complained about not being able to locate the points described in the video on the virtual stones.

“I think the illustration is not that great I don't quite like the illustration with the video because the video reminds me of it makes me feel that I have to watch the whole video now and I cannot do something that I'm curious about. and I mean my exploration of this place is restricted to the video. You see this video which doesn’t match to the background screen, and there are a lot of details which are shown in the video but not on the screen behind it so I think it's kind of distracting and since videos don’t match with what is happening on the screen it’s hard to understand the woman video is talking about, is she talking about the stone behind the video or so” Participant 10

“Sometimes you don’t know which part she's talking about, because there are no labels. When they show a picture, sometimes I felt they didn't match. I don't know, maybe she was talking about some stone, but then in the video, there's a picture of something, I don't recognize the view, so I don't know. I can't map it to the video.” Participant 5

As soon as the visitor lands on the Stonehenge tour, hotspots are shown blinking on the stones. Participants had positive feedback on how the hotspots were presented as it did not distract them from the entire environment.

“I liked this these hotspots are not disturbing your experience and only if you mouse over them you see what they are”- Participant 8

“I really like these hotspots. They are not distracting. They are not forcing me to click on the”- Participant 9

Some of the other participants found it hard to keep track of the videos and texts they had watched/read and sometimes they clicked on the same hotspot twice, this caused repetition which causes a distraction in user experience.

“I found it difficult to find out which videos or which text I already read or saw”- Participant 1

Participant 2 proposed a solution for the above problem by suggesting a sequence in the ‘points’ that the visitor have visited so far.

“Maybe it would help if there was a sequence in the points that you have clicked”- Participant 2

Imparting correct knowledge in a meaning-making context is a crucial aspect of virtual museums as it is responsible for describing the purpose behind the entire website(Frykman, 2009). It is highly important that the information represented in the virtual museum is accessible and easy to understand, otherwise it will leave the visitors unsatisfied and with the user-experience.
6.1.3. Autonomy

Intuitive and straightforward structure, easiness of navigation and autonomy are some of the essential factors in creating a user-centered interface. The user should be able to move around the website without being confused and restricted (Fotakis and Economides 2008). This was also highlighted in research by (Santos, n.d) on an evaluation of virtual museums, that user-experience of the Louvre website was affected negatively because of poor navigation and orientation functionality. For the Stonehenge virtual tour, 7 out of 11 participants had issues with navigation, participants felt ‘locked,’ restricted and in some cases thought the tour felt ‘incomplete’ because they were not able to go out of the stone ‘circle’ or view them from the top. This was experienced by the participants even after they were showed different ways to navigate the virtual site.

“It was a little bit difficult also because I think that the thing is inside of the stone circle and not that you can first get a view from outside and then kind of walk in. So you might have a better orientation.” Participant 1

“I felt like I'm locked in one place. I wanted to move a little bit around and view the stone from 'birds-eye-view’” Participant 3

Previous experiences influenced Participant 3 and 8’s navigation of the virtual tour.

The participants mentioned that they had previous experience with virtual museums and sites through google maps.

“I didn't like it that much, maybe because I was expecting to be able to walk around so in that sense I was a little bit disappointed, I don't know why. I was hoping for that. But at least I was in the middle of the place and was able to see something - like Google maps, like if I want to go there because I had more control of what I want to see” Participant 8

Participant 10 compared this tour with a previous example but he took his experience of the physical world and compared it to the virtual site. According to him guided tour in the real museum and remarked that an audio tour would not stop the visitor from exploring the artifacts it is describing, but the videos and the tour in this website does.

“That doesn't give me any real experience. Yes, and there is like a let's take the audio guide as an example again. Does the museum ask you not to move while you're listening to the audio guide and that's the problem? I would always let's not say the painting but the statues. You can go around it, and the audio guide would tell you that about the details on the back of the statue and the details on the front. There are details left, or right there you have to go around there follow it. And this virtual tour is ok. It's just like a classroom that tells me about the history or all about the mechanism of such things. It's not a tour. It's just a history class I think. It's a history class.” Participant 10

Even though navigation was a problem for the participants mentioned above, Participant 7, 3 and, 4 liked the navigation ‘position’ and how ‘smooth’ it was for them to walk around.
“First of all to try it out because I've never done it before. For me, the most interesting is how smooth in terms of how it works, where what you actually need to do for a virtual tour or like you know what I mean that you can click there you can go around with the arrows and stuff like that.” Participant-7

It should be noted that for the above mentioned participants who liked the navigation, they did not have any prior experience with virtual museums or virtual sites, not even Google maps, so the fact that they did not have any previous experience to compare with might have resulted in no issues with navigation.

The ability to move around easily and explore the tour freely played one of the most significant factors in defining how the user-experience of all participants went. As mentioned earlier in the case of Louvre museum, where the inability to move around affected the user-experience of the visitors negatively(Santos, n.d), the same situation was repeated in this virtual tour as well. The users felt ‘restricted’ and ‘locked’ because they could not move outside the ‘stone circle.’ Users previous experience with the virtual as well as the physical museums also influenced their expectations from the Stonehenge virtual tour and how they chose to explore it.

Navigation and orientation is an important factor in creating an easy-to-use user experience for the visitors of the virtual tour (Kabassi). Existence of alternative paths to navigate through a virtual website helps an experienced user(Fotakis, Economides 2008). By experienced users, the authors meant visitors who had prior experience with the virtual museums(Fotakis, Economides 2008).

In the case of the participants of the Stonehenge virtual tour, it was observed that the Participant 1 from the pilot interview had difficulty navigating through the virtual website. The Participant 1 navigated through the widgets provided by the virtual website at the right corner of the screen, which affected her user-experience negatively.

“As I said I think the orientation with the mouse. And everything was kind of difficult for me. And also because like it was a little bit over-sensitive to my moves and so on. And I also didn't like that.”-Participant 1

Based on above experience, the rest of the participants were informed about the different ways of navigating the site before they started the virtual tour. Most of the participants chose to navigate through the laptop’s trackpad. While using the trackpad made the navigation comparatively easier, it was observed that the participants still felt uneasy in navigating the site through the trackpad. For many participants like Participant 3, 4, 5, 8 and 10 it was observed, that at the beginning of the tour they kept moving the cursor up and down the tour relentlessly as they were facing difficulty in adjusting to the trackpad navigation.

This was also evident from Participant 10’s quote who was not comfortable with the navigation and wanted to navigate the tour with external mouse.

“To be honest I think it's (virtual tour) good because it provides me a good chance to go to some place where I can never have access to. But there is much work that can be done. I like the freedom when I'm
doing this (navigating around) and the navigation is not that comfortable I guess. I mean it's like I think with mouse it's it would be better.”-Participant 10:

While most participants chose to use the trackpad, Participant 9, chose to navigate through keyboard arrow keys. Even though participant was aware of using the trackpad, he felt easy tracking through the ‘arrow keys’ on the keyboard; this made browsing around the screen difficult, as the navigation on the screen kept breaking up.

“-my another least impressive things about this tour is my inability to move around the tour with this arrows-key, they are killing me.” Participant 9

Based on the above observations, it can be concluded that visitors have different navigational preferences, and to make the user experience easier all of the possibilities need to kept under account to make a better user-experience.

6.2. Enjoyment

In a study of ‘presence centered user study of a virtual museum,’ it was reported there is a secure connection between the sense of presence and enjoyment (Sylaiou et al., 2010). The sense of presence refers to as the user being immersed in the virtual world as compared to the physical environment the user is currently in (Stanney et al., 1998).

As mentioned before, some of the participants did not find this tour immersive because they could not move around or the fact that they could not navigate the virtual screen behind the videos. One of the participants described this tour as more of a ‘history class’ rather than a virtual tour. This is in contradiction with one of the main criteria of an immersive virtual tour, which is that virtual museum should aim at being a medium for learning and enjoyment without being instructional (Lin & Gregor, 2006)

“That doesn't give me any real experience. Yes, and there is like a let's take the audio guide as an example again. Does the museum ask you to not move while you're listening to the audio guide and that's the problem? I would always let's not say the painting but the statues. You can go around it and the audio guide would tell you that about the details on the back of the statue and the details on the front. There are details left or right there you have to go around there follow it. And this virtual tour is ok. It's just like a classroom that tells me about the history or all about the mechanism of such things. It's not a tour. It's just a history class I think. It's a history class.”Participant 10

There is an animated black object placed in the middle of the virtual tour for user’s navigation, since the black animated block does not exist in the original site, it was found unnatural and took away the feeling of realism from the tour.
“The black thing does not look natural. Of course, standing before standing in front of the laptop cannot bring to you the real experience but seeing something that is not related with the whole place it reminds me of that I am not in that place.” Participant 10

While some of the participants did not find the virtual tour very engaging, one participant, however, found the virtual tour immersive and nicely presented.

According to Participant 11 “the fact that you can move as you would with your eyes. I mean everything is within your eyesight and the graphics are excellent. So it looks very realistic. I can definitely see myself standing there like looking around, so that was good. I mean it could never be as immersive as it would be in real life so for example, I can't touch the stone which I think would be interesting, but I definitely feel that for a short amount of time I learned a lot about Stonehenge.”

Most of the participant did not enjoy the virtual tour, as they did not think it was immersive enough to grab their attention. Inability to explore the stones from the outside of 'stone circle' and the presence of a black animated object in the middle negatively affected their user experience.

### 6.3. Realistic and Engaging Representation of the Virtual Environment

(Komianos, Kavvadia, & Oikonomou, 2014) developed a large-scale virtual environment of the Ionian Islands, Greece. This study was performed as part of promotion and preservation of the Ionian Islands. According to the research, some of the main characteristics of the virtual environment to design a large scale environment suitable for a ‘digitized, efficient and realistic aspects of the virtual environment included, a realistic display of the cultural heritage objects and providing the users with a comprehensive and holistic view of the represented virtual environment.
The height of the stones in the Stonehenge Virtual tour does not appear to be accurately represented, this was evident from the participants' remarks who called the stones and small, climbable and shorter than their heights. Stonehenge ranges from 13 feet to 24 feet (Nash, 2015).

When the participant 8 was asked about the least impressive feature of this tour, the participant remarked, that she wanted to move around this ‘small’ place then she should have been able to walk around. On being informed that some of the stones are 24 feet tall, the participant felt that the stones height was not an accurate representation of the real place. The participant continued her explanation by comparing her experience of a heritage site she had visited physically with this virtual tour; she later proceeded to call the Stonehenge ‘tiny’ as compared to the Machu Pichu site in Peru she had visited physically. Similarly, Participant 10 also, compared his previous experience of a physical place to describe his experience in the virtual tour.

“I do think this place is important but what you told me I think I can get everything I need to know from this, I mean if this allows to me to have a better look at the inside place. It can be enough. Yeah because this is also a tiny place. If you compare it to Machu Pichu In Peru or pyramids in Mexico.” Participant 8

The height of the stones was also judged inaccurately by Participant 10 who thought that “these stones are 2 to 3 feet tall.”

This inaccurate representation of the stones was also noticed by Participant 1, who had visited the Stonehenge in person.

“Well, I think it's kind of difficult to compare the virtual tour with the actual heritage site because the area where the specific site is really really big. And what I've found really strange when I was there was that we had to take a bus from the entrance to the real side and also like on the way back we did like a little hike because it took us I think 40 minutes to go back to the entrance. And I mean when I was there it looked much bigger than what I can and what I experienced on the screen.” Participant 1

The height of the stones is inaccurately represented in the Stonehenge virtual tour, which made the participants call the Stonehenge site as ‘small’ and ‘tiny.’ This inaccurate representation affected the way the participants perceived the Stonehenge heritage site as compared to the other heritage sites they had visited physically and made the participants lose interest in visiting the real heritage site in person.

6.3.1 Environment Perception

Another interesting observation that came out of the interviews was how the participants viewed the ‘environment’ of the tour. The weather in the Stonehenge is cloudy and grey which ‘disturbed’ one of the participants. According to the participant the overall impression of the tour could be greatly improved if the stones were shown in a ‘sunny’ weather.

“Also what disturbed me was maybe- I am not right, but I was thinking why is this tour in this bad weather(weather is cloudy on tour)? I would prefer like a beautiful sky would be a better experience for me, everything is green, and the sky is blue, but right now I can even feel the cold maybe because I don't
like that kind of weather, I don't feel that happy about being there. If I would spend my money on being there and have a rainy, I would probably regret being there.” -Participant 8

Participant 9, however, liked the overall environment.

“I really liked it. How it looks like in all this green grass and stones.”

The first impression of a site depends on the way it is presented(Fotakis, Economides 2008), in the case of Stonehenge virtual tour, the user ended up feeling ‘cold’ just by looking at the virtual tour. Based on this, it can be concluded that background environment plays a significant role in creating a virtual environment which is inviting and more engaging.

6.4. Intention to visit the Actual Heritage Site

One of the primary purposes of this research was to identify whether the Stonehenge Virtual tour could be an adequate replacement to the physical site. Based on the interviews, results were compiled under the following factors, that could potentially play a role, in a user’s decision to visit the actual place:

6.4.1. Previous Experience and Personal Interest

From the interviews, it was observed that people who like visiting museums and had plenty of experience visiting different heritage places, did not want to visit the Stonehenge site, as they did not find the Stonehenge Virtual tour engaging enough.

Participant 8 in the pre and post tour mentioned that she had traveled to various heritage places and museums in South America and Europe like Machu Pichu in Peru or Pyramids in Mexico and Casa Batllo Museum in Spain Europe. She was mostly interested in art museums and gave examples of the’ Garden of Earthly Delights’ painting virtual website that she liked and the ‘Great Wall of China’ through google maps. According to her, the virtual museum should provide a personal experience from the comfort of one’s home, as a real-life museum could be very crowded.

“I saw some news two years ago on Google, that they opened virtual museum... and I was excited since I have never been to Asia. I went through a museum in China, I can’t remember now, and I thought that was really interesting, but I spent like 20 minutes maybe. but, for example, there is a beautiful painting, from Bosch called ‘the garden of earthly delights, its in Madrid, it’s one of the most amazing paintings in human history. And they have a digital version and you zoom in and see certain sounds based on what you are watching, and the experience is very very unique, to be honest, I have visited the museum in person, and it’s hard to say but it’s even better to watch it on the internet because you can really see the detail and in real life you cannot go and observe it in such detail”Participant 8

Even though Participant 8 was interested in visiting the heritage site before the tour, she later changed her mind after being told she could not go into the ‘stone circle.’

“Now that I know, that I cannot enter, then maybe I do not want to visit the actual site. What I want to do is not just to view, not just being in the circle, but explore the place.”Participant 8
The above quote also highlights the importance of providing the freedom to explore the heritage site virtually as it is not allowed to do so in the physical world.

Similarly, Participant 10 had also traveled to various museums in Europe and Asia. As he was mainly interested in Arts museums, he gave an example of audio, virtual guide in Nintendo 3ds of Louvre Museum in Paris.

“yes- there was one thing that impressed me, its the museum Louvre in Paris and audio guide in Nintendo 3ds, its a game terminal and they have even developed a game chip for the audio and buy it in information. It's interactive; you can access it within the museum and outside as well. If you are inside it can detect your position and automatically provide you like if you’re standing in front of painting it can provide you information on it. It has a display screen and a touchable screen.” Participant 10

Participant 9 and 10 also referred to their previous experiences to describe their experience with the Stonehenge Virtual tour. The Participants felt the virtual tour was ‘not complete’ and wanted to visit the stones in person, later when they were informed they could not visit the inside of stones, they did not want to go there.

“I actually think that rocks are quite far, right? So we can't go near this place, even if I knew that you cannot touch these stones. I didn't know that tourists are made to stand so far away from this place. I think that I would get to do great experience if I would come close and maybe touch these stones or something like that. In this case, it's not possible, so I just don't think I will get what I want.” Participant 9

The above 3 participants, visited the virtual tour as a way of knowing more about it, so they could decide if they wanted to visit it or not. They did not view the virtual tour as a replacement to the heritage site, which shows that to them the virtual tour did not prove engaging enough to be provided as a sufficient replacement. This point was also emphasized by Participant 1 who had been to Stonehenge.

“Well, I think it's something that you can watch before you actually go there to decide whether you think it's worth it or not. Or you could totally watch it when you don't have the possibility or opportunity to go there. Then I would recommend it but I don't think that it is a replacement to actually going there.” Participant 1

Participant 11, did not have any prior experience with virtual museums but she also did not want to visit the Stonehenge. Participant 11’s decision to not visit the heritage site was mainly influenced by the opinions of people who had been to the actual site, which she discussed in the pre-tour discussion as well.

Interviewer: Have you been to Stonehenge?

Participant 11: No, but I considered though I looked it up at because I lived in the UK people said its rather disappointing because you can’t go very close so they were like, it's not worth it, don't go -don't go.

However, Participant 11 found the Stonehenge virtual tour to be immersive and realistic.
“No, I do not want to visit the place. I mean I actually feel like now I kind of visited it. So I mean If I can only see these stones from far away than this is actually better. I mean the only thing that would've been interesting to me would be to kind of to touch the stone because that would kind of build a feeling of connection maybe like to know how old they are. But no I don't think I would spend money ongoing” Participant 11

On the contrary, participant 2, 3, 4, 5, 6 and 7 wanted to visit the place in person. According to them the virtual tour ‘encouraged’ them to visit the actual heritage site. All of them liked the virtual tour, and how the information was presented yet still, they wanted to see the actual site in person. However, it should be noted that apart from Participant 3 none of them had any prior experience with any virtual tours. According to these participants they had all heard about Stonehenge and the information shared in the virtual tour made them even more curious about the place.

“I would like to visit Stonehenge regardless of virtually visited it or not”- Participant 2

“I think I would like to visit the actual place. But of course, when I visit the actual place, I would have this experience in my mind. It's encouraging me now to visit it” - Participant 3

Despite having no prior experience with virtual museums the participants above also viewed the virtual tour as a way of gaining more knowledge rather than a replacement of the actual heritage site. Their previous interest in the Stonehenge site also played a role in their decision to visit the actual Heritage site.

Previous experiences influence the way participants choose to navigate through the virtual tour. These previous experiences can include the participants’ physical as well as virtual encounters with the heritage sites and museums. Participants’ interests and previous knowledge about a virtual website also influences how they choose to explore it. While a virtual museum can provide an enjoyable experience user-experience for the participants with no prior expectations or experience, it will fail to leave a positive impact on visitors who have explored other options as well.

6.4.2. Cost of the Stonehenge Tour

English Heritage only allows a group of 30 people to visit the ‘stone circle’. Tours are booked online, and they are not guided. The reservation cost 38.5 Pounds for adults and 23 Pounds for children from the age of 5-15 and even then touching the stones is prohibited (“English Heritage Home Page | English Heritage,” n.d.).

One of the reasons why some of the participants did not want to visit the Stonehenge was because they thought the entrance to the circle was expensive. In the pre-tour discussion, it was asked to the participants if money played a role in their decision to visit a museum or heritage site. Participant 8, who was interested in art said that even though she is a student and sometimes it becomes hard to afford the museum tickets, so she prioritizes the museums based on her interest.

“I really like art, so to me, it feels that I cannot die without seeing this beautiful house. I have been looking at it through books and house. So if I'm here, I need to be there. Usually when I'm traveling, since I am a student, I don't have enough budget, so I need to decide which museum I need to visit. So if I
need to choose maybe, I would choose the cheaper, it depends on my interest. For example, when I went
to Cuba, there were a lot of different museums, but I did not like what they had. So I decided that this is
the only museum I will spend my money on here and will do something else with the rest rather than
visiting a museum.”

Similarly, Participant 11 and 10 also shared their interest in museums and that they prioritized them based
on their interests.

“All I do consider it so for example when I travel to a new city like the list of museums is something I
would look at but the price definitely plays a role. So for example when I went to Stockholm we kind of
decided, one museum to visit because it’s quite expensive. So we went to Nobel museum. But there are
others that would be interested in but then because of a price we decided to rather go to one and look at
stuff in more detail.”

When it was asked from the participants mentioned above if they would like to spend money on the
Stonehenge tour, all of them refused.

“Well if it’s 40 pounds I wouldn't go there and have a lot of choices too. I can donate. I mean I can’t. If
it's really well done here I can make some money for the protection or something. But I won't, I won't pay
40 pounds to go to such a place” - Participant 10

“No, I do not want to visit the place. I mean I actually feel like now I kind of visited it. So I mean If I can
only see these stones from far away than this is actually better. I mean the only thing that would've been
interesting to me would be to kind of to touch the stone because that would kind of build a feeling of
connection maybe like to know how old they are. But no I don't think I would spend money on
going” - Participant 11

Expensive entrance tickets discouraged the users from visiting the actual site. While the high cost of
tickets may discourage people to visit Stonehenge physically, it automatically raises high expectations
among the visitors from the virtual site. These high expectations are formed because the visitors are aware
of not being able to visit the place in person and this is the only way they will able to experience it.

6.5. Suggestions on making the Virtual Tour more Immersive

Another primary focus of this research was to find how this virtual tour could be made more immersive.
After the tour, when the participants were informed they could not touch the stones, or go inside the stone
circle, they gave suggestions on how the virtual tour could be improved so it can be made more
immersive. This was especially useful as the knowledge represented in the virtual tour encouraged the
visitors to learn more about it. It increased their curiosity about the heritage site without leaving them
dissatisfied.

For example, Participant 10 who did not want to visit the actual site, stated the tour could have been
made more immersive if the information shown in text and video could have been displayed in augmented
reality.
“Probably instead of text and videos, you could modify what is happening like augmented reality on the screen. For example, if we were talking about this stone, we could I don't know draw something around this place and talk something in the audio. But I think you also could work for example she's talking about concrete in the video. So we could for example highlight that this is concrete or something.” Participant 10

Apart from the inability to go inside the stone circle, Participant 9 suggested to have a tactile functionality to feel the stones, especially if it is not possible in the actual site.

“I think if we have managed somehow to imitate the tactile feeling, it will be really a great thing, you know you could have a feeling that you touch the stones. But in real life you don't touch the exact stone right? So it even makes more sense to have this function.” Participant 9

As mentioned before, representation of information plays a crucial role in creating an immersive environment, which is why Participant 11 suggested graphic illustration of the information.

“I liked how in one of the videos they presented a kind of like picture of how it could have looked in old times I would have actually liked to see more that. I think this is really interesting like if they had actually shown the color because in the picture they mentioned some were white and blue, but they didn't really show that in the picture.” Participant 11.

Meanwhile other participants gave various suggestions like virtual reality (VR), graphic illustrations of the purpose behind the tour and augmented reality to the virtual tour more enjoyable experience.

Participants gave active feedback on the improvement of virtual tour after being informed they cannot visit the physical site. This feedback was related to the information related to the stones, which shows knowledge representation is a crucial aspect of an immersive virtual environment.

6.6. The difference in the opinions of participants with and without pre-tour discussion

With the exception of pilot interview, the interviews conducted with the initial five participants were without pre-discussion. Apart from the usability issues there was a drastic change in the opinions of the participants who had a pre-tour discussion with those who did not. All of the first five participants wanted to visit the place in person, and none of the last four participants wanted to go to the actual site. This difference of opinion could have occurred because, in the pre-tour interview discussion, the participants were able to express their interests in museums and their expectations from the virtual and physical site of the Stonehenge. The participants were also asked if money played any role in their decision to visit the actual place. This pre-tour interview thus encouraged those participants to recall their previous experiences and compare them with the current virtual tour. The initial five participants were not asked any of these questions, which is why they were only able to provide limited answers. However, in both the cases, most of the participants did not find the tour as a sufficient replacement for the actual site.
7. Discussion

This paper has explored views and experiences of users who have visited the Stonehenge virtual tour site. The evaluation methods used to study the user-experience of the Stonehenge virtual site were drawn from the field of HCI and the evaluation criteria from the research done on virtual museums. The primary purpose of this study was to investigate how this tour discouraged or encouraged users to visit the heritage site in person. More specifically, the purpose of this study was to find what is required of the virtual tour to act as a sufficient replacement for the actual trip. This study also aimed at evaluating how users felt about their overall user-experience of the virtual tour. For this purpose, visitors’ previous experiences with the virtual world and heritage sites were also taken into account, to learn about how the user-experience can be made better for users with different interest and expectations.

Over the past years, researchers have developed numerous ways of evaluating virtual museums. They have established different criteria to measure the immersiveness and engagement of the virtual world. While the methods to measure those criteria depended on the type of museum that was being evaluated, the end-goal of all the evaluations was to provide an immersive and engaging user experience (Kabassi, 2017; Komianos, Kavvadia, & Oikonomou, 2014; Lewis & Rieman, 1993; Martijn van Welie, 2004).

This study was conducted using inductive approach, where semi-structured interviews were conducted with the participants to gain an insight about how they felt about the virtual tour. Previous research have also used these empirical methods for evaluating the user experience of visitors of the virtual museums (Kabassi, 2017; Komianos, Kavvadia, & Oikonomou, 2014; Lewis & Rieman, 1993; Martijn van Welie, 2004; Saldaña, 2013; Marty, 2007; Tsaih & Han, 2016). This empirical method was opted after considering other options that have been used in previous research.

Other options such as comparative study of a physical visit with a virtual visit as done by (Marty, 2007) could have also been an ideal way of conducting this study, if more participants had visited the actual site. This would have been helpful in order to gain a deeper insight on how to improve the virtual visit. Previous research have used other empirical methods such as data logging, questionnaires and surveys as well to evaluate a wide number of users visiting different virtual sites (Goldman & Schaller 2004; Styliani et al., 2009; Wang et al., 2016). These empirical methods were conducted to understand users’ motivation behind visiting a specific virtual museum site. Data logging in the case of current study could have also been useful to understand how visitors’ navigated the site and the problems they faced but would have provided limited knowledge on how they felt about those problems. Another empirical method used to evaluate and understand design problems is ethnography. This would have been the least suited method for this study as it would not have allowed the observer to ask questions relevant to user-experience. Even though these empirical methods were well suited for their own specific research, it would have been difficult to achieve the purpose of this study by using them.

Participants who did not want to visit the Heritage site based their decision on their interest and impression of the Stonehenge from the virtual tour. Money also played a role in some of the participant's decision to not visit the actual place. However, none of the participants believed the virtual tour could replace the real experience, which raises a question if the virtual tour can be used as a replacement of the
actual site. According to one of the participant, the digital version of the painting “Garden of the earthly delights” provided her a better experience than the actual site. This proves that virtual sites do have a potential to provide a fulfilling user experience. The fact that the outside view is crowded and access to the inside of the stones is limited and expensive provides an even better opportunity for the website developers to make the virtual tour an even more immersive experience for the visitors.

Various factors need to be taken into consideration to improve the user experience of Stonehenge virtual tour to actively discourage a physical tour. For instance, the ability to explore the Stonehenge from different angles can resolve much of this virtual tour’s navigation issues. Currently, visitors can only view the inside of the circle and cannot see how the stones look from the outside; this proved to be an issue for some of the participants as they felt restricted. These navigation issues could be resolved if the users are provided an outside view of the stones. This is essential in this case because the visitors cannot enter the ‘stone circle’ and the Stonehenge virtual tour developers need to provide the visitors freedom to explore the place virtually if not in reality. Another issue that needs to be resolved is the angle at which the stones are displayed, these stones are massive in reality, yet they are shown to be at human height in the tour, having a lower angle might help get a better impression of the size of the stones.

Another reason why some of the participants did not find the virtual tour immersive was because of the videos that were shown on clicking the hotspots. The participants did not find the videos engaging, as they were unable to browse the screen at the back. This limited the visitors movement in the tour and made them feel restricted. This could be solved by showing the videos on the side instead of center. There should also be a way for the visitors to know which hotspot they have visited, as clicking on the same hotspot causes redundancy.

One of the participants pointed out that the environment of the virtual tour could also be improved, by showing the stones in ‘sunnier’ weather. She stated that she did not find the tour engaging because the weather looked cold and grey.

Interestingly, most of the above insights were shared by the participants who had a pre-tour discussion, which raises a question, if the initial five participants who showed interest in visiting the physical place, would change their decision if they were told about the cost of the tour or the fact they could not get inside the circle? When the last four participants were informed about the cost and the restrictions applied in visiting the physical site, their immediate answer was negative. The main advantage of their response was that it was immediately followed by suggestions on how the virtual museum experience could be improved, as to those visitors this was the closest experience to the actual site they might ever have.

Another fact that was observed while evaluating the results was that only one of the participant had been to Stonehenge. Ideally, for this study, it would have been useful if more participants who had been to Stonehenge were interviewed but because of the shortage of time, this was not possible. Interviewing participants who had visited the Stonehenge could have proven useful for this study as more insights could have been gained from their comparison of the virtual tour and the actual place to make the user experience better.

Even though results from this study may suggest that virtual tours cannot replace an actual experience, the virtual sites can be improved visually for a better user experience. Moreover, an entire experience of a
place is not complete without a sense of touch, smell or the feelings the environment of the physical place evokes, but with current technology, visual experience can be improved. The visual experience of the monuments, art, and heritage sites of the world needs to be improved not only for preservation but also for providing a near to life experience for people who may never get to experience those places physically. Even for those who do visit, in physical experiences, visitors complain about overcrowdedness and limited representation of the background attached to those historical sites. Therefore, the virtual world developers and researchers, in this day and age have a responsibility to not only make the site visually engaging, but they should also keep into account different ways in which the history related to those places could be represented to provide a fulfilling user experience.

8. Conclusion

Based on the results from this empirical study it was concluded that, due to several limitations of the Stonehenge virtual tour, it does not provide a sufficient user experience for visitors to consider it a replacement for the actual place. Knowledge representation and autonomy to move around the virtual place plays a crucial role in defining how the users experience the place virtually. Visitors of the virtual site are aware that, virtual tours cannot replace the physical experience, yet they still compare their online experiences with that of the real world. Personal interests, economic conditions and previous experience with the virtual museums, influences users’ virtual museum experience as well.

For this study, the inductive approach proved to be useful as it observed user behaviour and was able to draw results which provided a deeper insight on how the virtual tour can be improved. These results could be further strengthened by interviewing people with various travelling experiences. Based on this study, it was found people with lengthy travelling history provided a new perspective on how the user experience can be improved as they end up comparing their past experiences with the virtual tour. Also, interviewing people who have visited Stonehenge in person can immensely help improve the virtual experience.

What makes Stonehenge heritage site unique from other places, is perhaps its constant efforts to discourage a physical visit either by raising the ticket prices or by limiting the access of stones. Therefore, it is essential for HCI to study these factors from a perspective that takes into account not only the design but also the users’ preferences and previous experiences. This way designers can create virtual tours that are better suited for the people who visit them.

9. References


Komianos, Vasileios, Eleni Kavvadia, and Konstantinos Oikonomou. 2014. “Efficient and


Consent Form

You are being asked to take part in a research study that will identify if Stonehenge Virtual Tour plays any role in preserving the actual heritage site. Stonehenge is a prehistoric monument in England and is believed to have been constructed between 2000 BC to 3000 BC.

What is the study about: This study is part of the ongoing research project called GIFT at Uppsala University which explores hybrid forms of virtual museums experiences. To learn about the GIFT project you can visit the site www.gift.itu.dk/.

The purpose of the study will be to observe you while you are exploring the Stonehenge virtual tour, to gain an insight about your experience with the virtual museum.

What you will be asked to do: If you agree to be a part of this study, you will navigate through the Stonehenge virtual tour, you will be asked to explore the virtual heritage site for as long as you want to. After you have completed your tour, an interview will be conducted. The interview will be about your experience with the virtual museum. With your permission, interview will be audio-recorded. As this interview will be conducted by one person, so with your permission, photographs might be taken, which will later be written down in notes.

Confidentiality: Your answers and identity will remain confidential and will only be used for research purpose. If you have been photographed during the observation the pictures will be deleted as soon as they have been written down.

Participation: Taking part in this study is completely voluntary. If you decide to not be part of this study at any point in time, you can terminate your participation.

Questions: This study is being conducted by Rabiah Saleem, and is being supervised by Lina Eklund. If you have any questions regarding this study, you can contact Rabiah Saleem, who is conducting this study. Please ask if you have any questions now. If you have any questions later, you can contact Rabiah Saleem at rabiah.saleem.2954@student.uu.se.

You will be given a copy of this form for your records.

Statement of Consent: I have read the above information and have received answers to all my questions. I consent to take part in the study.

Your Signature                  Date                  Your name
1. Appendix 2

Interview Questions

- Based on the tour what your impression of Stonehenge and how the experience?
- Did you find the tour interesting?
  - If yes what did you find interesting?
- Do you visit museums regularly?
- What was your favourite part of the tour?
- What was your least favourite part of the tour?
- Based on the experience would they want to visit the actual place?
  - If yes, why? Did the quality of the digital museum play any role?
  - If not, why? Did the quality of the digital museum play any role?