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Adopting Augmented Reality to Explore Historical Artifacts in Saudi Arabia Historical Museums

By

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Rayed Alakhtar, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Computer Science at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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5. Towards a Design Framework for Conversational Agents for Diabetes Prevention.

Abstract

Historical locations have many artifacts of generations that people from other cultures might not know about. Visitors to these locations want to understand the novel stories of buildings, people's lifestyles, and artifacts of centuries past. Tourism has become a digitized industry. This means that tourism is now employing technology to enhance tourism experience of locations. Technology that has been used for digital tourism is referred to as Augmented Reality. Augmented Reality is a promising technology that can deliver better understanding of the historical artifacts in Saudi Arabia. This research adopted the technology of Augmented Reality to deliver better understanding of the historical artifact in Saudi Arabia Museums.

This research aims to Investigating the user experiences and expectation when exploring Saudi artifacts in historical and general locations in Saudi Arabia and to establish whether using AR technology provides an enhanced understanding of the usage of the historical artifacts and gives a richer historical context to Saudi visitors. In order to Methodologically answer these objectives, I have carried out three sub-objectives. First, Investigating the user experiences and expectation when exploring artifacts in historical and general locations in Saudi Arabia. Second, Investigate the designing expectations of Augmented Reality characteristics so that users can compare different characteristics to explore historical artifacts at a particular location in Saudi Arabia. Third, Investigate the designing acceptance of Augmented Reality application that can be used to deliver a better understanding of the use of non-touchable historical artifacts in Saudi Arabia.

Given the nature and scoop of my research, my research is hybrid (Qualitative and Quantitative). Therefore, the research has three phases of study. Each study has a sub-objective that related to the main objective. The phase one study was an exploratory interview with 24 participants after they use low-fidelity prototype to answer objective one. Then, the research carried phase two study which was a qualitative data collection that included 100 participants to solve objective two of the research. Finally, phase their study involved 31 participants in mixed methods between interview and survey to answer objective three of the research.

The key finding in phase one study shows that the participant who were in Saudi Arabia have not used any augmented reality before in the context of tourism and they found the augmented reality is helpful in exploring historical artifacts. The key finding

in phase two shows that Augmented reality context, 3D animation provides clear information about historical artifact and ints preferred and recommend. Lastly, the research key finding in phase three shows that that users are engaged to the system, adopting the AR to deliver better understanding of the Artifact and deliver rich information, and it is acceptable to be use in the Saudi Arabia museums.

In conclusion, the result of this research shows with appropriate media characteristics, museum visitors can gain a deeper understanding of non-touchable historical artifacts using the Augmented Realty application in Saudi Arabia historical museums.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Museums have long been the custodians of our cultural heritage, being sources of historical artifacts, artworks, and matters that provide insight into human history and creativity. These institutions play an essential role in conserving, verifying, and showcasing the tangible and intangible fundamentals of our past, making them available to present and future generations. Within this context, artificial artifacts have appeared as a vibrant and transformative force, redefining how museums interrelate with their viewers and safeguard our cooperative heritage.

Artificial artifacts, also known as augmented or virtual artifacts, are a combination of the actual world with the digital world. They contain a wide variability of digital portrayals, 3D reconstructions, holographic predictions, and augmented reality understandings that give traditional museum demonstrations a fresh new look. These artificial artifacts go beyond the confines of time and space through immersive and cooperating involvements that go beyond the capabilities of conventional displays.

This research aims to advance augmented reality (AR) technology to enable a deeper comprehension of historical artifacts in Saudi Arabian historical museums. Through this study, we aim to upscale AR technology, improving its capacity to offer visitors a richer and more immersive historical experience. By leveraging AR, we seek to deal with an

innovative platform for the understanding and arrangement of these artifacts, thereby encouraging a more profound understanding of the historical background and implications they hold within the Saudi Arabian cultural landscape. This research attempts to link the gap between technology and heritage, eventually leading to a more enriched museum experience.

Research on artifacts in museums has become a vital part of their mission. Muse-ums, beyond being places of exhibition, are also centers of research and information dissemination. Scholars and curators research deeply into the history, attribution, and significance of artifacts, shedding light on the cultures and civilizations from which they originate. This research endeavor seeks to discover the multifaceted setting of artificial artifacts within museums, with a precise emphasis on their role, effect, and implications. There are many benefits to keeping manufactured objects in museum settings. It also enables museums to make digital reproductions of objects that may be viewed indefinitely to overcome the complications of keeping delicate or decaying artifacts. Furthermore, by offering cutting-edge approaches to communicate historical tales and encouraging a greater indebtedness of cultural heritage, it supports educational programs.

The primary objective of this study is to investigate how museums are incorporating artificial artifacts into their displays and collections and to explore the diverse types of artificial artifacts being used and the technologies employed for their formation. This research also examines the influence of artificial artifacts on visitor learning outcomes, and overall satisfaction and analyzes how augmented and virtual experiences enhance the museum visit. It also assesses to what degreeartificial artifacts assist in conserving and documenting historical objects. The efficiency of 3D scanning, visual acknowledgment, and other technologies in digitizing and validating artifacts is estimated. This research also explores the integration of artificial artifacts into educational programs and programs and explores collaborations between museums and educational institutions to progress AR-based educational resources.

By addressing these issues, this research offers a comprehensive understanding of the growing role of artificial artifacts in museums and their impact on the preservation, presentation, and clarification of cultural heritage. Also, it seeks to improve understandings that can inform the sustained expansion and incorporation of artificial artifacts in the museum sector.

1.2 Augmented Reality And Historical Tourism

Digital Tourism: Navigating the Digital Landscape of Travel:

The advent of the digital age has irreversibly altered how we engage with the world. By combining cutting-edge technology with the timeless appeal of utilization, digital tourism is a prime example of this transformation. As smartphones and virtual platforms become more ubiquitous, access to information becomes easier, enabling digital tourism to transcend physical boundaries and physical distances [61]. The concept encompasses the whole journey of a traveler - from the moment they are inspired to explore another place to the moment they share their experiences with the world.

The concept of virtual travel is intrinsically related to digital tourism. A virtual journey into historical and cultural landscapes can be an immersive experience in a world where mobility can be limited. It is possible to experience historic sites, interact with artifacts, and relive historical events through virtual reality (VR) and 360-degree videos. By democratizing travel experiences, individuals can transcend limitations and explore a world of historical wonders and knowledge that might otherwise remain out of their reach.

Augmented Reality: Enriching Reality with a Historical Context:

The groundbreaking technology of AR is fundamental to the evolution of digital tourism. Virtual and real worlds are seamlessly blended with the assistance of AR. This technology combines digital information, such as images, text, and animations with the real world. Historical artifacts and landmarks can be experienced differently with AR in the context of historical tourism. A user can see historical events unfold in front of their eyes using AR-enabled devices [90].

For example, digital reconstructions of historic ruins and interactive overlays can bring these to life through AR. During a tourist's exploration of the archaeological site, information about the archaeological context, architectural intricacies, and historical significance of the ruins appears in real time, enriching their understanding and engage-

ment. By combining tangible remains with digital enhancements, this fusion of past and present engenders a deeper appreciation for the landscape's history.

Augmented Reality (AR): Bridging Real and Virtual Realms:

Entertainment, education, healthcare, and tourism have all embraced AR as an innovative technology. Integrating the real and virtual world seamlessly and interactively will transform our interaction with the world.

Historical Tourism: Journeying Through Time:

The human instinct to connect with the past has always driven historical tourism, a venerable pursuit dating back millennia. A historical landmark or artifact can serve as a bridge between contemporary society and the legacies of antiquity, from the pyramids of Giza to the enigmatic Stonehenge stone circles. An ancestral yearning is universal, transcending cultures and generations, which draws people to retrace the footsteps of their ancestors.

Historical tourism strives to connect travelers with the past through personal connections. As visitors wander through the museum, they are encouraged to contemplate the lives of those who have gone before them, the social influences that shaped their actions, and the echoes of their achievements that are still reverberating today. The intangible essence of the human experience across eras is captured by historical tourism through immersive experiences and guided narratives [120].

Historical Tourism: A Journey Through Time and Culture:

Historical tourism, also known as heritage tourism or cultural tourism, involves exploring historical sites, landmarks, and artifacts to gain insight into the past and connect with a civilization's cultural, social, and architectural legacies. By learning more about bygone eras and their stories, traditions, and achievements, a bridge can be built between the past and the present [97]. Through historical tourism, visitors can discover more about the past and see what life looked like in the past.

Historical Artifacts: Portals to the Past:

At the heart of historical tourism are artifacts. Our ability to access the voices and visions of ancient civilizations can be facilitated by examining the tangible remnants of ancient civilizations, whether they are preserved in museums, archaeological sites, or cultural heritage centers. Artifacts encapsulate history, representing the triumphs, struggles, and nuances of previous centuries.

The story of human ingenuity and creativity can be told through historical artifacts ranging from intricate sculptures to weathered manuscripts. In essence, these objects are time capsules that capture the aesthetics, beliefs, and technological advancements of the people who made them. As discerning travelers and history enthusiasts, these artifacts are not mere relics. Instead, they provide a means to understand societies and the myriad ways humans have influenced our world.

We discover a world of possibilities as we explore the intersection of digital tourism, AR, historical tourism, and historical artifacts. Travel and cultural exploitation have reached a watershed moment with the convergence of these elements. The advent of the digital age heralds a time when travelers are no longer passive observers but actively engaged in history. By taking a holistic approach to heritage appreciation, we can peel back the layers of time, interact with the past, create connections that span eras, and transcend traditional tourism [75]. A new lens will be offered through which humanity's rich tapestry can be perceived, experienced, and cherished as the integration of these components is explored.

AR in Historical Tourism: Bringing the Past to Life:

With AR, travelers can interact with historical artifacts, landmarks, and cultural sites in a new way. With AR-enabled devices and applications, tourists can engage with a rich tapestry of historical narratives and visualizations they previously could only access in books and static displays.

AR also bridges temporal gaps by contextualizing historical artifacts and structures. By pointing their devices at artifacts, visitors can access in-depth information about the items in museums. To demonstrate the past more accurately, paintings and sculptures

can be animated to depict scenes from their creation [37].

As a result of AR, history becomes a living, interactive experience. In addition, it fosters a connection that transcends time and space, enabling travelers to experience the past on a deeper level. AR can enrich historical tourism by seamlessly merging the physical and digital worlds, providing a gateway to bygone eras and brightening our understanding of world culture.

The primary focus of this research lies in addressing a fascinating issue within the area of historical tourism. At historical locations, visitors regularly flock to discover and interact with a rich collection of historical artifacts, each with its own particular story to tell. Traditionally, visitors have depended on on information plates placed beside these artifacts to advance their knowledge of their historical significance and context. However, the conventional method of using static text can limit the depth of collaboration that tourists can have with these relics. So, the core motivation behind this research is to harness AR technology to transform the way historical material is presented to visitors. By leveraging AR, a wealth of novel and interactive material about various historical artifacts can be provided and tourists can have a more immersive and interesting experience, improving the wider setting of historical tourism.

1.3 Enhancing the AR Experience

Augmented Reality (AR): Elevating the Historical Site Experience

Historical sites are now being enhanced in unprecedented ways by AR, which has emerged as a powerful tool to enhance and enrich the experience. Using AR, historical locations are given new life by seamlessly combining the digital and physical realms. Visitors are able to enjoy immersive and interactive encounters that enable them to experience the past in a new way.

Interactive Historical Context

By overlaying historical context onto physical sites, AR serves as a digital guide. Using a device equipped with an AR module, tourists can learn more about the castle,Äö

history, architectural style, and eventful past and gain a deeper understanding of the significance of the site through digital annotations. In addition to providing an interactive experience, these overlays allow the tourist to gain a deeper understanding of history through the use of living narratives on historical sites [8].

Visual Reconstructions

AR enables the visualization of historical structures in their former glory. It can be difficult to imagine the original appearance of historical sites due to their varying states of decay. AR addresses this by superimposing digital reconstructions onto the existing ruins. Previously neglected amphitheaters are turned into bustling arenas with performers and spectators. The visualization allows visitors to experience the splendor of historical sites as they used to be, providing a tangible connection to the past.

Virtual Time Travel

Visitors are able to witness historical events and scenes through AR's virtual time travel feature. A user can relive significant events that took place in a specific place by pointing an AR-enabled device there. With the assistance of AR, visitors experience key moments in history, such as historical battles, pivotal speeches, and cultural events.

Interactive Artifacts

Museums and cultural centers can use AR to display historical artifacts. By pointing at artifacts, visitors can access detailed information about them using AR-enabled devices. Animation can be used to portray scenes showing how a painting was created, giving viewers an inside look at the artist's method of creation. Digital reconstructions reveal intricate details from all angles that are otherwise invisible to the naked eye when examining sculptures .

Personalized Experiences

AR provides a personalized experience tailored to individual interests. Visitors can explore more deeply aspects of history in which they are particularly interested. For example, if a tourist is interested in political history, with AR, they can journey through

the corridors of power. By recreating daily scenes and activities from the past, augmented reality can help a tourist empathize with historical figures and their lives [77].

As a result of AR, historical sites are transformed into dynamic, multidimensional encounters. The interactive experience incorporates visualization, interactivity, and context to reimagine the past as a whole. AR connects tangible and digital worlds, enabling present and future generations to experience historical sites in a new way.

In relation to historical tourism, the incorporation of AR technology improves the visitor's experience and overcomes the limitations of conventional information distri-bution. This research is motivated by a desire to arrange a more self-motivated, appealing, and informative phase for tourists looking to investigate the historical treasures found at these locations. By exploiting AR, the gap between the past and the present can be bridged, empowering visitors to discover historical artifacts in a way that is both educational and entertaining. This effort aims to cater to the specific requirements and interests of visitors and to enrich the tourism landscape by promoting a greater appreciated and shared historical heritage. Finally, this research endeavors to foster an association between technology and history, resulting in a more immersive and enlightening experience for visitors, while also improving the overall value of historical tourism.

1.4 Chapter Overview

This section discusses the potential benefit of using AR in the historical Saudi context. This research embarks on a journey to untie the intricate world of artificial artifacts in the realm of museums. In this comprehensive examination, we investigate the dynamic fusion of the physical and digital, where traditional artifacts meet cutting-edge technology to redefine museum involvement. This chapter overview indicates the multifaceted landscape of our research, presenting a roadmap for the chapters that follow. In this foundational chapter, we set the steps for our research journey. We highlight the profound importance of artificial artifacts and their transformative effect on the museum landscape. The chapter details the main research aims, highlighting our goal to realise the incorporation of artificial artifacts in the real world, examine their effect on the visitor experience and their contribution to conservation, devise ways to include them in educational endeavours, identify the challenges, and present future guidelines.

The historical evolution of museums forms the background of our research. We traverse through time to trace the origins of museums, from their early cabinets of interest to modern establishments. Understanding this development offers a vital context for understanding the role of artificial artifacts in modern museums.

This research deeply explores the world of artificial artifacts, introducing the various forms they take in museum situations. We discover the spectrum of augmented and virtual artifacts, from digital symbols to holographic exhibitions and immersive augmented reality experiences. It discusses the technologies sustaining these artifacts and their varied forms. The visitor experience takes center stage as the influence of artificial artifacts is examined. We explore how these digital marvels captivate and involve museum-goers, helping them to become more deeply associated with historical objects. Through extensive investigation, we discover how augmented and virtual reality experiences boost learning and overall satisfaction. Artificial artifacts play a critical role in conserving cultural heritage. This thesis assesses the degree to which artificial artifacts assist in the preservation and certification of historical objects. The conversation incorporates 3D scanning, visual acknowledgment, and other technologies that digitize artifacts, certifying their durability and convenience.

Education and technology assemble as we examine the incorporation of artificial artifacts into educational programs. We shed light on the associations between museums and educational establishments, and the introduction of AR-based resources that improve classroom learning. No exploration is complete without identifying the challenges and envisioning the future. we dissect the obstacles facing the introduction and use of artificial artifacts. We also chart a progression for the future, proposing strategies to address the challenges and offer potential guidelines for both research and execution. Our research concludes by elaborating our findings and all-encompassing conclusions are drawn to highlight their broader effects. We emphasise the transformative possibility of artificial artifacts and their continuing significance in determining the museum of the future. Our research expedition promises to be a fascinating and informative voyage through the world of museums, history, and technology.

1.5 Research problem and motivation

The motivation of this research is to develop AR technology to enhance tourism at historical locations. These historical locations contain many types of artifacts. Many tourists visit a historical location to see the artifacts and to better understand their story. The only way visitors can discover this is by reading the information plate normally located next to the artifacts. The use of AR can enhance the delivery of information on the artifacts and make it more interactive for users. Therefore, the thesis aims to deliver novel information concerning historical artifacts to visitors specifically and to enhance the tourism context.

1.6 Research Objectives

1. To investigate the user's experience and expectations when exploring artifacts in historical and general locations in Saudi Arabia.

2. To investigate the expectations of AR characteristics so that users can compare different characteristics to explore historical artifacts at a particular location in Saudi Arabia.

3. To investigate the designing acceptance of AR which can be used to enhance the understanding of non-touchable historical artifacts in Saudi Arabia.

1.7 Overview of chapters

This section overviews the chapters in this thesis with a brief description of of each.

Chapter 1:Introduction

In this chapter, the research will dimonistrate his introduction to his research and will overreview his motitivation of the research and his objectives of research?

Chapter 2: Literature Review

This chapter identifies the research gaps based on the systematic literature review.

Chapter 3: Problem Definition

This section provides an overview and a definition of the problem to be addressed. It also

details the research questions and objectives of the research.

Chapter 4: Research Methodology

This section describes the user-centered design method used in this thesis. The research comprises three phases to achieve the research objectives.

Chapter 5: Phase One: Perspectives on using Augmented Reality in Saudi Arabia

Based on the user-centered design, the first phase is to understand the context of use. Therefore, this chapter investigates user experiences and expectations when exploring artifacts in historical and general locations in Saudi Arabia. To achieve the objective, the methodology used is an exploratory interview.

Chapter 6: Phase Two: User Expectations of Media Method Content for the Augmented Reality Application

Using the UCD module, the second phase is to understand user requirements. To do so, phase two investigates the designing expectations of Augmented Reality characteristics so that users can compare different characteristics to explore historical artifacts in a particular location in Saudi Arabia. Therefore, a quantitative method is utilized to identify which media the user prefers to view in the AR application when exploring historical artifacts.

Chapter 7: Phase Three: The Exploration of non-touchable Historical Artifacts

Based on the user-centered design, the last phase is to design the solution and evaluate it against the requirements. Therefore this chapter investigates the acceptance of the AR application which can be used to promote a better understanding of non-touchable historical artifacts in Saudi Arabia. The user interface of the augmented reality application is designed and the media methods are evaluated to determine how the system will deliver a better understanding of the system.

Chapter 8: Conclusion

This chapter summarizes the key findings of the three phases and the contribution of the research. The chapter has also discusses the limitations of the research and provides suggestions for future work.

1.8 Conclusion

This thesis examines how the physical and digital worlds interact in complex ways at the crossroads of museums and artifacts. The research explores the historical development of museums in Saudi Arabia, tracing their beginnings to contemporary establishments, and provides a context for comprehending the function of historical muesume artifacts. The study investigates numerous artificial artifacts in Saudi Arabian museums, such as holographic exhibitions and immersive augmented reality experiences, as well as augmented and virtual objects. Through technologies like 3D scanning and visual identification, the emphasis is on how these objects improve Saudi visitor experiences, improve educational results, and aid in the preservation of Saudi Arabia's cultural heritage. The research also looks into how Saudi artificial artifacts are used in educational settings, highlighting partnerships between educational institutions and Saudi Arabian museums. The research discusses the difficulties encountered in the field of Saudi artificial artifacts and suggests potential solutions. The final chapter summarizes the research, provides a detailed conclusion, and highlights the potential for historical artifacts to change Saudi Arabian museums in the future. The study encourages readers to embark on a scholarly trip to investigate the complex network of produced objects and their significant influence on Saudi Arabian and cultural heritage.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This section describes the literature review that was undertaken to identify the research gaps. This chapter is organized as follows. In section 2.2, we discuss the contemporary uses of augmented reality (AR). Section 2.3 details how AR has been used in various tourism contexts across the globe. Section 2.4 describes how AR has been used in historical contexts across the globe. Section 2.5 details how AR has been used in exploring historical artifacts .Section 6 provides a thorough review of the relevant literature. Section 2.7 defines the research gaps and section 2.8 concludes the chapter.

2.2 Augmented Reality

2.2.1 Definition of Augmented Reality

Towards the end of the first decade of the 21st century, the world experienced the advent of ubiquitous computing (UbiComp), which plays an essential role in improving the interaction between people and their environment at any place and time [36]. UbiComp is a technique where critical information is derived from lifestyle activities and the interactive objects which people utilize daily. [36] contended that Ubi-

Comp is widely used in modern society to link electronic machines such as microchips to facilitate efficient communication and the flow of information between people and systems. Currently, UbiComp, also known as pervasive computing, emphasizes the elimination of redundancy in computing and improves efficacy when executing computational functions for various day-to-day activities [36]; [6]. [36] also noted that UbiComp's all-in-one integration of computing into user settings helps make the process of computing somehow invisible after a particular point in time. Currently, the most common, widely known, and critical real-world innovation of UbiComp is augmented reality (AR) [36].

AR is a variant of virtual reality, where technology is utilized to enhance real-world elements rather than creating an environment from scratch [41]. AR is more technologically constrained that virtual reality (VR), which makes it easier to implement [109]. The basic component of AR is the use of superimposed 3D visuals in the real-world environment when viewed through an AR tool. Theoretically, even olfactory and gustatory interfaces can be considered a part of AR, though the technology is under-developed [109]. In their systematic review, [85] defined AR as a form of interactive, collaborative, and reality-based display settings that assume the abilities of computer-driven presentation, resonance, content, and effects to improve the human experience. In other words, AR is an interactive experience that integrates the actual world and imaginary events and pictures to generate an improved outlook of the world [69]. AR is associated with various applications and implementation frameworks, but its core purpose is to offer an advanced audio-visual encounter in the real world [36]. In their analysis, [85] revealed that AR functions could be made more effective by applying computer-based simulations and other methods or features such as image and sound recognition, animatronics, headgear, hand-held devices, and powered display settings to improve the experience of real landscapes and regions. With improved and sophisticated AR in modern society, people can enhance their perceptions of the physical world with augmentations of their choice.

Various studies have confirmed that AR concepts are mainly based on the belief that real-world objects or activities can be improved by computer-based outputs that are seamlessly integrated into it [69]; [92]; [3]. AR is largely characterized by the integration and interaction of virtual and real objects, which makes it an exceptional component of UbiComp. AR was first introduced in the early 1990s [36]. With the advent of smartphones and other mobile technologies in the 21st century, mobile augmented reality (MAR) has become a common interactive experience [36]. MAR is characterized by multi-

ple features and abilities such as a quick connection, sophisticated sensor data, and a wide variety of software characteristics [36]. Furthermore, MAR has unique capabilities which allow digital components to supplement and fuse with the physical world view. In contemporary society, AR applications are used to enhance people's comprehension of their environment, for instance, when vital details are highlighted for smartphone users. MAR represents a novel opportunity for software designers, developers, sellers/dealers, and mobile owners. The next two sections discuss how AR has revolutionized sectors such as education and tourism.

2.2.2 Contemporary Useof Augmented Reality

The work in [6] highlights that AR integrates current technologies such as active sensors and object recognition to create virtual experiences in actual environments. The interplay of simulated objects and real-world settings involves a combined reality with which humans can interact in real time. AR can be employed in various scenarios because computer-generated visuals are extremely useful during daily operations [6]. Further, AR can be seamlessly integrated with the immediate surroundings [6]. The work in [6] explored how AR can be used as a tool to improve education. The researchers used a technologically advanced learning environment where students were provided with head-mounted displays (HMDs) to augment their visual experiences [6]. According to the authors, HMDs are essential AR devices for learners because they help visualize sophisticated diagrams that are hard to impart through conventional techniques like diagrams, experiments, or books. Typically, traditional multimedia devices mainly focus on student interaction to enhance overall academic learning [80]. AR can enhance comprehension through the use of computer-generated information and media on, for example, magnetism, airflow, and other phenomena not easily observable in the physical world [6]. This allows modern AR devices to offer a practical solution to teaching scientific concepts to students [6]. AR and other wearable devices are a relatively new phenomenon that has not fully penetrated the public domain. Currently, AR is used in fields such as healthcare, education, manufacturing, defence, emergency services, and other domains. The work in [81] states that the main difference between AR systems and computer display-based systems is the need to design and develop AR systems using different approaches. For instance, students can learn basic molecular models and assemble molecules in an AR environment to gain a better understanding. Architects and engineers can use it to supplement building site data, allowing them to work faster [15]. Individuals can even

play games with real-world elements, for example, the popular AR game Pokemon GO. AR is being used to solve global health problems [55]. According to [40], AR concepts are helping to create new opportunities that are advancing the delivery of healthcare. New AR technologies on the market are helping physicians and surgeons diagnose, treat, and conduct surgery on their patients more successfully [63]. Modern AR tools have improved medicine and healthcare by giving doctors and surgeons instantaneous access to real-time information and patients' records [63]. New augmented surgical systems are now being created to better implement minimally invasive surgery [104]. Such systems use detectors to visualize the inside of a surgical environment, allowing doctors to operate more easily. The presence of AR technologies has supported the use of evidence-based practice (EBP). AR has also plays a vital role in healthcare and education by offering learners and nursing students a chance to examine medical issues and events; this helps them accumulate experience more quickly [22]. The future of AR in the healthcare sector seems promising, considering the early successes which have been achieved. In addition to science-based endeavours, AR may also be implemented in science education. The work in [6] argues that the implementation of this technology in education may help to improve our understanding of the factors that contribute to embracing a technology [6]. The acceptance of AR technology further helps to boost the success of its implementation in any field [52].

In the future, AR technology will help furnish more accurate and life-saving medical information that can optimize surgical procedures and treatments [100]. AR allows medical practitioners to clearly assess their patients' health faster by displaying magnetic resonance imaging (MRI) outcomes and computed tomography (CT) scans directly onto AR headgear [100]. According to Sanchez [100], this allows surgeons to obtain a clearer picture of the bones, neurons, muscles, tendons, and other internal organs without the need for more invasive procedures. This makes it easier for physicians to identify symptoms and diagnose patients [100]. AR can also help inform initial responders about patients' conditions in the emergency room. AR technologies like Microsoft's HoloLens AR glasses, EchoPixel, and MedicalRealities are being used to conduct safer surgeries, saving time in the event of an emergency [100]. Rather than randomly searching for patients' data on traditional paper-based records, files or electronic health records (EHRs), doctors can access all critical health information on their AR display within the shortest time possible. Currently, AR is being used to improve education, business, marketing, construction, manufacturing, and other fields by providing accurate and real-time infor-

mation [100].

2.3 Augmented Reality Usage in the Tourism Context

The work in [57] argues that businesses in the tourism industry often need to use AR to improve their marketing campaigns. Their argument is based on past studies showing that different aspects of AR have been developed for specific applications [57]. The tourism sector, in this case, may need to adopt ways to enhance the tourist experience. Recent advances in mobile technology, digital systems, wireless computing, and sensor innovations have helped the rapid introduction of AR apps to smartphones [122]. This has, in turn, transformed the tourism industry. According to [122], visual AR technologies are vital to the tourism industry because they augment tourist destinations with computer-generated details. Contrary to conventional AR tools such as HMDs and portable laptops, MAR integrates all technological innovations pertaining to augmentation into a single tiny device. Since its onset, MAR has had a significant influence on tourists' visual experiences while on holiday [122]. Typically, GPS-based MAR apps for outdoor use enable tourists to have an improved user-experience while travelling.

Tourists are able to use their smartphones to view additional information and useful data overlaid on top of the physical world via virtual annotations [122]. The kind of information and volume of data within these simulated systems differ; they can incorporate videos, photos, notifications, or symbols for various landmarks [122]. The information displayed on AR applications can involve tourist destinations, attractions, sites, accommodation facilities, and historical artifacts. Other data that tourists can access using MAR include information on parking areas, transport systems, local news or details, climatic conditions, and WiFi hotspots [122]. AR apps in the tourism sector permit guests or travellers to easily access geographically coded simulated information such as tweets, images, clips, remarks, and suggestions regarding a tourist destination [122]. The arguments are further supported by the work in [64], which argues that AR tools are quite interactive and can be easily manipulated in a digital manner to improve tourists' experiences [64]. Furthermore, they can assist tourism businesses and organizations to reach a wider audience.

There are also other functionalities that can define AR in the tourism industry. As

stated in[95], mobile technologies in the tourism sector possess a search and browse option or categorical search engine system that allows travellers to easily access critical information. The work in [122] noted that mobile AR tools have context-aware push notifications that allow guests or tourists to peruse relevant data, particularly in busy urban environments. Having m-commerce or E-book functionality creates an opportunity for tourists to book, pay, or cancel any services to which they may have subscribed while travelling [95]; [43]. As discussed in [122], MAR hosts a platform to receive feedback from tourists. The technology allows easier routing and navigation for travellers, which makes it possible for users to obtain directions and navigate to a point of interest (POI) once it is selected in the AR display [122]. A study by [73] shows that AR may be effectively provided to tourists, depending on the places and objects of cultural interest. These places and objects may be superimposed with virtual contents on the physical space where they were originally located. To this end, AR can help to increase the general public's interest in and understanding of historical contents [73]. Moreover, AR can be used to provide the geolocation of the users, thus making it possible to easily locate where the users actually are [19]. According to [35], it is for this reason that most of the solutions to AR in the field of cultural support for tourists have been heavily focused on indoor presentations [35].

A study conducted by [68] found that AR technologies such as CityViewAR allow users to add POIs to their predetermined itinerary, which gives them an opportunity to plan better and enhance their enjoyment of their holiday experience. AR sites provide tourists with map services that offer an extensive overview or summary of destinations [122]; [68]. As an application that helps browse and search for content, the core purpose of the CityViewAR software is to allow travellers to easily access geo-located content [68]. Mostly, MAR tools use in-built sensors such as GPS to offer critical information on a tourist's current location [56]. To meet the varied needs of travellers, MARs display information using visualization techniques like AR, interactive virtual maps, and search history. [68] confirmed that these three methods are the primary interfaces that tourists can use to search and review the presented data.

A study conducted by [41] revealed that AR technologies can help improve communication by allowing tourists to directly connect with accommodation facilities, travel agencies, and other service providers. Additionally, AR tools like PRISMA offer users an opportunity to explore the nearby surroundings [41]. PRISMA is a visualization system

that records live video feeds using inertial sensors and cameras to synchronize virtual information with a physical environment. In accordance with the settings applied by users of this system, it helps project multimedia in a way that encourages visitors to immerse themselves in the environment and retrieve personalized information. Instead of searching for information regarding a certain commodity, location, and categories, tourists can use MARs to access data about their environment through a predetermined strategy or procedure [122]. Interactive AR visualization provides an interface containing more comprehensive information about POIs.

Similarly, the functionality that permits users to filter and alter information in an AR view is a vital feature in urban settings that are rife with change; consequently, updating information concerning these locations becomes easier. AR also offers an engaging learning environment for tourists [59]. Consumer education is one of the dimensions that has significantly progressed due to AR; this is primarily because the technology presents a tangible and easy-to-use interface promoting interaction with new information[4]. AR enables rich travel experiences and guest involvement, which are essential drivers of the tourism industry [82]. AR can help actively engage tourists in learning about and interacting with museum environments and artifacts in a unique and advanced way.

2.4 Augmented Reality Usage in Historical Contexts

AR is a promising technology that has the potential to impact a wide range of fields, including ones not often associated with computer technology, as virtual objects can be are added to a real-world environment using AR to superimpose photos so that people can see and learn more about various artifacts [9]. When a user places their camera on an image, it shows them a realistic version of the museum. In museums, AR can be used in a variety of ways. The simplest method is to include a description of the parts. As a result, visitors can use AR to gain a better picture of museums. It can also be used to display digitised artifacts that can be displayed alongside the artist who created the work. In addition, there are numerous ways in which augmented reality 'AR' might assist in the exhibition of artifacts in three dimensions.

Artifacts are items that carry information about the item's inventor, date of creation, and history. As research into these as digital relics continues, the details of the object may alter as time and culture change. Digital artifacts are those that are made digitally

and their data is recorded [24]. As we all know, a museum is a place where artifacts are maintained and kept for the purpose of education and research. AR ensures the artifact's details are accessible for investigation and in good working order. The majority of museums use AR for exhibitions and traditional displays [29].

Various studies have been carried out with the objective of researching the use of AR for museum artifacts. Designers can develop new exhibitions using dynamic visualization [116].The latest technological advancements in the computer world have generated new ways to use things, with AR being the most recent [26]. AR allowes users to interact directly with artifacts[13]. A museum is a place where artifacts is maintained and displayed, thus there are numerous types of artifacts that need to be digitalized [27].

By providing immersive experiences in both the digital and physical worlds, mixed reality has revived the interpretation of a variety of fields [62]. Around 80 percent of the participants suggested that AR could be used to provide detailed access to museum objects [30]. Visitors can obtain a better overview of museum artifacts by using virtual reality. Many enabling AR technologies have advanced in recent years. In addition, a lot of study has been done on how AR might be utilized to improve existing apps [76]. Computer technology is used to enhance the richness of the actual world by combining real-world interactions with computational data [38]. However, most museums have retained their low-tech state. Hence, the need for AR is must for museums [12]. The use of mixed reality has great promise for enriching museum visits, but the limitations of museum environments must be carefully considered. New techniques and technology to enhance the understanding of cultural heritage have received a lot of attention recently [1].

Computation can be used to augment rather than replace the external world without conflicting social issues [53]. Museums have been attempting to expand their collections by encouraging tourists to peruse their artifacts. AR is a solution which allows 3D digital models to be visualized [116]. All virtual exhibitions in end-user interfaces are dynamically produced, allowing for differentiation in content and presentation style based on the parameters provided by end-users. The presentation domain concept allows for alternative visualizations of the same cultural object collections depending on the target context [42]. Some museums have a more restrictive environment for electronics. Furthermore, the restrictions are extremely stringent, and they are not accepting of

the introduction of new technologies [49]. Most museums have embraced AR to be able to present their exhibits in more imaginative ways as digital technology has advanced. The application of AR will expose users to extremely rich heritage communications, increasing museum interactivity. [83] . AR has improved several aspects of people's lives. Furthermore, research demonstrates that AR has provided many answers in most disciplines, with applications spanning from education to other utilities [66].

All AR displays for end users are developed on a regular basis, which allows for and supports the differentiation of the parameters offered to end users [114]. One of the studies described how augmented representation assisted in the development of a technology chain for presenting digitized cultural artifacts that can be accessed from both inside and outside museums[42]. The next AR works feature templates for visualization in such a way that it is more attractive and appealing[107]. After the initial demonstrations, the augmented technique utilized for displaying the system received positive comments because it provides computer solutions and increases its value [91].

2.4.1 Research on Museum Artifacts

Virtual reconstructions can be generated using AR, which is difficult to achieve with other virtual approaches.[60] With the use of multiple templates, AR displays can be provided in a variety of ways and in varied locations. The concept of introducing more methods of visualization presentation was introduced to obtain more methods of visualization. The presentation domain is employed in this environment [31]. Due to the rapid progress of the industrial revolution, the use of digitalization and machine learning enables displays to be identified more accurately, allowing visitors to have a better experience with the display [74]. As detailed in [13], the major components of the AR system are content administration, content development, and visualization. These components and procedures assist in the digitization of museum objects.

All the necessary parameters are set, but optional parameters are not - the display area is visualized immediately, but the end-user has the option of changing some of the presentation parameters (e.g. the default historical period) [1]. The organization of virtual exhibitions is dictated by the database structure of specific exhibition spaces [102]. The augmented database stores digital representations, which are maintained via the enhanced Content Management Application. Each digitized cultural object consists

of a collection of media assets and information [25]. The museum's use of technology allows them to present an entire collection in a much more digitized format, enabling them to make these items virtually available to the public. This technology will also assist in the creation of a virtual display for educational and tourist purposes. According to recent surveys, roughly 33 percent of museums in Europe use AR to present objects to the public [107] [113]. The advancement of technology aids in the development of new methods for digitizing museums. Because of the difficulties that museums have had in keeping space filled for objects, new technologies will aid in gradually modifying the museum's surroundings [108].

AR allows users to see virtual objects in real-world settings. This promotes physical activity by allowing virtual items to enter the physical world, so contributing to the creation of an important element of the environment[89]. Another example of employing AR is to reconstruct a historical place, which is one of the main goals of virtual heritage [39]. As far as AR is concerned, it is a situation in which the real world can be enhanced by the use of virtual things [117]. The prototype that serves as a museum guide for the fine arts is AR [46].

The device can also display 3-dimensional models with a real-time museum experience using AR [7]. The museum instruction is provided through AR, which provides a user-friendly encounter between man and machine and is based on a new computer approach [10]. Virtual exhibitions are dynamically built in end-user interfaces using parameterized visualization templates and database content [101].

With the widespread use of computers, several technological advancements have been widely available. Computers are commonly used to provide information, which is beneficial in museums and other tourist sites [123]. Using the potential of AR for the user's vision of the world around them to use AR to enhance engagement because AR provides a safe environment that anybody can use. [103]. The creation of a useful framework for interacting with AR technology allows end users to see artifacts in a convenient way [45].

Content designers may quickly develop virtual exhibitions using dynamic content creation based on pre-designed visualization templates [87]. Exhibits in virtual reality may be more enjoyable. both inside museums, for example on touch-screens placed in galleries and on the internet at the same time. Furthermore, the presentation will be

based on AR. Museum visitors can engage with the content using technology in a way that is both intuitive and interesting [78].

2.4.2 Use of Augmented Reality in Historical Places

According to [71], AR is being used to enhance the tourists' experience in historical places and is being employed in cultural heritage destinations. Setting the appropriate items in place for future digital transformation is critical in any organisation, and its value in museum artifacts has been assessed as critical[111]. According to [50], AR is critical for numerous interactions in museums, which include gesture-based holograph objects. The work in [118] uses AR for the presentation and animation of objects in exhibitions, which helped in the planning of exhibitions and the 3D visualization of artifacts. The discussion of AR is boosting brand potential and reinforcing consumers' wishes in their interactions with artifacts [16].

The work in [106] discusses the implementation of new museum strategies to address the difficulty of framing and endorsing new technology in museums for long-term viability. The work in [115] shows how visitors benefit from having a setting where they can see the artifacts in a variety of ways using AR. This topic of study has attracted a lot of research and many prototypes have been developed. The study conducted in [96] shows how current frameworks are focused on the transformation of digital accessibility and what they suggest for museum artifacts, with an emphasis on artifacts that have been digitalized. Studies on new museum experiences enhanced with technology are being conducted and the prior use of technology is being transformed with the introduction of AR[121].

Hedonic and utilitarian expectations are both present in today's museum visitors [44]. A variety of technologies have been implemented by traditional museums in order to meet the diverse expectations and demands of visitors. An example of this tendency is the emergence of digital museums, which present a virtual environment with projectors, surround sound, ambient lights, and multimedia cues. It is believed that virtual environments are more engaging when emotions and a sense of presence are present. Therefore, [48] research empirically investigates digital museum visitor experience perceptions and the influence of emotional state and sense of presence on experience perceptions.

Additionally, the relative mediation effect and multisensory cues were examined [48].

Data were collected with a scenario-based online survey conducted through Amazon Mechanical Turk (MTurk). Analyses were conducted using a split-sample approach involving 382 respondents. Digital museum visitor experience perceptions were explored using exploratory factor analysis and confirmatory factor analysis. In order to examine the influence of emotional state and sense of presence, structural equation modeling was employed. In order to compare the difference in impact of multisensory cues on visitors' overall experience, a one-way analysis of variance was performed. Multisensory cues were also used in this study to demonstrate the mediating effect of emotional state and sense of presence on overall visitor experience by using the PROCESS macro in SPSS. According to the results of this study, there are three experiences of digital museums that are characterized as jovial, personal escapism, and local. Additionally, this research found a positive relationship between emotional state and joviality experience and a negative relationship between emotional state and locality experience. Furthermore, sense of presence was found to positively impact joviality, personal escapism, and localness experiences. According to this study, emotional state did not affect personal escapism significantly. It was also concluded that auditory and visual cues together were most powerful for triggering the greatest levels of experience. A sense of presence effect was also examined as a mediator of the impact [67].

The work in [28] contributed theoretically and practically to the literature on experiences in museums. Theoretical implications were discussed to measure the digital museum visitor experience based on the proposed three-factor structure. Practical implications were provided for museum managers. Limitations and future research were discussed.

Marketing campaigns in the tourism industry need to be enhanced in a variety of ways in order to stay competitive [33]. Media outlets and a variety of use cases are gaining increasing attention to augmented reality as the buzzword of modern information technology. As a result of Google Glass' upcoming launch in 2014, this trend is prevalent throughout mobile applications and wearable computing. Despite the fact that AR has been researched in various fields including urban tourism, the majority of studies focus on the technical aspects of the technology, while others target specific purposes. The purpose of this paper is to examine the current implementation of AR in the urban

tourism context in order to identify areas for future research and development to guide the early stages of AR implementation in a way that enhances the tourist experience. AR is discussed in the paper, as well as the economic impacts it has had. Therefore, AR applications in urban tourism are identified and the benefits of AR are discussed[58].

2.4.3 Technologies Used for Museum Artifacts

Studies on new museum experiences with technology are being undertaken and the prior use of technology is being transformed with the introduction of AR [93]. The evolution of digitalisation in museums has attracted a lot of interest in recent years. Museums require a high level of innovation, which is now feasible due to to digital transformations, and this will ultimately aid in the preservation of cultures while also generating cash. The literature reviews reported in [34] [17] examined the relevant material on museums, thereby increasing their value, and the experience of heritage assets in museums has improved as a result of digitalisation. The introduction of interactive panels and other mobile technology has increased visitor participation in the visit's entertainment.

It is customary for museums to have photos of art history, and as a result, museums have the greatest digitalisation share. Digitization also defines the record of an object with images. Because locating the desired thing without an image may not be less desirable than finding a substitute object with an image, complete access to images in museums is achievable [17].

The study conducted in [20] gathered empirical data from 390 museums in the field of culture. In this day and age, digital technology has advanced to the point where there are instruments to assess the readiness of museum items, and the digital readiness of the objects has been widely known owing to the usage of AR. Operational metrices have been developed for the empirical settings of museums, which is done by using the new roles for the collection of digital strategies.

The work in [23] Fuses tags and other tools for the exhibits and guidance system, which display various information that is contained on paintings in the form of video and photos. Many tourists do not like to accompany guides when visiting an exhibition, thus the AR guidance system will assist in providing information to visitors. For the displays, the researchers developed a system that uses an ultra mobile and inertia tracker as well

as a camera. The numerous advantages of AR include the ability to observe artifacts in new ways. In addition to many technologies, AR has revolutionised many things. This technology allows people to connect with computer simulated and interactive systems in a more efficient manner[79].

The work in [79] aims to assist people to understand AR and how it can help them experience and learn about different cultures. This research contributes to our understanding of AR's impact on cultural assets and museums. The research on the use of AR is crucial for users since it allows them to have firsthand encounters with artifacts and will aid in the better understanding of artefact specifics [86].

The use of AR in museums can help broaden people's minds and enable them to have a better grasp of the subject. The technology utilised in the virtual reality reconstruction, encoding, and visualisation of archaeological remains. The procedure aids in the development of a system capable of recording archaeological phases [5]. AR is a new technology that displays digitized content to users. Various heritage sites have begun to focus on AR technology and have started to integrate it to enhance the museum experience. Various studies have been undertaken to demonstrate the value of AR in preserving heritage sites.

Cultural heritage assists in providing the most up-to-date technology and advances, attracting people and their interests. The emphasis is turning towards a vision-centered approach, with consumer-oriented applications and displays.Many studies have been conducted to determine the impact of AR on cultural sites and its behaviour in order to improve the user experience in relation to cultural heritage. In addition, the employment of a combination of modern technology aided in the preservation of museum objects. Many people have firsthand experience with AR and are interested in learning more about how this technology might be used with museum objects.The use of AR in museums was taken into consideration in [105].

Using AR in conjunction with various technologies to improve users' experiences with cultural heritage, forecasting future technologies, and addressing these concerns are all helpful in the field of technology with museum artifacts being the main focus of many studies. AR has improved knowledge on a variety of topics, enhancing user experiences. However, research has shown that AR does not completely improve the user experience in relation to museums and cultural treasures[51].

The lengthy legacy of museums in relation to the preservation of art and photographic history as well as the digitisation of digital archives, is significant.The primary elements in determining the framework for measuring process are technology, customer, and strategy, which assists consumers in locating inquiries addressed to businesses and in locating specific information about museum objects.

Exhibits that allow people to interact dynamically in terms of presentation aid in the discovery of cultural objects for museum artifacts that are dependent on the environment. Members of the public employed AR for the experience of the museum with their phones at the gallery in London, where a QR scan code was used to find the details of artworks [29]. The innovative tool for museums and other art galleries that allows art enthusiasts and other first-time viewers to receive a better and more informative look at the institution. AR gives people a more innovative and better perspective. A tool for museums that changes items using AR, the visitors get the image more clear and better with all the details with more deeply felt.

2.5 The use of Augmented Reality in Exploring Historical Artifacts

Various studies have been conducted with the objective of conducting research on the use of AR to explore museum artifacts. Many designers have developed new exhibitions using dynamic visualizations [116].The latest technological advancements in the computer world have generated new ways to use things, with AR being the most recent [26]. AR enables users to interact directly with artifacts [13]. As we all know, a museum is a location where everything is maintained and displayed, thus there are numerous types of items that need to be digitalized [27]. By providing immersive experiences in both the digital and physical worlds, mixed reality has revived the interpretation of a variety of fields [62].

In the work in [30] 80 percent of the participants suggested that AR could be used to provide detailed access to museum objects. Visitors can obtain a better understanding of museum artifacts by using virtual reality. Many enabling AR technologies have advanced in recent years. In addition, many studies have been conducted on how AR might be utilized to improve existing apps [76]. The computer is used to enhance the richness

of the actual world by combining real-world interactions with computational data. A museum is also a place that has been kept in a low-tech state, therefore the need to implement AR is must for museums [12] The use of mixed reality has great promise for enriching a museum visit, but the limitations of museum environments must be carefully considered. New techniques and technology for cultural heritage have received a lot of attention [1].

Computation can be used to augment rather than replace the external world without conflicting social issues [53]. Museums have been attempting to expand their collections by attracting tourists through their artifacts. AR is a solution to enable 3D digital models to be visualized [116]. All virtual exhibitions in end-user interfaces are dynamically produced, allowing for differentiation in content and presentation style based on the parameters provided by end-users. The presentation domain concept allows for alternative visualizations of the same cultural object collections depending on the target context[42]. Some museums have a more restrictive environment for electronics. Furthermore, the restrictions are extremely stringent, and they are not prepared for the introduction of new technologies [49] Most museums have embraced AR to enhance the interpretation of their exhibits in more imaginative ways as digital technology has advanced. The application of AR will give users extremely rich heritage communications, increasing museum interactivity.[83] AR has improved several aspects of people's lives. Furthermore, research demonstrates that AR has provided many answers in most disciplines, with applications spanning from education to other utilities[66].

All AR displays for end users are developed on a regular basis, which allows for and supports the differentiation of the parameters offered to end users [114]. The work in [42] discusses how augmented representation assists in the development of a technology chain to present digitized cultural artifacts that can be accessed from both inside and outside museums. The next AR works feature templates for visualization in a way that it's more attractive and appealing. [107] After the initial demonstrations, the augmented technique utilized for displaying the system received positive comments because it provides computer solutions and increases its value [91].

We can acquire a real sense of virtual reconstructions with AR, which is difficult to achieve with virtual approaches [60] With the use of multiple templates, AR displays can be shown in a variety of ways and in varied locations. The concept of introducing

more methods of visualization presentation was introduced to obtain more methods of visualization. The presentation domain is employed in this environment [31]. Given how quickly the industrial revolution is unfolding, the use of digitalization and machine learning allows displays to be identified more accurately, enabling visitors to have a better experience with the display [74] . The work in [13] reports that the major components of the AR system are content administration, content development, and visualization. These instruments and procedures assist in the digitization of museum objects. All the necessary parameters are set, but the optional parameters are not ‚Äî the display area is visualized immediately, but the end-user has the option of changing some of the presentation parameters (e.g. the default historical period) [1]. The organization of virtual exhibitions is dictated by the database's structure of specific exhibition space. [102]. The augmented database stores digital representations, which are maintained via the enhanced Content Management Application. Each digitized cultural object consists of a collection of media assets and information [25]. The museum's use of technology allows them to present the entire collection in a much more digital format, enabling them to make the items virtually available to the public. This technology will eventually assist in the creation of a display for educational and visiting purposes. According to recent surveys, roughly 33 percent of museums in Europe use AR to present objects to the public [107] [113]. The advancement of technology aids in the development of new methods for digitizing museums. Because of the difficulties that museums have had in keeping spaces filled for objects, new technologies will aid in gradually modifying the museum's surroundings [108].

Art galleries and museums have begun adopting AR technologies within their institutions. AR has a critical role to play in the preservation and display of historical artifacts [92] ; [119]. For instance, TombSeer - which is a digital cultural heritage (DCH) app - is a popular holographic AR that can reconstruct the historical inner chapel of the Egyptian Tomb of Kitines at the Royal Ontario Museum (ROM). Historical artifacts help connect to our ancestors, offering a strong link to the past and how life was lived in other cultures. TombSeer helps people immerse themselves in ancient Egyptian culture, providing context and information about the everyday lives and contributions of the civilization's inhabitants [92]. TombSeer involves the integration of three essential features: firstly, 3D holograms; secondly, an AR interface that provides computer-generated information; and thirdly, cultural heritage artifacts that connect people to our ancestors [92]. AR technologies are widely used to simulate virtual and museum artifacts while

maintaining user-friendliness and attractiveness of interfaces. Currently, TombSeer is serving to revitalize an exhibition by making computer-generated displays of ancient Egyptian artifacts that appear to be tangible for ROM guests.

According to [3], MAR technologies are increasingly being used to develop, share, explain, and distribute historical artifacts, making cultural heritage more appealing or attractive. [98] added that the exceptional global penetration of smartphones and tablets had garnered the attention of numerous investigators. Consequently, the use of wearable and mobile gadgets in the cultural heritage domain will only increase [88]. However, despite the fact that smartphones and tablets are easy to use, these devices can distract individuals from their real surroundings. Additionally, [18] noted that artifacts visualized via AR tools lack authenticity since the focus is shifted from its culture and sociological aspects to the technology being used. Ramly and [94] propose the need for museums to explore AR as a part of their operations to reduce the risk of being overshadowed by other entertainment media [94]. The application of digital media and AR technology needs to be enhanced in a proper way to create a digital museum and digital heritage that people can relate to and understand [70]. This will encourage more people to visit museums and enjoy a blend of traditions and modern technology within these institutions [65].

The study in [98] found that historical artifacts offer evidence of ancient events, making it possible to explore and assess them. This helps preserve and impart cultural values to subsequent generations of people and particularly tourists. Museum cultural artifacts are always associated with geometric information that is hard to differentiate due to aging or corrosion [72]. AR technologies like 3D scanning and mobile computing can help virtually record historical artifacts for the purposes of preservation [98]; [110]. The presence of AR tools has helped people improve their comprehension of historic artifacts and sites through virtual replicas [84]. AR systems can offer a 3D view of objects, allowing for the identification of shapes and symmetric characteristics, which are otherwise hard to visualize with the naked eye [32]. According to Nofal et al. [84], AR tools present a valuable opportunity to understand and assess historical artifacts and their contexts. In contrast to virtual reality (VR), AR helps museum guests to comprehend the culture and archaeological evidence through real-world examples [54]. For instance, AR enables museum visitors to visualize and interact with virtual artifacts, giving them a different perspective.

2.6 Comparative literature reviews of Augmented Reality

Based on the literature reviews of AR that were explored in the previous section, the gaps in the research that we will investigate have been identified. Table 2.1 explains the gaps and the research studies in the context of using AR in the tourism context.

Comparative literature reviews of Augmented Realty in exploring tourism context					
Reference	Enhancing the Comprehension of tourism using AR?	Their study explores the user's understanding of tourism locations using AR.	Develop an AR application for investigating experiences	Develop an AR application for investigating experiences in Saudi Arabia's tourism locations	Their study explores the user's understanding of cultural needs when exploring tourism locations in Saudi Arabia.
Jung and Han 2014	Yes	Yes	Yes	No	No
Yovcheva et al 2012	Yes	Yes	Yes	No	No
Rasinger et al 2009	Yes	Yes	Yes	No	No
Mesaro et al 2016	Yes	Yes	Yes	No	No
Brito 2015	Yes	Yes	Yes	No	No
Lee et al 2012	Yes	Yes	Yes	No	No
Hui et al 2014	Yes	Yes	Yes	No	No
Nobrega et al 2017	Yes	Yes	Yes	No	No
Brito 2015	Yes	Yes	Yes	No	No
Debandi et al 2018	Yes	Yes	Yes	No	No
Gao and Deng 2012	Yes	Yes	Yes	No	No
Jung et al 2018	Yes	Yes	Yes	No	No
Kounavis et al 2012	Yes	Yes	Yes	No	No
Nobrega 2017	Yes	Yes	Yes	No	No

Table 2.1: Comparative literature reviews of Augmented Realty in exploring tourism context

Comparative literature reviews of Augmented Realty in historical context					
Reference	Enhancing the Comprehension of historical locations using AR?	Their study explores the user's understanding of historical locations using AR?	Developed an Augmented Reality application for investigating experiences?	Developed an Augmented Reality application for investigating experiences in Saudi Arabia's historical locations.	Their study explores the user's understanding of cultural needs when exploring historical locations in Saudi Arabia.
Abawi et al 2004	Yes	Yes	Yes	No	No
Bederson 1995	Yes	Yes	Yes	No	No
Benko et al 2012	Yes	Yes	Yes	No	No
Chen et al 2914	Yes	Yes	Yes	No	No
Chien et al 2009	Yes	Yes	Yes	No	No
Cranmer 2019	Yes	Yes	Yes	No	No
Damala et al 2008	Yes	Yes	Yes	No	No
Frohlich et al 2001	Yes	Yes	Yes	No	No
Haines 2019	Yes	Yes	Yes	No	No
Hill et al 1992	Yes	Yes	Yes	No	No
Khan et al 20121	Yes	Yes	Yes	No	No
Langlotz et al 2012	Yes	Yes	Yes	No	No
Miyashita et al 2008	Yes	Yes	Yes	No	No
Nofal et al 2018	Yes	Yes	Yes	No	No
Patel 2003	Yes	Yes	Yes	No	No
Tsapatori et al 2003	Yes	Yes	Yes	No	No
Walczak and W. Cellary 2003	Yes	Yes	Yes	No	No
Wojciechowski et al 2004	Yes	Yes	Yes	No	No

Table 2.2: Comparative literature reviews of Augmented Realty in historical context

Comparative literature reviews of Augmented Realty in exploring historical artifacts					
Reference	Enhancing the Comprehension of Historical Artifacts using AR?	Their study explores the user's understanding of historical Artifacts using AR	Developed an Augmented Reality application for investigating experiences?	developed an Augmented Reality application for investigating experiences in Saudi Arabia's historical Artifacts?	Their study explores the user's understanding of cultural needs when exploring historical artifacts in Saudi Arabia
Akcayr and Akcayr 2017	Yes	Yes	Yes	No	No
Asai et al 2010	Yes	Yes	NYeso	No	No
Badioze Zaman et al 2013	Yes	Yes	Yes	No	No
Benko et al 2012	Yes	Yes	Yes	No	No
Brancati et al 2015	Yes	Yes	Yes	No	No
Chen et al 2014	Yes	Yes	Yes	No	No
Chien et al 2009	Yes	Yes	Yes	No	No
Damala et al 2008	Yes	Yes	Yes	No	No
Damala et al	Yes	Yes	Yes	No	No
El-Hakim et al 2006	Yes	Yes	Yes	No	No
Frohlich et al 2001	Yes	Yes	Yes	No	No
Gervautz and D. Schmalstieg 2012	Yes	Yes	Yes	No	No
Ghouaiel et al 2017	Yes	Yes	Yes	No	No
Haines et al 1997	Yes	Yes	Yes	No	No
Hill et al 1992	Yes	Yes	Yes	No	No
Hu and P.-F. Tsai 2018	Yes	Yes	Yes	No	No
Khan et al 2021	Yes	Yes	Yes	No	No
Kyriakou and S. Hermon 2019	Yes	Yes	Yes	No	No
Langlotz et al 2012	Yes	Yes	Yes	No	No
Lee et al	Yes	Yes	Yes	No	No
Manuella and D. Ovidiu	Yes	Yes	Yes	No	No
Miyashita et al 2008	Yes	Yes	Yes	No	No
Mourkoussis et al 2003	Yes	Yes	Yes	No	No
Nofal et al 2018	Yes	Yes	Yes	No	No
Olsson et al 2012	Yes	Yes	Yes	No	No
Pedersen et al 2017	Yes	Yes	Yes	No	No
Ramly and B. B. Neupane 2018	Yes	Yes	Yes	No	No
Ridel et al 2014	Yes	Yes	Yes	No	No
Seo et al 2006	Yes	Yes	Yes	No	No
Spelmezan et al 2017	Yes	Yes	Yes	No	No
Vanoni et al 2012	Yes	Yes	Yes	No	No
Wojciechowski et al 2004	Yes	Yes	Yes	No	No
Woods et al 2004	Yes	Yes	Yes	No	No
Xie and X. Tang 2018	Yes	Yes	Yes	No	No
Yu 2006	Yes	Yes	Yes	No	No

Table 2.3: Comparative literature reviews of Augmented Realty in exploring historical artifacts

2.7 Identify the Research Gaps

1. Lack of using augmented reality in Saudi Arabia to explore historical artifacts.
2. Lack of using augmented reality to understand Saudi historical artifacts.

2.8 Chapter Summary

This chapter overviews the various research studies on the users' experience in the context of AR, providing insights into the use of technology to explore digital tourism in different locations. It presents all the studies of how they used the technology in different countries to explore digital tourism. Then it presents a comparative between these studies in the usage of AR in tourism and historical location.

The comparison was divided into tables to compare the studies and find the gaps in the research. 68 studies were compared to investigate the user experience in using the AR in exploring digital tourism, historical tourism, and historical artifacts.

The studies show the different user experience of using AR in historical locations to explore historical artifacts. However, to date no research has been conducted to explore the user experience of AR technology to explore historical artifacts in Saudi Arabian historical locations. Also, I have identified that there were no application in the use of AR in Saudi context.

CHAPTER 3

PROBLEM DEFINITION

3.1 Introduction

This chapter provides an overview of the problem based on the research studies in the literature review detailed in Chapter 2. It also discusses the research problem, the aim and objectives of the study and the research questions.

3.2 Key Concept

This section defines several key concepts that are used in the thesis.

Augmented Reality: Merging live images with virtual layers of information [112]. Also digital information is integrated with the real-time environment of the user. The AR experience differs from virtual reality (VR) because it overlays generated perceptions onto a real-world environment.

User Experience is the overall feelings users have when using products, applications, systems, or services. A product's usability, ease of using, relevance of the content displayed, etc., all fall under this term.

Digital Tourism A digital tourism experience can be organized, managed, or even enjoyed with the aid of digital tools. As a result of digital transformation, digital

tourism is reshaping the way people travel and how the tourism industry operates. [11]

Digital Media The ability to use texts, tools, and technologies; the ability to think critically and analyze; the ability to compose and create messages; the ability to reflect and think ethically; and the ability to participate actively as a team member and collaborator.[2].

User Interface: An interface design (UI) is applied to software or devices that focus on the aesthetics of the user interface. Users should be able to easily and pleasurably use interfaces designed by designers. In addition to graphical user interfaces, voice-controlled interfaces are commonly used in UI design.

Historical Artifact: An object that has meaning in relation to the culture of its creators and users. It is a product of human workmanship or handicraft.

Real-time Interaction: One of the defining features of AR is its real-time nature. A user has the experience of being in the immediate vicinity of digital information and objects. In this way, their attention and curiosity are captured by this immersive and engaging experience.

Device Integration: A camera, sensor, and display are necessary to facilitate AR experiences. In addition to smartphones, tablets, smart glasses, and even wearable technology can be used to access augmented content.

Digital Overlays: Augmenting the physical world with digital content is the goal of augmented reality. Text, images, animations, videos, and 3D models can be used as part of the presentation. Information can be provided contextually, interactive features can be added, and objects can even be redesigned to appear different.

Spatial Understanding: AR technology often incorporates spatial mapping and recognition to understand the user's environment. This enables the digital content to align accurately with physical objects and surfaces, creating a seamless integration that appears coherent to the user.

User Engagement: Interaction and engagement are encouraged by AR experiences. With digital elements integrated into physical environments, users are empowered and can manipulate them.

Tourism and Exploration: Travelers can now engage with historical landmarks, tourist attractions, and historical sites using AR. The use of AR-equipped devices allows tourists to gain a deeper understanding of the significance of the site by accessing historical information, visual reconstructions of past structures, and interactive guides.

Cultural Exploration: By engaging in historical tourism, travelers can gain a deeper understanding of a destination's culture and heritage. Historical sites provide tourists with insights into the values, traditions, and customs that have shaped societies throughout history.

Educational Experience: There is an inherent educational component to historical tourism. Individuals can gain a first-hand understanding of historical events, figures, and periods through this program. By interacting with artifacts and landmarks, students gain a deeper understanding than they can from textbooks.

Cultural Heritage Tourism: A cultural tourist experiences a particular culture's traditions, arts, crafts, and festivals. A society's heritage is preserved and showcased through museums, art galleries, and cultural centers.

3.3 Problem Overview and Problem Definition

Chapter 2 provided a comprehensive analysis of the existing literature on AR in the context of tourism, historical examination, and cultural heritage. This analysis emphasized thewidespread use of AR in numerous countries to enhance the user experience in these domains. The studies detailed in Chapter 2 highlight the advantages of AR in conveying immersive and educational experiences for tourists and history enthusiasts. However, a prominent gap in this research became apparent, which forms the source of the problem addressed in this section.

The problem at hand is the limited research and application of AR in the setting of tourism, historical examination, and cultural heritage, chiefly in Saudi Arabia. While AR has been used worldwide to enhance the user experience in these areas, there is a visible gap in the research and practical execution within Saudi Arabia.

Tourism and Exploration: AR has changed how tourists interact with historical landmarks, and cultural sites across the world, as demonstrated by the studies presented

in Chapter 2. But, in Saudi Arabia, the use of AR to improve the tourism experience remains principally unused.

Theory Being Used in This Research: The primary objective of this research as we described below is to explore the use and efficacy of AR In the context of Saudi cultural site usage. In this regard, we find the blended theory is the most appropriate. The blended theory has been used in the past specifically, with a view to understand and to augment a site or a historical site by end users or experience [14]. However, the blended theory has not been used in the context of Saudi historical sites. Hence, in this research, we will be building upon the blended theory and using it in this context to achieve and to develop our research solution. In other words, the research solution that we will be developing would be based on blended theory.

Cultural Heritage Tourism: AR has the ability to offer tourists a deeper understanding of Saudi Arabia's rich cultural tradition, yet there are fewstudies which focus on the use of AR for tourism purposes and to promote interest in the country's historical artifacts and milestones.

3.4 Research Question

Does augmented reality provide an enhanced understanding of artifacts in historical or significant locations and sites, and what are the critical components that influence this understanding?

3.4.1 Research Sub-Questions

1. Does augmented reality enhance the tourist experience when visiting historical or significant locations and sites in Saudi Arabia?

2. Which media method is the most preferred by tourists when exploring historical artifacts in Saudi Arabian museums?

3. Does augmented reality provide an enhanced understanding of non-touchable artifacts displayed in Saudi Arabian museum contexts, and what are the critical media characteristics that influence this understanding?

3.5 Aims and Objectives

3.5.1 Aims

To determine whether the use of AR technology enhances an understanding of historical artifacts and gives a richer historical context to Saudi visitors.

3.5.2 Objectives

1. To investigate user experiences and expectations when exploring artifacts in historical and other locations in Saudi Arabia.

2. To investigate the expectations of AR characteristics so that users can compare different characteristics to explore historical artifacts at a particular location in Saudi Arabia.

3. To investigate the designing acceptance of AR which can be used to enhance the understanding of non-touchable historical artifacts in Saudi Arabia.

3.6 Research Significance

This research aims to help visitors obtain a better understanding and experience when visiting historical locations and exploring historical artifacts. The actual significance of this research is as follows. Firstly, it is the first research review on users' understanding of artifacts in historical locations. Secondly, it is the first study to develop an AR technology to explore the artifacts in historical locations in Saudi Arabia. Thirdly, is the first research that proposes the use of AR to help visitors understand the artifacts in historical locations in Saudi Arabia. Fourthly, digitalizing and visualizing the artifacts in Saudi museums will increase the number of visitors who choose to see them. Fifthly and finally, Saudi museums will be encouraged to digitalize aspects of their locations and the artifacts they display.

3.7 Conclusion

In conclusion, this chapter has outlined the importance of exploring the use of AR in the context of tourism, historical inspection, and cultural heritage, with a detailed concentration on Saudi Arabia. The research gap in the application of AR in this region was

acknowledged, emphasizing the necessity for additional exploration and execution of AR technology to enhance the visitor experience in historical places and museums.

By setting comprehensive research questions and establishing clear aims, this study aims to examine the potential of AR to deliver a deeper understanding of historical artifacts and landmarks, inspiring a cultural experience for tourists and visitors in Saudi Arabia.

The proposed research aims to shed light on user understandings, the users' preferred form of media, and the effect of AR applications on enhancing the understanding of non-touchable artifacts, with the objective of improving the overall tourism and cultural experience in the region. The importance of this study lies in its ability to pave the way for the digitalization and visualization of historical artifacts, thereby attracting more visitors to museums and cultural sites in Saudi Arabia.

In this research, it is anticipated that the use of AR technology will not only offer an immersive and informative experience for tourists, it will also contribute to the preservation and elevation of Saudi Arabia's rich cultural heritage. This study will serve as an initial step in developing a deeper understanding of and respect for the historical significance of the artifacts and landmarks in the country.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

This chapter outlines the research methodology for examining the role of augmented reality (AR) in museums and cultural heritage, concentrating on user experiences and the maintenance of cultural artifacts. The methodology comprises a multi-phase approach, data collection, and ethical considerations.

This chapter is structured as follows: Section 4.2 overviews the research methodology and how UCD is used to solve the research problem, Section 4.3 Phase one presents the first phase of the solution, Section 4.4 Phase two presents the second phase of the solution, Section 4.5 Phase three presents the last phase of the solution, Section 4.6 summarizes the chapter.

4.2 Research Design

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The research is conducted within a user-centered design (UCD) methodology which is acknowledged for its ability to design solutions tailored to the end-users' requirements and preferences. It is arranged into three phases to address the research objectives. The first phase serves as groundwork, aiming to provide a comprehensive understanding of the existing landscape of AR technology application in Saudi Arabian museums in

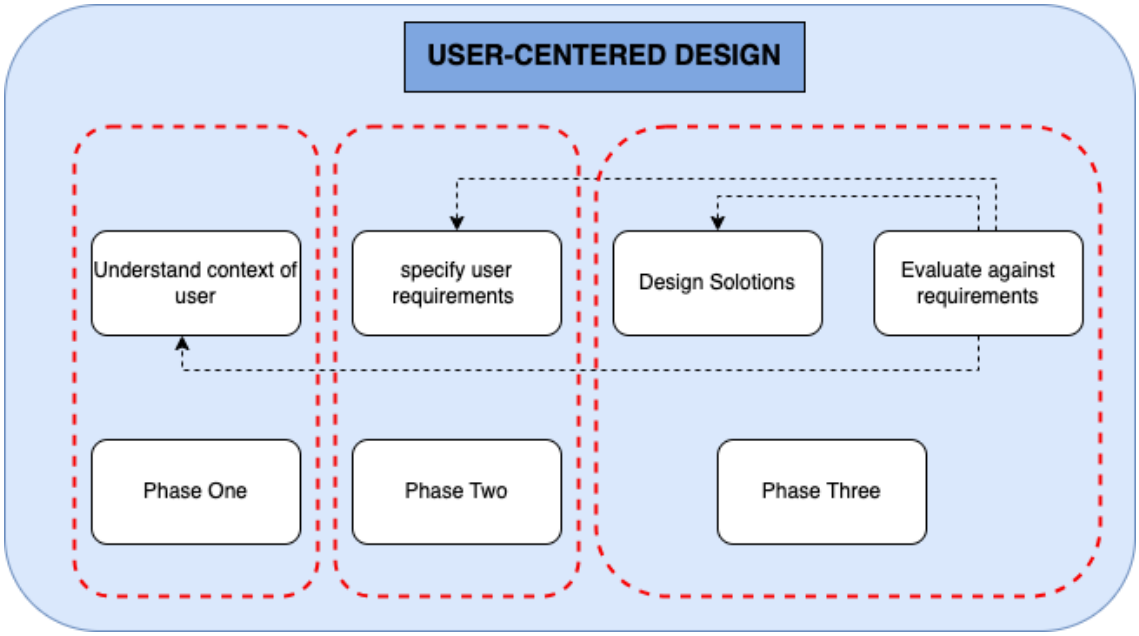


Figure 4.1: Proposed Research Design: USER-CENTERED DESIGN

relation to historical artifacts. This initial phase is vital for grounding the following research actions in the specific context of Saudi Arabia. In the second phase, the focus shifts to describing precise user needs for the effective use of AR when exploring historical artifacts. By explaining preferences, this phase ensures that the AR application supports the requirements of the end-users. The culmination of the research occurs in the third phase, where an AR submission is not only considered but thoroughly appraised. The primary objective here is to form an application that enhances the understanding of museum visitors in relation to historical artifacts in Saudi Arabia. These three phases lay the foundation for an in-depth examination of AR in the context of Saudi Arabian museums and their historical treasures, addressing the research objectives with careful planning and careful implementation.

4.3 Phase One: The Saudi Arabia perspective of using AR

This phase investigates the users' experiences and outlook in the setting of Saudi Arabian museums. To do this, an AR application is designed, providing users with an immersive tool to explore historical artifacts. This method supports qualitative data collection, which is suited to answer the questions of 'why,' 'what,' and 'how' users are involved with

AR technology in the context of historical artifacts [99]. By implementing a qualitative method, this phase uncovers valuable understandings into the details of user connections with AR, laying the foundation for subsequent phases of the research.
The detail of the solution is provided in Chapter Five.

4.4 Phase two: User Expectations of Media Method Content for Augmented Reality Applications in the Kingdom of Saudi Arabia

During Phase 2, "Predicting Augmented Reality Design Expectations," the primary objective is to expect the precise augmented reality structures that users in Saudi Arabia expect and prefer when discovering historical artifacts. Due to the restrictions imposed as a result of the COVID-19 pandemic, face-to-face conferences, the conventional technique for collecting in-depth understandings, were replaced by surveys to ensure the safety and well-being of all involved. The qualitative study method which uses sheds light on their preferences concerning the augmented reality framework. This shift in methodology reflects the flexibility and resilience of the research process in the face of external challenges, certifying that the study upholds its precision and significance.

For the details of the solution, refer to Chapter Six.

4.5 Phase Three: The exploration of non-touchable historical artifacts in the Kingdom of Saudi Arabia

In Phase 3, the research evaluates the users' reaction to an AR application which is tailored to enhance the understanding of non-touchable historical artifacts in the cultural context of Saudi Arabia. This phase examines the 'why,' 'what,' and 'how' features of user collaboration with the augmented reality application by employing qualitative data. By executing a qualitative method, the study aims to uncover nuanced understandings into user experiences, motivations, and behaviors in relation to AR technology in the context

of Saudi Arabian cultural heritage. The qualitative nature of the study enables a deeper examination of user outlooks and experiences, leading to a more inclusive understanding of how AR applications affect the appreciation of historical artifacts within certain cultural contexts.

For the details of the solution, we refer the reader to Chapter Seven.

4.6 Chapter Summary

The research methodology employed in this thesis is designed to simplify the widespread examination of the effect and potential of AR in the realm of Saudi Arabian museums and cultural heritage. Each phase in this methodology is designed to yield valuable insights that align with the research objectives. Also, ethical considerations are placed at the front of the research process. By following this inclusive methodology, the study aims to shed light on the transformative potential of AR in the conservation and demonstration of Saudi Arabia's rich cultural heritage, contributing to a deeper sympathetic view of the role of technology in the museum and heritage sectors.

CHAPTER 5

PHASE ONE: DETERMINING THE SAUDI ARABIAN PERSPECTIVE ON USING AUGMENTED REALITY

5.1 Introduction

Chapter four details the research methodology and approach and introduces the three phases of the research based on the user-centred design approach. Chapter five describes the first phase of the study, which aims to understand the content of augmented reality (AR) in the context of Saudi Arabian historical locations. To achieve this aim, 24 participants who were divided in two groups of 12 took part in the study. Half of the members of each group were asked to use an AR prototype application to explore five historical artifacts. The results are analyzed using Nvivo software.

The structure of this chapter is as follows: Section 5.2 presents the proposed approach for determining the Saudi perspective on AR, Section 5.3 describes the participants, Section 5.4 presents the interview questions, Section 5.5 details the tools used during the experimentation, Section 5.6 provides an overview of the data and the data analysis, Section 5.7 discusses the results, Section 5.8 presents a discussion and Section 5.9 concludes the chapter.

5.2 Proposed Approach for Determining the Saudi Perspective on AR

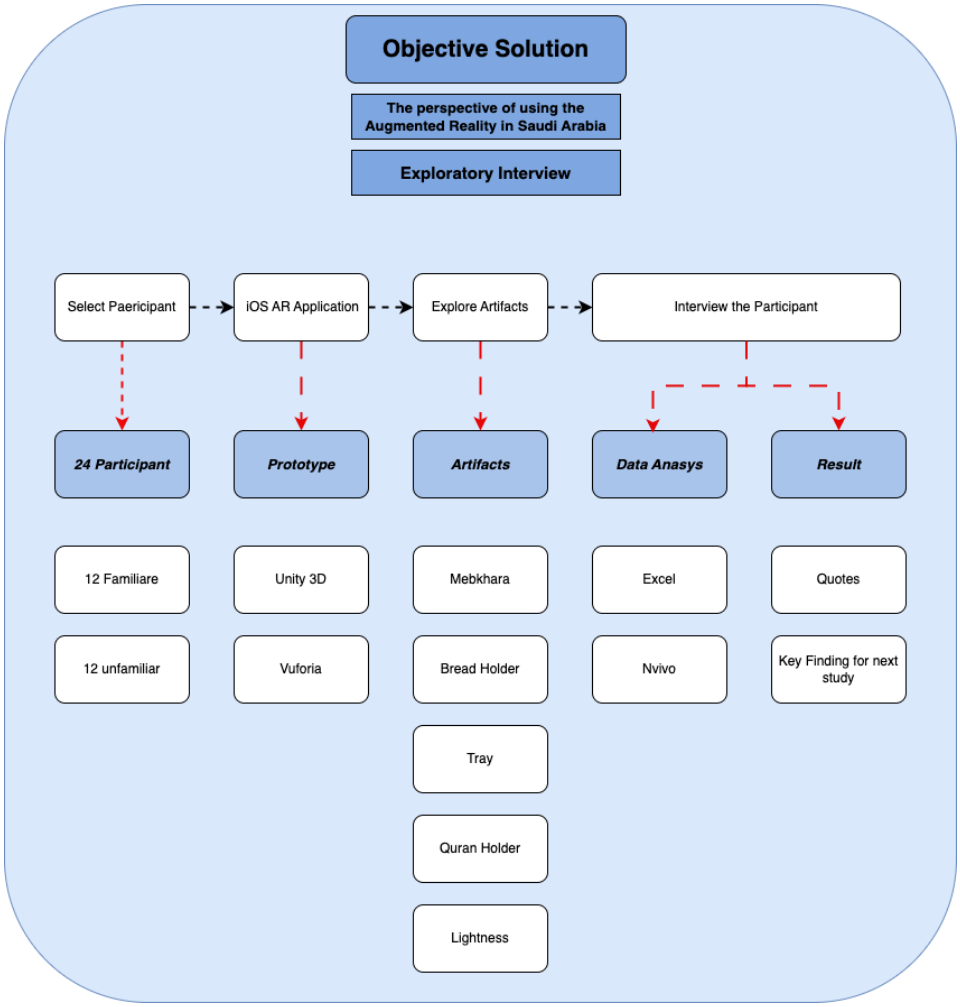


Figure 5.1: Solution Overview for Objective One to determine the Saudi Arabian perspective on using AR

In accordance with the user-centered design, the first phase is to understand the context of use. Therefore, the users' experience and expectations when exploring artifacts in historical and general locations in Saudi Arabia are investigated. To achieve the objective, the methodology used is an exploratory interview. According to Rohrer [99], qualitative approaches are a better way to address questions of 'why', 'what', and 'how'.

The researcher developed a low fidelity prototype of the AR application to determine

whether AR would be helpful in the context of Saudi Arabian historical tourism. The study procedures and the data collection are explained and the results and key findings are elaborated. Figure 5.1 shows the workflow of the solution overview for objective one.

5.3 Selection of study participants

The participants in this study were divided into two treatment groups. The first group (A) of 12 participants were familiar with the area and culture of Saudi Arabia's west coast where Old Jeddah City is located. The second group (B) of 12 participants were not familiar with this part of the country.

- (Group A) Treatment 1 comprises 6 participants who are familiar with the artifacts and used the iOS device to explore the artifacts.
- (Group A) Treatment 2 comprises 6 participants who are familiar with the artifacts but did not use the iOS device to explore the artifacts.
- (Group B) Treatment 1 comprises 6 participants who are not familiar with the artifacts but who used the iOS device to explore the artifacts.
- (Group B) Treatment 2 comprises 6 participants who are not familiar with the artifacts and did not use the iOS device to explore the artifacts.

This study sample comprised 24 participants. According to Guest, Bunce, and Johnson [99], a reasonable sample size for a qualitative study when interviews are being conducted is between 15 and 30 people. The sampling size here is estimated to be about 20 to 25 participants, and all the respondents were students at the Faculty of Engineering and IT, University of Technology Sydney.

5.4 Interview Questions

Different interview questions were posed to the group that used the iOS device and the group that did not. *Screen shots of the interviews are provided in the Appendix section .*
Open Questions (for all 4 treatment groups)

1. Have you ever participated in a digital tour?

2. How often do you visit historical locations?
3. How do you get answers to your questions when you are exploring historical locations?
4. What type of media do you engage with when exploring tourist locations?
5. Have you ever explored any tourist locations using interactive technology?
6. When you visit historical locations, how do you find information on existing artifacts?

   Prototype Questions (for the participants in groups 1 and 2 who used the iOS device)

7. Did the application provide information about the artifacts?
8. Did you find the content helpful?
9. Did you like the video in the augmented reality application which helped you explore these artifacts in the historical location?
10. What other types of media would you prefer to use to explore historical artifacts?
11. Do you prefer to simply read about the artifacts in the museum?
12. Did holding the phone and pointing the camera at the artifact for about 30 seconds to see the story make you feel tired?
13. Is the video in the augmented reality application too short or is it sufficient?
14. Do you think this is a better way to gain information on specific artifacts when visiting museums?
15. Did you interact with the story?
16. Do you prefer to read a story about these artifacts or simply see the way it can be used? Why?
17. Do you prefer to read a story to learn about these artifacts or do you prefer gamification (a gaming augmented reality application)?
18. Please let me know if you have any other suggestions or comments, or if there is anything else that I should add to the augmented reality application.

Non-Prototype Questions (for the participants in groups 3 and 4 whodid not use the iOS device)

7. Are you familiar with these artifacts?
8. Would you prefer to use an augmented reality application to help explore these artifacts?
9. What types of media do you prefer to use to explore an artifact in a historical location?
10. Do you prefer to simply read about the artifacts in a museum?
11. How do find a better way to use in the museums when you need to be informed on specific artifacts?
12. How would you interact with the story?
13. Do you prefer to read a story about these artifacts in the museum or to see the way the artifacts can be used? why?
14. Do you prefer to learn about these artifacts through a story or do you prefer gamification (using a gaming augmented reality application)?
15. Please let me know if you have any other suggestions or comments, or if there anything else that I should add to the augmented reality application.

5.5 Tools used during the experimentation

This research uses Unity 3D software to design an AR application that can recognize artifacts and generate information about them for users via a short and animated video. Vuforia targets the objects in the database and offers them an augmentable rate of the picture based on the picture features (Figure 4.1). Unity 3D is a cross-platform program that can be used to create video games and smartphone apps. Vuforia, on the other hand, is an AR software development kit that can be linked to Unity using a unique licence key. It recognises and tracks planar images and 3D structures in real time using computer vision technologies.

The following is a description of the five artifacts in Figure 4.2 that were used in the study to be explored using the AR system:

Mebkhara (Incense): This is a a traditional censer for burning incense. When burnt, incense is an aromatic biotic agent that emits a fragrant smoke. The word refers to either the substance or the scent. Incense is used for a variety of purposes, including aesthetics, aromatherapy, sleep, and rituals. It's also effective as a deodorant and insect repellent.

Lightness: An old-fashioned way to brighten rooms, houses, and streets

Tray : An old-fashioned tray. The tray is used to hold things when being transferred to somewhere else.

Bread Holder and Keeper : An old-fashioned way to keep bread from becoming mouldy.

Quran holder : This is used in Mosques to assist those who want to read the holy Quran. This is because worshippers spend a long time reading the holy Quran and the Quran holder helps them from becoming tired when they hold the Quran for a long time.

Using Unity 3D, we designed an animated video that illustrates a short story with a description of the five artifacts and we took pictures of them, saving them as targets in Vuforia. When the user points the phone at an artifact, the camera recognizes the tracker of the artifact and plays a short video saved in Unity.

Figure 5.2: Example of one participant pointing to the artifacts and watching the information on each.

5.6 Research approach to determine the Saudi perspective on AR

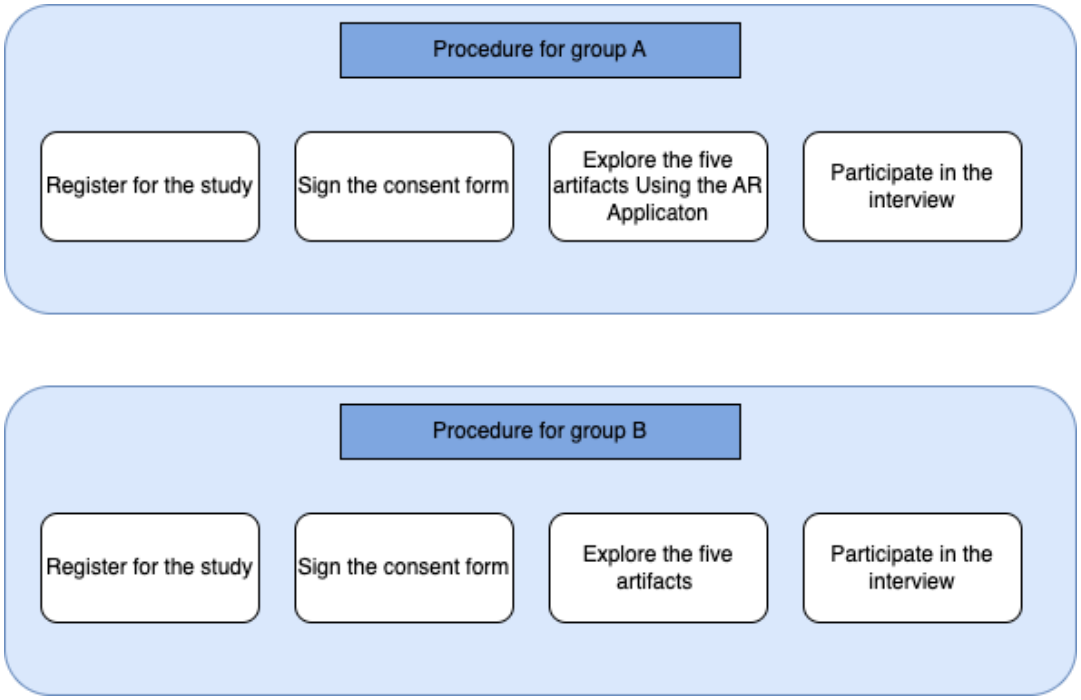


Figure 5.3: The experiment steps in Phase 1 of the study

The five artifacts were placed on a table in a small quiet closed room (Figure 2). After each user answered the interview questions, they entered the room and commenced the study. The participants were asked the screening questions to ascertain their knowledge of the artifacts. For example, if a participant recognized two of the five artifacts, then he/she was tested only on the remaining three unrecognized artifacts.

Figure 5.4: The artifacts used in the study.

First, we conducted experiments with treatment Group 1. These participants were

familiar with the artifacts and used the iOS device. Second, we conducted experiments with treatment Group 3. These participants were familiar with the artifacts but did not use the iOS device. Then, we conducted experiments with treatment Group 2. These participants were not familiar with the artifacts and they used the iOS device. Last, we conducted experiments with treatment Group 4. These participants were not familiar with the artifacts and did not use the iOS device. In accordance with the experiment protocol, each participant signed the consent form and then the participants were divided into groups for the experiment. Finally, each participant was interviewed individually.

5.7 Data and Data Analysis

The research data presented in this chapter were analyzed using thematic analysis. The ability to code and categorize data into themes, for instance, how issues affect participants' perceptions, is made possible by thematic analysis. Processed data may be categorized according to similarities and differences in thematic analysis. Therefore, we coded all the answers that employed the keywords of each part of the results that aim in this chapter. Then, all the coded words were documented on an Excel spreadsheet to calculate the results.

The data was secured and stored in Google drive. To view the data (CLICK HERE)

5.8 Results

5.8.1 Augmented reality preference of use

To answer research question 1, we coded only those responses from Group 1 that contained the words "satisfied", "helpful content", "helpful information", and "accurate information". The reason for choosing Group 1 responses only is because this was the only group to use the AR application. The coded results were documented in a separate Excel spreadsheet.

The results show that 100% of the participants indicated that the AR application provided helpful information on the artifacts and described the artifacts to them i a meaningful way. Furthermore, 100% of the participants agreed that this is a better way to acquire information in the museum while only 90% interacted with the story.

The interview participants made some very interesting comments. User 1 stated *"It gave me a quite descriptive illustration about it"* and user 2 stated *"as application I know*

How Augmented reality technology is preferred to be used in historical locations to explore historical artifacts?	*Files*	*Reference*
Accurate information about the artifacts	12	36
Satisfactory about the augmnted reality experience	12	35

Figure 5.5: The number of referencing the keywords of user satisfaction with augmented reality

How Augmented reality technology is preferred to be used in historical locations to explore historical artifacts?	*YES*	*NO*
Did the application informed you about the artifacts?	100%	0%
Do you find that the content is helpful?	100%	0%
Do you like the video in Augmented reality application that help in exploring these artifacts in the location?	100%	0%
Do find this is a better way to use in the museums when you need to be informed on specific Artifacts	100%	0%
Did you interact with the story?	90%	10%

Figure 5.6: The percentage of user satisfaction with augmented reality

that the best using some of the things it's through that things". User 4 stated *"You asking about you a particular one, I think, yes. So I've been going through the beach artifacts and the explanation using the video. And it's like, really, a story, telling me about this artifact and the function of the artifacts and how they are used in the culture. I particularly like what I've seen and I think it's from Saudi Arabia. So yeah, it was really awesome"*.

User 5 said *"I might see like a regular triangle-shaped object. I might know what it is used for in that culture. But if I see the video, I can understand what it's for"*. User 16 and user 18 agreed the AR application was helpful by saying *"it did. In a very interactive manner, or in a very intuitive manner"*and user 18 said *"I think the use of technology was very insightful and helpful as well,"* while user 17 stated that the animation helped him better understand the artifact. All these statements indicate the users' satisfaction with the content and technology.

How Augmented reality technology is preferred to be used in historical locations to explore historical artifacts?
it did. In a very interactive manner, or in a very intuitive manner
Because of the animations
I think the use of technology there was very insightful and helpful as well,
as application I know that the best using some of the things it's through that things.
I might see like a regular triangle shaped object. But I might know what it is used for in that culture. But if I see the video, I can understand what's the application of it
You asking about you a particular one, I think, yes. So I've been going through the beach artifacts, and the explanation through the video. And it's like, really, a story, telling me about this artifact and the function of artifacts and how it's used through the culture, particularly like what I've seen in I think it's from Saudi Arabia. So yeah, it was really awesome
of course. Because if you have no idea about what the tool is used for, the video will really help you to understand what's the usage of it

Figure 5.7: Examples of user quotes from the interviews

5.8.2 Video Experience Methods

To answer research question WHAT NUMBER RESEARCH QUESTION??? , we coded only those responses from Group 1 that contained the words "satisfied", "helpful content", "helpful information", and "accurate information". The reason for choosing Group 1 responses only is because this is the only group to use the AR application. The coded responses were documented in a separate Excel spreadsheet.

Why video experience method in Augmented reality mobile application are preferred to be use in historical locations to explore historical artifacts?	*Files*	*Reference*
Prefer to mediate the Information	12	36
Vedio Methods Satisfaction	12	12

Figure 5.8: The number of references to keywords indicating user satisfaction with augmented reality.

Why video experience method in Augmented reality mobile application are preferred to be use in historical locations to explore historical artifacts?

	Yes	*No*
Do you like the video in Augmented reality application that help in exploring these artifacts in the location?	100%	0%
Do you prefer just to read about the artifacts in the museum?	25%	75%
Did you interact with the story?	91%	9%
	Enoght	*Too Long*
Is the video in the Augmented reality application too short or enough?	92%	8%
	vedio	*Oudio*
If you prefer other media, what types of media do you prefer to use to explore the artifacts?	5 Users	2 Users

Figure 5.9: The percentage of user satisfaction with augmented reality.

The results show that 100% of users liked the experience of augmented reality when exploring museum artifacts and 91% interacted with the experience. 92% of the users agreed that the content of the video was an appropriate length and was not too long. Five of the 12 preferred the video, only 2 users preferred the audio while the others preferred different methods such as *"Virtual assistant", "Hologram", "Using YouTube to find about the artifacts", "Camera",* and *"Animation"*.

Furthermore, some interesting responses were obtained from participants. To explain this clearly, their responses to two different sections of the interview *"Preferring Video Methods"* and *"Video Methods Satisfaction"* are given.

In response to section *"Preferring Video Methods"*, user one said *"I think nowadays, this is the most efficient way to get information. It's more effective than just getting a textbook or the other usual the convenient"*. User three described how videos are more explainable by saying *"videos are better. They explainable information in a much better way"*. User Five indicated that people may prefer the audio method because they want to imagine what the audio is describing regarding the historical artifact. He said *"I personally prefer audio and I think most people do. Let's say if someone explains it to you using audio, you need to imagine by yourself how this object is used. But I think the video*

Why video experience method in Augmented reality mobile application are preferred to be use in historical locations to explore historical artifacts?
Prefereing Videos Methods Qoutations
I think for nowadays, this is the most efficient way to get information. It's it's more effective than getting just a textbook or the other usual the convenient.
videos are better. It's much more explainable
stories is much better. It actually explains the things a lot more.
I personally prefer audio and I think most people do. let's say if someone will explain it to you by an audio, you need to imagine by yourself how this object is used. But I think the video gives this external dimension of illustration.
Maybe virtual assistant
I think the the animation that you showed me using AR, I think it was very comprehensive in the sense that it was for even for people who have no background, very little education levels, they can understand what it is about.
probably text and audio, more than video, because maybe I want to touch it, and then listen at the same time. Nut also it It depends on what kind of tour I'm going on. And it depends on the history of the thing. So for example, if it's, if it's a painting that I cannot touch or not allowed to touch, then I'd probably prefer to see a video
Videos Methods Satisfaction Qoutations
I will definitely like the use of augmented reality to know more about the historical places, and artifacts inside the historical museums and stuff like that.
I like the idea of the augmnted reality in general
In my personal opinion, that is a very smart use of technology in trying to provide information about those artifacts.
I liked the video because it's specially not just defining the what the item is. It's actually defining the culture that holds the background of the item
The disadvantages of using technologies is like when you go to historical places, you want to, you want to live the moment. you dont want to be distracted with any kind of thing about using the phone, we try to get away of using the phone as much as we can.

Figure 5.10: Quotations from the participants.

gives this external dimension of illustration". User eight mentioned that the animation he saw in the video method was comprehensive *"I think the animation that you showed me using AR, I think it was very comprehensive in the sense that it was even for people who have no background or very low education levels, they can understand what it is about."*. Finally, user twelve preferred the audio method but this depended on what historical artifact he was exploring. He said *"probably text and audio, more than video, because maybe I want to touch it, and then listen at the same time. But also it depends on what kind of tour I'm going on. And it depends on the history of the thing. So for example, if it's, if it's a painting that I cannot touch or I'm not allowed to touch, then I'd probably prefer to see a video"*. In response to the section *"Video Methods Satisfaction"*, user one, fourteen, fifteen and eighteen explained how they are satisfied with AR technology. User one said *"I liked the video because it does not only define what the item is. It actually defines the culture that holds the background of the item"*, User fourteen said *"I definitely liked the use of augmented reality to know more about the historical places, and artifacts inside the historical museums and stuff like that"*, user fifteen said *" I like the idea of augmented reality in general"*, and user eighteen said *"In my personal opinion, that is a very smart use of technology to provide information about those artifacts."*. On the other hand, user six thinks differently, indicating that in her opinion, the use of technology in such a historical location has a negative effect as users want to enjoy historical locations without being distracted by technologies such as phones. He said: *"The disadvantages of using technologies is like when you go to historical places, you want to, you want to live in the moment. You don't want to be distracted by any kind of thing such as a phone. We try to get away from using the phone as much as we can"*.

5.8.3 Effective and Informative media

We coded those responses which contained the words "story", "how it works or details", or "gamification or gaming." The coded responses were documented in an Excel spreadsheet.

The results show that the users preferred to use media to enhance their experience in historical museums. The result came after 1 of the users who wanted to explore the historical artifact watched a short video explaining the purpose of the artifacts and how they were used in historical sites. A total of 14 users preferred the technique of storytelling to inform and educate them about the history of the artifacts, where they came from and how they were used, while no participants preferred gaming to explore the historical artifacts and obtain information in this way.

Do you prefer to view a story about these artifacts, Gaming, or just to see how it works?	*Percentage*		
	Group One	*Group Two*	*Overall*
Stories	50%	67%	59%
How it works	8%	0%	4%
gaming	0%	0%	0%
Stories and Gaming	8%	0%	4%
stories and Information	34%	16%	25%
information and games	0%	17%	9%
Gaming, Information, and Gaming	0%	0%	0%

Figure 5.11: The results for groups A, and B, and the average result for questions 17 and 18 for the questionnaire for iOS device users and questions 13 and 14 for the questionnaire for non-iOS device users.

The result for group A (those who used AR technology to explore the museum's artifacts) revealed that six people preferred historical stories, and four preferred the option of both stories and information about how they worked. Only one user preferred to only receive information about how the artifacts worked, while one other participant preferred stories and gaming to explore the artifacts.

The results for group B (those who did not use AR technology to explore the museum's artifacts) revealed that eight participants preferred stories, two preferred both stories and information, and two were receptive to both gamification and receiving information on how the artifacts work. The study employed NVivo software to code the participants' statements. Table 5 shows the results for group B and Table 6 summarizes the references to storytelling, information about the artifacts, and gamification.

Query	*Description*	*Files*	*References*
IOS Users	Prefer Gamification	3	3
	Prefer To get information of the artifacts	3	4
	Prefer a Story	9	16
I don't Preferer to Read	Prefer Gamification	4	4
	Prefer To get information of the artifacts	5	6
	Prefer a Story	7	11

Figure 5.12: The number of references to storytelling, information on the artifacts, and gamification.

5.9 Discussion

The results for research question 1 show that the participants responded positively to the use of AR technology in historical locations to explore artifacts and obtain information, as previously discussed. The participants agreed that they liked the video in the AR application because the content was helpful and informative. All twelve participants who used the AR technology to explore information or the story behind the historical artifacts agreed that this is a better way to interact with a historical location. The participants offered many interesting statements on the use of AR technology, examples of which are as follows: *"I think the use of technology was very insightful and helpful as well.", "I might seem like a regular triangle-shaped object. But I might know what it is used for in that culture. But if I see the video, I can understand what's the application of it", and "if you have no idea about what the tool is used for, the video will really help you to understand what's the usage of it"*.

The results for research question 2 show that the participants prefer to explore artifacts in historical locations with the use of videos, as indicated by the participants' responses. None of the participants indicated that they preferred other methods such as reading about the artifact either from signs or elsewhere. The participants also indicated that the length of the video was appropriate, being neither too long nor too short. Therefore, the participants liked the video and 92% of them indicated that they interacted with the story. The participants offered many interesting statements on the use of video in the AR application, examples of which are as follows:*"videos are better.*

Query	*Description*
Storytelling	Story will be much better because it can relate to it. Whenever I see stories like this, it's more than just getting a passive information. for just the sake of information. So, I think the story is enough.
	stories are much better. It actually explains the things a lot more.
	showing the story in different ways could interact people for watching
	I prefer a story because it's just like giving an example. And that example includes the name in some cases, so you can fit the information inside the story that will be even better. I'm satisfied with the story that I have seen.
	Beyond knowing the history, a story is great.
Gamification	Personally, I would not use tech as little tech as possible because that's an additional overhead for the people to read and do that. Videos, gaming's, and all I think are quite intuitive and easy to follow.
	I think that would be more interactive for them to go through the history and using kind of games tracking them to too deeply to the history of that artifacts and moving them or transferring them from this year to two other years through the history to different periods. So that would be really great if you use it
	Gaming would be the new beta
Short video	I don't want a story. I just want to see how it's work. That's it. Most of the people I think they want the same thing.
	I would first I would want to know what it is. I imagine that is what would prompt me to do, a short description of this is what I want.

Figure 5.13: Interesting quotes from the participants.

It's much more explainable", "I think for nowadays, this is the most efficient way to get information. It's more effective than getting just a textbook or the other usual the convenient.". However, some participants thought that the use of technology in historical locations may be a disadvantage as it could be a distraction to those who want to enjoy the moment without using technology in historic locations. This is interesting to research as a part of the following research I would like to see what other participant thinks about this. The two participants who preferred to obtain information on historical locations using the audio method explained their preference as follows: *" I prefer audio, and I think most people do. If someone explains it to you by audio, you need to imagine by yourself how this object is used. But I think the video gives this the external dimension of illustration"*, and the second one said *"It depends on what kind of tour I'm going on. And it depends*

on the history of the thing. So for example, if it's a painting that I cannot touch or not allowed to touch, then I'd probably prefer to see a video". This indicates that the second participant agreed that if the artifact is not touchable, watching a video is preferred in this situation. The participants agreed that they liked the video in the AR application because the content was helpful and informative. All twelve participants who used the AR technology to explore the information or story behind the historical artifacts agreed that this is a better way to interact with a historical location. The participants offered many interesting statements on the use of audio in historical locations, examples of which are as follows: *"I think the use of technology there was very insightful and helpful as well.", "I might seem like a regular triangle-shaped object. But I might know what it is used for in that culture. But if I see the video, I can understand what's the application of it", and "if you have no idea about what the tool is used for, the video will really help you to understand what it is used for"*.

The results show *"what type of media the users prefer to use when exploring historical artifacts"*. The results show that 59% of participants prefer the technique of storytelling to inform and educate them about the history of the artifacts, how they were used, etc. This was applicable to all 24 participants but when we divided the results into two different groups, we see that the users prefer the storytelling method to explore the artifacts. The data for group A (those who used AR technology to explore the museum's artifacts) indicates that 50% of users prefer historical stories while the other half can be broken down into 16% who prefer both stories and artifact details, 8% who like both stories and gamification, and 8% who are receptive to information about how the artifacts work. On the other hand, the data relating to group 2 (those who have NOT used AR technology to explore museum artifacts) indicate that 67% of users like historical stories, 34% prefer both stories and artifact details, and 17% want to use both gamification and information about how the artifacts function.

The results for research question 3 indicate which type of media the participants prefer to use when exploring historical artifacts. It emerged that all of the 24 participants preferred storytelling to inform and educate them about the history of the artifacts, how they were used, etc. However, when the results were divided into two different groups to see why the users preferred the storytelling method to explore the artifacts, the data for group A (those who used AR technology to explore the museum's artifacts) showed that 50% of the users preferred historical stories. Of the remaining half, 16% preferred both stories and artifact details, 8% preferred both stories and gamification, and 8% preferred information about how the artifacts work. On the other hand, the results for group 2

(those who did not use AR technology to explore the museum's artifacts) indicate that 67% of users like historical stories, 34% prefer both stories and artifact details, and 17% prefer to use both gamification and information about how the artifacts function. The participants offered many interesting statements on the use of storytelling to explore the museum's artifacts, examples of which are as follows: *"I think it would be interesting because in gaming you still have stories"*, while another user remarked, *"A story would be much better because I can relate to it. Whenever I see stories like this, it's more than just getting passive information"*. A user from group 2 remarked, *"To better understand the history, a story is great. A game would be interesting. But the story is enough"* (see more responses in Fig. 5). Thus, in answering the research question, it is evident that storytelling is the preferred information technique of users to get information about the artifacts in historical locations.

5.10 Conclusion

This chapter reports on the second phase of the research to identify what AR technology adds to the experience of historical artifacts and how AR technologies affect people's understanding of historical artifacts in general. To achieve this, this chapter answered the three research questions. [RQ1] How augmented reality technology is preferred to be used in historical locations to explore historical artifacts? [RQ2] Why the video experience method in the AR mobile applications is preferred to be used in historical locations to explore historical artifacts? And finally [RQ3]: What type of media will be effective and informative to use in historical locations to explore historical artifacts?

The research findings indicate that the participants feel that using AR in a historical area to investigate artifacts is a superior technique. This is because AR can provide videos so that the user can investigate historical artifacts more easily. The research also shows that the users felt the video material was a successful narrative tool and gave a brief overview of the history behind the artefacts. Therefore, the aims of the research were achieved and the results show that AR adds to the users' experience in historical locations by providing a short story of the history behind the artifacts. This positively affected the experience of understanding historical artifacts.

CHAPTER 6

PHASE TWO: USER EXPECTATION OF MEDIA METHOD CONTENT FOR THE AUGMENTED REALITY APPLICATION IN THE KINGDOM OF SAUDI ARABIA

6.1 Introduction

In Chapter Five, we detailed the first phase of the study, which aims to understand the content of augmented reality (AR) in the context of use in Saudi Arabian historical locations. The chapter investigated an augmented reality prototype with 24 participants who were divided in two groups. Half of these participants used the AR application to explore five historical artifacts. The results show that the participants had a positive experience when using the AR application in Saudi Arabian historical museums.

This chapter details phase two of the study, which aims to understand the users' requirements when using the AR application in historical museums. To do this, three media methods are designed to explore historical artifacts. The study involved 100 participants who were required to explore several artifacts using the three media methods. Each participant is sent a link to the survey that included the artifacts, three media methods of explorations, and then questionnaire. The data then was analyzed to measure the user preferences in relation to the media methods in the AR application.

This chapter is organised as follows: Section 6.2 proposes an approach to determine the users' expectations of the media method in the Kingdom of Saudi Arabia (KSA); Section 6.3 details the design of the survey to determine the preferred media method in KSA, Section 6.4 describes the data collection and storage method, Section 6.5 discusses the results, Section 6.6 provides a discussion, and Section 6.7 concludes the chapter".

6.2 Proposed approach to determine the users' expectations of the media method in KSA

Using the UCD module, the second phase of this research is to understand the users' requirements. To do so, phase two investigate the expectations of AR characteristics so that users can compare different characteristics to explore historical artifacts at a particular location in Saudi Arabia. Therefore, the researcher used a quantitative method to measure the users' preferences in relation to viewing media in the AR application when exploring historical artifacts. To collect the qualitative data, an online survey will be used to collect the user's responses. Figure 6.1 shows the workflow of the solution overview for objective two.

In this case, the researcher will involve 50-75 users in the study and one artifact. The artifact is Mebkharah (incense). *"Mebkharah (Incense): This is a traditional censer for burning incense. When burnt, incense is an aromatic biotic agent that emits a fragrant smoke. The word refers to either the substance or the scent. Incense is used for a variety of purposes, including aesthetics, aromatherapy, sleep, and rituals. It's also effective as a deodorant and insect repellent"*.

The survey is published online to be accessed by different users. To participate in the study, the user must first read the consent form and agree to the terms of the research to proceed to the survey. Once they start the survey, they will see the artifact. Then they must answer various yes or no questions (e.g. are you familiar with the artifacts). The researcher will need to compare the answers of the familiar and non-familiar in future research.

After answering the yes and no questions about the artifact, the participants will then view three different media methods which provide information on the historical

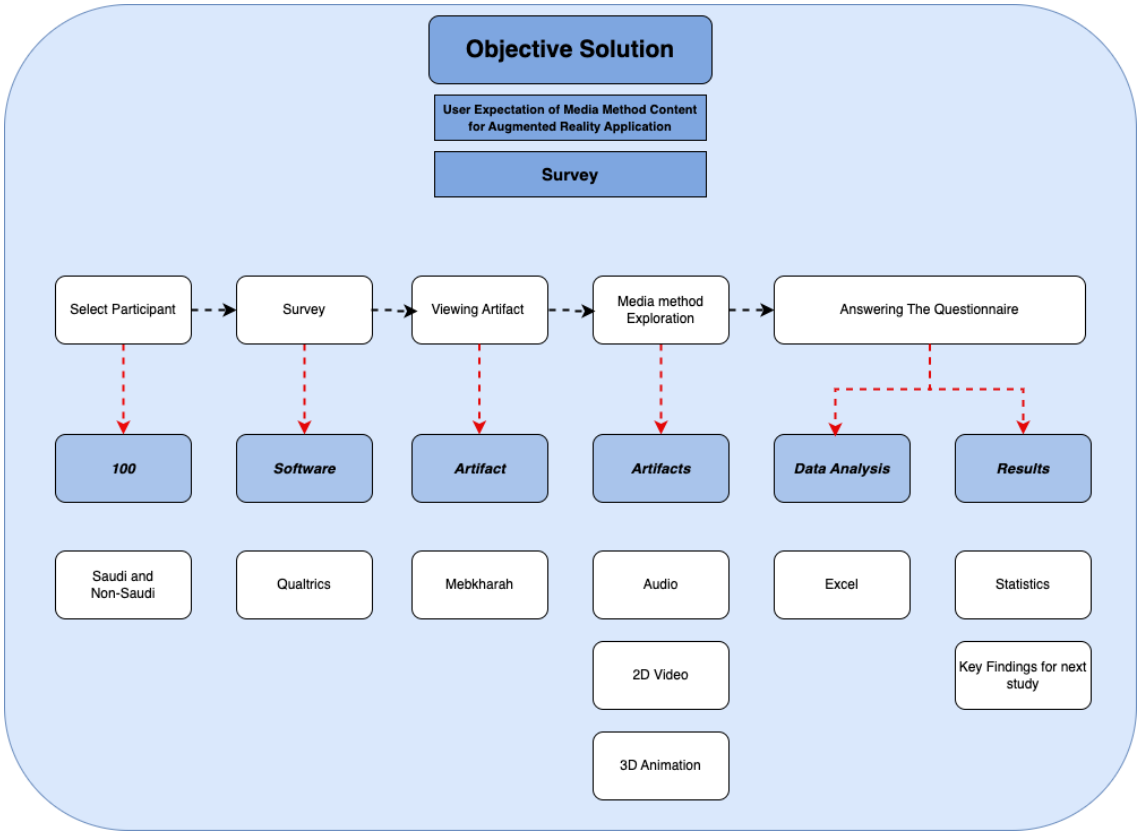


Figure 6.1: Solution Overview for Objective Two to determine the proposed approach to identify user expectations of media methods in KSA

artifact.

Audio: Audio information on the historical artifacts.

2D Video: A short 2D video to provide information on the historical artifacts.

3D Animation: A 3D animation to provide information on the historical artifacts.

Audio

2D Video 

3D Animation 

After the participants have reviewed the various media methods, they are required to fill in a survey and submit it. The researcher will store the users' response data in his computer with a secure password. This data will then be ready for analysis and the finding will be findings presented in the next stage of the study.

6.3 Design of the survey to determine the preferred media method in KSA

Introduction: This aim of this survey is to identify user expectations and preferences in relation to the media methods used in AR applications when exploring historical artefacts. To do this, the users will first be shown an artifact which will then be explained in three different ways using different media methods.

1. Audio
2. Video
3. Animation

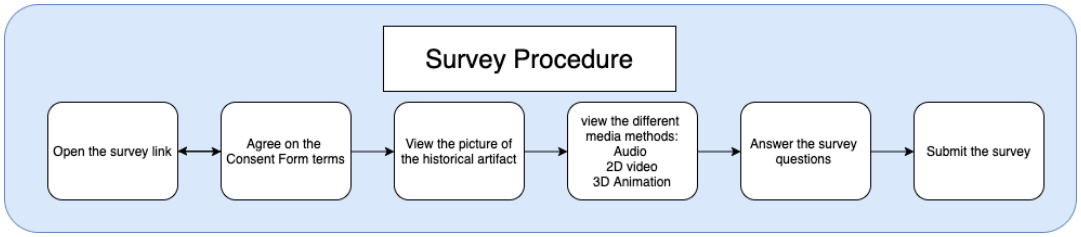


Figure 6.2: The experiment steps in Phase 2 of the study

After they have completed the survey, the participants who agreed to be interviewed are contacted by the researcher.

Survey duration: The survey should not take more than 5-7 minutes to complete.

Screeners: Any one can complete the survey.

Body: **Section 1: User Details:** User's name (for accuracy of responses) User's preferred method of contact and if they wish to be contacted for future research purposes or to participate in the interview.

Section 2: Media methods: Users view a picture of the artifact (Mebkharah) and then the three ways of exploring the artifact (audio,2D video, and 3D animation). First, the user views the picture of the artifact,

Section three: Feedback: To identify the users' expectations and their media preferences, the researcher measures the following: (this section will be ranking and scaling):

1. The delivery of artifact information.
2. Engagements.
3. Learnable and understandable ways of delivering information
4. Usable ways of delivering information.
5. Recommended to be used In the future.

Final thoughts: Close with an open-ended question and follow up with an interview question asking why they chose the media methods and any additional ideas.

Redirects: A simple thank you page

Figure 6.3: Mebkhrah artifact

Figure 6.4: The three media methods: audio, video, and animation

6.4 Data collection and storage

The data was analysed to answer the research question three. Therefore, we coded the responses of the pericipants to investigate the content of the artifact information, the clarity of the information, and other recommendations. Also the investigation included measuring user attractiveness, focusing on the artifacts, and the level of user engagement, comfort and enjoyment when exploring the artifact using the AR experience. The data were analyzed on an Excel spreadsheet and converted to pie charts to summarise the data.

The data was securely stored on the Google drive. To view the data (CLICK HERE)

6.5 Results

6.5.1 User Feedback on the Content on the Artifact

The users were given three options and were asked to rank each in order of preference.

The results show that 46% of users chose to be informed of how to use the mebkhara as their first option, 39% chose this as their second option and 15% chose this as their last option. 32% of users chose to be informed of what is mebkhara is used for as their first option, 43% chose this as their second option and 25% chose this as their last option. Finally, 22% of users chose to be informed of what the mebkhara is made of as their first option, 18% chose this as their second option and 60% chose this as their last option.

6.5.2 User feedback on the Artifact Information

Users were asked to select one of the three media options, namely 3D animation, audio, or 2D video, to obtain clear information about the Mebkhara and how to use the Mebkhara.

The results show that 59% of the users chose the 3D animation media method to gain the clearest information about the Mebkhara, 16% of the users chose audio and 25% chose 2D video. On other hand, 62% of the users chosen that 3D Animation media method what gave them clearest information about how to use Mebkhara when 13% of the users chosen that audio gave them a clear information about how to use Mebkahra and 25% chosen that 2D video gave them this information about how to use Mebkhara.

6.5.3 User Feedback Measurements

The users' preferences were measured by asking them to rank on a scale of one to ten to what degree they were attracted to, focused on, engaged with, comfortable with and enjoyed using the three media methods, namely 3D animation, audio, and 2D video when exploring the historical artifacts. Then the average of the rankings were calculated. Last, the researcher divided the scale into the following: zero to three was considered low, four to 6 was considered average, and seven to ten was considered high.

The results show that the participants strongly prefer 3D animation, then 2D video and then audio. They are also more engaged with the 3D animation, then the 2D video and lastly the audio. The results show that the users feel the most comfortable by exploring the artifact using the 3D animation, then the 2D video and lastly the audio. Moreover, the users enjoy exploring the artifact using the 3D animation the most, then the 2D Video and lastly the audio. It can therefore be concluded that the users are more

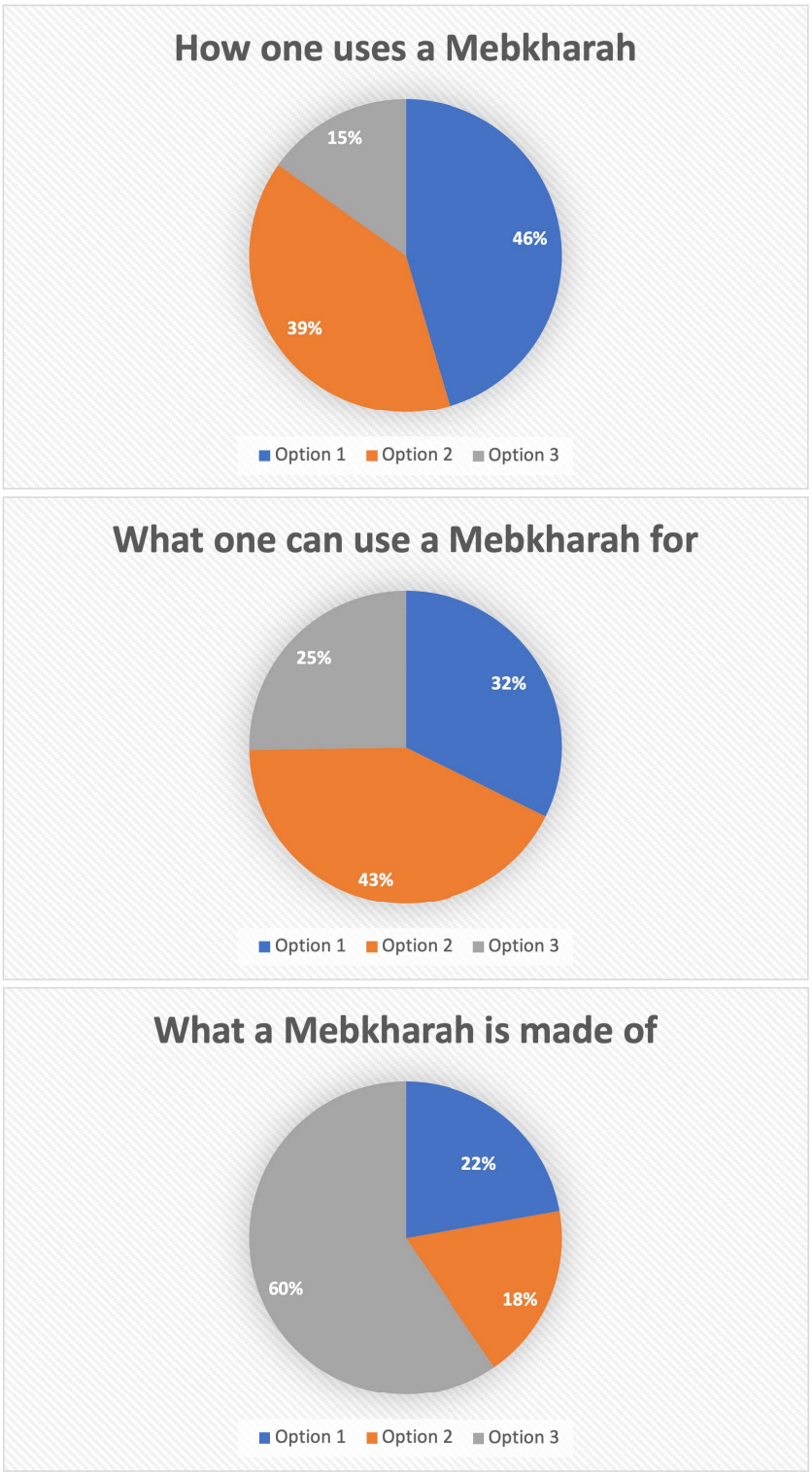


Figure 6.5: User feedback on the Content Information on the Artifact

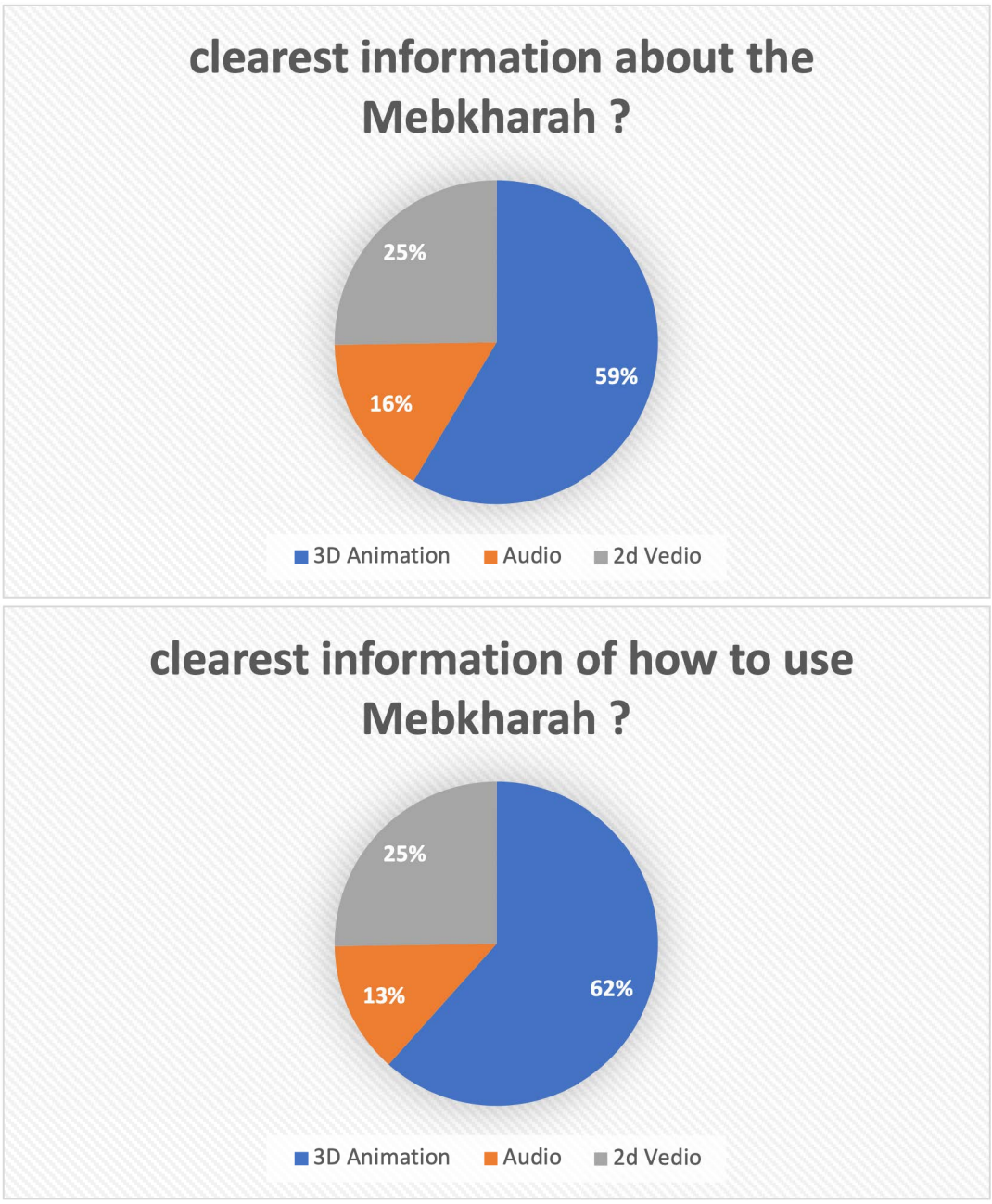


Figure 6.6: User feedback on the Artifact Information

attracted to the 3D animation than the 2D Video or the audio.

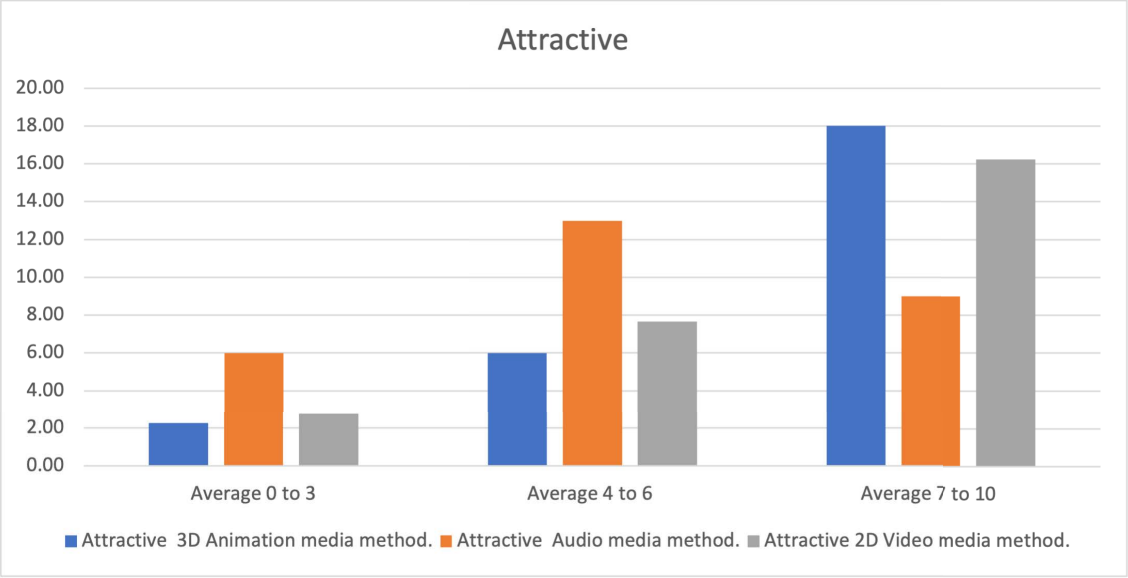


Figure 6.7: Level of attraction to the three media methods.

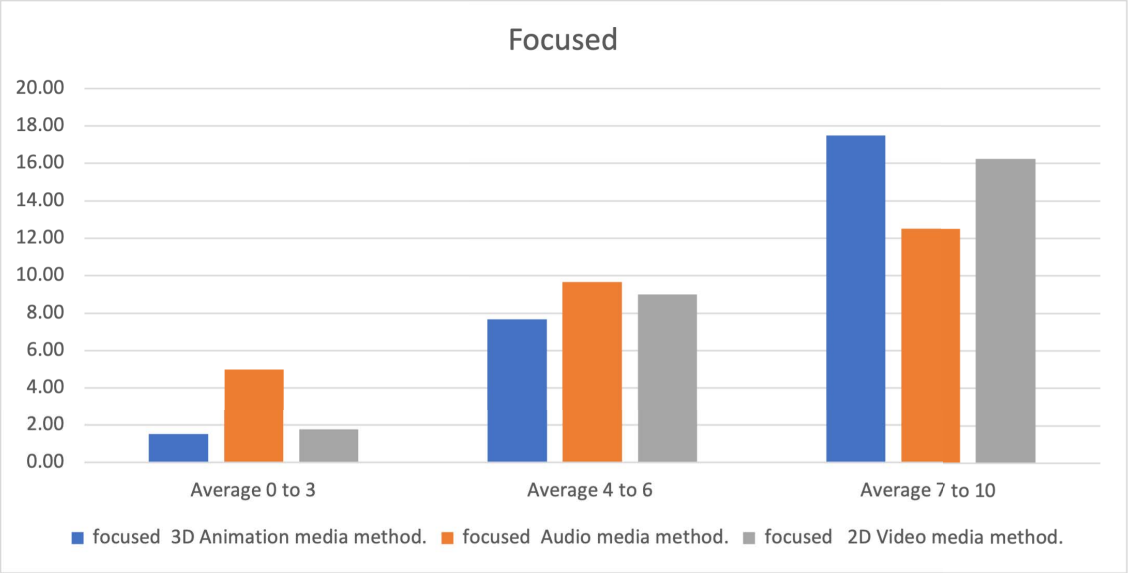


Figure 6.8: Level of focus on the three media methods.

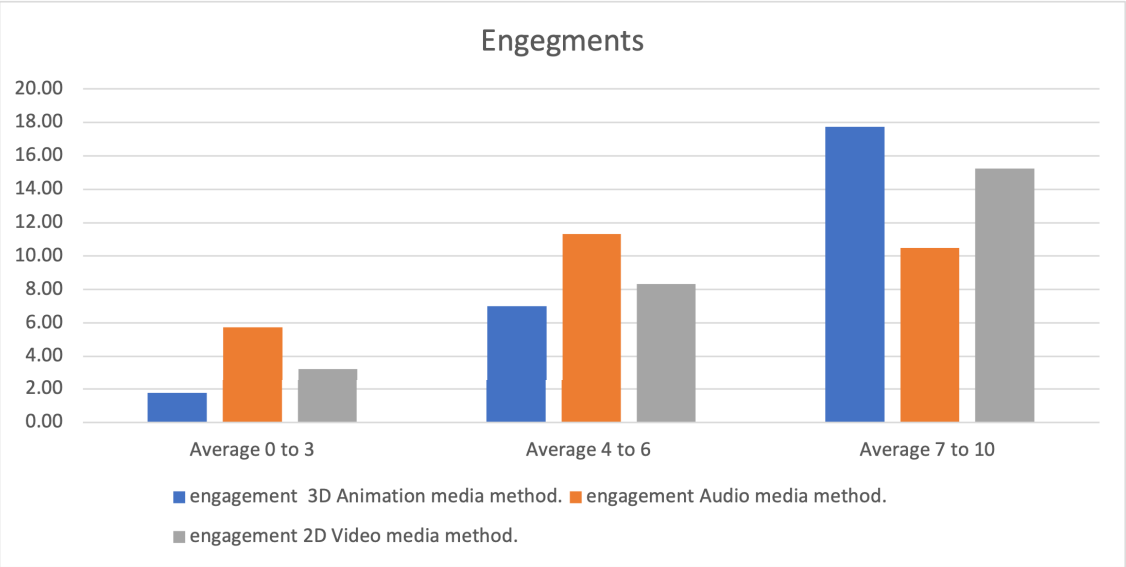


Figure 6.9: Level of engagement with the three media methods.

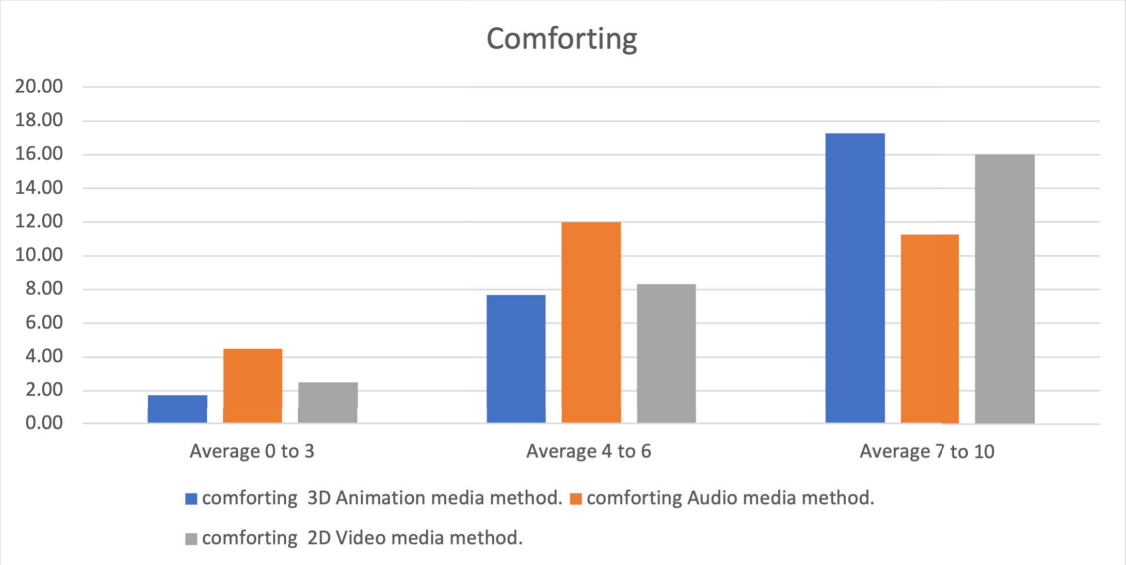


Figure 6.10: Level of comfort with the three media methods.

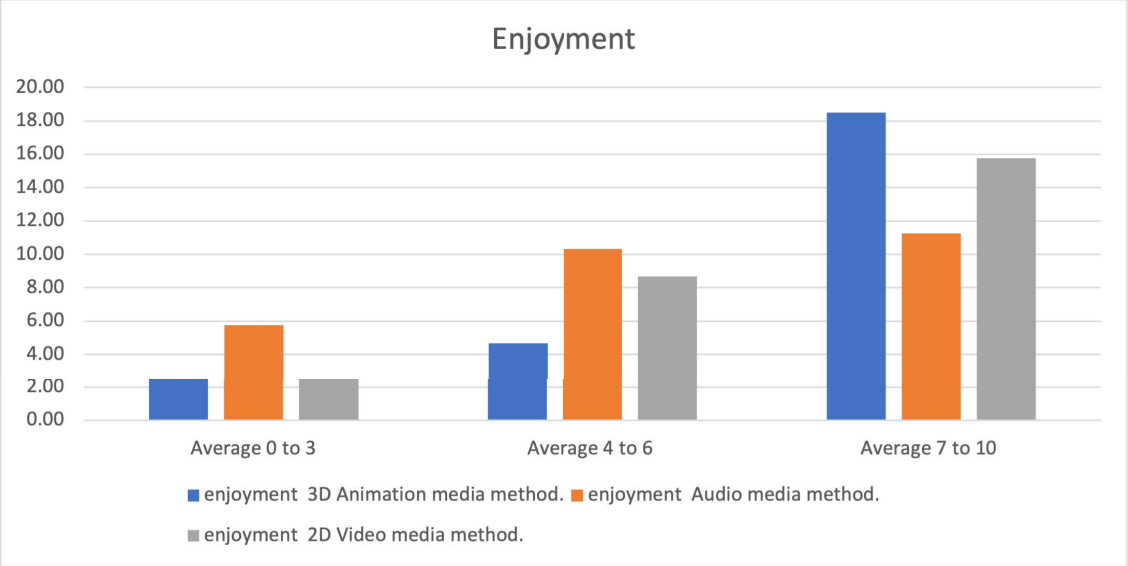


Figure 6.11: Level of enjoyment with the three media methods.

6.5.4 User recommendation

The participants were asked to indicate which of the five options they felt was the easiest way to obtain information on the artifacts in historical museums and what their recommendations are after exploring the three media methods.

The results show that 60% of the users found that 3D animation is the easiest way to explore an artifact, 25% of the users agreed that 2D video is the easiest way to explore historical artifacts in museums, 7% of the users chose audio, 6% preferred to read a sign and 2% preferred not to use any media methods when exploring historical artifacts.

The results show that 64% of the participants recommended 3D animation as their preferred media method when exploring historic artifacts , 22% recommended the 2D video media method, 9% recommended the audio method, 4% recommended reading signs on the displayed artifact, and 1% preferred not to use any type of media method.

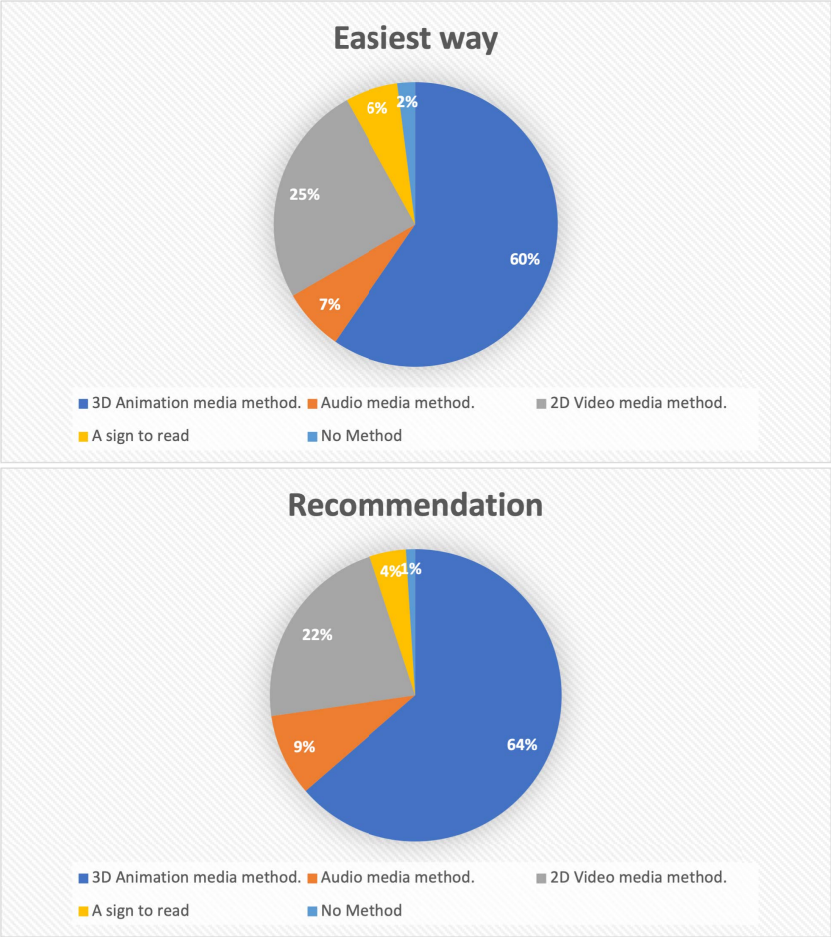


Figure 6.12: User recommendations of media methods when exploring historical artifacts

6.6 Discussion

6.6.1 User feedback on the Content on the Artifact

The user feedback data is valuable in shaping how information about historical artifacts should be communicated. An overwhelming majority of users, 46%, are primarily interested in learning how to use the Mebkhara. The artifact's cultural and historical significance is directly connected to a desire for practical knowledge.

Furthermore, 32% of users prioritize understanding the Mebkhara's function. The artifact is still important to many people, even though this percentage is smaller, indicating that people are curious not only about the "how" of an artifact, but also as to why it is there.

In contrast, only 22% of respondents consider the composition of the material to be the most important consideration. It appears that users are less interested in the physical properties of the Mebkhara than in its cultural and functional aspects.

It makes sense to present information in this manner given these priorities. In meeting the needs of the majority of users, practical usage information and functional significance should be emphasised. A step-by-step explanation of how to use the Mebkhara, accompanied by images or diagrams, is important to cater to hands-on learners and those who wish to see the artifact in person.

Users are curious about its cultural value when they learn about the Mebkhara's function and historical context. In addition to adding depth to the content, stories, traditions, and rituals associated with the artifact, an emotional connection is created for users interested in the broader context as well. In spite of the fact that material composition may not be a top priority, it should still be included. There may be some users who are interested in the artifact's construction for scientific or technical reasons. This information is presented concisely to make it easier for those who are interested to access it without compromising its primary practical and functional aspects.

A discussion such as this illustrates the importance of understanding user priorities when creating content on historical artifacts.Providing practical and functional information as well as additional information tailored to different interests will help engage a wider audience and provide a well-rounded learning experience.

6.6.2 User feedback on the Information of the Artifact

A majority of users consistently chose 3Danimation media as the most effective method for conveying information about the Mebkhara. Audio and 2D video were chosen by a smaller percentage of users. In both instances, 3D animation ranked significantly higher, suggesting that this media method conveyed information about the historical artifacts particularly effectively.

The results show that 3D animation is consistently preferred to other media methods. The majority of users, 59% and 62% respectively, chose 3D animation as the medium

that provided the clearest description of the Mebkhara in both instances. Accordingly, 3D animation can be particularly effective at conveying complicated concepts, historical contexts, and practical instructions for Mebkhara usage.

The advantage of 3D animation is that it presents the artifact in a dynamic and interactive manner, enabling users to see the Mebkhara from various angles, see its intricate details, and even simulate its use, which would not be possible using other media.

Even though audio garnered a smaller percentage of user preferences (16% and 13%, respectively), its role in communicating information should not be overlooked. Audio can be effective in providing narration, context, and emotional engagement. Sound effects, historical anecdotes, or guided explanations might have made it more appealing to users who prefer auditory learning. However, a comprehensive understanding of the Mebkhara may not be achieved by relying on audio alone.

The choice of 2D video by 25% of users in both instances suggests its visual appeal. Using videos for step-by-step instructions can be engaging and effective because this form of media combines visual and auditory elements. Despite its widespread use for educational purposes, 2D videos were still outperformed by 3D animation in providing clarity of information about the Mebkhara.

The investigation focused on media methods in the context of an ARexperience. 3D animation is a strong preference, demonstrating the potential of AR to create immersive and interactive learning experiences. Users can engage more deeply with the Mebkhara by interacting with it in an AR environment, manipulating it, and observing it in different contexts, improving their understanding of it.

The results also emphasize the importance of catering to different learning styles. Visual learning might be preferred by some users, while auditory or kinaesthetic learning might be preferred by others. A variety of media methods would enable a more inclusive learning experience and address these diverse preferences.

In conclusion, in the AR context, 3D animation provides clear information about Mebkhara usage in an effective manner. Nonetheless, a comprehensive educational

approach can integrate multiple media methods to meet a wide range of learning styles and preferences, ensuring an engaging, well-rounded learning experience.

6.6.3 User Feedback Measurements

In this phase of the data investigation, user preferences were assessed by asking them to rate the three different media methods on a scale of one to ten for attractiveness, focus, engagement, comfort, and enjoyment levels. 3D animation, audio, and 2D Video were rated on a scale of one to five. To analyze the collected data, average scores were calculated for each scale. Low scores were categorized as zero to three, average scores were categorized as four to six, and high scores were categorized as seven to ten.

The results show that most of the participants preferred 3D animation over 2D video and audio. Their focus was found to be highest with 3D animation, followed by 2D video and audio. Similarly, engagement was greatest with 3D animation, followed by 2D video and then audio. Participants reported feeling most comfortable exploring the historical artifact through 3D animation, followed by 2D video and audio. Furthermore, participants indicated that they enjoyed the exploration process the most when using 3D animation, followed by 2D video and audio. Lastly, participants were primarily attracted to 3D animation, followed by 2D video and then audio.

Participants preferred, engaged with, and enjoyed 3D animation more than audio or 2D video. They also expressed the highest levels of comfort, enjoyment, and attraction towards 3D animation. In enhancing user experiences and interactions with historical artifacts, 3D animation has the greatest potential.

Preference Order and Engagement Levels:

The investigation demonstrated that participants showed a clear preference for 3D animation over 2D video and audio in terms of attractiveness, focus, engagement, comfort, enjoyment, and attraction. Therefore, 3D animation was more effective at capturing participants' attention and interest because it is immersive and dynamic. It is consistent with the idea that interactive and visually engaging material can provide users with a more contextualized and understandable understanding of historical artifacts.

Multi-sensory Engagement:

The results show that 3D animation and 2D video were more engaging than audio.

Both visual and auditory cues enhance engagement with a historical artifact through a multi-sensory experience. Despite its potential to convey complex information and context without visuals, audio was less engaging.

Comfort and Enjoyment:
Compared to the other methods, 3D animation was more comfortable and more enjoyable for participants. As a result of 3D animation's immersive and interactive nature, users interacted with the historical artifacts in a more natural and intuitive way. Additionally, users reported greater comfort with the interface and navigation, reducing potential barriers to engagement.

Implications for Education and Interpretation:
It is possible that the study's conclusions could have major implications for education and interpretation in relation to historical artifacts. Learning experiences can be enhanced by incorporating 3D animation into educational platforms and museums. Using this method, learners can gain a deeper understanding of historical context, spatial relationships, and details that might be difficult to convey using static images or audio alone.

6.6.4 User recommendations

Effectiveness of the three Media Methods:
The study results show that 60% of users find 3D animation to be the easiest and most effective way to explore historic artifacts. As a result of the immersive nature of 3D animations, which can provide an interactive or dynamic experience, users are more likely to engage with and understand the artifact's historical context.

Visual Engagement:
3D Animation and 2D Video both engage participants visually. By using visual media methods, users can get a better understanding and appreciation of artifacts from different angles and perspectives.

The limited appeal of Audio
It is possible that audio alone might not be sufficient to convey the complexities of historical artifacts, based on the relatively low percentage of users (7%) who preferred the audio medium. Users may not find audio to be useful in understanding the historical

significance of artifacts without a visual context.

Reading Signs vs. Multimedia:

In some cases, users still value traditional methods of communicating information, as evidenced by their preference for reading signs near artifacts (6%). Reading provides concise information and is simple and direct, negating the need for users to engage with multimedia technologies. Multimedia, on the other hand, is more immersive and engaging than this method.

Recommendations and User Preferences:

Users' preferences and recommendations seem to align strongly as a significant percentage recommend the same media method (64% recommend 3D animation). Consequently, users prefer the method they themselves would suggest to others as the most engaging and informative.

6.7 Conclusion

The study results indicate that users are more inclined to prioritize information on the artifact's practical usage and function over its material composition. This insight can guide how information on historical artifacts is presented. For example, a greater focus should be placed on explaining how to use the Mebkhara and its functional significance while providing material composition information in a way that doesn't overshadow these other aspects.

Moreover, 3D animation in the AR context provides clear information about Mebkhara usage in an effective manner. Nonetheless, a comprehensive educational approach can integrate multiple media methods to meet a wide range of learning styles and preferences, ensuring an engaging, well-rounded learning experience.

Also, this study concludes that 3D animation offers users a more engaging and effective way to explore historical artifacts than other media. Immersive, dynamic, and multi-sensory experiences seem to be more preferred, engaging, comfortable, and enjoyable. The findings suggest that technology can enhance our interaction with and learning from historical artifacts, enriching and democratizing the experience.

Finally, of the available media methods for exploring historical artifacts, 3D animation is the most preferred and recommended, followed by 2D Video. To convey historical context effectively, visual engagement and interactivity are essential. Nevertheless, the study emphasizes the value of traditional methods such as reading signs and catering to diverse user preferences.

CHAPTER 7

PHASE THREE: THE EXPLORATION OF NON-TOUCHABLE HISTORICAL ARTIFACTS IN THE KINGDOM OF SAUDI ARABIA

7.1 Introduction

Chapter six detailed phase two of the study, which aims to understand user requirements when using an augmented reality (AR) application in historical museums. The study investigates the use of three media methods to explore historical artifacts. The study involved 31 participants who were asked to explore the artifacts using the three media methods. Each participant was given a link to a survey that included questions on the artifacts, the three media methods used in the explorations, and then a questionnaire. The results show that 3D animation is the most preferred and recommended media method, followed by 2D video.

This chapter details phase three of the study, in which the AR application is designed to explore historical artifacts using the three media methods and is evaluated. The study involves 31 participants who first used the system and were then interviewed and asked to join the survey. The data was analysed using Nvivo and Excel to analyse the interview and survey questions.

This chapter is structured as follows: Section 7.2 details the proposed approach for

the exploration of non-touchable historical artifacts in the Kingdom of Saudi Arabia, Section 7.3 describes the participant selection, Section 7.4 overviews the data collection approach, Section 7.5 details the tools used during the experimentation, Section 7.6 describes the user interface application, Section 7.7 discusses the research approach for exploring non-touchable historical artifacts in KSA, Section 7.8 provides the data analysis, Section 7.9 discusses the results, Section 7.10 provides a discussion, Section 7.11 draws the conclusion.

7.2 Proposed approach for the exploration of non-touchable historical artifacts in the Kingdom of Saudi Arabia

Based on the user-centered design, the last phase of the research is to design the solution and evaluate it against the requirements. Therefore, this chapter investigates the acceptance of the design of the AR application that can be used to deliver a better understanding of the use of non-touchable historical artifacts in Saudi Arabia. The researcher designed the user interface of the AR application and evaluated the media methods to see if the system is able to deliver a better understanding of the non-touchable artifacts. Figure 7.1 illustrates the workflow of the solution overview of objective three.

The research uses a mixed-method approach in this phase by incorporating both an interview and a survey. The interview examines the extent to which the system is able to deliver a better understanding by providing rich information on the historical artifact, the level to which the users are engaged with the system, and the degree to which AR is acceptable in the context of Saudi Arabian historical museums.

The survey measured to what degree the users were attracted to the system, to what degree they were focused on the system, to what degree they engaged with the system, to what degree they felt comfortable using the system, and to what degree they enjoyed using the system. These measurements were taken via the survey which asked the participants to rate the three media methods on a scale of 1 - 10. The survey also measured the usability and accessibility of the AR application.

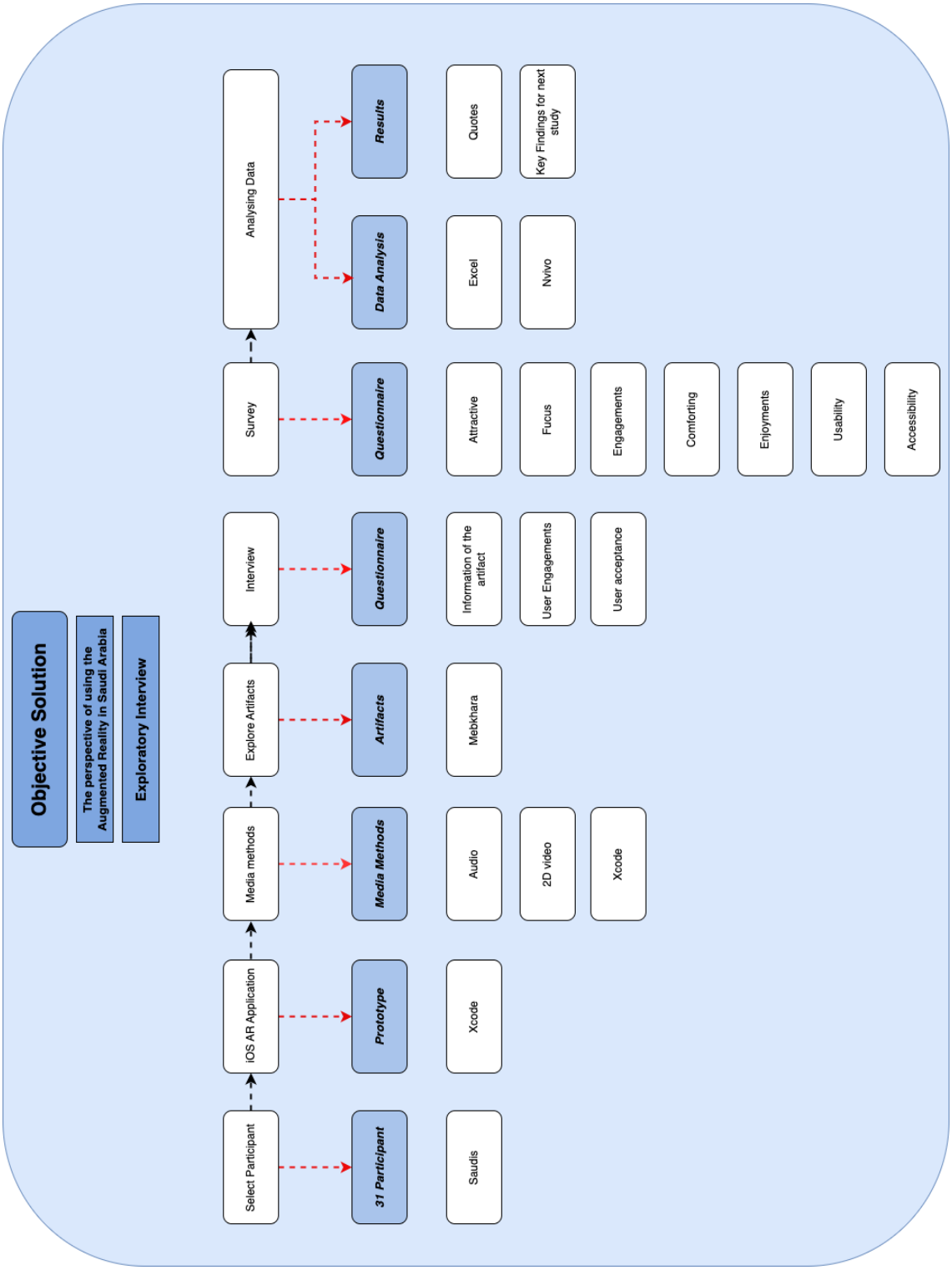


Figure 7.1: Solution Overview for Objective Three to investigate whether AR enhances the understanding of non-touchable historical artifacts in Saudi Arabia

7.3 Participant selection

A total of 30 male and female participants from Saudi Arabia, aged between 18-60, were selected for this study. The participants were required to experiment with the system, participate in an interview and complete a short one-hour survey. They participated individually in the experiment.

The sample size target is 31 interviews. Guest et al. [47] stated that data saturation occurs within the first twelve interviews. Moreover, Caine [21] stated that "the most typical sample size for manuscripts published at CHI is 12, with a range of 1 to 916,000". Additionally, we see that sample sizes vary depending on the study's design and methods. Therefore, taking into consideration the limitations of time and resources, the sample size here is estimated to be about 12 to 14 participants. However, the sample interviews will be conducted until data replication or nothing new emerges.

There are two versions of the interview questions, the Participant Information Statements and the Consent Forms, one version written in English and one in Arabic. screener questions will be used to include or exclude participants. The term of screening questions is frequently used interchangeably with the phrase qualitative procedure [99]. The following exclusion criteria apply:

1. Participants under the age of 18 years old are excluded.

2. Participants with significant visual or hearing impairments are excluded.

7.4 Data Collection approach

The data collection used to solve objective three of the research was mixed method. Therefore, we interviewed the participants and ask them to fill in a survey. The aim of the interview was to investigate user engagement, a better understanding of the artifacts, and how they are accepted for use in Saudi Arabia's historical museums by quitting their responses.
The aim of the survey is to first scale the level of attractiveness, engagement, focusing, enjoyment, and comfort. The second is to evaluate the acceptability and usability of the AR application.

The following figures 7.2, 7.3, and 7.4 are the questionnaire that was used in the investigation. To view the survey: Please click here.

7.4.1 Interview Questions

The open questions that were asked immediately after using the AR application are presented in Figure 7.2.

1. What Media Methods of this Augmented Reality Application gave you rich understanding of the non-touchable historical artifact? And how?
2. What Media Methods of this Augmented Reality Application do you find most helpful in exploring the historical artifact? And why?
3. What Media Methods of this Augmented Reality Application do you find easiest in exploring the historical artifact? And why?
4. What imagination did you had about the artifact when using the Augmented Reality Application to explore the historical artifact?
5. How did the experience make you feel about the display artifact when using the Augmented Reality Application to explore the historical artifact?
6. What Media Methods of the Augmented Reality Application gave you this feeling?
7. How did the experience affect your opinion in viewing the historical artifacts in augmented reality rather than holding the actual artifact?
8. Did the Augmented Reality Application experience make you curious to learn more about other artifact?
9. If yes, what Media Methods of the Augmented Reality Application would you like to use to explore more about other artifacts?
10. Do you think the Augmented Reality Application experience will be acceptable in Saudi Arabia Museums to explore the historical? If yes, will you use this experience in the future to explore historical artifacts in Saudi Arabia museums?
11. Do you have any other suggestions regarding the experience?

Figure 7.2: Interview Questions: AR Application Open Questions asked immediately after using AR Application

7.4.2 Survey Questions

Section 1: Evaluating the characteristics of the system

The survey questions for evaluating the system's characteristics are presented in Figure 7.3.

1. Please rate how attractive you found the explanation for the following characteristics (where 0 is not attractive, and 10 is extremely attractive)
2. Please rate how focused you were on the explanation for the following characteristics (where 0 is not focused, and 10 is extremely focused)
3. Please rate how engaged you were in the explanation for the following characteristics (where 0 is not engaged, and 10 is extremely engaged)
4. Please rate how comfortable you were with the explanation for the following characteristics (where 0 is not comfortable, and 10 is extremely comfortable)
5. Please rate your level of enjoyment with the explanation for the following characteristics (where 0 is not enjoyable, and 10 is extremely enjoyable)

Figure 7.3: Survey Questions: Evaluating the characteristics of the system

Section 2: Evaluating the capability and usability of the AR application

The survey questions for evaluating the capability and usability of the AR application are presented in Figure 7.4.

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

Figure 7.4: Survey Questions: Evaluating the capability and usability of the AR application

7.5 Tools used during the experimentation

Converting to USDZ: I converted the 3D model in USDZ format using the Python tool created by Apple usdzconvert. usdzconvert box.fbx box.usdz

Importing the USDZ Model to Xcode I imported the 3D model in Xcode and used SceneKit(iOS framework). To use SceneKit, I converted it to .scn format using the Xcode.

UI: The user interface of each screen is created programmatically using UIKit (iOS framework)

Plane Detection and Presenting the Audio, 3D and Video: First of all, the tracking configuration is set to ImageTracking and after the image is tracked, another plane of the same detected dimension is created, and whatever media type is selected, the respective media type starts playing on top of the newly created plane except for the audio type. For the audio type, after the detection of the tracker, the respective audio is played.

Mebkhara (Incense): This is an incense burner. The smoke from incense is aromatic and fragrant when it is burned. Either the substance or the scent is referred to by the word. A variety of purposes are served by incense, including aesthetics, aromatherapy, sleep, and rituals. Deodorant and insect repellent properties are also present.

Tracker: The tracker is the picture the participant points at to explore the artifacts:

Figure 7.5: Augmented Reality system Tracker to explore the artifact using the AR application

Other material for the study:

1. iPhone
2. iPhone Charger
3. Laptop
4. Laptop Charger
5. Camera
6. Camera Charger
7. Camera Stand
8. Consent form
9. Pen
10. Artifact
11. Audio recording

7.6 User Interface Application

Figure 7.6: Augmented Reality Application UI (Registration and Sign up)

Figure 7.7: Augmented Reality Application UI (Media Methods)

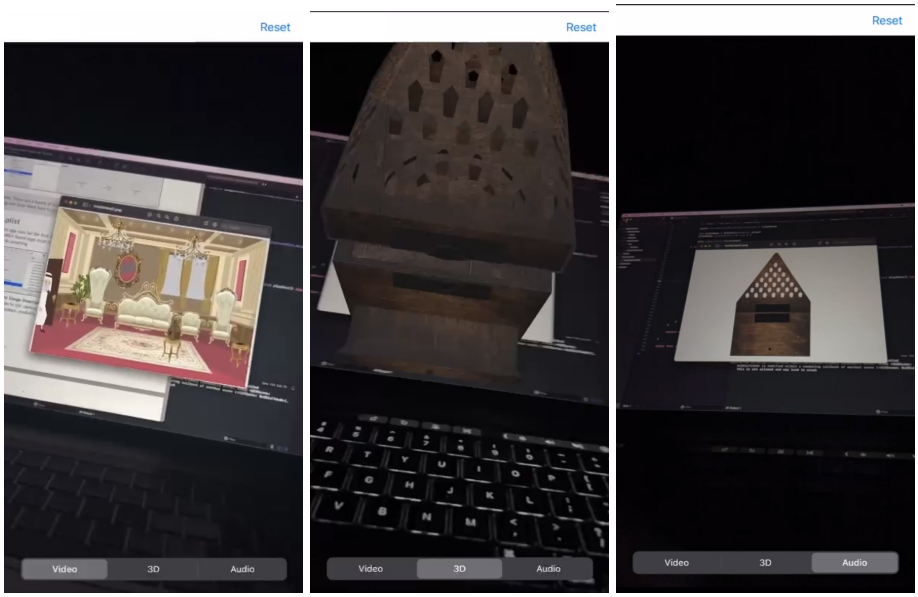


Figure 7.8: Augmented Reality System User Interface when exploring the artifact using Video Media Methods

7.7 Research approach to explore non-touchable Historical Artifacts In KSA

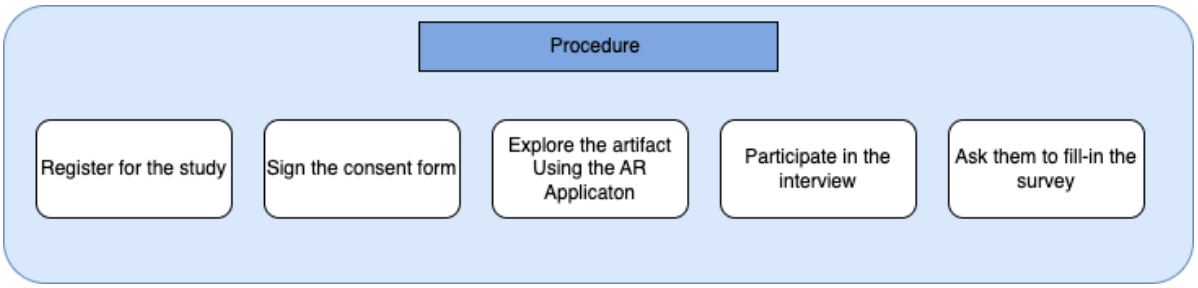


Figure 7.9: Phase 3 Experiment steps

Location: The phase three study was planned to be conducted in one of the historical locations in the city of Jeddah, Saudi Arabia. However, due to unavoidable circumstances, the study was conducted in an interactive research lab located in CB 02.12.175 at the University of Technology Sydney.

Study set-up: The study was set up in one of the of the school of computer science lab in the University of Technology Sydney.

Investigators: The following investigators will be involved in this research.

1. Main Investigator: Rayed Alakhtar, PhD Researcher at the University of Technology Sydney
2. Investigation Supervisor: Prof. Farookh Hussain, PhD
3. Investigation Co-Supervisor: Srinivas Madhisetty, Lecturer
4. Co-Investigator: Hada Alsobhi, PhD Researcher at the University of Technology Sydney

Pre-Study: Before starting the experiment, I contacted participants via email and social networks to ask them to participate in the system. Also, I posted flyers about my experiments around the the lab locations were we did the experiment. When participant arrived at the location, I welcomed them and thank them for their time. Then, I went through the screening test to see if they are eligible to participate or not. Then, I hand them the Participant information sheet and consent form. Last, I gave them the application and ask them to explore the location.

During the Study During the study, I was close proximity to the participants while they were exploring the artifact to help them if they had any concerns regarding the location or the application.

The participant explored the location, and I asked them to explore the Mebkhara artifact using the application. The Mebkhara was displayed with other artifacts but the participants were told that that this one can be explored digitally.

Post-study Once the participant has finished exploring the location, I ask them to chat about what they have explored. I again requested their permission to record the chat for analyses and future use. After the chat, I thanked them for attending the experiment.

7.8 Data Analysis

The results from this section are analyzed using three different procedures (system analysis, interviews, and survey). The data is secured and stored in Google Drive. To view the data (CLICK HERE)

7.8.1 Analysing the interview questions

The interview questions are analyzed using Nvivo software. According to [99], the coding procedure is the foundation of the analysis because the qualitative data are text-based. "Tags or labels which give units of significance to the descriptive or inferential information acquired throughout a research" are defined as codes. Therefore, all the answers that employ the keywords of each part of the results in this chapter are coded. Then, all the coded words are documented on an Excel spreadsheet to calculate the results.

7.8.2 System Engagement

Each time the user plays any type of media after detection, the play count is incremented for the respective media type on the back end. However, for the video, the total playtime of each count is also stored on the back end.

The play count is not incremented immediately after the detection of the tracker instead, it is incremented after 3 seconds. So, at the time of analyzing the data, 3 seconds is added to the playtime of each log of users.

7.8.3 Survey

The study also includes a survey section. The two parts of the study are analyzed. The first part compares the level of attractiveness, focusing, engagement, comfort, and enjoyment of the media methods between this study and the previous study detailed in Chapter 6. The second part of the survey collects the users' feedback on the system. These data are analyzed using Excel to measure the significance of the data.

7.9 Results

7.9.1 Interview Quotations

This section reports on the results of the interview questions with the participants after they used the AR application. The results were analysed using Nvivo software. The data was measured based on the following codes:

1. Information on the artifacts
2. User Engagement
3. User Acceptance

After the participants' responses were coded, they were analysed using sentiment analysis tools to identify and measure the positive, neutral and negative sentiments.

7.9.1.1 Information on the Artifacts

Information on the Artifact	
Rich Information on the Historical Artifact	
Positive Sentiment	0.74
Neutral Sentiment	0.00
Negative Sentiment	0.00
Helpful Information on the Artifacts	
Positive Sentiment	0.54
Neutral Sentiment	0.00
Negative Sentiment	0.00
Easiest way to Explore the Artifacts	
Positive Sentiment	0.58
Neutral Sentiment	0.00
Negative Sentiment	0.00

Table 7.1: Sentiment analysis of user interviews in the context of information on the artifacts.

7.9.1.2 User Engagement

User Engagement	
Curious to learn more about the artifacts	
Positive Sentiment	0.57
Neutral Sentiment	0.00
Negative Sentiment	0.00
Effecting Actual Artifact when using Augmented Reality Application to explore the Artifacts	
Positive Sentiment	0.71
Neutral Sentiment	0.00
Negative Sentiment	-0.23
Feeling About the Artifact	
Positive Sentiment	0.62
Neutral Sentiment	0.00
Negative Sentiment	0.00
Imagination of the Technology when exploring Artifact	
Positive Sentiment	0.53
Neutral Sentiment	0.00
Negative Sentiment	0.00

Table 7.2: Sentiment analysis of the user interviews in the context of user engagement with the AR application.

7.9.1.3 Acceptance of using Augmented Reality in Saudi Arabia

User Acceptance	
Accepting the use of augmented reality in Saudi Arabian historical museums	
Positive Sentiment	0.80
Neutral Sentiment	0.00
Negative Sentiment	-0.30

Table 7.3: Sentiment analysis of the user interviews in the context of user acceptance of augmented reality technology.

The results show that the participants expressed positive sentiments (0.74) in relation to AR providing rich information the historical artifacts. The participants also expressed positive sentiments (0.54) in relation to the information provided by the augmented reality application when exploring the historical artifacts and they also expressed positive sentiments (0.58) in relation to the AR application being the easiest way to explore historical artifacts in museums. The results show that there were no

neutral or negative sentiments expressed by the participants. Hence, the 31 interviewees all expressed positive sentiments in relation to the augmented reality application providing better information on the historical artifacts when visiting historical museums.

To measure user engagement in the study, we explored how curious the participants were to learn more about the artifacts, how the experience affected their opinion on exploring historical artifacts in museums, how they felt about the historical artifacts when they used the augmented reality application to explore them, what imagination they had about the technology they used to explore the historical artifacts.

The results show that the participants expressed positive sentiments (0.57) in relation to their level of curiosity to learn more about the historical artifacts using the augmented reality application. The participants also expressed positive sentiments (0.62) in relation to how they felt about the artifact using the AR application, they also expressed positive sentiments (0.53) in relation to their imagination of the AR when exploring historical artifacts, and they expressed positive sentiments in relation to how the AR affected their opinion of the artifact when using the AR application. However, they expressed negative sentiments (-0.23) in relation to how the AR affected their opinion of the artifact when using the AR application.

Finally, in this study, we also need to understand the acceptance of Saudi Arabian culture in relation to the use of AR in Saudi Arabian historical museums. Therefore, we asked the participants if they accepted the use of this technology to explore Saudi Arabian historical artifacts and if so, would they use it? A total of 31 users said yes and based on the sentiment analysis of the responses, the result indicated a positive sentiment of 0.80 and negative sentiment of - 0.30.

7.9.2 User Feedback Measurements

The users were asked to rate on a scale of one to ten the degree to which they were attracted to, focused on, engaged with, comfortable with and enjoyed using the three media methods, namely 3D animation, audio, and 2D video when exploring historical artifacts. Then the researcher analysed the results by calculating the average score. A score of zero to three was considered low, four to 6 was considered average, and seven to ten was considered high.

The results show that the participants are strongly focused on 3D animation then the 2D video, then the audio. They are also engaged with the 3D animation, then the 2D video and lastly the audio. The results also show that the users feel comfortable when exploring the artifact using first the 3D animation, then the 2D video and lastly the audio. Moreover, the users enjoy exploring the artifact using the 3D animation, then 2D video and lastly the audio. Finally, the users are attracted to the 3D animation, then the 2D video and then the audio.

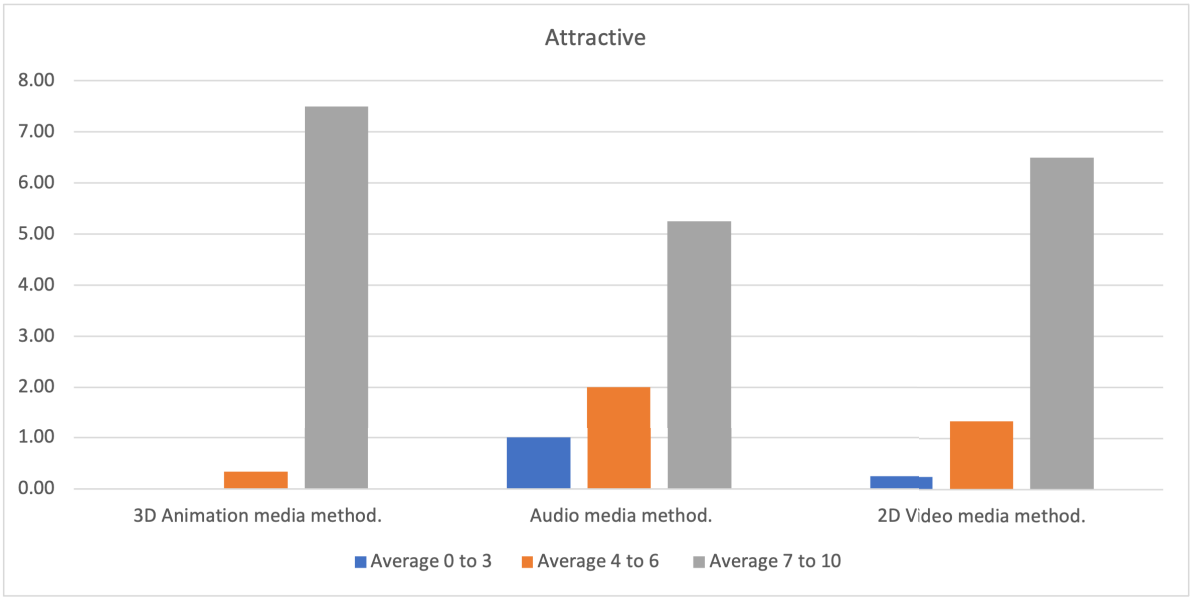


Figure 7.10: Level of attraction to the three media methods

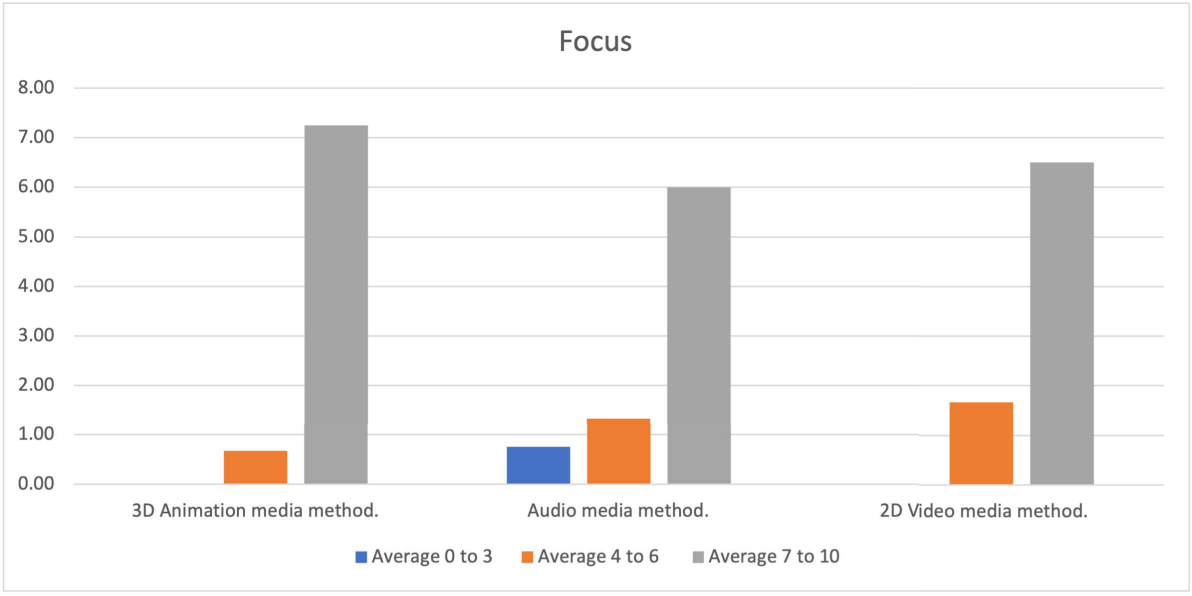


Figure 7.11: Level of focus on the three media methods.

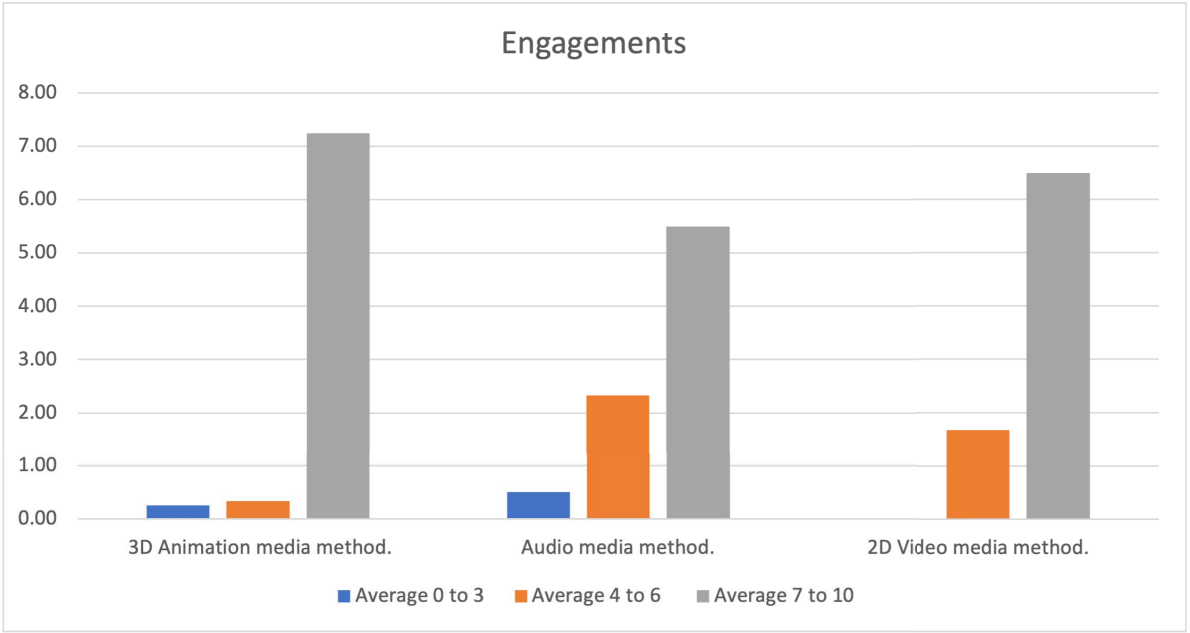


Figure 7.12: Level of engagement with the three media methods.

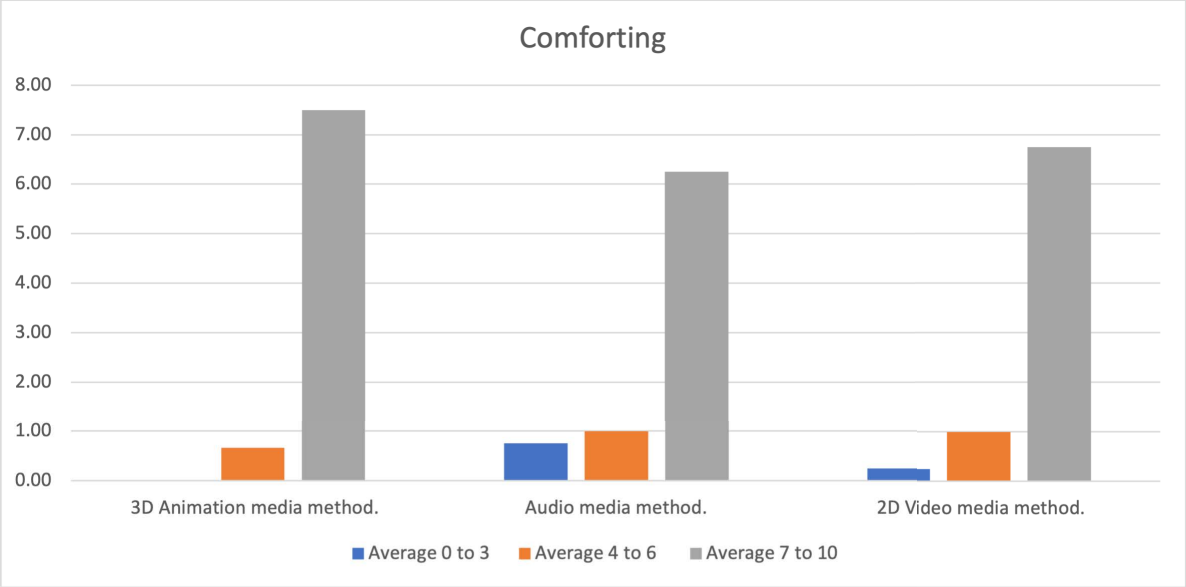


Figure 7.13: Level of comfort with the three media methods.

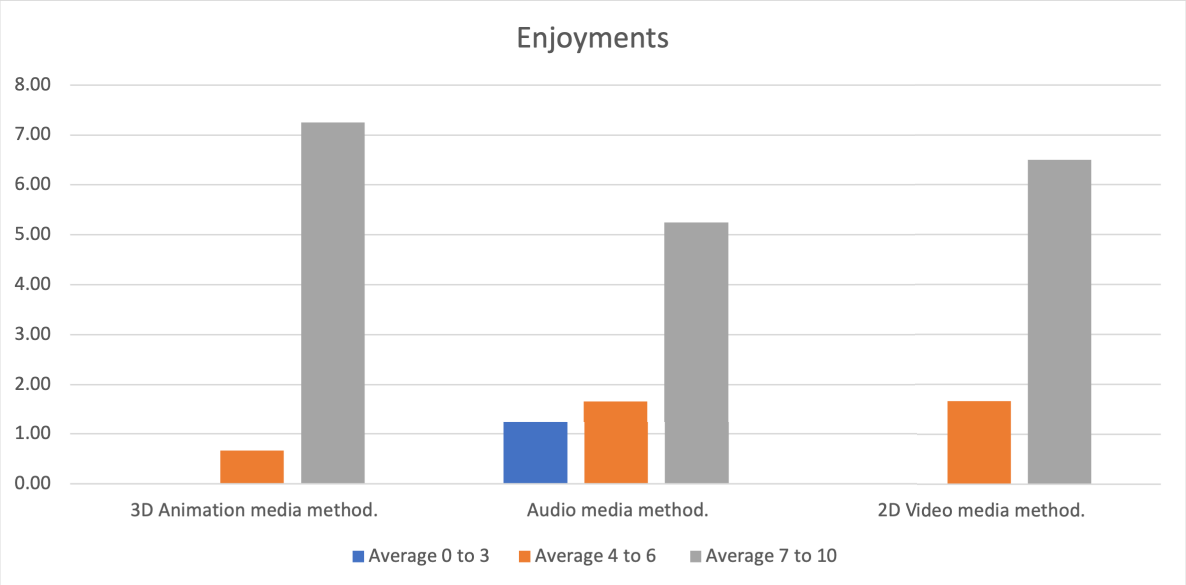
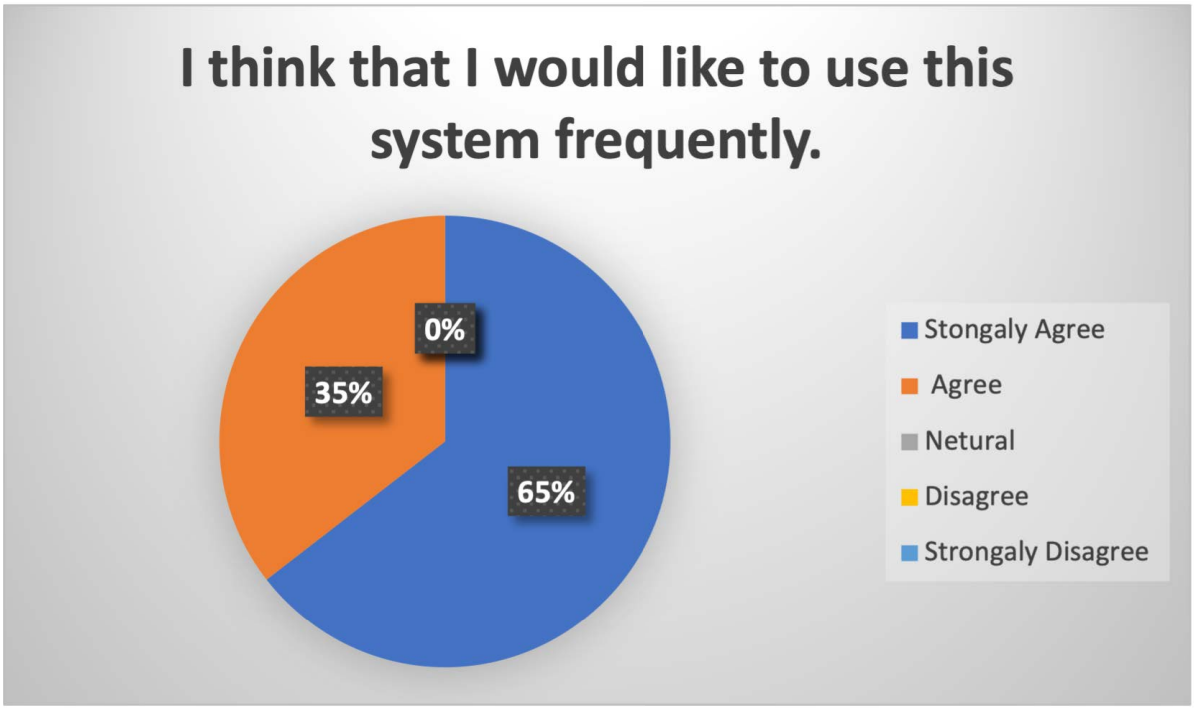
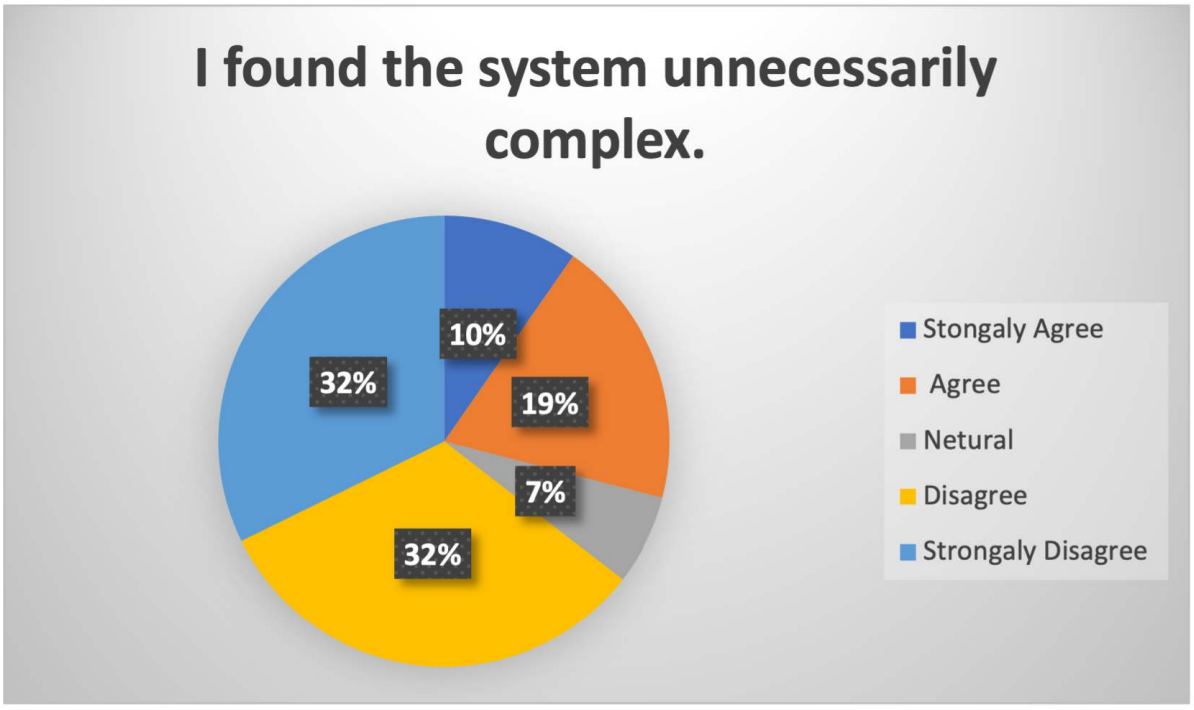


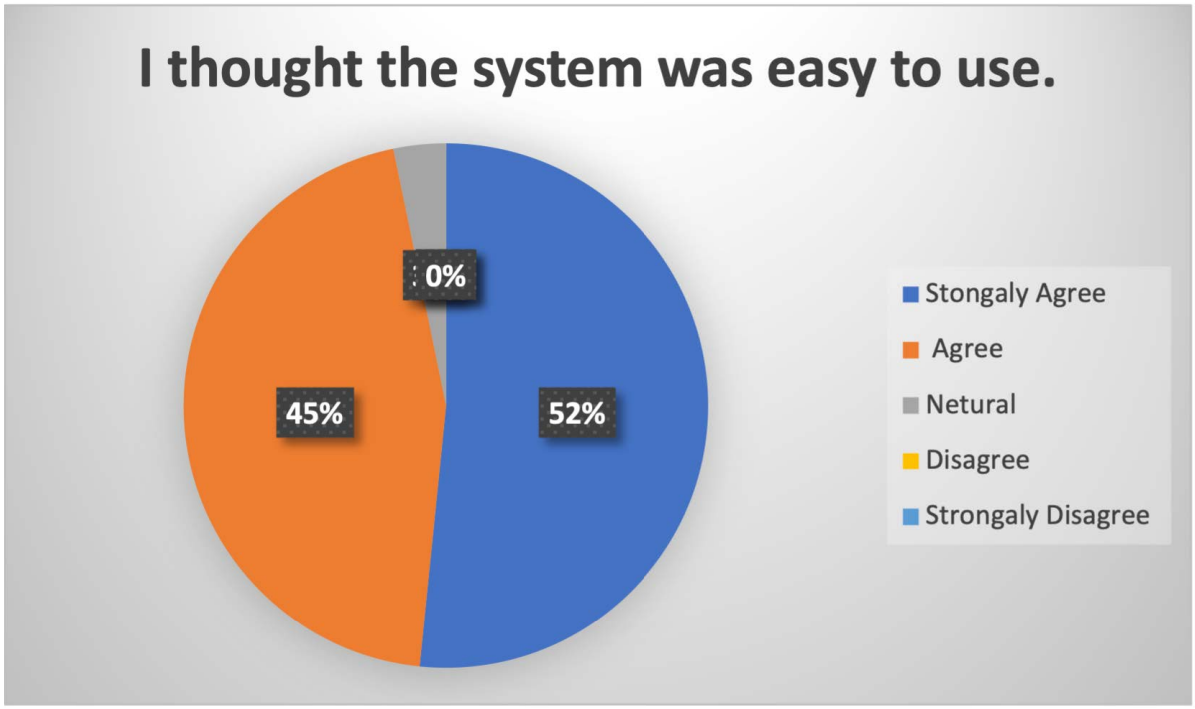
Figure 7.14: Level of enjoyment with the three media methods.

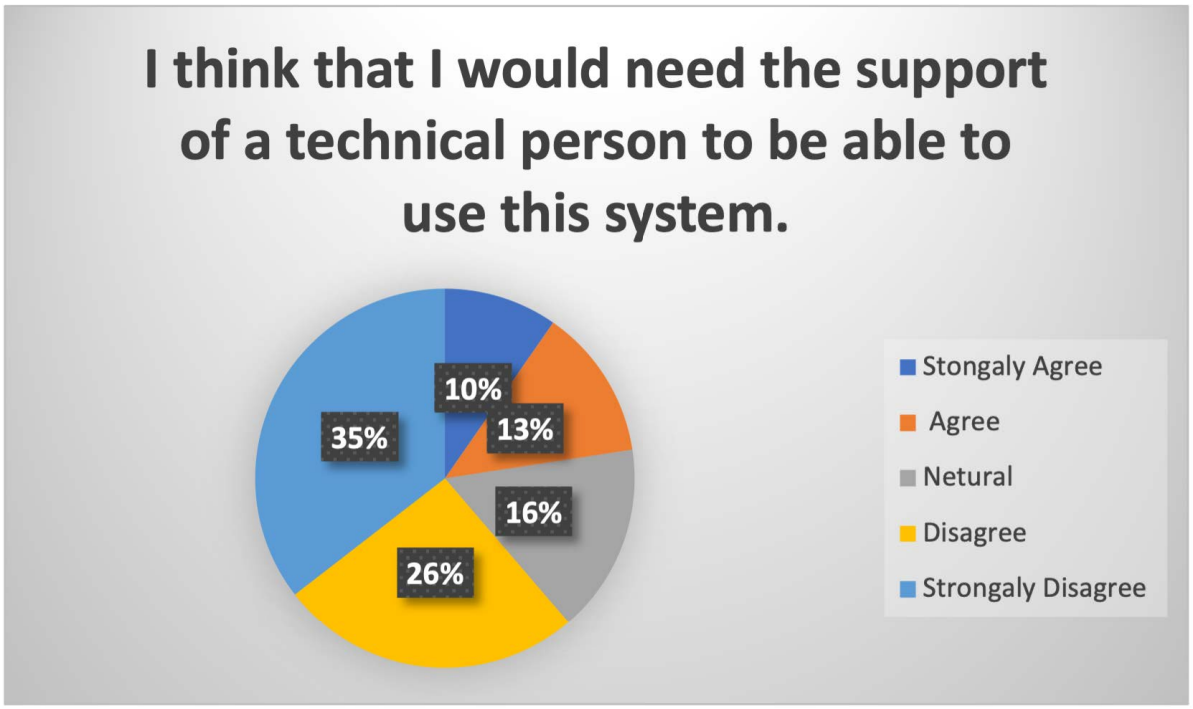
7.9.3 System and User Interface Feedback

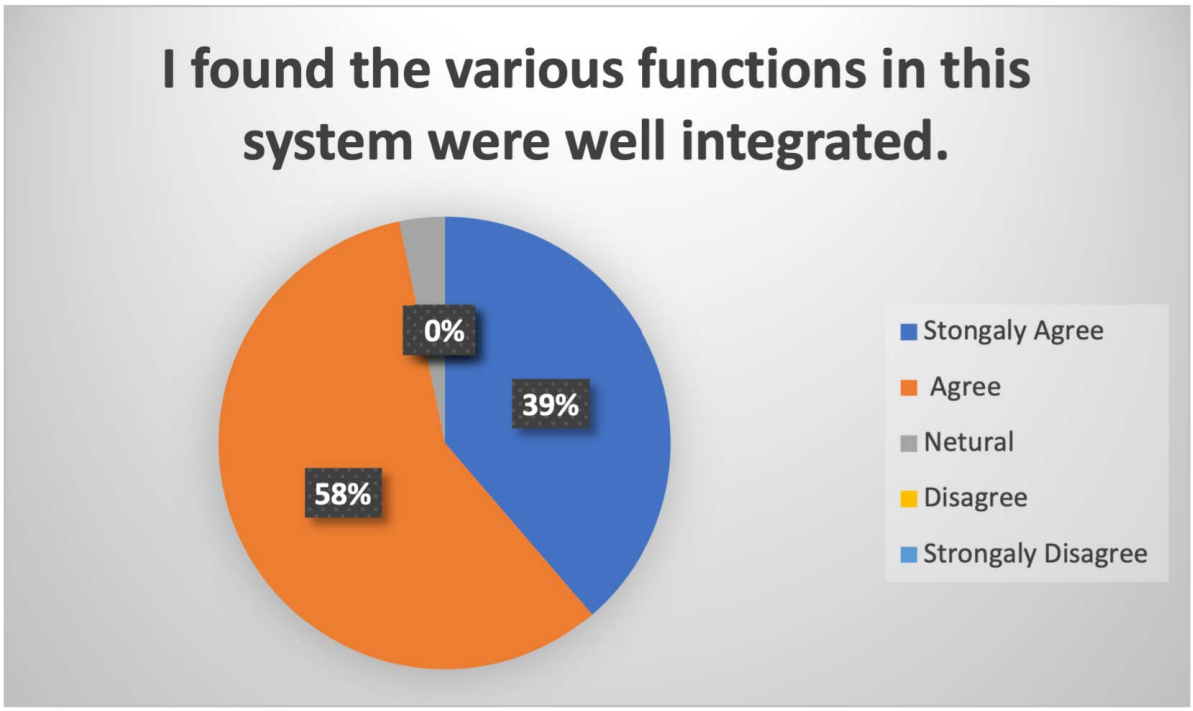


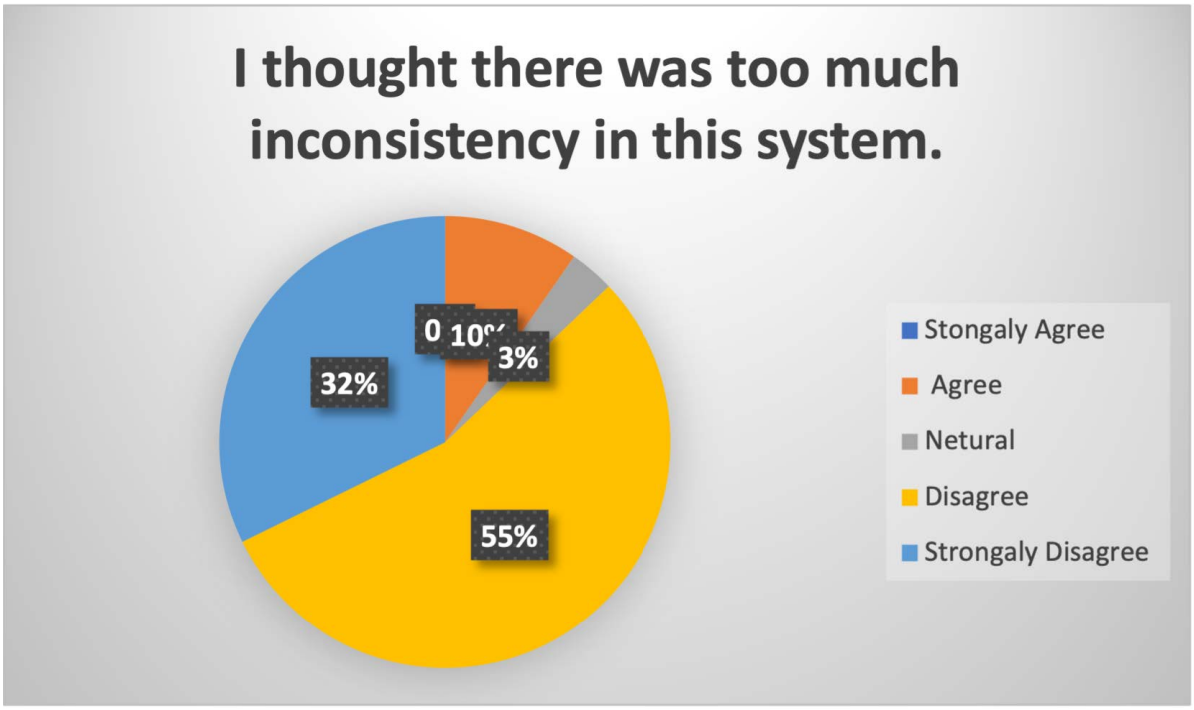


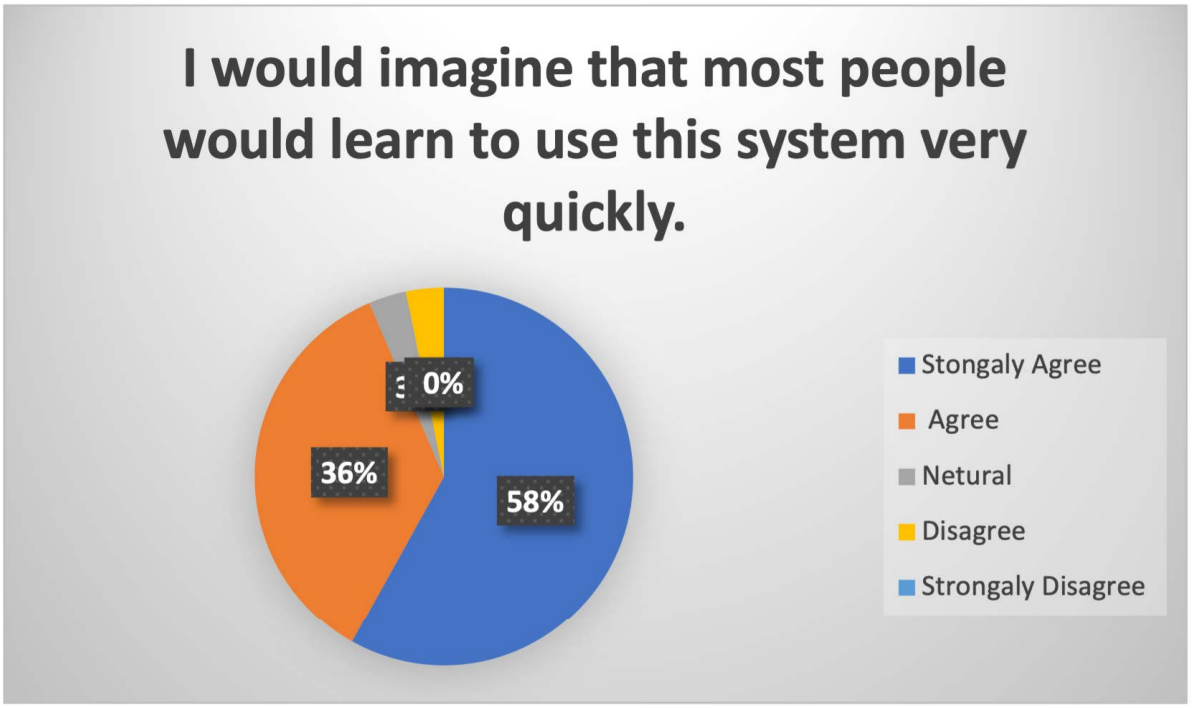
The results in this section are based on the surveys completed by the participants after they had tested the AR application. The aim of this survey is to collect user feedback based on the usability and accessibility of the AR application. All the data were analysed

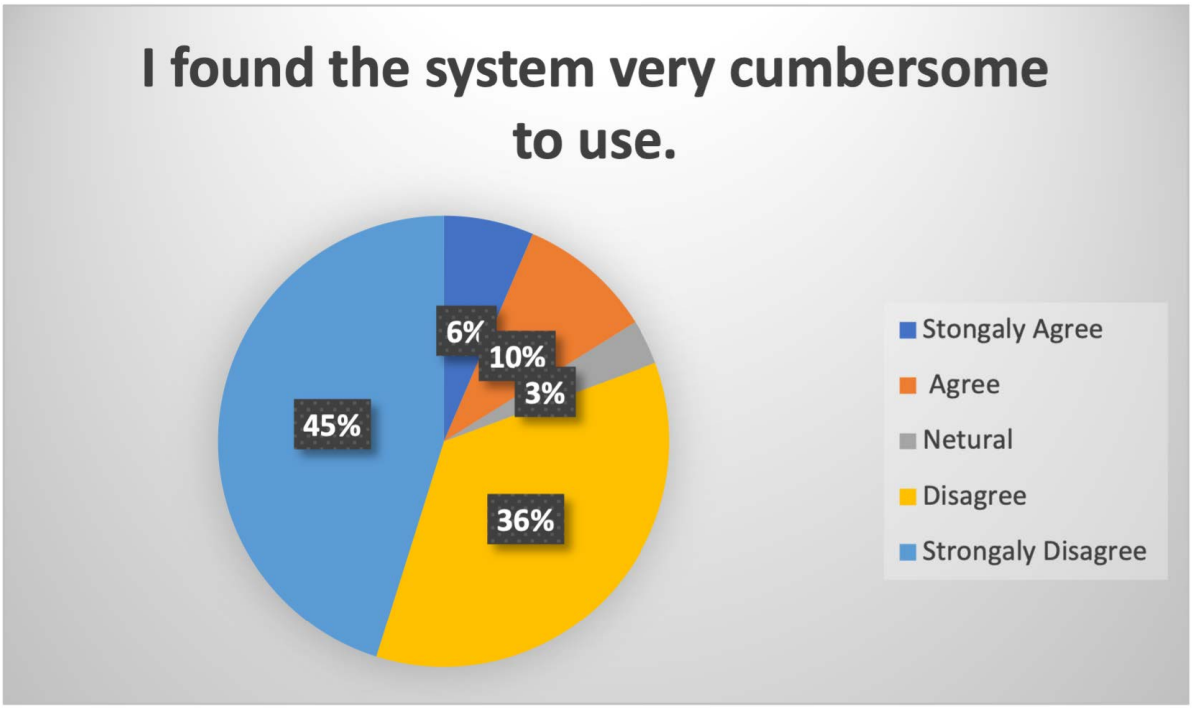

I thought the system was easy to use.
0%
45%
52%
Stongaly Agree
Agree
Netural
Disagree
Strongaly Disagree


I think that I would need the support of a technical person to be able to use this system.
10%
13%
35%
16%
26%
Stongaly Agree
Agree
Netural
Disagree
Strongaly Disagree


I found the various functions in this system were well integrated.
0%
39%
58%
Stongaly Agree
Agree
Netural
Disagree
Strongaly Disagree


I thought there was too much inconsistency in this system.
0
10%
3%
32%
55%
Stongaly Agree
Agree
Netural
Disagree
Strongaly Disagree


I would imagine that most people would learn to use this system very quickly.
0%
36%
58%
Stongaly Agree
Agree
Netural
Disagree
Strongaly Disagree


I found the system very cumbersome to use.
6%
10%
3%
45%
36%
Stongaly Agree
Agree
Netural
Disagree
Strongaly Disagree

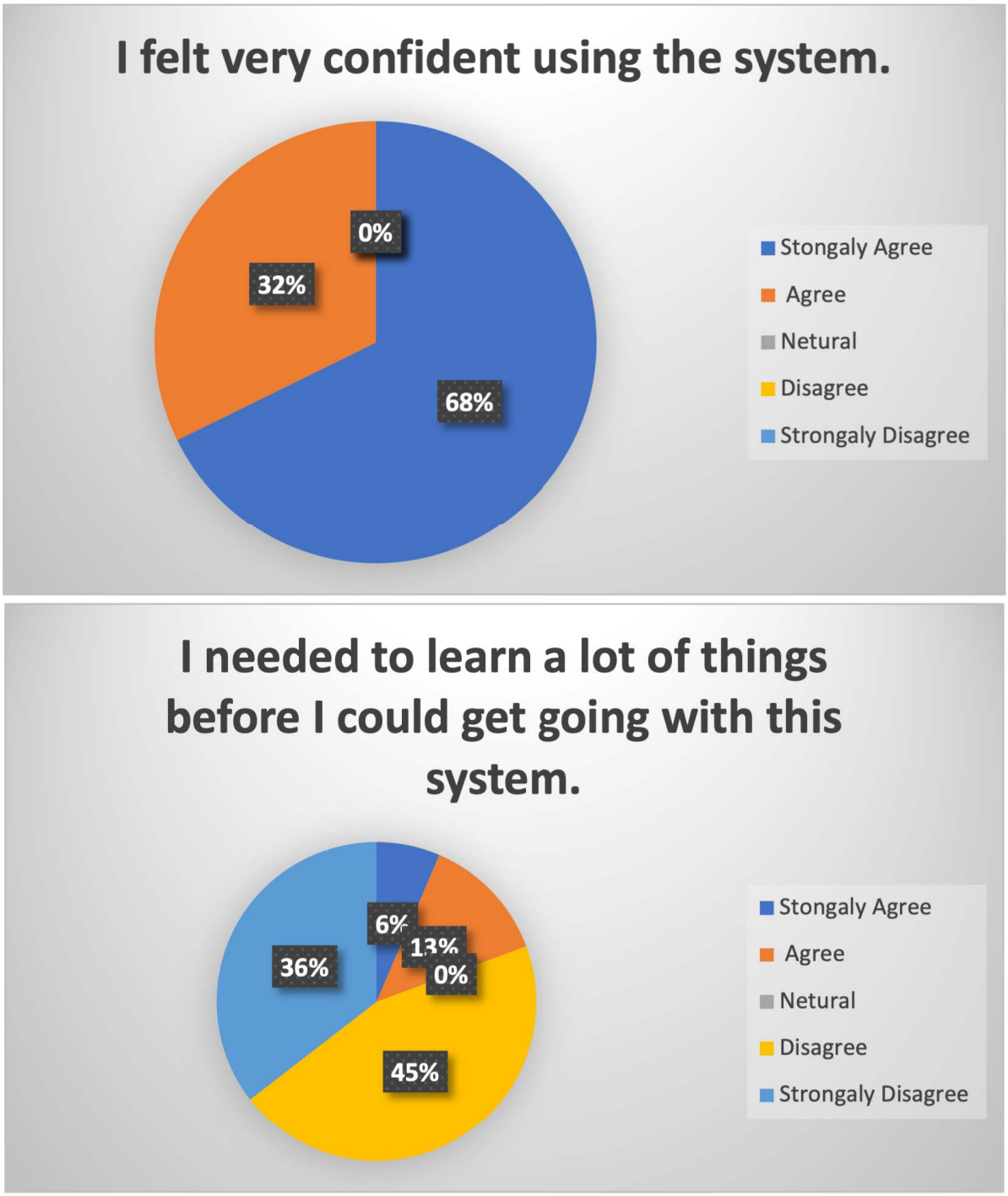


Figure 7.15: User feedback on the system

using Excel.

The results show that the participants gave positive feedback on the usability and accessibility of the system. 100% of the users either agreed or strongly agreed that they would use the system frequently, and 64% indicated that they didn't think the system is unnecessarily complex. 97% of the users thought the system was easy to use and 61% disagreed that they would need to support of a technical person to use the system. Moreover, 97% found that the various functions in the AR application were well integrated and 81% disagreed that there was too much inconsistency in the AR application. 94% imagined that most people would learn to use this system very quickly and 81% disagreed that they found the system cumbersome to use. Finally, the results show that 100% of the users felt very confident using the system and 81% disagreed that they need to learn a lot of things before they could get going with the AR application.

7.9.4 System engagement

This section reports on the engagement of the participant with the system when testing the AR application. The aim is to collect data on how many times the users utilized the particular media methods to explore the historical artifacts. All the data was analysed on Excel.

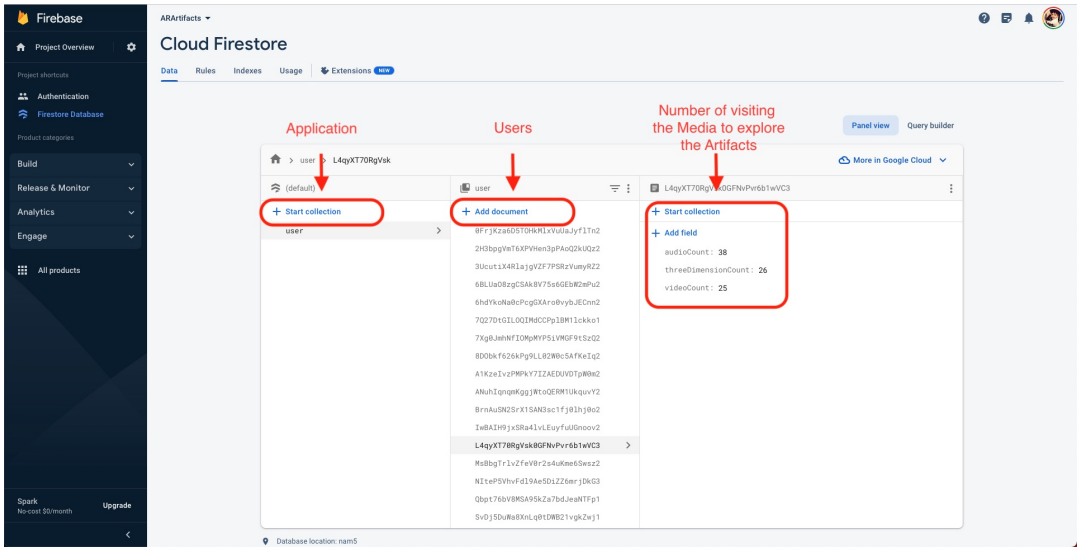


Figure 7.16: Interface of the Firestore Database

Users	3D Animation	Audio	2D Video
User 1	10	10	10
User 2	13	4	4
User 3	14	17	5
User 4	22	25	6
User 5	30	26	8
User 6	38	28	10
User 7	44	32	23
User 8	41	29	19
User 9	13	14	7
User 10	14	15	9
User 11	15	16	11
User 12	16	19	12
User 13	47	35	29
User 14	18	23	13
User 15	57	36	32
User 16	61	42	37
User 17	63	43	41
User 18	69	47	46
User 19	21	35	16
User 20	25	37	23
User 21	26	37	25
User 22	26	38	25
User 23	58	56	60
User 24	71	49	50
User 25	74	50	51
User 26	34	39	27
User 27	79	52	55
User 28	82	54	58
User 29	83	56	59
User 30	35	40	29
User 31	42	46	31
Average	40.03	33.87	26.81

Table 7.4: System Engagements: Number of time participants engagments in the Ststem.

The results show how many times the participants explored historical artifacts using a particular type of media in the AR application. We calculated the number of times the participants used a media type and then we calculated the average of the total users. The results show that the average engagement with the 3D media method was 40.03, followed by 33.87 for the audio media method and lastly 26.81 for the 2D media method. This indicates that the users were the most engaged with the 3D media methods, then with the audio and lastly with the 2D video.

7.10 Discussion

In this study, AR was used in museums to help users understand and engage with non-touchable artifacts. The critical media characteristics that influence the understanding of non-touchable artifacts in museums with the use of AR are discussed in depth in the following section.

Enhanced Understanding with Augmented Reality:

The study findings show that the users' understanding of historical artifacts is positively impacted by the use of AR technology in museums. Overall, the 31 participants expressed positive sentiments about the richness of the information provided, the usefulness of the AR application, and the ease of use (all 0.58), indicating that the artifacts were well understood. AR could enhance museum visits in terms of education and information, as these sentiments indicate.

User Engagement and Media Characteristics:

Curiosity and Imagination: The study found that users showed high levels of curiosity (0.57) when learning more about historical artifacts using the AR application. Users' interest and desire to explore more are stimulated by AR, as indicated by this finding.

Emotional Connection: Interacting with artifacts through the AR application resulted in positive sentiments among users (0.62). As a result, users will experience museum objects in a more engaging way when they use AR technology.

Opinion Influence: There was a positive effect on the users' opinions of the artifacts when the AR application was used (0.71). As a result, it can be concluded that AR is potentially capable of influencing users' perceptions and opinions of physical artifacts in a positive way.

Acceptance of AR: All the participants (31 out of 31) agreed that Saudi Arabian historical museums would benefit from using AR. AR is highly accepted (0.80) among museum visitors, indicating a willingness to embrace the technology as a valuable tool to enhance museum visits.

Preferred Media Methods: In this study, users tended to prefer 3D animation over 2D video and audio when engaging with historical artifacts. In addition, 3D animation is more helpful for enhancing engagement and understanding when combined with interactive and immersive media.

System and User Interface Feedback:

A crucial aspect of the discussion was the feedback received regarding the usability and accessibility of the AR system. Of those who agreed with the ease of use, simplicity, and lack of technical support, the high agreement percentage shows the importance of user-friendly AR applications for enhancing engagement and understanding.

System Engagement:

Compared to 2D audio and video, users interacted with 3D media methods more frequently. A 3D animation, for example, is more effective at engaging users when it is interactive and visually immersive.

7.11 Conclusion

As a result of this study, it is concluded that AR is beneficial in museum contexts to enhance the understanding and engagement of non-touchable artifacts. By providing more rich, more interactive, and more emotionally engaging experiences with historical objects, AR technology can revolutionize the museum experience through positive senti-

ments, high acceptance rates, and media preferences.

In addition, interactivity, immersion, emotional connection, and ease of use are important media characteristics that influence understanding and engagement in AR experiences. AR applications typically incorporate three-dimensional and interactive elements, with 3D animation emerging as the preferred media method.

Museum curators and designers are impacted significantly by these findings. By integrating AR technology with appropriate media characteristics, museum visitors can gain a deeper understanding of non-touchable artifacts as a result, resulting in a more enriching and educational experience for visitors. However, further research and development are needed to continue exploring the potential of AR in museum contexts and to refine the design of AR applications to maximize their educational and engagement potential.

CHAPTER 8

CONCLUSION AND FUTURE WORK

8.1 Introduction

Recently, tourism has become a digitized industry. This means that tourism is now employing technology to enhance tourists' experiences of locations. Technology that is used for digital tourism is referred to as augmented reality (AR). AR is a 2D media technology used in smartphone applications. This technology has been used in many sectors of the economy such as business, education, marketing, and tourism.

Tourists travel to different countries to learn about and understand the cultures that they are visiting and experiencing and visit attractions, also known as points of interest (POI). Most people gain a better understanding of a culture by visiting historical locations. Historical locations provide insight a country's development from the past to the present. Therefore most visitors tend to be very enthusiastic about visiting historical tourist attractions to understand the culture and how countries have developed. Each individual location has its own story to tell.

These historical locations usually hold many artifacts that generations of people from other cultures might not understand. Visitors to these locations usually want to understand the history of the buildings, people's lifestyles, and artifacts from centuries past. It is important for visitors to develop empathy for the culture they are experiencing.

They can obtain information by searching online, taking tour guides, or by reading information brochures, maps, etc. The motivation of this study is to use AR technology in heritage cultural sites specifically to deliver information about historical artifacts to visitors.

AR technology has been used in many countries in many different ways to enhance the tourism experience. Experiments were conducted with the users to evaluate the user experience and what the user understands when visiting and exploring historical sites and artifacts.

The only way visitors can obtain information about them is by reading the information plate normally located next to the artifacts. The use of AR can enhance the delivery of information on Saudi artifacts and make the experinece more interactive for users. Therefore, another motivation of this research is to deliver novel information on Saudi artifacts to visitors to Saudi Arabia specifically and to enhance the tourism context.

The research is conducted in three phases to achieve the aim and objectives of the research. Each phase solves a particular objective. The main objective of this research is to investigating the users' experiences and expectations when exploring artifacts in historical and general locations in Saudi Arabia and to determine whether the use of AR technology provides an enhanced understanding of the usage of historical artifacts and gives a richer historical context to Saudi visitors. The main objective was divided into the following sub-objectives:

1. To investigate user experiences and expectations when exploring artifacts in historical and other locations in Saudi Arabia.

2. To investigate the expectations of AR characteristics so that users can compare different characteristics to explore historical artifacts at a particular location in Saudi Arabia.

3. To investigate the designing acceptance of AR which can be used to enhance the understanding of non-touchable historical artifacts in Saudi Arabia.

The methodology used in this chapter is a hybrid of the quantitative and qualitative methods. Each chapter explains the methodology that was used to achieve each objective.

8.2 Problem Addressed in the Thesis

1. To investigate the use of augmented reality in the context of tourism in Saudi Arabia.

2. To investigate the use of augmented reality to evaluate the user experience in exploring historical museums in Saudi Arabia.

3. To investigate the use of augmented reality to evaluate the user experience in exploring historical artifacts in Saudi Arabian museums.

4. To investigate the use of augmented reality to deliver a better understanding of historical artifacts in Saudi Arabian museums.

8.3 Contributions of the Thesis to the Existing Literature

Chapter 5: To identify the Saudi Arabian perspective on using augmented reality

Methodology: To achieve this objective, the researcher developed an AR application to investigate the user experience to deliver a better experience where users can live the experience when visiting a historical site. This phase of the study uses qualitative data. According to Rohrer [99], qualitative approaches are a better way to address the questions of 'why', 'what', and 'how'.

Results: The research findings of this phase show that users agree that using AR in a historical area to investigate artifacts is a superior technique. This is because AR can offer the user a video to explore the historical relic more easily. The research also shows that users like to utilize video material as a narrative tool to present a brief story about the history behind the artefacts. Therefore, the research has achieved the aims by finding that AR adds to the user experience in historical locations by providing a short story of the history behind the artifacts. This positively affected the experience of the user in understanding the artifact.

Chapter 6: To identify the Visibility of augmented reality media to explore Saudi Arabian historical artifacts.
Methodology: This chapter discusses the methodology used to predict the expectations stage of the media method content that users desire to use in the AR application when exploring artifacts before designing the application. To achieve this objective, the researcher uses a qualitative study, the reason being that this study was conducted during COVID-19. The restrictions during the pandemic did not allow any face-to-face interviews. Therefore, we had to change the method in this study to a survey instead of an interview.

Result: The results indicate that users tend to prefer information on the use of artifacts rather than information on an artifact's material composition. This insight can guide how information on historical artifacts is presented in various contexts, for example, information on the use of the Mebkhara and its functional significance should be a higher priority than providing information on its material composition .

Furthermore, in the context of AR, 3D animation provides clear information about the use of the Mebkhara in an effective manner. Nonetheless, a comprehensive educational approach can integrate multiple media methods to meet a wide range of learning styles and preferences, ensuring an engaging, well-rounded learning experience.

Also, this study concludes that 3D animation offers users a more engaging and effective way to explore historical artifacts than other media. Immersive, dynamic, and multi-sensory experiences seem to be more preferred, engaging, comfortable, and enjoyable. The findings suggest that technology can enhance our interaction with and learning from historical artifacts, enriching and democratizing the experience.

Finally, of the available media methods for exploring historical artifacts, 3D animation is the preferred and most recommended method, followed by 2D Video. To convey historical context effectively, visual engagement and interactivity are essential. Nevertheless, the study emphasizes the value of traditional methods such as reading signs and catering to diverse user preferences.

Chapter 7: To examine the use of Augmented Reality in the Culture of Saudi Arabia.

Methodology: This chapter details the development of an AR application with different characteristics to investigate the user experience when exploring non-touchable historical artifacts in historical sites. This phase of the study uses a qualitative data collection method. According to Rohrer [99], qualitative approaches are a better way to address the questions of 'why', 'what', and 'how'.

Result: The results of this study show that the use of AR in museum contexts enhances the users' understanding of and engagement with non-touchable artifacts. By providing more rich, more interactive and more emotionally engaging experiences with historical objects, AR technology can revolutionize the museum experience through positive sentiments, high acceptance rates, and media preferences.

In addition, interactivity, immersion, emotional connection, and ease of use are important media characteristics that influence the understanding of and engagement with AR experiences. AR applications typically incorporate three-dimensional and interactive elements, with 3D animation emerging as the preferred media method.

Museum curators and designers are impacted significantly by these findings. By integrating AR technology with appropriate media characteristics, museum visitors can gain a deeper understanding of non-touchable artifacts as a result, resulting in a more enriching educational experience for visitors. However, further research and development are needed to continue exploring the potential of AR in museum contexts and to refine the design of AR applications to maximize their educational and engagement potential.

8.4 Limitations

COVID-19

The COVID pandemic restrictions had a negative impact on phase two and phase three of this research. In phase two, we had to change the methodology from interviews to surveys as the COVID-19 restrictions did not to allow face-to-face communications to be conducted. Other impacts involved persuading the participant to complete the survey

during the stay-at-home restrictions. Another impact on phase two of the study pertained to the data collection process. Because of border closures due to COVID-19, it was not possible for the researcher to travel to Saudi Arabia to collect the data from Saudi museums.

System Limitations

The development of the system in phase one of the study has several issues. The system was developed using Unity 3D. The system was uncoded but the issue that we had was that after each iOS update, the application had to be downloaded again. After the study data had been collected, there was an iOS update that removed the application permanently and it was not possible to download it again. In Phase 3 of the study, the application was coded but there was another issue with the system had after the XCODE software had been updated, namely I had to download the application from the Testflight web site.

Participants Selection

We had problem in selecting participants for our study based on using only Saudi participant in phase tow study and phase three. Phase two study we asked participants to involve in survey by send them the link. However, working remotely from other country was critical as we couldnt find more than 100 participant. In other hand, in phase three study we asked the Saudi international student to etend but the critical problem we phased is that they was busy working on their own study. Means, we had problem in arranging them to participate in the study.

8.5 Future work

1. ***Age Preference Dimension:*** In this research, we did not take into account the age of the participants. It is quite possible that the preferences may vary from one generation to another. Means, people in their 60s may be different from people in their 30s, who may be different from millennials. That analysis needs much further investigation and analysis, which we intend to do in the future.

2. ***Roadmap for Digitisation of Saudi Artifacts:*** This study outlines the importance of AR in the context of Saudi artefacts. and hence it provides a compelling case for the Saudi museums to digitise their artefacts so that end users can have a better experience.

3. ***Deploying the solution in Saudi Arabian museums:*** To ensure that every visitors will be using this technology to explore the historical artifacts, the researcher will develop the technology using Android platform so that users using ether iOS or Android will be able to explore the historical artifacts using AR technology.

4. ***Deploying Android Platform:***

5. ***To develop an augmented reality gaming application for use in Saudi Arabian Museums:*** Our future research will be to develop an augmented reality gamification application that will take the tourist through historical locations by asking them to play a game. The aim of this is to develop a better way for tourists to understand historical locations in Saudi Arabia by providing them with various entertaining historical games.

6. ***To develop a platform to explore historical artifacts virtually from home:*** During the COVID-19 pandemic, many activities had to be done online. This includes exploring historical artifacts virtually from home. The first aim is to help users develop an understanding of historical artifacts without the need to visit historical locations during lock down. The second aim is to help users understand the significance of historical artifacts in different countries without the need to travel to these places.Lastly, this will help visitors to be enthusiastic about exploring more historical artifacts.

7. ***Consider Disabilities limitation:*** During the research, several concerns were raised about catering for those with a disability. To address these concerns, future research will explore the use of AR to cater for those with a disability to enable them to explore historical locations and artifacts.

APPENDIX

The appendix includes:

- Ethical Approval for Phase 1 Study.
- Ethical Approval for Phase 2 and 3 Study.
- Phase 2 Survey.
- Phase 3 Registration Questionnaire.
- Phase 3 Survey.
- Phase 3 Participant Information Sheet and Consent Form.

A.0.1 Ethical Approval for Phase 1 Study

UTS Creativity and Cognition Studios
2-page Ethics Approval Application
From: *Dr.Sam Ferguson and Rayed Alakhtar*

Project Number 2019-* HREC 2013000135

1. Title

Using Augmented Reality in Tourism Contexts.

2. Aims

1. To find what augmented reality experience will add to the experience of these artifacts
2. To find out how AR technologies affect the experience of understanding artifacts in general

3. Methodology

The users will use an IOS ARKit software application to test a prototype Augmented reality experience of several historical artefacts and places. Following this, the user will be interviewed. The user will be audio recorded during this experiment and video recorded for further investigation. For this experiment, I will be using NVIVO for analysis of the transcript of the audio recording, and video-cued recall for the video recording.

4. Significance

The evaluation of prospective tourist expectations will provide an understanding of the problems and opportunities of how audiences expect to interact with augmented reality in tourism contexts, including but not limited to within historic sites.

5. Number of participants and justification of numbers

Between 24 – 32 participants. This number of users is suitable for the pre-test study to examine user expectations and experiences of the augmented reality prototype.

6. Selection/exclusion criteria

My study sample has to include to group of people who are familiar and NOT familiar with the area and culture of the western coast of Saudi Arabia "Old Jeddah city". Therefore, I will ask kindly ask some FEIT HDR student to participate in the evaluation. Some of the students will be Saudi residents, while others will not be residents of Saudi Arabia.

7. Children under 18 years of age will participate in the evaluation.

NO.

8. Procedures

Participants will be contacted through the mailing list. The participant who will response to my mail will be given a particular time and location of the experiment. After the agreement, the participant will participate in the study.

The participants will be divided in four different group as the following:

1. Treatment1: group of 6 participants who are familiar with the artifacts will participate with IOS device
2. Treatment 2: a group of 6 participants who are NOT familiar with the artifacts will participate with IOS device
3. Treatment 3: a group of 6 participants who are familiar with the artifacts will participate without IOS device
4. Treatment 4: a group of 6 participants who are NOT familiar with the artifacts will participate without IOS device

These participants will be divided into groups based on the screening questions.

After dividing and during the Study:

1. The participant will be given the consent form to sign
2. The participant will be giving an IOS device to test the prototype
3. The participant will be interviewed.

And last, the participants will be thanked for their participation.

9. Time commitment for participants

The total time of the experiment will be between 50-60 minutes/per participant.

Part1: Introducing the Project.
In order to initial the experiment, the project will be introduced. Then, the participant will be requested to sign the consent form. This process will take approximately **15 minutes**.

Part 2: The Experiment:
There will be 5 artifacts in the experiments. Each artifact will take proximity 2 minutes. So, the total time will be around 10 minutes.
5*2=10 minutes

Part 3: The Interview:
First, brief discussion about the project before conducting the interview (3 minutes). Second, the interview will include 16 questions. The average of each question will be 2 minutes.
3+32= 35 minutes

for a **total of 60 minutes.**

UTS Creativity & Cognition Studios, 2-page Ethics Approval Application, (Appendix A) last updated: January 2016

10. Location of research

Building 11 University of Technology Sydney
81 Broadway, Ultimo NSW 2007

11. Consent procedures

Signed consent sheet (see attached).

12. Additional Risks (additional to those noted in the CCS Generic Approval)

None.

13. Strategies to cope with risks mentioned in 12.

None.

14. Funding source(s) & potential conflicts of interest

Saudi Arabia Culture Mission is funding my PhD research scholarship.

15. Strategies to cope with any conflicts of interest identified in 14.

Not applicable.

15. Other issues

No other issues perceived as being problematic.

*Number obtained from CCS Ethics Administrator prior to completing form.

A.0.2 Ethical Approval for Phase 2 and 3 Study

ResearchMaster

Human Ethics Application

Application ID :	ETH19-4473
Application Title :	Using Augmented Reality to Explore Museum Artefacts
Date of Submission :	13/01/2020
Primary Investigator :	Dr Sam John Ferguson (Chief Investigator)
Other Personnel :	Mr Rayed Alakhtar (Chief Investigator)
	Muhammed Binsawad (Partner Investigator)
	Mrs Huda Alsobhi (Partner Investigator)

Section 1: Ethics Portal

Select your application type

What type of application are you looking for?
Please **do not** change your application type without first consulting with the Ethics Secretariat (9514 9772).*

- (•) New application (including scope-checking for nil/negligible risk research)
- ( ) Ratification of existing approval
- ( ) Transfer of existing approval
- ( ) Evaluation of teaching and learning activities
- ( ) Amendment to existing approval
- ( ) Program approval

You have selected "new application (including scope checking for nil/negligible risk research)". This option allows you to create a new form. The system will check if your application can be approved by the Faculty or whether it requires full ethics approval by the HREC. Please click "save" before continuing.

What should I know before I start?

Would you like more information on:

- ( ) This system
- (•) The ethics process
- ( ) Purpose of the ethics review process

The ethics process

This form has a risk assessment which will help decide whether your research is nil/negligible risk or whether you will need to complete a full ethics application form. If you are unsure how to answer these questions or disagree with the outcome you can contact us by phone (02) 9514 9772 or by email the Ethics Secretariat.

Staff applications: If your research is nil/negligible risk, you will receive an email after submitting this form which will confirm this. If your research is low or high risk, it will be submitted automatically to your local research office after you click on Submit.

Student applications: Your application will first be reviewed by your supervisor. If your research is nil/negligible risk, you will receive an email after your supervisor has endorsed the application. If your research is low or high risk, it will be submitted automatically to your local research office after your supervisor has endorsed your application online.

For more information, go to Staff Connect.

What you should read when completing this form
This form should be read in conjunction with the relevant University policies and guidelines, the National Statement on Ethical Conduct in Research Involving Humans (PDF, 652Kb) and the Australian Code for the Responsible Conduct of Research (2007) (PDF, 829Kb).

Section 1A: Risk evaluation

Risk A

Determining the level of risk

For assistance with answering these questions please refer to the National Statement on Ethical Conduct in Human Research as per the chapters listed below.

You can save your application at any time by clicking on the save button on the left hand side in the toolbar. For further information and help in completing your application go to Staff Connect.

Please answer each question carefully **and consecutively**.

If you need to contact the Research Ethics Officer you can call (02) 9514 9772

Does your research involve:

Projects involving covert observation, active concealment, or planned deception of participants

e.g. covert observation of the hand-washing behaviour of hospital employees, undisclosed role-playing by a researcher, etc. Does NOT include observation in a public place WITHOUT the use of photographs, images, video or audio footage (Chapter 2.3, p.19)

*

- ( ) Yes
- (•) No

Targeted recruitment or analysis of data from any of the vulnerable groups listed below (or where any of these vulnerable groups are likely to be significantly over-represented in the group being studied)

- Women who are pregnant and the human fetus (Chapter 4.1, p. 61)
- Children and young people (under 18 years) (Chapter 4.2, p. 65)
- People in dependent or unequal relationships (e.g. lecturer/student [except T&L], doctor/patient, employer/employee) (Chapter 4.3, p.68)
- People highly dependent on medical care who may be unable to give consent Chapter 4.4, p.68)
- People with a cognitive impairment, an intellectual disability, or a mental illness (may include the disadvantaged/homeless) (Chapter 4.5, p. 70)
- People who may be involved in illegal activities (including those affected e.g. victims of domestic violence) (Chapter 4.6, p.73)
- Aboriginal and Torres Strait Islander Peoples (Chapter 4.7, p.77)

*

○ Yes
◉ No

People in / from countries that are politically unstable; where human rights are restricted; and/or where the research involves economically disadvantaged, exploited or marginalised participants from such countries e.g. includes countries that score <50 on the Transparency Index

*

◉ Yes
○ No

Collection, use or disclosure of personal information WITHOUT consent of the participant

- **Name, address and other details about the participant (e.g. date of birth, financial information etc.)**
- **Photographs, images, video or audio footage**
- **Fingerprints**

*

○ Yes
◉ No

Collection, use or disclosure of health information

- Personal information (as defined above) collected to provide, or in providing, a health service (e.g. admission to hospital, GP visit, pathology, pharmacy etc.)
- Information or an opinion about:

  (i) the health or a disability (at any time) of an individual; or
  (ii) an individual's expressed wishes about the future provision of health services to him
  (iii) a health service provided, or to be provided, to an individual

- Personal information about organ donation
- Genetic information about an individual or the individual's relatives

*

○ Yes
◉ No

Collection, use or disclosure of sensitive information

Racial, ethnic information, political, religious and philosophical beliefs, sexual activity or identity, and trade union membership

*

○ Yes
◉ No

Activity that potentially infringes the privacy or professional reputation of participants, providers or organisations

e.g. observation in the workplace, collection of commercially confidential information, etc.
Commercially confidential information = Any information which is not in the public domain or publicly available, and where disclosure may undermine the economic interest or competitive position of the owner of the information (TGA adopted definition from European Medicines Agency (EMA)).

N.B. if canvassing opinion via consensus methods i.e. Delphi (?), answer "No" here

*

○ Yes
◉ No

Establishment of a register or databank of identifiable information for possible use in future research projects (Chapter 3.1, Element 4, pp.32-38)

*

○ Yes
◉ No

Collection, transfer and/or banking of human biospecimens.
e.g. tissue, blood, urine, sputum etc.

*

○ Yes
◉ No

Any significant alteration to routine care or service provided to participants

e.g. deviation from standard care or usual practice

*

○ Yes
◉ No

Prospective assignment of human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes (Chapter 3.14-3.17)

WHO definition of a Clinical Trial

*

○ Yes
◉ No

Potential for participants to experience harm

e.g. physical, psychological, social, economic and/or legal (Chapter 2.1, p.12)

*

○ Yes
◉ No

This question is not answered.

Section 2: Project information

Project title

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

When you use special characters in the application form, the application can crash. To avoid this, it is strongly recommended that you do not copy and paste from a Word document or PDF into your online application form as some characters can be hidden

Application ID (automatically generated):

ETH19-4473

Application Title:*

Using Augmented Reality to Explore Museum Artefacts

Please note that the HREC is now granting a standard approval period for the research proposals.
The approval period for your project will be specified in your approval letter.
Please also note that research should not commence until ethics approval has been granted. The Committee cannot grant retrospective approval for data that has already been collected.

Ethics category code (automatically selected):*

Human

Is this a resubmission of a previous application?*

○ Yes
◉ No

Is this a pilot study? *

○ Yes
◉ No

Has a pilot study been conducted as part of this project? *

○ Yes
◉ No

Please save and continue to the next page

Consultation

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Have you undertaken any consultation in preparing this application?*

- (•) Yes
- ( ) No

Please describe (1500 character limit)*

We have consulted Racheal Laugery (Senior Research Ethics Officer)
We have consulted Dr. Kirk (Research Ethics Officer)
We have consulted with the PhD committee.

Please save and continue to the next page

Section 3: Personnel

Investigators

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Are there external investigators or personnel listed on this protocol?*

- ( ) Yes
- (•) No

Is this application for a student project?*

- (•) Yes
- ( ) No

Students - Please note that once you submit your application is submitted it will go directly to your supervisor and not to the Committee. Once your supervisor endorses your application it will come to the Research Ethics Officer for review. Please hold off on printing your hardcopy until you have received feedback from the Research Ethics Officer. Your electronic application must be submitted by the closing date.

Personnel Table

Position type	In the personnel table use the following positions from the drop-down list
Chief Investigator	1Chief Investigator
Co Investigator	3Assoc. Investigator
Supervisor	1Chief Investigator
Co Supervisor	Co-Supervisor
Research Student	5Research Student

Further options are available for Research/Project Managers and Administrators.
The main contact should be marked as 'primary' and should be a UTS staff member.
Please click on 'More Criteria' located on the top right hand side of the table to find personnel.

If any details are incorrect or missing please contact the Ethics Secretariat on (02) 9514 9772 or by email.

Instructions on how to add a person to the personnel table:
1. Click on 'More criteria' which is located on the top right hand corner of the table below
2. Enter the surname (and given name if the surname is common) in the fields marked 'Surname' and 'Given name' and click 'Search'
If the system cannot find the person you are looking for you have the option of adding them in - just click "Ok" when the pop-up window shows.
3. Click on the name of the person you wish to add
4. If they are the primary contact (e.g. Chief Investigator/Supervisor), tick "Yes" under 'Primary contact'
5. Select the position from the drop-down list (e.g. Chief Investigator/Research Student)
6. Click on the green tick

Students must add their supervisors to their application and must
mark their primary supervisor as a Chief Investigator and as a primary contact.
Students should be listed as "5Research student"

Internal personnel listed on this ethics protocol:
*

1	Primary	No
	ID	[redacted]
	Surname	Alakhtar
	Given Name	Rayed
	Full Name	Mr Rayed Alakhtar
	Position	Chief Investigator
	Type	Student
	AOU	FEIT.Faculty of Engineering & Information Technology
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Rayed.Alakhtar@student.uts.edu.au
	Work Number	
2	Primary	No
	ID	[redacted]
	Surname	Binsawad
	Given Name	Muhammed
	Full Name	Muhammed Binsawad
	Position	Partner Investigator
	Type	External
	AOU	
	Managing Unit	
	Email Address	mbinsawad@kau.edu.sa
	Work Number	
3	Primary	No
	ID	[redacted]
	Surname	Alsobhi
	Given Name	Huda
	Full Name	Mrs Huda Alsobhi
	Position	Partner Investigator
	Type	International
	AOU	FEIT.School of Computer Science
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Hada.Alsobhi@student.uts.edu.au
	Work Number	
4	Primary	Yes
	ID	[redacted]
	Surname	Ferguson
	Given Name	Sam
	Full Name	Dr Sam John Ferguson
	Position	Chief Investigator
	Type	Internal
	AOU	FEIT.School of Computer Science
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Samuel.Ferguson@uts.edu.au
	Work Number	4682

If you cannot find a person through the personnel table(s) above, please enter their details here (title, name, organisation, department, phone number, address, email address and their position on this protocol). (2000 character limit)

This question is not answered.

Please provide additional (or preferred) contact details of any of the people listed on the project if necessary (2000 character limit)

Dr Sam Ferguson (Chief Investegator)
Phone: +61 2 95144682
Email: Samuel.Ferguson@uts.edu.au

Rayed Alakhtar (Research Student)
Phone:
Email: rayed.alakhtar@student.uts.edu.au

Please provide details of any formal qualifications (REF NS 1.1(e)) of each person listed on the project
(2000 character limit)*

Dr Sam Ferguson (Chief Investegator)
B.Mus, M. Des. Sci (Hons) (Audio), PhD
Phone: +61 2 95144682
Email: Samuel.Ferguson@uts.edu.au

Rayed Alakhtar (Research Student)
BSc (Computer Science), MSc (Information Technology)
Phone:
Email: rayed.alakhtar@student.uts.edu.au

Please outline the experience of each person listed on this project relevant to this application
(2000 character limit)*

Sam Ferguson is a musician, researcher and programmer who is a lecturer at the University of Technology, Sydney. His research focus is to understand the relationship between, and the effects of, sound and music on human beings. He has around 40 publications in areas as diverse as spatial hearing and loudness research, to data sonification, emotion, and tabletop computing. He has been a research fellow or assistant on more than 6 ARC research projects, and continues to maintain several open source code projects. He has taught numerous subjects at the postgraduate and undergraduate level at the University of Technology, Sydney, the University of Sydney and UWS, and currently is a lecturer at UTS in the Faculty of Engineering and IT.

Rayed Alakhtar is a research student in School of Computer Science at Faculty of Information Technology at the University of Technology. Rayed got his bachelor's degree from Taif University, Saudi Arabia then he got a scholarship from King Abdulaziz University to pursue his master's degree in Applied Information Technology from RIT, US. Rayed currently is an academic lecturer at Information Technology Department, Faculty of Computing and Information Technology, King Abdulaziz University, Saudi Arabia.

Primary AOU*

FEIT.Faculty of Engineering & Information Technology

Managing Unit

Faculty of Engineering & Information Technology

Please save and continue to the next page

Student details

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Degree being undertaken (500 character limit)*

PhD Degree

Have you been successful in your doctoral/masters assessment? *

- (•) Yes
- ( ) No

Please make sure you attach a copy of your DA/Stage one confirmation in the attachments section.

Students, please read carefully: Your application should be reviewed by the Ethics Secretariat prior to submitting to the Committee. Once you have completed this application and followed the submission instructions, your application will go to your supervisor for review. Once your supervisor has endorsed the application it will come to the Ethics Secretariat for a pre-review. This pre-review process is necessary to ensure that your application is complete, has all necessary attachments, and that the quality of responses to the questions meets the Committee¿s expectations. Your application should therefore be submitted at least one week prior to the closing date. If you do not submit your application in time, it may be delayed and held off until the next closing date.

Section 4: Funding

Funding details

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Have you received funding in relation to this research?*

- (●) Yes
- ( ) No

Do you have a RM Project ID number?*

- ( ) Yes
- (●) No

List the source of funding (e.g. funding body / type)
(REF NS Page 8 "When is ethical review needed?", 2.2.6(h), 3.3.5(a), 3.3.18(b), 4.8.6, 5.2.7, and 5.7)
(2000 character limit)*

Saudi Arabia Culture Mission is funding my PhD research scholarship and they will also fund my data collection expenses

Total amount of funding obtained, including in-kind contribution (please indicate which is applicable)
(1500 character limit):*

Saudi Arabia Culture Mission will purchase the flight tickets.
Saudi Arabia Culture Mission will pay one-month extra salary for each month (Max 3 month)

What is your relationship to the funding source? (e.g. grant recipient, industry partner, contractor, employee, office-bearer, personal, other) (1500 character limit)*

Saudi Arabia Culture Mission is the responsible organization of my scholarship

Please save and continue to the next page

Funding continued

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Is there any potential conflict of interest for you as a researcher because of the funding or commercial arrangements?*

- ( ) Yes
- (●) No

Are there any constraints on the research as a result of the funding arrangements, e.g. to intellectual property, publication, etc? (Section 4, The Code)*

- ( ) Yes
- (●) No

Please save and continue to the next page

Section 5: Methodology

Description

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

The purpose of this section is to place your research in context for the HREC and demonstrate your ability to conduct the research. The HREC may only approve research which is methodologically sound. Remember to use simple language that can be understood by people from a variety of backgrounds. Avoid jargon and acronyms.

What are the hypotheses/goals/aims/objectives of your research? Please include a brief description using plain English explaining your research aims (approximately 100 words) (1500 character limit)*

a) To find how the technology of Augmented Reality affects people's experience of understanding artifacts.
b) To find how the technology of Augmented Reality affects people's experience of engaging with artifacts.
c) To find how the technology of Augmented Reality affects people's feelings about the artifacts.

Note: Clinical Trials, Recruitment of Participants and Data Collection are dealt with later so you will not need to describe them in detail below

Please provide a brief description of the research design including research questions and proposed methods for conducting the research (approximately 250 words) (1500 character limit)*

My research questions:
1. Does Augmented Reality enhance the tourist experience when visiting historical or significant locations and sites?
2. Does Augmented Reality provide an enhanced understanding of historical or significant locations and sites, and what are the critical components that influence that understanding?
3. Does Augmented Reality provide an enhanced understanding of artifacts in historical or significant locations and sites, and what are the critical components that influence that understanding?

The proposed research design:
1 Exploratory Survey:
2 Exploratory Interview study:
3 Saudi Interview Study:
4 Designing an Augmented Reality User Interface:
5 Re-test the UI/Saudi:

What do you hope the outcome(s) of this research will be? (1500 character limit)*

By the end of this research, i hope my outcome will be a theoretical finding and a solid development application for the General Entertainment Authority, Saudi Arabia.

Who do you think will benefit from this research? (1500 character limit)*

This research will benifit:
1. the current investigator to conduct more research in the field of Augmented Reality in exploring the Saudi Arabia Tourism
2. King Abdulaziz University by resing the Scientific Research at the university
3. General Entertainment Athority, Saudi Arabia.
4. Historical Location and sits in Saudi Arabia.

Please provide a brief description of the significance of your research (approximately 100 words)
(1500 character limit)*

1. The first research review on users' understanding of artifacts at historical locations.
2. The first study to develop an AR technology to explore the artifacts at historical locations in Saudi Arabia.
3. The first research that proposed using AR to help visitors understand the artifacts at historical locations in Saudi Arabia.
4. Digitalizing and visualizing the artifacts in Saudi museums will increase the number of visitors to them.
5. , Saudi museums will be encouraged to digitalize aspects of their locations and the artifacts within them.

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Literature review & references

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Please do not include special characters, including brackets on links, e.g. <https://...>;

Please give a brief literature review. The aim is to explain how your research fits
into the context of other research in the area (REF NS 1.1(c)) (2000 character limit with spaces)
Please note that you cannot paste links into the online form
*

Art galleries and museums have begun adopting AR technologies within their institutions. AR has a critical role to play in the preservation and display of historical artifacts (Pedersen et al. 2017; Xie and Tang 2018). For instance, TombSeer - which is a digital cultural heritage (DCH) app - is a popular holographic AR used to reconstruct the historical inner chapel of the Egyptian Tomb of Kitines at the Royal Ontario Museum (ROM). Historical artifacts help connect to our ancestors, offering a strong link to the past. The TombSeer helps people immerse themselves in ancient Egyptian culture, providing context and information about the everyday lives and contributions of the civilization's inhabitants (Pedersen et al. 2017). TombSeer involves the integration of three essential features: 3D holograms, an AR interface that provides computer-generated information, and cultural heritage artifacts that connect people to our ancestors (Pedersen et al. 2017). AR technologies are widely used to simulate virtual and museum artifacts while maintaining user-friendliness and attractiveness of interfaces. Currently, TombSeer is being used to revitalize an exhibition by making computer-generated displays of Egyptian artifacts that appear to be tangible for ROM guests.
According to Brancati et al. (2015), MAR technologies are increasingly being used to develop, share, explain, and distribute historical artifacts, making cultural heritage more appealing or attractive. Ridel et al. (2014) added that the exceptional global penetration of smartphones and tablets has attracted the focus of numerous investigators. As a result, the use of wearable and mobile gadgets in the cultural heritage domain will only increase (Olsson, et al., 2012). However, despite the fact that smartphones and tablets are east to use, these gadgets can act as distraction if it distracts individuals from their surroundings. Additionally, Brancati et al. (2015) noted that artifacts visualized via AR tools lack authenticity since the focus is shifted from its culture and sociological aspects to the technology being used. Ramly and Neupane, (2018) declares the need for museums to explore AR into they operations to reduce the risk of being overshadowed by other entertainment media (Ramly & Neupane, 2018). The application of the digital media and AR technology needs to be enhanced to create a picture of a digital museum and digital heritage among the population (Lee, et al., 2011). This will encourage more people to visit the museums and enjoy a blend of traditions and modern technology within the institutions (Kyriakou & Hermon, 2018).
A study by Riel et al. (2013) that historical artifacts offer evidence of ancient events, allowing for their exploration and assessment; this helps preserve and impart cultural values to upcoming generations. Museum cultural artifacts are always associated with geometric information that is hard to differentiate due to aging or corrosion (Manuella & Ovidiu, 2016). AR technologies like 3D scanning and mobile computing can help virtually record historical artifacts for preservation (Ridel et al. 2014; Vanoni et al. 2014). The presence of AR tools has helped people improve their comprehension of historical artifacts through virtual replicas (Nofal et al. 2014). AR systems can offer a 3D view of objects, allowing for the identification of shapes and symmetric characteristics otherwise hard to visualize with naked eyes (Damala, et al., 2012). According to Nofal et al. (2014), AR tools present a valuable opportunity to understand and assess historical artifacts. Contrary to virtual reality (VR), AR helps museum guests to comprehend culture and archeological evidence through real world examples (Hu & Tsai, 2016). For instance, AR enables museum visitors to visualize and interact with virtual artifacts, allowing them a different perspective.

Please list the references only used in the literature review and cited in your application
NOTE: Do not include references you have not used in this application (1500 character limit)
*

Brancati, N., Caggianese, G., De Pietro, G., Frucci, M., Gallo, L. and Neroni, P., 2015, November. Usability evaluation of a wearable augmented reality system for the enjoyment of the cultural heritage. In 2015 11th International Conference on Signal-Image Technology & Internet-Based Systems (SITIS) (pp. 768-774). IEEE.
Damala, A., Stojanovic, N., Schuchert, T., Moragues, J., Ana, C., & Gilleade, K., 2012. Adaptive Augmented Reality for Cultural Heritage: ARtSENSE Project. EuroMed, pp. 746-755.
Hu, P.-Y., & Tsai, F.-P., 2016. Mobile Outdoor Augmented Reality Project for Historic Sites in Tainan. International Conference on Advanced Materials for Science and Engineering, pp. 509-511.
Kyriakou, P., & Hermon, S., 2018. Can I touch this? Using Natural Interaction in a Museum Augmented Reality System. Digital Applications in Archaeology and Cultural Heritage.
Lee, T., Hsu, K., & Yeh, L. (2011). Design and Application of the Augmented Reality with Digital Museum and Digital Heritage. In: Chang M., Hwang WY., Chen MP., Müller W. (eds.), Edutainment Technologies. Educational Games and Virtual Reality/Augmented Reality Applications. Edutainment 2011. Lecture Notes in Computer Science, vol 6872. Springer, Berlin, Heidelberg, pp. 25-26.
Manuella, K., & Ovidiu, D., 2016. ArchaeoInside: Multimodal Visualization of Augmented Reality and Interaction with Archaeological Artifacts. In: Ioannides M. et al. (eds.), Digital Heritage. Progress in Cultural Heritage: Documentation, Preservation, and Protection. EuroMed 2016. Lecture Notes in Computer Science, vol. 10058. Springer, Cham.
Nofal, E., Elhanafi, A.M., Hameeuw, H. and Moere, A.V., 2018. Architectural contextualization of heritage museum artifacts using augmented reality. Studies in Digital Heritage, 2(1), pp. 42-67.
Olsson, T., Kärkkäinena, T., Lagerstama, E., & Ventä-Olkkonen, L. (2012). User evaluation of mobile augmented reality scenarios. Journal of Ambient Intelligence and Smart Environments, 4(1), pp. 29-47.
Pedersen, I., Gale, N., Mirza-Babaei, P. and Reid, S., 2017. More than meets the eye: The benefits of augmented reality and holographic displays for digital cultural heritage. Journal on Computing and Cultural Heritage (JOCCH), 10(2), pp. 1-15.
Ramly, M. A., & Neupane, B. B., 2018. explorAR: A Collaborative Artifact-based. Asian HCI Symposium, pp. 21-26.
Ridel, B., Reuter, P., Laviole, J., Mellado, N., Couture, N. and Granier, X., 2014. The revealing flashlight: Interactive spatial augmented reality for detail exploration of cultural heritage artifacts. Journal on Computing and Cultural Heritage, 7(2), pp. 1-17.
Vanoni, D., Seracini, M. and Kuester, F., 2012, December. ARtifact: tablet-based augmented reality for interactive analysis of cultural artifacts. In 2012 IEEE International Symposium on Multimedia (pp. 44-49). IEEE.
Xie, X. and Tang, X., 2018, July. The application of augmented reality technology in digital display for intangible cultural heritage: The case of Cantonese furniture. In International Conference on Human-Computer Interaction (pp. 334-343). Springer, Cham.

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Methods and methodologies

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
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In order to consider your research, the HREC will need to know what it will involve for your participants (REF NS 3.1)

What kinds of methods and methodologies will you use in your research? (More than one box may be checked)*

- ☐ Quantitative
- ☑ Qualitative

Please save and continue to the next page

Qualitative

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
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What **qualitative** methodology and methods will be using in this research?

Section 1: Qualitative methodology*

- ☐ Auto-ethnography
- ☐ Historical research
- ☐ Other *(Please describe below)
- ☐ Action research
- ☐ Narrative enquiry
- ☐ Biographical research
- ☑ Case study
- ☐ Phenomenology
- ☐ Indigenous research paradigm
- ☐ Discourse analysis
- ☐ Grounded theory

Section 2: Qualitative methods*

- ☐ Participants observation
- ☐ Covert observation
- ☐ Life story or oral history
- ☐ Focus groups
- ☑ Structured interviews
- ☐ Semi-structured interviews
- ☐ Unstructured interviews
- ☐ Other * (Please describe below)
- ☐ On-line research
- ☐ Psychological testing/assessment
- ☐ Verbal protocol
- ☐ Journaling
- ☐ Artifact analysis
- ☐ Document/Policy analysis
- ☐ Access to records
- ☑ Audio/video recording

Please describe how interviews will be conducted, including how many participants will be involved (from each participant group if there is more than one group/cohort), the amount of time required of participants for this, whether it will be recorded, and any other information applicable*

The users will use an IOS ARKit software application to test a prototype Augmented reality experience of several historical artefacts and places. The User will be divided into two treatment group.
a) Treatment 1: a group of 15 participants will use the system first and then they will be interviewed.
b) Treatment 2: a group of 15 participants will be interviewed first and then they will use the AR System.
Following this, the user will be interviewed. The user will be audio and video recorded during this experiment. Finally, I will be using NVIVO for analysis of the transcript of the audio recording, and video-cued recall for the video recording.

Please describe how audio/video recording will be used in the research, including how many participants will be involved (from each participant group if there is more than one group/cohort), the amount of time required of participants for this, whether it will be recorded, and any other information applicable (1500 character limit)*

30 participant will participate in this experiment. each participant will participate individually. The duration for the experiment will be 60 minutes total of Introducing the project, experiencing the technology, and interviewing.

During experimenting the iOS: I will be video recording the participant while using the application. This will be by recording form small distance away from the participant

During the Interview: I will be having the camera on a camera stands pointing at the participant while being interviewed. Regarding to the audio recording, I will be using a voice record device beside the participant to record their responses. The record will be necessary for the interview responses and also as a backup of the responses. Finally, the participant may review their response transcript if they need.

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Section 6: Research participants/subjects part 1

Recruitment of participants

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In line with the National Statement, the definition of participants includes not only those humans who are the primary focus of the research but also those who will be affected by the research. The HREC regards the principle of respect for persons as of paramount importance. (REF NS 1.1 (d), 1.6-1.9, 1.10, 2.1).

How will you initially select and contact your participants? More than one box may be checked, if appropriate*

- ☐ Advertisement/flyer
- ☑ E-mail
- ☐ Telephone
- ☑ Internet
- ☐ Organisation
- ☐ Personal contact
- ☐ Letter
- ☐ Other contact method to be used

Outline how you will obtain participants' contact details and what your recruitment process will be (1500 character limit)*

Several strategies consist of contacting participants:
1. Through organizational function channels and personal communication.
2. I will contact who can suggest participation who fit the research criteria.
3. I will contact key people for interviews in these incubators and I will them to nominate participation of incubated people who fulfill the criteria.
4. I will ask participants of incubated people to suggest other participants who have such particular interests.

Please describe your recruitment plan/strategy

This question is not answered.

How many participants do you intend to recruit? (If you are intending to recruit different groups of participants, please answer all relevant questions for each group, e.g. control group, test group, etc)
(1500 character limit)*

In this study, the participant will include 30 participants male and female, multicultural who came to the old Jeddah to visit the historical locations. The age of these participants will be between 18 to 60 years old. The experiment will be conducted on those who have visited the location before and who have not visited these locations before.
This participant will be divided into two different groups randomly, and each participant will be experimenting individually. Each group will have different treatments.
a)Treatment1: a group of 15 participants will be using the system first and then will be interviewed.
b)Treatment 2: a group of 15 participants will be interviewed first and then using the system.

Explain how and why you have chosen this number (If the research is quantitative, explain the power calculations; if the research is qualitative, explain why the proposed number is likely to result in adequate data) (1500 character limit). For guidance, see how to address sample size here.*

A sensible sample size is considered to be btween 15 to 30 interviews regarding to (Pertaux,1981 as cited in Guest, Bunce, and Johnson, 2006; Teddlie, 2009 (cited in Panahi 2014)). Moreover, Guest etal, (2006) as cited in Panahi (2014) also mentioned that " data saturation occurs within the first twelve interviews" ; and therefore taking into consideration the limitation of time and resources, the sampling size here is estimated to be about 20 to 25 participants. However, the sample interviews will be carried until the data replication or nothing new emerge.

Describe your inclusion and exclusion criteria for participants (1500 character limit)*

The inclusion and exclusion of participant will be through screener question. However, this research will exclude the following only:
Participants under the age of 18 years old will be excluded.
Participants with significant visual or hearing impairments will be excluded.
Prticipant with pre-existing health conditions will be excluded.

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Participant involvement

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What time commitment will the research involve for your participants?
NOTE: This information must be included in any information to participants
(1500 character limit)*

Each participant will be experimenting and interviewed in a total time of one hour. These participants will participate in the experiment while they are visiting the museum. The participant will be giving translated material in Arabic. All the material will be translated in Arabic before commencing the study and once i got the ethical approval.

In what location will the research/data collection take place?
NOTE: This information must be included in any information to participants
(1500 character limit)*

The location of the Musume will be in Old Jeddah city, Jeddah, Saudi Arabia. TheGeneral Supervisor for the Management of the Historical Jeddah Project will provide the available house based on the dates set aside for the data collection.

What travel, if any, does the research involve for your participants?
NOTE: This information must be included in any information to participants
(1500 character limit)*

There will be no travelling requires for the participant.

Please include any additional information relating to participants that you think relevant
NOTE: This information must be included in any information to participants
(1500 character limit)*

There is no additional information relating to participants that are relevant

Describe and justify any benefit, payment or compensation the participants will receive. For research being conducted with Aboriginal and Torres Strait Islander People, the described benefits from research should have been discussed with and agreed to by the Aboriginal or Torres Strait Islander research stakeholders. (REF NS 2.1) and 4.7.8 & 4.7.9)
(1500 character limit)*

There are no benefits or payment for participants. However, Participant will get free entry to the museum if the museum requires additional payment.

Please save and continue to the next page

Consent

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Will you be obtaining written consent?*

- (●) Yes
- ( ) No

Please provide sample documents in attachments list at the end of the application form
Please use the following HREC templates when creating an information sheet and consent form: HREC templates

Do you believe there will be any special issues relating to consent in your research? (REF NS 1.13, 2.2, 2.3, Chapter 4)*

- ( ) Yes
- (●) No

Are the participants able to consent fully? (REF NS Chapter 2, 4.4, 4.5)*

- (●) Yes
- ( ) No

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Limited disclosure

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Does this research involve limited disclosure to participants? (REF NS 2.3)*

- ( ) Yes
- (●) No

Please save and continue to the next page

Vulnerable populations

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
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Indicate if your research will involve the following vulnerable populations (as per the National Statement) other than as incidental participants (i.e. they are not included in the design of the project but may be participants) (REF NS Chapter 4)
*

- [ ] Women who are pregnant and the human foetus
- [ ] Children and young people
- [ ] People in dependent or unequal relationships
- [ ] People highly dependent upon medical care who may be unable to give consent
- [ ] People with a cognitive impairment, an intellectual disability or a mental illness
- [ ] People who may be involved in illegal activities
- [ ] People who are incarcerated
- [ ] Aboriginal and Torres Strait Islander Peoples
- [x] People in other countries
- [ ] None of the above

Describe how you will respect the ethical considerations specific to your participants, in accordance with Chapter 4 of the National Statement (1500 character limit)*

In the design of this research, the value of local culture will be considered. Since the researcher is from the same culture, he will have enough knowledge of the culture and society rules. Also, the safety of the participants will be considered based on all political and social factors that may endanger the safety of the participants. There will be contacting information for participant who has and questions and concerns regarding the research. These concerns will be considered carefully and ensure that there will be a process independent for dealing with these complaints. Moreover, local circumstances will be considered for the participants. Furthermore, participants customs, cultural heritage and local laws will be considering and respected by the researcher. All local beliefs and practices regarding recruitment, consent, and remuneration to participants or contributions to communities for participating in the research will be taken into account in the design and the conduct of this research and in the ethical review process. Finally, the researcher will be establishing the recruiting process that the participant will follow in the research carefully and based on that the participant and through which they choose whether to be involved are respectful of their cultural context.

If your research is being conducted in Australia, does it involve Culturally and Linguistically Diverse (CALD) People?*

- ( ) Yes
- (●) No

Do you intend to recruit any members of the Australian Defence Force?*

- ( ) Yes
- (●) No

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Section 7: Research participants/subjects part 2

Risk/harm

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
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Risk or harm could be described as damage or hurt to the wellbeing, interests or welfare of an individual, institution or group. Harm could range from physical hurt or damage such as illness or injury, to psychological or emotional hurt or damage, such as embarrassment or distress.
Please note that as a researcher, you are not necessarily immune from risk yourself and should give careful consideration to this question (REF NS 2.1).
For help in addressing the risk/harm section please click here.

NOTE:
It is **really** important that you carefully consider all ***potential*** risks that could occur, even if they seem negligible.
Please **do not** provide one-word answers to any of the questions below.
Please refer to the guidelines to address risk and harm located on the UTS HREC website titled: Help for how to address the risk/harm section.
Describe, as best as you can, any possible risks to research participants, subjects and related groups
NOTE: This information must be included in any information to participants (2000 character limit)*

In my research, there will be no day to day risk associated with the participant. If the participant felt uncomfortable during the interview or of being video and/or audio recording, they have the full right to withdraw the experiment and leave without any penalty. Moreover, the participant will be testing AR system on iPhone device rather than using wearable glasses. Therefore, the participant will have no risk of having dizziness, risk of falling over, etc. However, in any emergency, a medical assistant will be covered.

How would you categorise the magnitude of potential risk? (e.g. inconvenience, discomfort, harmful, painful)
Explain why you believe this is so (1500 character limit)*

No major risk is expected in my research. However, the little risk might be categorized as an inconvenience to participants.
Participant may have a long time for the interview
Participant may preferer not to be audio and video recording
Participants may feel uncomfortable during the interview.
Since participation is voluntary, the participant has the right to withdraw any time during the interview without penalty.

How would you categorise the likelihood of risk? (i.e. slight, possible, likely, probable, unavoidable)
Explain why you believe this is so (1500 characters)*

Likelihood of these risks is slight. Slight risk for time and confidentiality risks;
1- Informed consent : Each participant will be asked to read and sign the consent form that will also foreground their right to withdraw at any time without penalty.

2- Recording permission: Each participant will be asked for their permission to be recorded and if they rejected they can leave without penalty.

3- Privacy and confidentiality issues: Each participant will not be asked about any personal identification or confidentiality information.

What strategies will you use to minimise and/or manage the risks? (1500 character limit)*

I will provide information sheet and consents form for the participant
I will limit the duration time of the interview if necessary
I will ask the participant to have a short break if they need
I will not ask them any personal identification or confidentiality information
I will pay the entrance fees for my participants

Discuss likely or possible risk to researchers (including yourself), and your strategies for minimising such risks (1500 character limit)*

In my research there will be no risk expected and I will take all necessary precautions while traveling according to the VC'S travel directive procedures.

Please save and continue to the next page

Pre-existing relationships

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Are there likely to be any pre-existing relationships with research participants? (e.g. employer/employee, colleague, friend, relation, student/teacher, etc)*

- (●) Yes
- ( ) No

Please describe (1500 character limit)*

The researcher will contact his colleague, friend, and relation to participate in the study.

How might these relationships influence their decision to participate, be affected by the proposed research or create potential ethical conflict? Please describe strategy for dealing with this (1500 character limit)*

All relation participants will be asked genitally to attend the study. the researcher is aware that relation participants could have social engagements. The researcher will respect any decision that the participant may have and will not affect the relation between the relation and the participant.
If the relative participant decide to join the study, then the researcher will conduct the research as there is no relation with the participant. If the relative decides not to participate, then the research will thank them and will still respect the relationship with them.

Describe how you will ensure that student assessment, employee security, etc., will not be adversely affected by participation in this research (1500 character limit)*

The researcher will not include any employee or student in his research. only colleague, friend and relation.

Will you be recruiting UTS staff and/or students as research participants?*

- ○ Yes
- ◉ No

Please save and continue to the next page

Aboriginal & Torres Strait Islanders/people overseas/culturally & linguistically diverse people

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

You have indicated on the Vulnerable Populations page that your research involves this particular population.
If your research does not involve this population, you will need to change your answer on the Vulnerable Populations page.

Research involving people from identifiable language and cultural groups, including your own, may require special sensitivity. If the research is being carried out in another country, you must comply with UTS as well as local standards, laws and guidelines.
Values and Ethics in Aboriginal and Torres Strait Islander Health Research, 2003 guidelines provide guidance to researchers in the conception, design and conduct of research. There are six values at the heart of these guidelines: reciprocity, respect, equality, responsibility, survival and protection, spirit and integrity. The questions regarding reciprocity have been addressed under 'Participant Involvement' and 'External organisations'.
Respectful research relationships acknowledge and affirm the right of people to have different values, norms and aspirations. Those involved in research processes should not be blind to difference. Also essential to a respectful research relationship is the recognition of the contribution of others and the consequences of research.

Is the research being conducted in English?*

- ○ Yes
- ◉ No

What language is the research being conducted in? (500 character limit)*

There Interview will be in Arabic for Arabian spoken language and in English for non-Arabian spoken language

What is your level of competence in this language?
1=None, 2=Some, 3=Conversational, 4=Fluent (spoken), 5=Fluent (written), 6=Fluent (spoken & written)
*

6

Please tick which of the following will be used (More than one box may be checked if required):*

- ☑ I will be translating
- ☐ Interpreter
- ☐ Translator
- ☐ I will be interpreting

Please save and continue to the next page

Aboriginal & Torres Strait Islanders/people overseas/culturally & linguistically diverse continued

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Has the participant information been translated from English into the relevant language(s)?*

- ◉ Yes
- ○ No

Please provide copies of all material, clearly labelled, in English and other relevant languages

The Committee requests that you arrange for a local independent contact person, to make it easier for your participants should they wish to confirm your identity or express any concerns. Please provide details (name and contact details) (NS Chapter 4.7 and Chapter 4.8):
(4000 character limit)*

Mohammed Binsawad, Ph.D
Assistant Professor
Information System Departments
Faculty of Computing and Information Technology
King Abdulaziz University
email:
Phone: +966

How have you incorporated consideration for local prudential rules and customs in your research design? (1500 character limit)*

In the design of this research, the value of local culture will be considered. Since the researcher is from the same culture, he will have enough knowledge of the culture and society rules. Also, the safety of the participants will be considered based on all political and social factors that may endanger the safety of the participants. There will be contacting information for participant who has and questions and concerns regarding the research. These concerns will be considered carefully and ensure that there will be a process independent for dealing with these complaints. Moreover, local circumstances will be considered for the participants. Furthermore, participants customs, cultural heritage and local laws will be considering and respected by the researcher. All local beliefs and practices regarding recruitment, consent, and remuneration to participants or contributions to communities for participating in the research will be taken into account in the design and the conduct of this research and in the ethical review process. Finally, the researcher will be establishing the recruiting process that the participant will follow in the research carefully and based on that the participant and through which they choose whether to be involved are respectful of their cultural context.

Please save and continue to the next page

People overseas/culturally and linguistically diverse people

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

You have indicated on the Vulnerable Populations page that your research involves this particular population.
If your research does not involve this population, you will need to change your answer on the Vulnerable Populations page.

Do you require any special approval arrangements (e.g. visa)? *

- ○ Yes
- ◉ No

Please explain why you do not require any special approval arrangements (e.g. visa)? (2000 character limit)*

I researcher is sitizen of Saudia Arabi

Have you read the Vice-Chancellor's Travel Directive? *

- ◉ Yes
- ○ No

Please save and continue to the next page

External organisations

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Indicate if your research will involve any of the following:*

- ☑ Institution
- ☑ Organisation
- ☐ Community Group
- ☐ None of the above

Please describe what type(s) of institution / organisation / community group will be involved and how many will be involved (1500 character limit)*

For this research, only two organizations will be involved to help in conducting the research officially in Old Jeddah museum.
1. King Abdulaziz University (one person to be an external supervisor)
2. Historical Municipality (only approval for conducting the research - non-human will be involved)

3.

Was the research generated from within the institution / organisation / community group?*

- ○ Yes
- ◉ No

Please save and continue to the next page

External organisation consent

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Have you sought appropriate approval or support from the institution / organisation / community group involved?*

- (●) Yes
- ( ) No

Please attach a copy of any letter of approval/agreement at the end of this form

Do you intend to feed the research results back to the institution / organisation /community group?*

- ( ) Yes
- (●) No

Please explain why not (1500 character limit)*

The participants can be from different institutions or organizations to satisfy the sampling criteria of this research. However, all these institutions or organizations in including the participants are satisfied to abide by UTS ethics approval.

Does this research involve any contracts, including confidentiality agreements? (REF NS 3.2.12, 3.5.6) (Section 2.5 and 4, The Code)*

- ( ) Yes
- (●) No

Please save and continue to the next page

Section 8: Data

Data collection

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

The collection, storage and use of data involve important considerations of privacy. When collecting data, researchers should show due sensitivity and respect for persons. It is also important that data be reliable, authentic, and where appropriate, replicable. This section will provide the HREC with information as to how you intend to deal with these issues.
(REF NS 2.2.6(f), 3.2) (Section 2, The Code)

Who will collect the data? (More than one box may be checked) (Section 2, The Code)*

- [x] External contract researcher
- [ ] External associate researcher
- [ ] External student
- [ ] Internal (UTS) academic researcher
- [ ] Internal (UTS) research assistant
- [x] Internal (UTS) student
- [ ] Research Assistant
- [ ] Volunteers
- [ ] Other

Will you be attaching a sample of your data recording/measurement instrument(s) to this application (e.g. survey, interview format, etc?)*

- (●) Yes
- ( ) No

Please save and continue to the next page

Information database or personal records

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Do your data collection or recruitment methods include access to an information database or personal records? (Section 95 and 95A, Privacy Act) (REF NS 3.2)
*

○ Yes
◉ No

Please save and continue to the next page

Data type

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

The HREC is required to report on privacy to the Federal and NSW Privacy Commissioners

Indicate the category of data you will be obtaining at the point of data collection (More than one box may be checked):*

☑ Individually identifiable data
☐ Re-identifiable data
☐ Non-identifiable data

Are you obtaining consent for individually identifiable or re-identifiable information?*

◉ Yes
○ No

Please select how you will be obtaining consent from the list below*

Written consent

Why do you need to have access to individually identifiable and/or re-identifiable data? (1500 character limit)*

all idantable date will be re-identifiable data

Will you be seeking identifiable information from a Commonwealth agency, without the consent from the individuals to which the data refer?*

○ Yes
◉ No

Please save and continue to the next page

Data storage

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Data must be stored and secured for a minimum of 5 years after publication (Some data are required for longer periods of time and the storage will need to take this into account). For further details on retention requirements, refer to the UTS Records Management Policy http://www.records.uts.edu.au/policies/index.html
The data should be stored so as to ensure maximum privacy for participants, reliability and retrievability of data.

Indicate the format(s) the data will be stored in (Choose as many categories as applicable)
NOTE: This information must be included in any information to participants
*

☑ Electronic/digital recording
☐ Handwritten notes
☐ Microfilm
☐ Non-identifiable(anonymous)data
☐ On-line data storage
☐ Paper questionnaires/Surveys
☑ Transcripts of tapes/recordingd
☐ Video tapes
☐ Other

Who will have access to the raw data? (Choose as many categories as applicable)
NOTE: This information must be included in any information to participants
*

☐ UTS academic researcher(s)
☑ UTS student(s) and supervisors
☐ External researcher(s)
☐ Research assistant(s)
☐ Funding body/organisation
☐ Partner organisation(s)
☐ Other

Please save and continue to the next page

Use & publication of data

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

How do you intend to use and/or publish the data? (Choose as many categories as applicable)
NOTE: This information must be included in any information to participants
*

- ☐ Book
- ☐ Client Report
- ☑ Conference paper
- ☑ Electronic publication
- ☐ Media
- ☑ Report
- ☑ Thesis
- ☑ Journal articles
- ☐ Other

Do you envisage any additional use of data in future research projects?*

- ○ Yes
- ◉ No

Please save and continue to the next page

Privacy principles

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

As a general principle, privacy and confidentiality should be respected at all stages of the research (raw data, analysis, published or archived), and by all those involved in the research (including the researcher, research assistants, administrative assistants, students, interpreters, translators, data processors, members of focus groups, etc.)

Note: Privacy and confidentiality is complicated in NSW because it is governed by a number of separate Acts. From 12 March 2014, the new Australian Privacy Principles (APPs) were introduced to regulate the handling of personal information by Australian government agencies and some private sector organisations.

The privacy fact sheet providing the text of the 13 APP can be accessed here.

The 13 APP apply to all research conducted by staff and students of this University.

Will this research be undertaken in conformity to ALL the Privacy Principles?*

- ◉ Yes
- ○ No

Please save and continue to the next page

Privacy & confidentiality

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

How will you ensure the security of the data? (1500 character limit)*

All the responses will be gathered and stored in the researcher's UTS OneDrive with a secure lock and require a password. also, my am going to manage my research data in my RDMP. Link: https://stash.research.uts.edu.au/default/rdmp/record/view/cc677d38e5b9bba53ba96dc1a5984575

How will you protect the confidentiality/privacy of your participants? (1500 character limit)*

The information in the study will be kept strictly confidential and data will be stored securely.

To what extent will you or anyone else be able to identify the research participants from the published or unpublished data? Please describe: (1500 character limit)*

Data will be stored securely and will be made available only for academic supervisors and me to conduct my PhD study .

Please save and continue to the next page

Interpretation/analysis/disposal

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

Regardless of whether data collected is qualitative or quantitative, how do you plan to analyse these data into material that is valid and reliable? (Include a brief summary of your Analysis Plan) (1500 character limit)*

I will be using a software programme that scripts all the audio voice to a text. Then, this scripted text will be organized in word files for data analysis using nvivo software.

Will the data be archived or destroyed? *

☑ Archived
☐ Destroyed

Where will the data be archived, who will have access to it, and will there be any conditions attached? (1500 character limit)*

these data will be stored and archived for seven years in an online drive with a complex password

Please save and continue to the next page

Section 9: Additional information

Other ethical issues

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

If there are any additional ethical issues which you do not believe have been covered by this form, please explain them for the HREC: (1500 character limit)*

No other issues is under concerns

Please save and continue to the next page

Section 10: Attachments

Attachments

You can save your application at any time by clicking on the save button on the left hand side in the toolbar.
For further information and help in completing your application go to Staff Connect

I have attached the following supporting documents

Doctoral or Masters assessment*

◉ Yes
○ N/A

Budget page from funding application*

○ Yes
◉ N/A

Informed consent form(s)*

◉ Yes
○ N/A

Participant Information Sheet(s)*

◉ Yes
○ No

Survey(s)/questionnaire(s)/outline of question(s)*

◉ Yes
○ N/A

Translation of forms/information letter(s)/instruments*

○ Yes
◉ N/A

Evidence of approval from external institution, organisation or community group*
○ Yes
◉ N/A

Explanations of any technical terms used*
○ Yes
◉ N/A

Standard Operating Procedures

N.B. May include a distress or disclosure protocol [see UTS HREC Disclosure Guidelines], Faculty of Health Low Risk protocol; procedures for participant screening, physiological, or biological sampling and/or laboratory or safety procedures where relevant.

*
○ Yes
◉ No

Please explain why any of the above items have not been attached (either softcopy/hardcopy) and when they will be provided (1500 character limit)*

1. Budget form: The Saudi Culture Mission will give a letter of Data collection approval once I apply to them ane one of the requirements is that I should have ethical approval from my institute.

2. Translation of forms/information letter(s)/instruments:
I will be translating all the materials once I got the ethical approval and before commencing recruitment

3. Evidence of approval from external institution, organisation or community group: IN PROGRESS

NOTE: If you are only attaching a hardcopy of any attachments relating to this application, you must still click on 'Add New Document' on the right hand side of the table.

If possible, please consolidate all attachments into one PDF

How to attach
1. Click on "Add New Document"
2. Enter a title in the "Document description" field
3. Click on the OK button
4. Click on SOFT COPY icon
5. Follow the instructions in the upload dialog box

To add a reference to a hard copy document:
1. Click on "Add New Document"
2. Enter a title in the "Document Description" field
3. Tick check box for "Hard Copy"
4. Enter details in the "Reference (Document Title)" field
5. Click on the OK button

Please use the following HREC templates when creating an information sheet and consent form: HREC templates

Documents attached to this application:*

1	Document type	Soft copy
	Name	Doctoral or Masters assessment
	Reference (Document Title)	Rayed ALAKHTAR - Candidature Assessment 1 form.pdf
	Description	Doctoral or Masters assessment
2	Document type	Soft copy
	Name	ETH19-4473 - HREC outcome & comments
	Reference (Document Title)	ETH19-4473 - FERGUSON (for ALAKHTAR) - HREC outcome and comments.docx
	Description	
3	Document type	Soft copy
	Name	Committee Response File
	Reference (Document Title)	ETH19-4473 - FERGUSON (for ALAKHTAR) - HREC outcome and comments (V.2) (EK).docx
	Description	
4	Document type	Soft copy
	Name	E-mail Invitation Script
	Reference (Document Title)	Email_invitation.docx
	Description	
5	Document type	Soft copy
	Name	Participant Brochure
	Reference (Document Title)	Flyer PhD.docx
	Description	
6	Document type	Soft copy
	Name	Letter from Mr. Alakhtar's Wife
	Reference (Document Title)	Mr. Alakhtar-Letter for helping data collection trip.pdf
	Description	
7	Document type	Soft copy
	Name	Edited open ended question
	Reference (Document Title)	open ended Interview questions(AR Application).docx
	Description	Edited Copy
8	Document type	Soft copy
	Name	description letter of selecting house
	Reference (Document Title)	description letter of selecting house.docx
	Description	
9	Document type	Soft copy
	Name	PIS
	Reference (Document Title)	Mr. Alakhtar Participant-information-sheet-consent-form.docx
	Description	
10	Document type	Soft copy
	Name	PIS Arabic Version
	Reference (Document Title)	Mr. Alakhtar Participant-information-sheet-consent-form (Arabic).docx
	Description	
11	Document type	Soft copy
	Name	Local Supervisore Letter
	Reference (Document Title)	Mr. Alakhtar-Letter for data collection trip.docx
	Description	
12	Document type	Soft copy
	Name	Subcommittee Comments Responding
	Reference (Document Title)	ETH19-4473 - FERGUSON (for ALAKHTAR) - HREC outcome and comments (V.2) (SubCom).docx
	Description	Responded File to the Subcommittee Comments

Please read the submission instructions carefully at the end of this application form.
Please save and continue to the next page

Declaration

Declaration

I have answered all questions in the risk assessment truly and completely to the best of my knowledge

I will notify the UTS Human Research Ethics Committee of any variation to this research that may alter the level of risk associated with it

This research will be undertaken in compliance with the UTS Research Ethics and Integrity Policy or any replacement or amendment thereof

This research will be undertaken in compliance with the Australian Code for the Responsible Conduct of Research and National Statement on Ethical Conduct in Human Research

Please click on **Action** and **Submit**

Confirmation

Confirmation by Local Research Office High Risk

Application type*

Research (student project)

Internal personnel listed on this ethics protocol*

1	Primary	No
	ID	
	Surname	Alakhtar
	Given Name	Rayed
	Full Name	Mr Rayed Alakhtar
	Position	Chief Investigator
	Type	Student
	AOU	FEIT.Faculty of Engineering & Information Technology
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Rayed.Alakhtar@student.uts.edu.au
	Work Number	
2	Primary	No
	ID	
	Surname	Binsawad
	Given Name	Muhammed
	Full Name	Muhammed Binsawad
	Position	Partner Investigator
	Type	External
	AOU	
	Managing Unit	
	Email Address	mbinsawad@kau.edu.sa
	Work Number	
3	Primary	No
	ID	
	Surname	Alsobhi
	Given Name	Huda
	Full Name	Mrs Huda Alsobhi
	Position	Partner Investigator
	Type	International
	AOU	FEIT.School of Computer Science
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Hada.Alsobhi@student.uts.edu.au
	Work Number	
4	Primary	Yes
	ID	
	Surname	Ferguson
	Given Name	Sam
	Full Name	Dr Sam John Ferguson
	Position	Chief Investigator
	Type	Internal
	AOU	FEIT.School of Computer Science
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Samuel.Ferguson@uts.edu.au
	Work Number	4682

Checked by:*

Irina Chung

Date of review:*

16/01/2020

The Research Office has confirmed that: All information in this application and supporting documentation is correct and as complete as possible *

- (●) Yes
- ( ) No

Confirmation by ADR

Application type

Human

Internal personnel listed on this ethics protocol

1	Primary	No
	ID	[redacted]
	Surname	Alakhtar
	Given Name	Rayed
	Full Name	Mr Rayed Alakhtar
	Position	Chief Investigator
	Type	Student
	AOU	FEIT.Faculty of Engineering & Information Technology
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Rayed.Alakhtar@student.uts.edu.au
	Work Number	
2	Primary	No
	ID	[redacted]
	Surname	Binsawad
	Given Name	Muhammed
	Full Name	Muhammed Binsawad
	Position	Partner Investigator
	Type	External
	AOU	
	Managing Unit	
	Email Address	mbinsawad@kau.edu.sa
	Work Number	
3	Primary	No
	ID	[redacted]
	Surname	Alsobhi
	Given Name	Huda
	Full Name	Mrs Huda Alsobhi
	Position	Partner Investigator
	Type	International
	AOU	FEIT.School of Computer Science
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Hada.Alsobhi@student.uts.edu.au
	Work Number	
4	Primary	Yes
	ID	[redacted]
	Surname	Ferguson
	Given Name	Sam
	Full Name	Dr Sam John Ferguson
	Position	Chief Investigator
	Type	Internal
	AOU	FEIT.School of Computer Science
	Managing Unit	Faculty of Engineering & Information Technology
	Email Address	Samuel.Ferguson@uts.edu.au
	Work Number	4682

Date of LRO review

23/01/2020

Declaration:

- I am aware that this research is being conducted within this Faculty/School/Centre.
- I am satisfied that the researchers have met all Faculty/School/Centre requirements in relation to this research
- This research will be undertaken in compliance with the UTS Research Ethics and Integrity Policy or any replacement or amendment thereof
- This research will be undertaken in compliance with the Australian Code for the Responsible Conduct of Research and National Statement on Ethical Conduct in Human Research

*

(●) Yes
( ) No

Comments

This question is not answered.

RIO use only

RIO use only

Application Status

Approved

Approval Purpose

Research (student project)

Current Committee

1Human Ethics Committee

TRIM number

This question is not answered.

Start date

17/06/2020

End date

17/06/2025

Date received

13/01/2020

Date Approved

17/06/2020

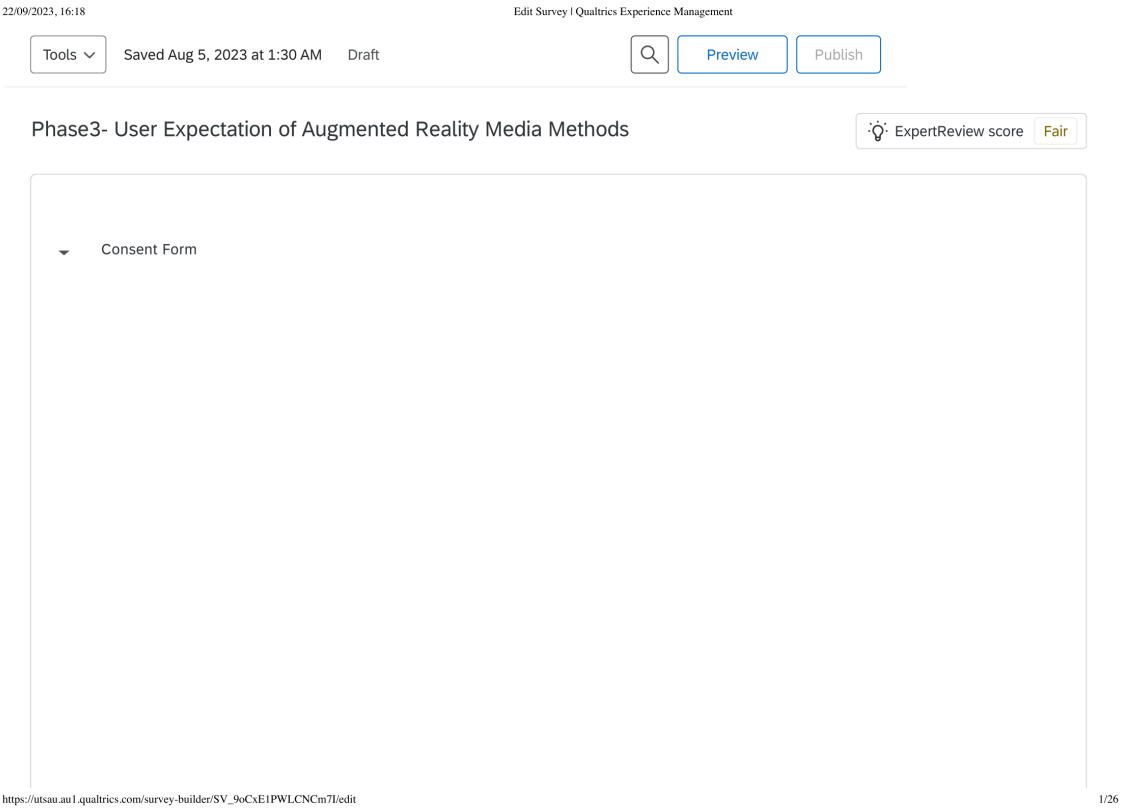
Date Reviewed

11/02/2020

Date Withdrawn

This question is not answered.

A.0.3 Phase 2 Survey



Consent Form - EN

UNIVERSITY OF TECHNOLOGY SYDNEY

UNIVERSITY OF THECHNOLOGY SYDNEY

CONSENT FORM .....UTS HREC REF NO ETH19-4473

Using Augmented Reality to Explore Museum Artefacts

Please be aware that by moving to section two, you have agreed to participate in the research project Using Augmented Reality in Tourism Contexts (HREC 2013000135 project number 2019-1) being conducted by Rayed Alakhtar and Dr Sam Ferguson of the Creativity and Cognition Studios at the University of Technology, Sydney.

You understand that you have been asked to participate in this research because you have the experience and knowledge necessary to fill out the questionnaire and that your participation in this research will involve filling in an online questionnaire of Three sections.

You understand that you have been selected because your answer is suitable and will help in the research.

You are aware that you can contact Dr Sam Ferguson (Samuel.ferguson@uts.edu.au) or Rayed Alakhtar (Rayed.Alakhtar@student.uts.edu.au) if you have any concerns about the research. Also, you understand that you are free to withdraw your participation from this research project at any time you wish, without consequences, and without giving a reason.

Finally, you agree that the research data gathered from this project may be published in a summary form that does not identify you in any way, and it may include anonymous quotes where applicable.

NOTE:

This study has been approved by the University of Technology, Sydney, Human Research Ethics Committee.
If you have any complaints or reservations about any aspect of your participation in this research that you cannot resolve with the researcher, you may contact the UTS Ethics Committee through the Research Ethics Officer at UTS Broadway, Building 1, Level 14; or 9514 9772; or Research.Ethics@uts.edu.au. Please quote the UTS HREC reference number.
Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

UTS Creativity & Cognition Studios, Participant Consent form (Appendix E) last updated: January 2016

Consent Form - AR

UNIVERSITY OF TECHNOLOGY SYDNEY

UNIVERSITY OF THECHNOLOGY SYDNEY

CONSENT FORM .....UTS HREC REF NO ETH19-4473

Using Augmented Reality to Explore Museum Artefacts

شكرا لك على المشاركة في بحثي. يهدف هذا البحث إلى دراسة توقعات الجمهور لطريقة وسائط الواقع المعزز عند استكشاف القطع الأثرية التاريخية.

يرجى العلم أنه بالانتقال إلى القسم الثاني، فإنك توافق على المشاركة في المشروع البحثي باستخدام الواقع المعزز في سياقات السياحة (HREC رقم المشروع 2019-1) 2013000135 الذي يديره رائد الأختر والدكتور سام فيرجسون من Creativity and Cognition Studios في جامعة التكنولوجيا، سيدني.

أنت تدرك أنه قد طُلب منك المشاركة في هذا البحث لأن لديك الخبرة والمعرفة اللازمتين لملء الاستبانة وأن مشاركتك في هذا البحث ستشمل ملئ استبيان عبر الإنترنت من ثلاث أقسام.

أنت تدرك أنه تم اختيارك لأن إجابتك مناسبة وستساعد في البحث.

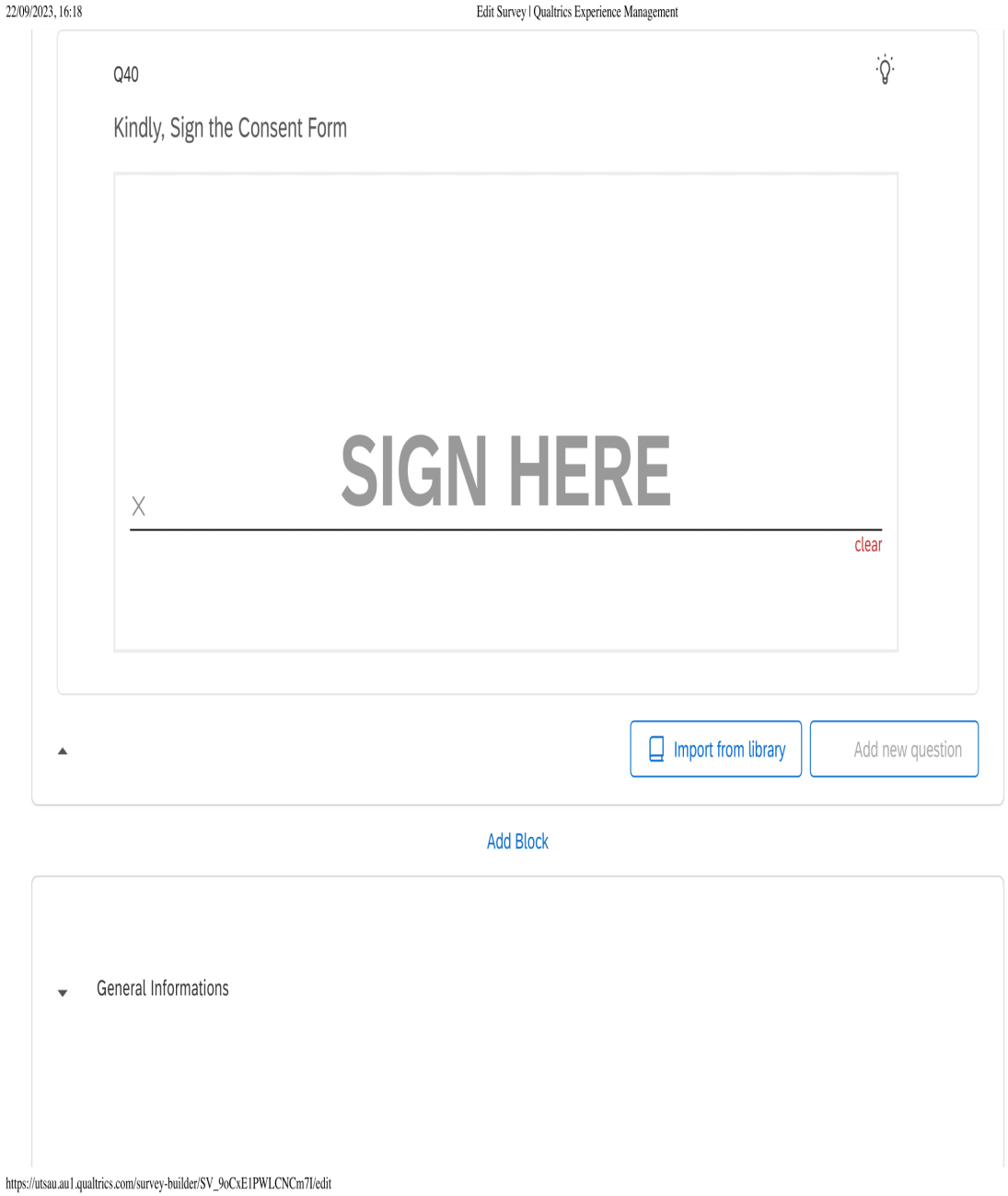
أنت تدرك أنه يمكنك الاتصال بالدكتور سام فيرجسون (Samuel.ferguson@uts.edu.au) أو Rayed Alakhtar (Rayed.Alakhtar@student.uts.edu.au) إذا كان لديك أي مخاوف بشأن البحث. كما أنك تدرك أن لك مطلق الحرية في سحب مشاركتك من هذا المشروع البحثي في أي وقت تشاء، دون عواقب ودون إبداء أسباب.

أخيرًا، أنت توافق على أن بيانات البحث التي تم جمعها من هذا المشروع قد يتم نشرها في نموذج ملخص لا يحدد هويتك بأي شكل من الأشكال،

ملحوظة:

تمت الموافقة على هذه الدراسة من قبل جامعة التكنولوجيا، سيدني لجنة أخلاقيات البحوث الإنسانية. إذا كانت لديك أي شكاوى أو تحفظات بشأن أي جانب من جوانب مشاركتك في هذا البحث
لا يمكنك حله مع الباحث ، فيمكنك الاتصال بلجنة أخلاقيات UTS من خلال مسؤول أخلاقيات البحث في UTS Broadway ، المبنى 1 ، المستوى 14 ؛ أو 9514 9772 ؛ أو

.Research.Ethics@uts.edu.au يرجى ذكر الرقم المرجعي UTS HREC ETH194473 سيتم التعامل مع أي شكوى تقدمها بسرية تامة والتحقيق فيها بالكامل وسيتم إبلاغك بالنتيجة.


22/09/2023, 16:18
Edit Survey | Qualtrics Experience Management
Q40
Kindly, Sign the Consent Form
SIGN HERE
X
clear
Import from library
Add new question
Add Block
General Informations
https://utsau.au1.qualtrics.com/survey-builder/SV_9oCxE1PWLCNCm7I/edit
8/26

Name

Q2

Gender

- Male
- Female
- Non-binary / third gender
- Prefer not to say

Q3

What is your best contact Method?

Email	Mobile
○	○

Q4

Please write your contact method (Type the mobile number or email address)

Q5

Can the researcher contact you for further information?

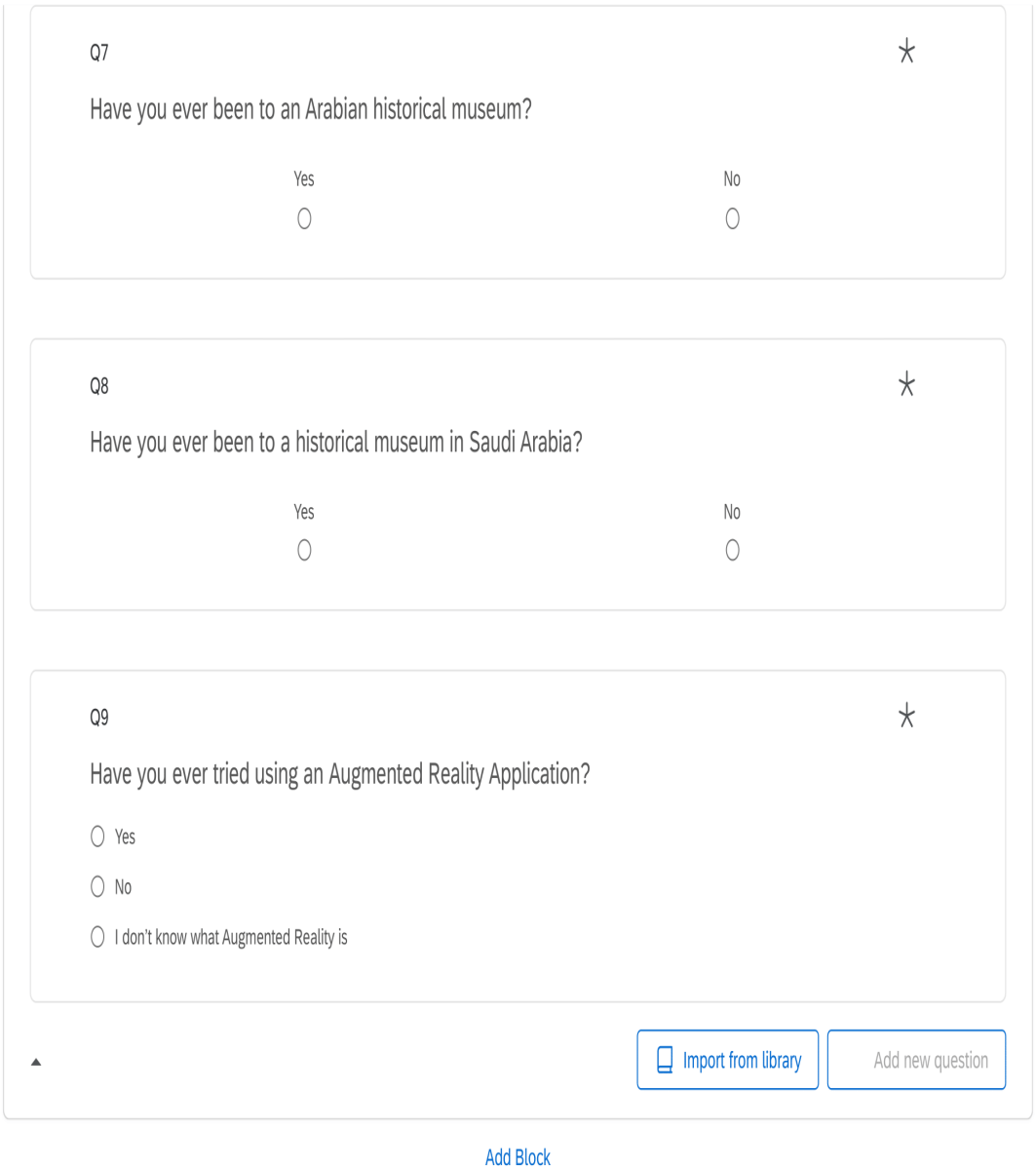
I am happy for the researcher to contact me for future feedback

I am not interested

Q6

Are you generally familiar with Arabian historical Artifacts?

- Yes- I am familiar with Arabian historical Artifacts.
- No- I am NOT familiar with Arabian historical Artifacts
- Maybe


Q7
Have you ever been to an Arabian historical museum?
Yes
No
Q8
Have you ever been to a historical museum in Saudi Arabia?
Yes
No
Q9
Have you ever tried using an Augmented Reality Application?
Yes
No
I don't know what Augmented Reality is
Import from library
Add new question
Add Block

Media Methods

Mebkharah

Artifact

Q51 *

Do you recognise this artifact?

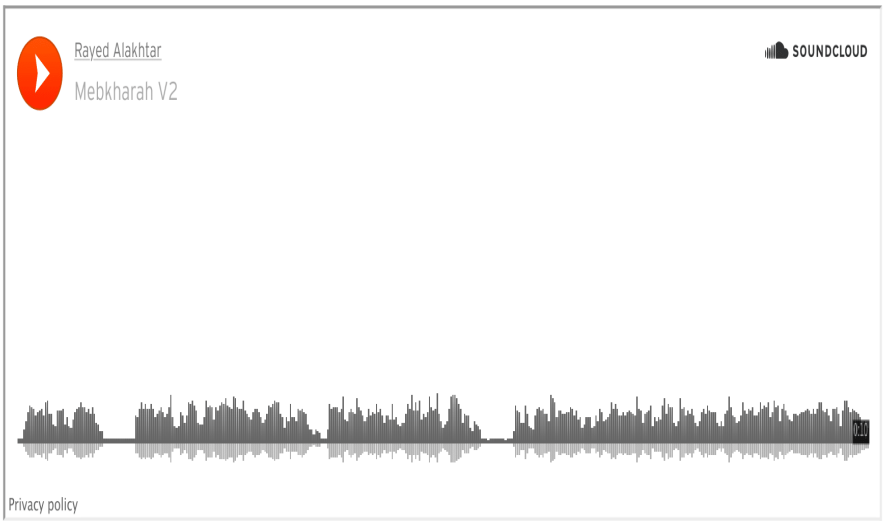
- Yes
- No
- I am not sure

Q52

if so, what is the name of the artifact?

Page Break

Audio Media Method



Rayed Alakhtar · Mebkharah V2

Q10

What is the purpose of Mebkharah artifact?

- ○ To improve the design of the space
- ○ To improve the Aroma of the surrounding Air
- ○ Its Arabian customs and traditions
- ○ I still have no idea what is the purpose of Mebkharah.

Page Break

2D Media Method

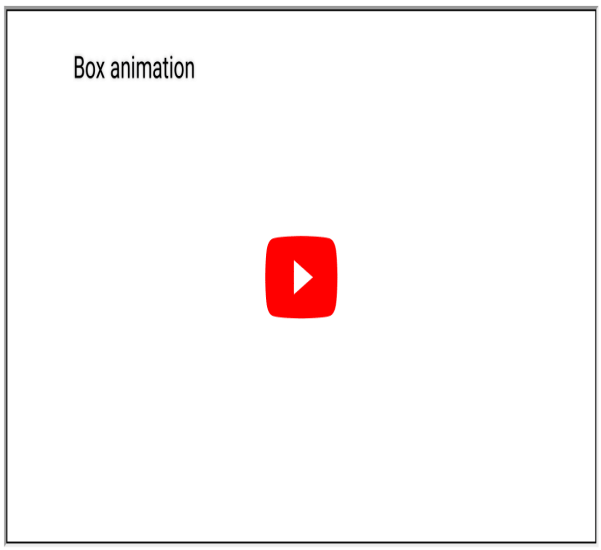
Q11 *

What is the purpose of Mebkharah artifact?

- ○ To improve the design of the space
- ○ To improve the Aroma of the surrounding Air
- ○ Its Arabian customs and traditions
- ○ I still have no idea what Mebkharah is

Page Break

3DMedia Method



Q53

What is the purpose of Mebkharah artifact?

- To improve the design of the space
- Its Arabian customs and traditions
- To improve the Aroma of the surrounding Air
- I still have no idea what Mebkharah is

Page Break

Q54

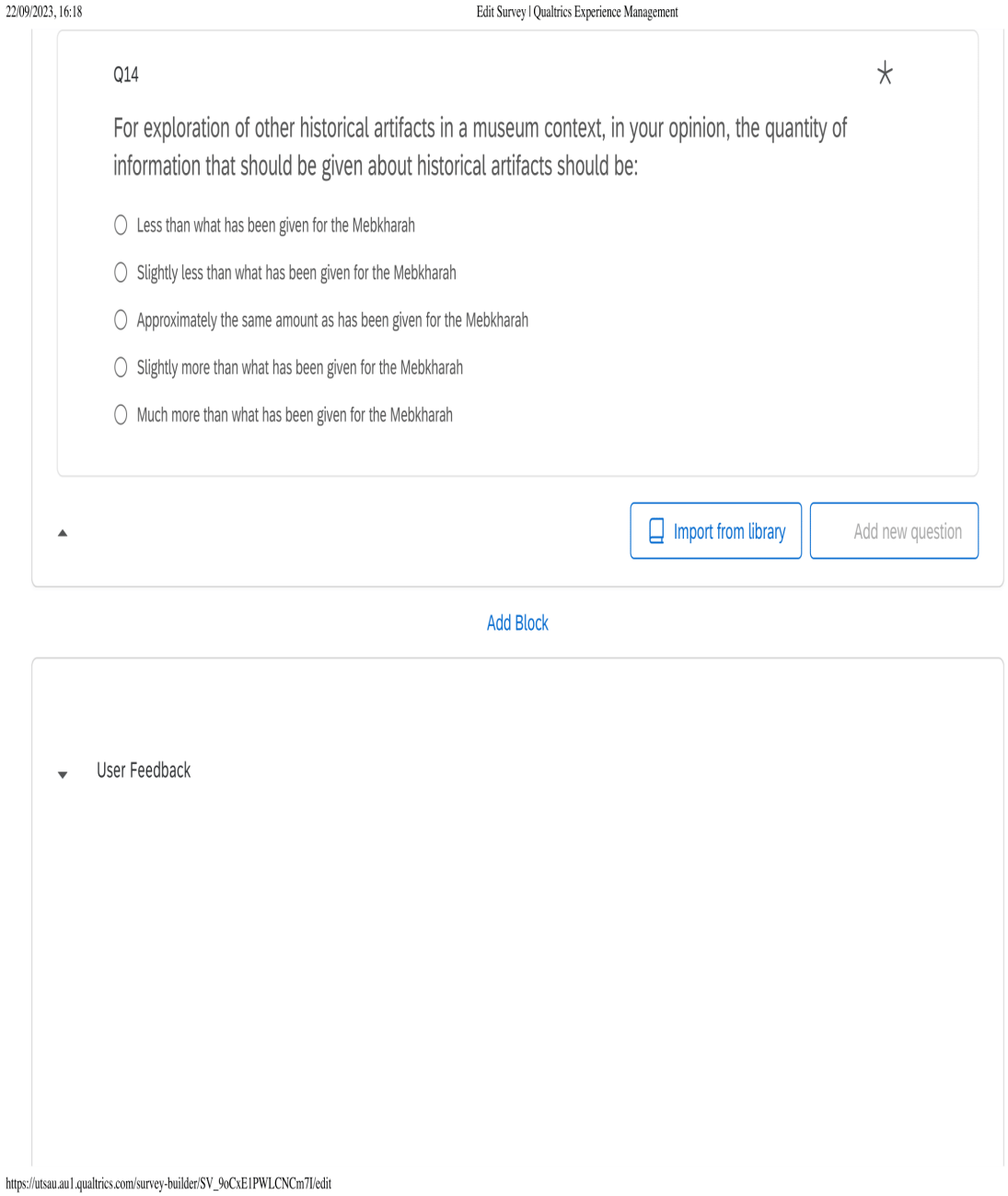
We have seen that the Mebkarah is a heritage artifact used to improve the aroma of the surrounding air. Please rank each of these three media methods in terms of how well they communicated this information to you. (Please select and drag the options to rank your priority)

3D animation	1
2D video	2
Audio	3

Q13

What is most important to you when exploring an historical artifact (please rank them with 1 being most important and 3 being lest important): (Please select and drag the options to rank your priority)

How one uses a Mebkharah	1
What one can use a Mebkharah for	2
What a Mebkharah is made of	3


22/09/2023, 16:18
Edit Survey | Qualtrics Experience Management
Q14
For exploration of other historical artifacts in a museum context, in your opinion, the quantity of information that should be given about historical artifacts should be:
Less than what has been given for the Mebkharah
Slightly less than what has been given for the Mebkharah
Approximately the same amount as has been given for the Mebkharah
Slightly more than what has been given for the Mebkharah
Much more than what has been given for the Mebkharah
Import from library
Add new question
Add Block
User Feedback
https://utsau.au1.qualtrics.com/survey-builder/SV_9oCxE1PWLCNCm7I/edit
18/26

Q15 *

Which one of the three media methods that you viewed in section two of this survey has given you the clearest information about the Mebkharah ?

- 3D Animation media method.
- Audio media method.
- 2D Video media method.

Q55 *

Which one of the three media methods that you viewed in section two of this survey has shown you the clearest information of how to use Mebkharah ?

- 3D Animation media method.
- Audio media method.
- 2D Video media method.

Q21 *

Please rate how attractive you found the explanation for the following media methods (where 0 is not attractive, and 10 is extremely attractive) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q23 *

Please rate how focused you found the explanation for the following media methods (where 0 is not focus, and 10 is extremely focus) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q25 *

Please rate how engagement you found the explanation for the following media methods (where 0 is not engaged, and 10 is extremely engaged) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q27 *

Please rate how comforting you found the explanation for the following media methods (where 0 is not comfortable, and 10 is extremely comfortable) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q29 *

Please rate how enjoyment you found the explanation for the following media methods (where 0 is not enjoyable, and 10 is extremely enjoyable) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q31

When you have seen a historical artifact displayed in a museum,, what do you think is the easiest way to find and explore the use of displayed artifact?

- 3D Animation media method.
- Audio media method.
- 2D Video media method.
- A sign to read
- No Method

Q33

Which one of the three media methods (that you viewed in section two of this survey) do you recommend exploring other displayed historical artifacts in historical locations?

- 3D Animation media method.
- Audio media method.
- 2D Video media method.
- A sign to read
- No Method

Import from library | Add new question

Add Block

End of Survey

We thank you for your time spent taking this survey.

Your response has been recorded.

A.0.4 Phase 3 Registration Questionnaire

Using Augmented Reality to Explore Museum Artefacts

UTS HREC APPROVAL NUMBER ETH194473

" Augmented reality is a way of seeing objects in the device's representation of the environment that does not exist in the real world. e.g. "Pokémon go" Pokémon go is an application that allows you to track some Pokémon's only in the application where they do not exist in the real world. AR also allows the software to add extra images and information so that the real and the digital world are seen together inside the device". Therefore, I'm going to use augmented reality to explore historical artifacts in historical locations. This research is to Investigate the designing of Augmented Reality application that can be used to deliver a better understanding of the use of historical artifacts in Saudi Arabia.

You have been invited to participate in this study because you are at the age between 18 - 60 and you have the experience and knowledge necessary to provide feedback about a tourism augmented reality experience. This AR tourism study requires a range of backgrounds including those who are familiar with Saudi's historical artefacts and those who are not familiar with.

The study will ask each participant to do the following:

1. Sign the consent form

2. Use the application to explore the artifact.

3. Being interviewed by the investigator.

4. filling-in a short survey that will take around 5-7 minutes

The whole process of the study will take approximately 20 minutes of your time . If you are willing to participate, please continue to fill-in the form.

If you have any questions, please do not hesitate to ask.

Rayed Alakhtar,

rayed.alakhtar@student.uts.edu.au

* Indicates required question

Contact Details

1. Full Name *

2. Gender *

Mark only one oval.

- ◯ Male
- ◯ Female

3. Email Address *

4. Cellphone *

Preferences to conduct the study

5. I prefare to be investigated by *

Mark only one oval.

- ◯ Male Investigator
- ◯ Female Investigator
- ◯ No Preferences

6. Days Preferences (You can choose more than one suitable day) *

Check all that apply.

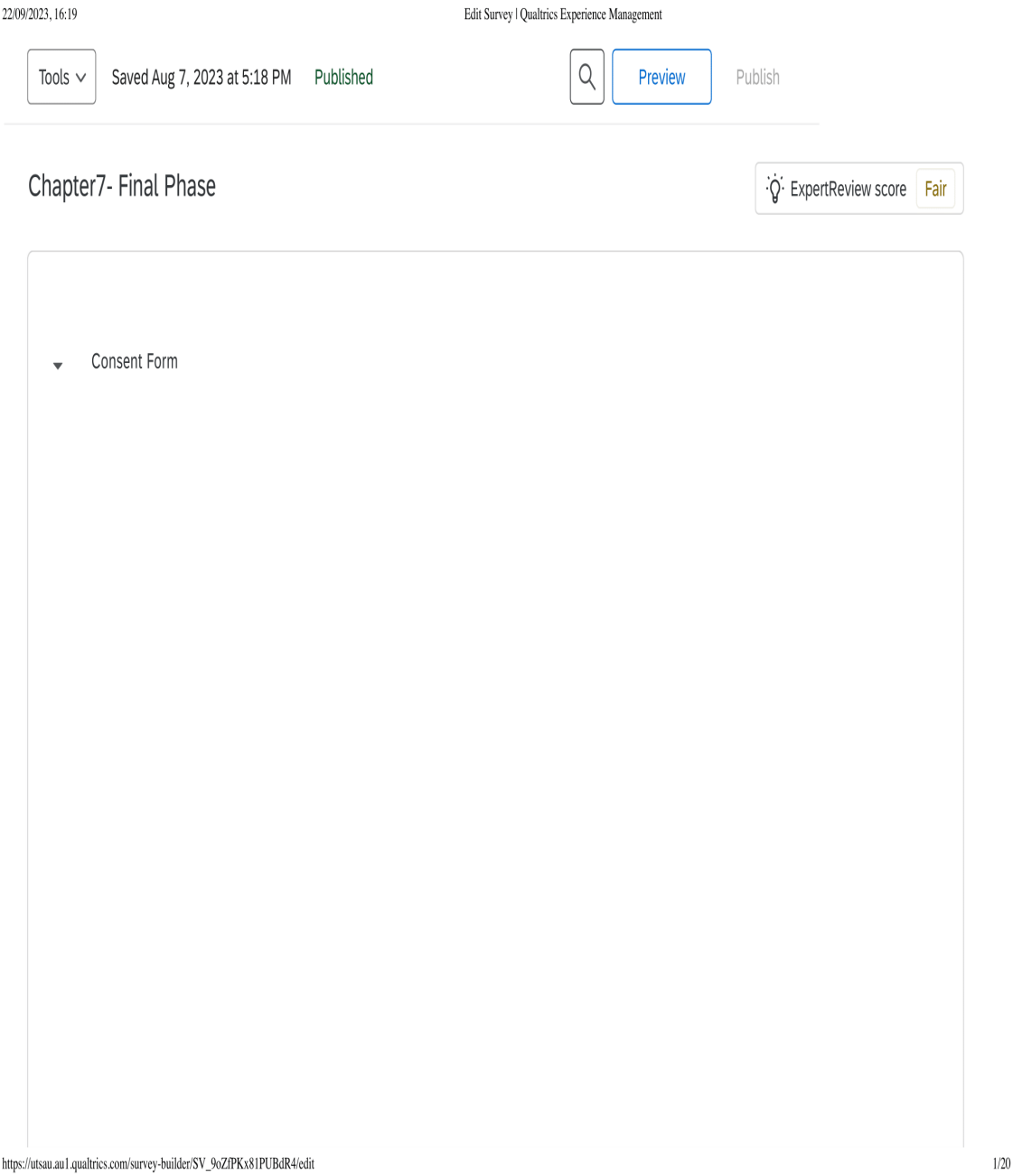
- ☐ Monday
- ☐ Tuesday
- ☐ Wednesday
- ☐ Thursday
- ☐ Friday
- ☐ Saturday
- ☐ Sunday

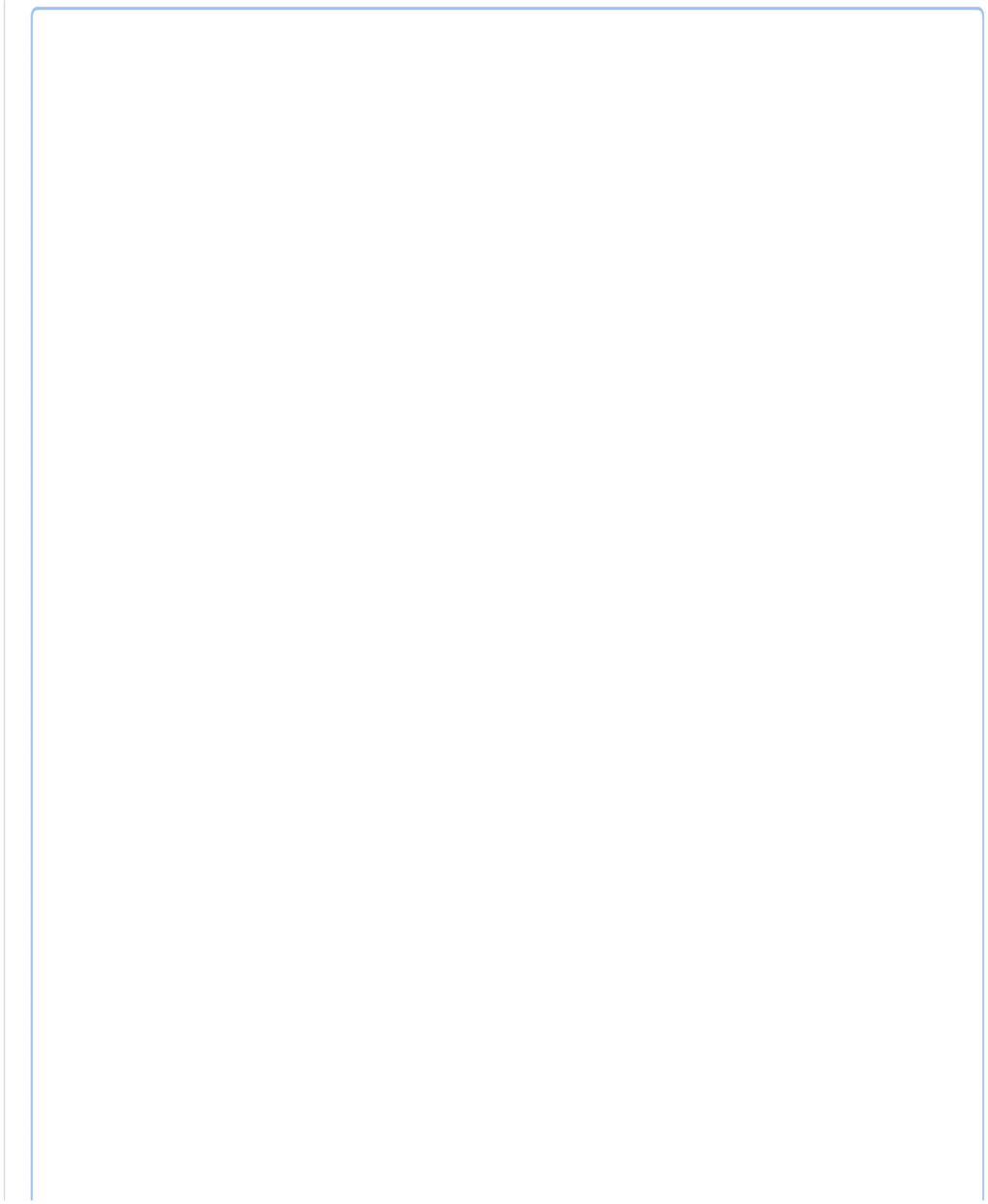
7. Times Preferences (You can choose more than one suitable session) *

Check all that apply.

- [ ] Morning session (anytime between 10 - 11.59 AM)
- [ ] Noon session (anytime between 12 - 4.59 PM)
- [ ] Evening session (anytime between after 5 PM)
- [ ] Anytime no preference

A.0.5 Phase 3 Survey





Consent Form - EN

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

CONSENT FORM

Using Augmented Reality to Explore Museum Artefacts

UTS HREC APPROVAL NUMBER ETH19-4473

I _____ *(participant's name)* agree to participate in the research project *Using Augmented Reality in Tourism Contexts (ETH19-4473)* being conducted by Rayed Alakhtar and Prof. Farookh Hussain at the University of Technology, Sydney.

I understand that the purpose of this study is to understand user needs and expectations when using augmented reality in tourism contexts.

I understand that I have been asked to participate in this research because have the experience and knowledge necessary to provide feedback about a tourism augmented reality experience.

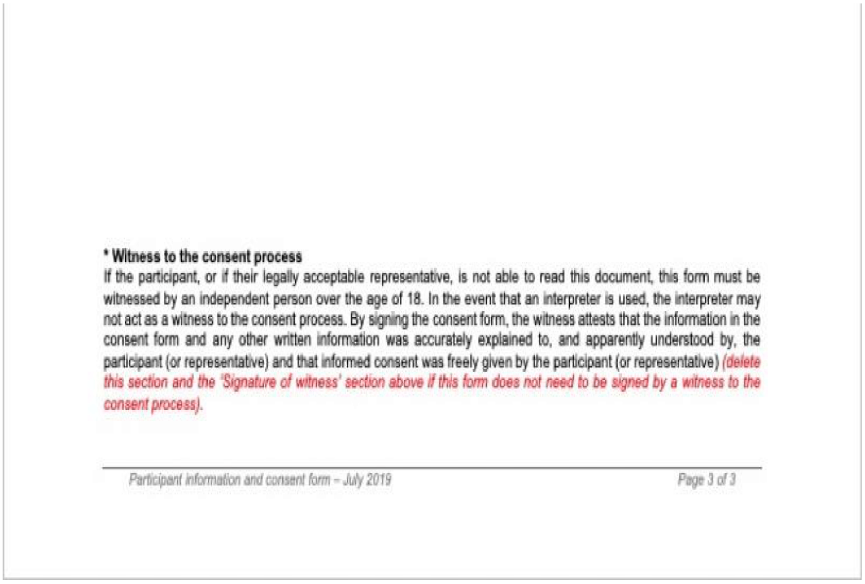
I understand that the total time for the experiment and interview will be around 50-60 minutes.

I understand that I should be in the age between 18- 60 years old

I understand that I will be audio and video recorded during this interview and when using the interactive experience

I am aware that I can contact Prof. Farookh Hussain (farookh.hussain@uts.edu.au) or Rayed Alakhtar (Rayed.Alakhtar@student.uts.edu.au) if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that the research data gathered from this project may be published in a summary form that does not identify me in any way, and it may include anonymous quotes where applicable.



*** Witness to the consent process**

If the participant, or if their legally acceptable representative, is not able to read this document, this form must be witnessed by an independent person over the age of 18. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. By signing the consent form, the witness attests that the information in the consent form and any other written information was accurately explained to, and apparently understood by, the participant (or representative) and that informed consent was freely given by the participant (or representative) *(delete this section and the 'Signature of witness' section above if this form does not need to be signed by a witness to the consent process).*

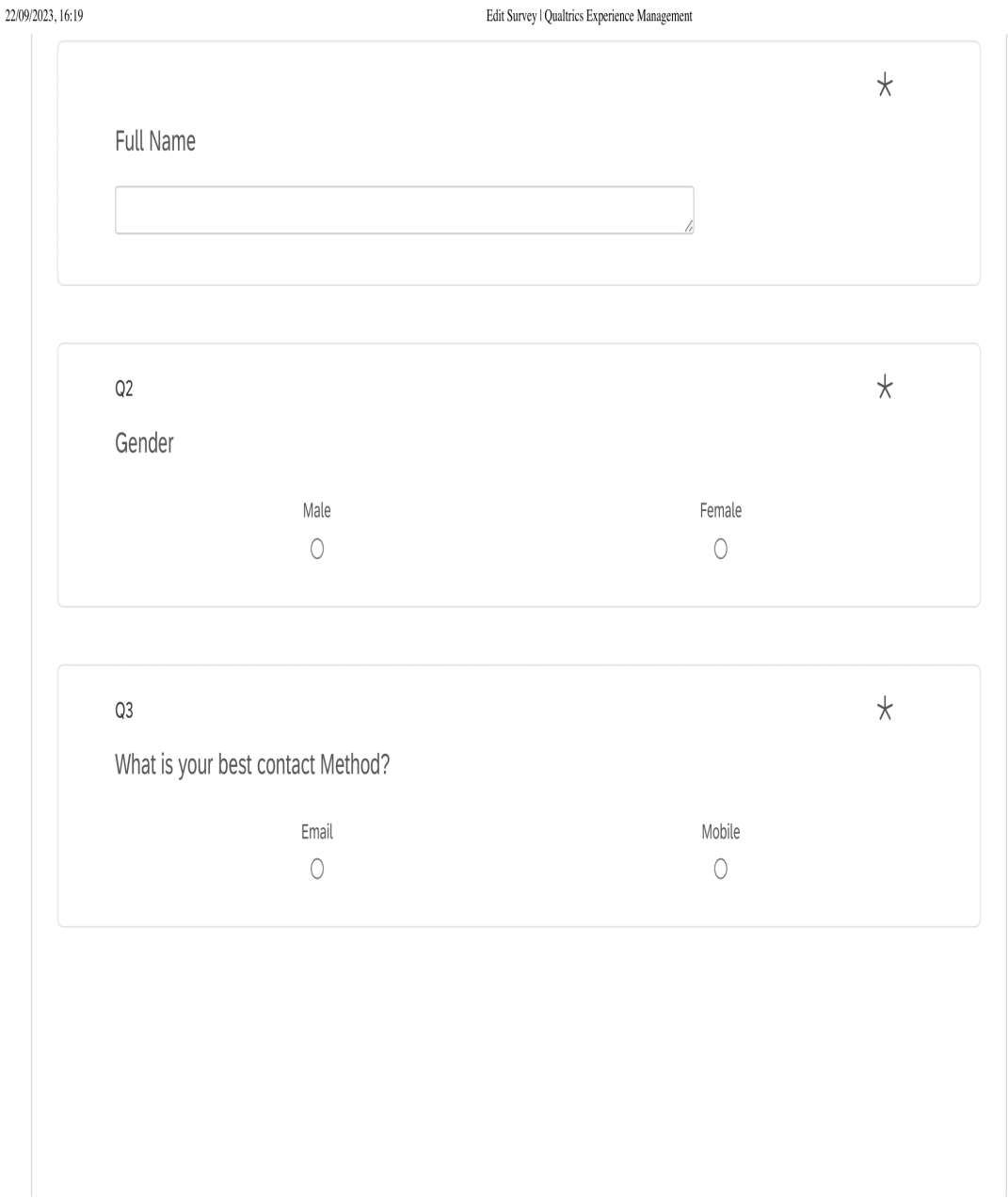
Participant information and consent form – July 2019 *Page 3 of 3*

Q68

I agree that the research data gathered from this project may be published in a form that

- ☐ Identifies me
- ☐ Does not identify me in any way
- ☐ May be used for future research purposes


Q69
Kindly, Sign the Consent Form
SIGN HERE
X
clear
Import from library
Add new question
Add Block
General Informations


22/09/2023, 16:19
Edit Survey | Qualtrics Experience Management
Full Name
Q2
Gender
Male
Female
Q3
What is your best contact Method?
Email
Mobile
https://utsau.au1.qualtrics.com/survey-builder/SV_9oZfPKx81PUBdR4/edit
6/20

Q4 *

Please write your contact method (Type the mobile number or email address)

Q6 *

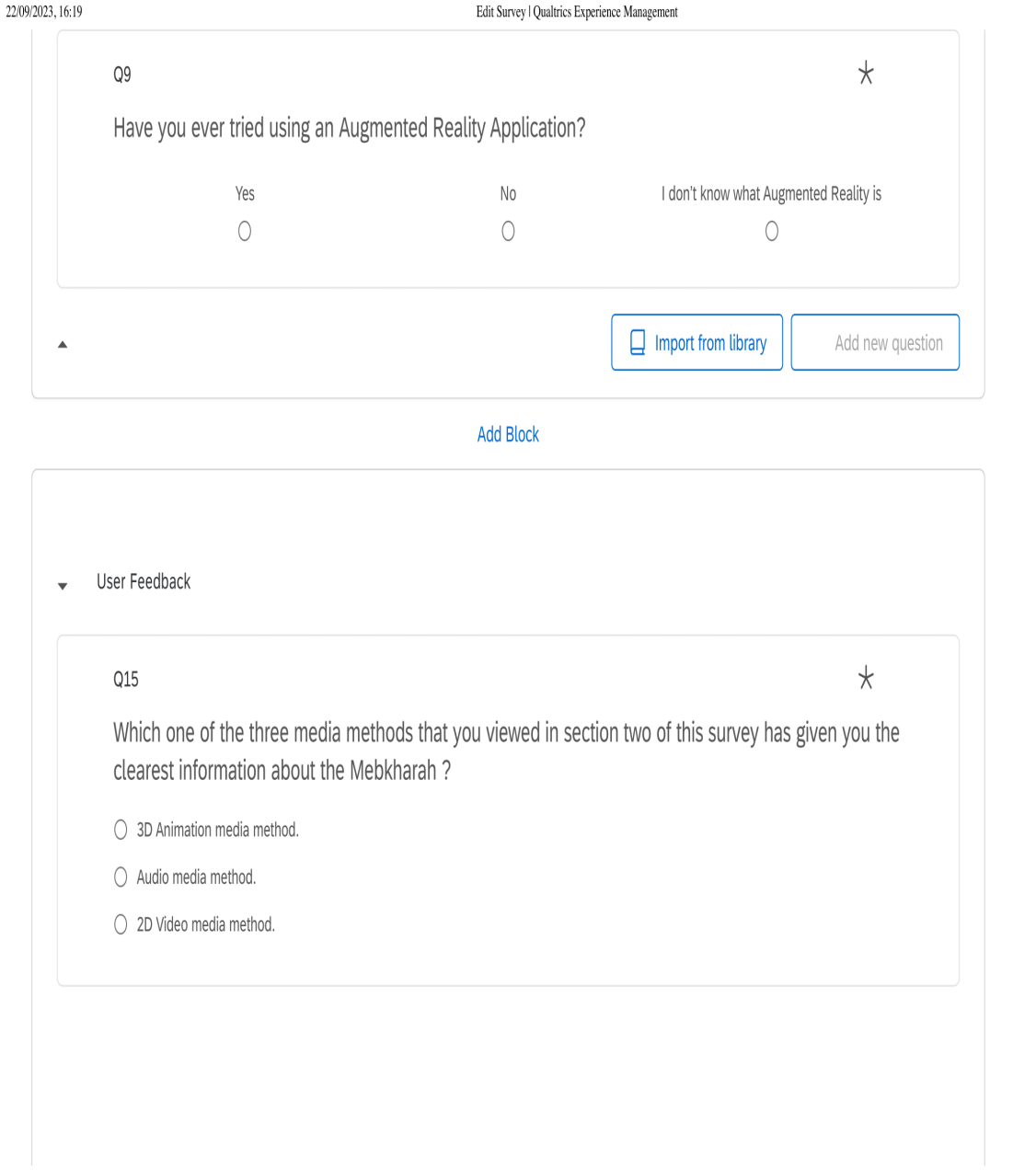
Are you from Saudi Arabia

Yes No

Q8 *

Have you ever been to a historical museum in Saudi Arabia?

Yes No


22/09/2023, 16:19
Edit Survey | Qualtrics Experience Management
Q9
Have you ever tried using an Augmented Reality Application?
Yes
No
I don't know what Augmented Reality is
Import from library
Add new question
Add Block
User Feedback
Q15
Which one of the three media methods that you viewed in section two of this survey has given you the clearest information about the Mebkharah ?
3D Animation media method.
Audio media method.
2D Video media method.
https://utsau.au1.qualtrics.com/survey-builder/SV_9oZfPKx81PUBdR4/edit
8/20

Q55 *

Which one of the three media methods that you used in the experience has shown you the clearest information of how to use Mebkharah ?

- ○ 3D Animation media method.
- ○ Audio media method.
- ○ 2D Video media method.

Q21 *

Please rate how attractive you found the explanation for the following media methods (where 0 is not attractive, and 10 is extremely attractive) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q23 *

Please rate how focused you found the explanation for the following media methods (where 0 is not focus, and 10 is extremely focus) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q25 *

Please rate how engagement you found the explanation for the following media methods (where 0 is not engaged, and 10 is extremely engaged) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q27 *

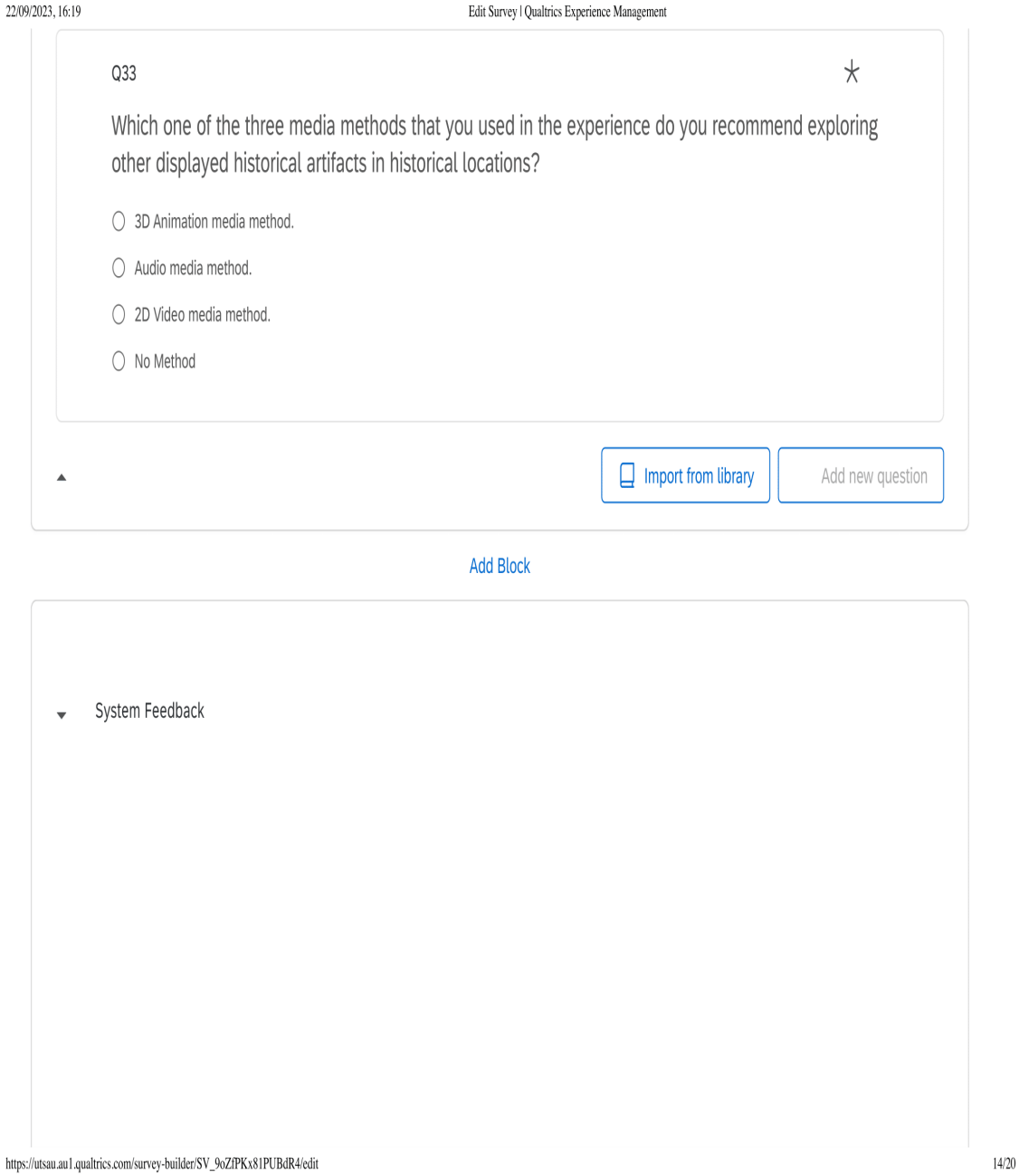
Please rate how comforting you found the explanation for the following media methods (where 0 is not comfortable, and 10 is extremely comfortable) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											

Q29 *

Please rate how enjoyment you found the explanation for the following media methods (where 0 is not enjoyable, and 10 is extremely enjoyable) :

	0	1	2	3	4	5	6	7	8	9	10
3D Animation media method.											
Audio media method.											
2D Video media method.											


22/09/2023, 16:19
Edit Survey | Qualtrics Experience Management
Q33
Which one of the three media methods that you used in the experience do you recommend exploring other displayed historical artifacts in historical locations?
3D Animation media method.
Audio media method.
2D Video media method.
No Method
Import from library
Add new question
Add Block
System Feedback
https://utsau.au1.qualtrics.com/survey-builder/SV_9oZfPKx81PUBdR4/edit
14/20

Q57

I think that I would like to use this system frequently.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q58

I found the system unnecessarily complex.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q59

I thought the system was easy to use.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q60

I think that I would need the support of a technical person to be able to use this system.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q61

I found the various functions in this system were well integrated.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q62

I thought there was too much inconsistency in this system.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q63

I would imagine that most people would learn to use this system very quickly.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q64

I found the system very cumbersome to use.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q66

I felt very confident using the system.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Q67

I needed to learn a lot of things before I could get going with this system.

- Strongly Agree
- Agree
- Neither
- Disagree
- Strongly Disagree

Import from library | Add new question

Add Block

End of Survey

We thank you for your time spent taking this survey.

Your response has been recorded.

A.0.6 Phase 3 Participant Information Sheet and Consent Form

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

PARTICIPANT INFORMATION SHEET
Using Augmented Reality to Explore Museum Artefacts UTS HREC APPROVAL NUMBER ETH19-4473

WHO IS DOING THE RESEARCH?
My name is Rayed Alakhtar and I am a research student at UTS. My supervisor is Prof Farookh Hussain.

WHAT IS THIS RESEARCH ABOUT?
" Augmented reality is a way of seeing objects in the device's representation of the environment that does not exist in the real world. e.g. "Pokémon go" Pokémon go is an application that allows you to track some Pokémon's only in the application where they do not exist in the real world. AR also allows the software to add extra images and information so that the real and the digital world are seen together inside the device". Therefore, I'm going to use augmented reality to explore historical artifacts in historical locations. This research is to Investigate the designing of Augmented Reality application that can be used to deliver a better understanding of the use of historical artifacts in Saudi Arabia.

FUNDING
Saudi Arabia Culture mission is funding my Ph.D research scholarship

WHY HAVE I BEEN ASKED?
You have been invited to participate in this study because you are at the age between 18 - 60 and you have the experience and knowledge necessary to provide feedback about a tourism augmented reality experience. This AR tourism study requires a range of backgrounds including those familiar with Saudi's "old Jeddah City" and those who are not familiar with the region, and therefore you may be asked about your familiarity with this region

IF I SAY YES, WHAT WILL IT INVOLVE?
I will introduce the plan for the study, and then will give you the augmented reality system to experience, and finally I will interview you, in the same house, by asking a series of short questions about your opinions on the use of augmented reality in this context. The total time for the experiment and interview should be around 50-60 minutes. You will be audio and video recorded during this interview and while using the system in the interactive experience. These records will be secured confidentially in the researcher UTS OneDrive and Research Management Data Plan RMDP.

ARE THERE ANY RISKS/INCONVENIENCE?
No major risks are anticipated in my research you will be asked to test the system while standing still in the front of the display artifacts. If you feel like the interview is too long, we can stop or take a break. You may also feel uncomfortable during the interview or being recorded. If this occurs, you can choose not to answer a question, ask me to stop recording or withdraw at any time during the interview.

I will not ask you any personal questions that could compromise your confidentiality.

I will also pay the entrance fees for you.

DO I HAVE TO SAY YES?
Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?
If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. *Data will be secured in a personal computer with a secure lock and requires a password*. The information in the study will be kept strictly confidential and data will be stored securely and will be made available only for academic supervisors and me to conduct my PhD study.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think or my supervisor can help you with, please feel free to contact us:

Prof. Farookh Hussain:
Research Chief Investigator
farookh.hussain@uts.edu.au

Rayed Alakhtar:
Research data manager
rayed.alakhtar@student.uts.edu.au

Huda Alsobhi
Research Co-investigator
hada.alsobhi@student.uts.edu.au

You will be given a copy of this form to keep.

NOTE:
This study has been approved in line with the University of Technology Sydney Human Research Ethics Committee [UTS HREC] guidelines. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au], and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

CONSENT FORM
Using Augmented Reality to Explore Museum Artefacts
UTS HREC APPROVAL NUMBER ETH19-4473

I _____ *(participant's name)* agree to participate in the research project *Using Augmented Reality in Tourism Contexts* (*ETH19-4473*) being conducted by Rayed Alakhtar and Prof. Farookh Hussain at the University of Technology, Sydney.

I understand that the purpose of this study is to understand user needs and expectations when using augmented reality in tourism contexts.

I understand that I have been asked to participate in this research because have the experience and knowledge necessary to provide feedback about a tourism augmented reality experience.

I understand that the total time for the experiment and interview will be around 50-60 minutes.

I understand that I should be in the age between 18- 60 years old

I understand that I will be audio and video recorded during this interview and when using the interactive experience

I am aware that I can contact Prof. Farookh Hussain (farookh.hussain@uts.edu.au) or Rayed Alakhtar (Rayed.Alakhtar@student.uts.edu.au) if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that the research data gathered from this project may be published in a summary form that does not identify me in any way, and it may include anonymous quotes where applicable.

I agree to be:
☐ Audio recorded

I agree that the research data gathered from this project may be published in a form that
☐ Identifies me
☐ Does not identify me in any way
☐ May be used for future research purposes

_____ ____/____/____
Name and Signature [participant] Date

_____ ____/____/____
Name and Signature [researcher or delegate] Date

*** Witness to the consent process**
If the participant, or if their legally acceptable representative, is not able to read this document, this form must be witnessed by an independent person over the age of 18. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. By signing the consent form, the witness attests that the information in the consent form and any other written information was accurately explained to, and apparently understood by, the participant (or representative) and that informed consent was freely given by the participant (or representative) *(delete this section and the 'Signature of witness' section above if this form does not need to be signed by a witness to the consent process).*

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