

Preserving Cork City's cultural heritage with Augmented reality

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Declaration of Originality

In signing this declaration, I am confirming in writing that this submitted work is entirely my own original work, except where clearly attributed otherwise, and that it has not been submitted partly or wholly for any other educational award. However, aspects of this dissertation have reasonably emerged from and followed from the digital project plan submitted for DH4002.

Therefore, I declare that:

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1. Introduction

Augmented Reality (AR) is revolutionizing various industries and, as a result, the world at an exponential rate. Although some younger and older generations may not be familiar with it yet, its gradual growth will soon impact all industries, guiding and teaching future generations. However, questions like the ones I will be exploring in this dissertation arise: How would AR will drive change, what improvements will it present in light of conservation and preservation of cultural heritage and how does it coincide with Digital Humanities.

Through the progression of this dissertation, these questions will be investigated via exploration of AR's relationship with technology by taking a look at its evolution, highlighting its growing importance, as well as AR's relationship with technology by touching on its evolution and highlighting its growing importance as well as its potential to transform the field of Digital Humanities.

To fully understand the impact of augmented reality on the digital world, it is important to examine its relationship with technology and how it has evolved over time. By looking back at AR's development, we can better understand its transformative power and potential implications for the future of Digital Humanities.

Especially speaking with regards to Digital Humanities, I find it particularly fascinating how limitations and more conservative approaches can be pushed further to re-discover new entities and prove to be functional, especially speaking of how it can be applied to real-world elements and problems. The importance of AR and how it has the capacity to play a prominent role within Digital Humanities by means of digitization and employing a cultural heritage preservation perspective.

As a result, the purpose of the artefact that I will be contributing towards is to make cultural heritage more accessible to the general public while also serving as a tool for digital storytelling. The aim is to educate people on the usage of AR technology. By explaining how to interact with it and what precautions to take. In addition, I will produce engaging content that explores culturally significant areas within Cork City. These new editions will delve into the city's historical background, and the use of multimedia elements will not only preserve its heritage but also make it much more educational and engaging.

2. Background

The birth of AR happened in 1968 thanks to Ivan Sutherland, the "father of computer graphics". The initial concept started with an AR-head-mounted display system that was later utilized by university laboratories and national agencies. (Javornik 2016) The next surge movement occurred in the year 2008 when the first commercial AR application surfaced for agencies based in Munich for advertisement purposes as they designed a printed magazine for a BMW Mini Car. (XMReality 2021)

Followed by the phenomenon that demonstrated AR's true potential and was adopted by mainstream culture, which was the publication of Pokémon Go in the year 2016. Not only did this advancement unveil the true potential of AR but it also opened a gateway for the gaming industry and encouraged many more companies to adapt and pursue these capabilities.

While VR (Virtual Reality) is a very promising software and is a much more universally recognized application, it has been used for assessment purposes and for the treatment of mental health disorders and has the capability to simulate intangibles. It has shown its potential to facilitate virtual tourism in cases of a worldwide pandemic such as in the case of the coronavirus. Perhaps the most prevalent example would be the use within the gaming sector. Not only does it enhance user experience in regard to immersion, it also provides a much more interactive experience. (Paul 2021)

VR may provide a more immersive experience for the user and can be utilized not only in disciplines such as gaming but also in training and education. In some cases, this can be viewed as a significant advantage. As it has the 'potential to move education from its reliance on textbook abstractions to experiential learning in a naturalistic setting. For example, rather than reading about a historical event, students are able to participate in the event and interact with simulated people in historical eras. Eventually, it will lead to an emphasis on learning via symbols. As people would be able to comprehend images much more quickly than they can grasp columns of numbers or lines of text.' (Helsel 1992)

However, despite its capabilities and future prospects, it has to offer, one has to consider the monetary burden that comes with it. As for full VR gear, including the headset and controllers, one can be looking at a price upwards of €280 or even for the best models currently available. This makes the technology being unaffordable for many, more so for the best model currently. Which, in some cases, not all individuals may be able to afford. Further on, the disadvantages of the headpiece vary from not being practical for long-term wear. The device may feel heavy for users after prolonged use and may not fit perfectly on the face universally. (LIPSKI 2023) Additionally, many people experience motion sickness while using VR. Pursuing an artefact with a VR component would pose great accessibility concerns in terms of hardware requirements and accessibility constraints however, this is not an issue with AR.

When it comes to AR, the application can be run via smartphone. It would work with the surrounding environments and create an overlay display for the user, all of which can be achieved by a smartphone device. This, in turn, rules out the accessibility concern for the majority of potential users. As in the case of AR technology, you only require a smartphone device to utilize the application, nothing more.

Additionally, AR is best suited for entertainment and exhibition purposes. As AR not only gives an immersive feeling but is also appealing because it combines the real and virtual worlds (Furht 2011). In some cases, users may find it a much easier tool to use and navigate as they would already be familiar with the initial device, unlike getting used to a completely new one.

Furthermore, location-based e-learning provides a personalized learning experience and helps keep the learners engaged in the learning activities, enhancing their effectiveness. (Qing Tan 2015) All while making the use of AR a more suitable choice in this case.

Just from a personal perspective, when I first asked my peers who do not follow up on many technological advancements what they knew of AR and how they felt about it. The majority responded with uncertainty and proceeded to Google, searching for relevant sources to learn more about it. I would argue in this instance that it's not necessarily the lack of information on AR but rather how it's perceived by the general public that causes this lack of information. The main catalyst for this issue is the invisible misinterpretation between VR and AR. Some people mistakenly interpret AR as VR or think there is no major significance between them. Followed by minor elements that contribute to the lack of awareness of AR. This brings me to the point that what AR lacks is not only awareness through the means of advertisement but also it lacks a user-focused design. Concerning user experience, ensuring that the technology is seamlessly integrated into user's lives and enhances their actions. (N. Kumar 2023)

Additionally, potential misuse of the technology has individuals hesitant to embrace it. Especially, concerning the surveillance of others, slight manipulation, and overlaying of AR content. Followed on potential risks of blackmail where users can not only have access to their precise location but also carry out data mining procedures all while putting users at risk. (Tantsiura 2023)

Interacting with AR-related applications does pose some risks. However, it goes without saying that even making a simple online purchase also carries some risk factors. But just like that, risks can be reduced by not only the implementation of tighter security measures but also by bringing regulations and awareness to those who aren't educated within the field. Following to the point where, in the case of AR, the market itself is considered to be a 'learning curve'. As there is no concrete 'regulation that designates what is allowed and what is not in the augmented reality environment.' (Tantsiura 2023) It does indeed pose some initial concerns. However, one should not be discouraged but rather should take these issues and potential downfalls as opportunities for improvement, and explore the challenges they offer. Just like the AR 3D technology that Google has adapted to 'Experience 3D & Augmented Reality in Search'. From the comfort of their own home, users are provided with the opportunity to learn about cultural heritage places as well as animals and insects by utilizing the Google search bar. Engaging with it through their smartphones, users can experience the animals at the scale they would be in the user's personal environment. Furthermore, the users would also be presented with some broad information in the instance of the animal, the sounds they make, and finally, information about their habitual backgrounds.

Concerning cultural heritage from the perspective of preservation and digital humanities. The relationship that it fosters falls to the importance of safeguarding the rich and irreplaceable heritage and history. This is not only from the perspective of industrialization but also changes that took place over time and, in return over time, have modelled places and cities to how we see them nowadays.

The concepts such as protection, preservation, conservation, restoration, and renovations are associated with actions taken to save and maintain cultural heritage. In response to the purpose of this dissertation, I look to evaluate the significance of adapting to these measures.

In some computerized systems, the zones or degrees of protection can be visualized, for example, in those based on Geographic Information Systems (GIS). Protection is also implicit in preservation and conservation in the broad sense of these terms (Remondino 2016). Various strategies and practices are implemented to safeguard resources for future generations. These strategies are crucial for the sustainable management of nature and cultural heritage, ensuring that precious assets are preserved and enjoyed by those who come after us.

3. Analysis

3.1 Introduction

The application of AR can be utilized in many manners, as seen from the promising games and applications. It is important to delve more into the intricacies of why, for instance, the implementation and running of the AR web application on a smart device, such as my artefact, proves to be suitable. By first exploring location services and their underlying technologies. Then, we will shift our focus to the preservation of cultural heritage for future generations.

3.2 Location Data and Technology Assessment

AR and location-based services provide a framework for users through the implementation and use of mobile devices integrated with AR. As by the use of smartphones ‘more and more information are enriched with geodata and thus can not only be presented in a virtual space, but in real, mobile contexts and in a context-sensitive way adapted to the user's preferences.’ (Sagaya Aurelia 2014) The popularity of mobile phones has increased by 86.5% and is projected to increase even further, close to seven billion by the year 2024.’ (Lin 2023) In response to the statistics, it is reasonable to develop an artefact as a web application as opposed to a device-specific application. It is anticipated that the usage of smartphone devices is going to grow significantly, therefore making it an ideal source to host an AR web application given the nature of universal ownership of smartphones.

Furthermore, the combination of AR and location-based applications not only offers a user-centric approach through smartphone devices, but the rapid growth in smartphone usage supports the decision to create the artefact as a web application accessible to a broader audience.

Adding to the point that due to this exponential growth in the consumption of mobile phones, AR is entering the scope of the mobile domain. In this context, one can argue that the application of smartphone devices is compatible with its integrations, such as cameras and sensor technologies, just as GPS and orientation sensors.

It provides users not only with a more streamlined experience but also the convenience of having their smartphones geared up with the software and hardware specs such as high-resolution, full-colour displays, high-speed networking, high computing power, and finally dedicated 3D graphics chips. (Sagaya Aurelia 2014)

To further my point and justification, the integration of AR offers smartphone devices not only possibilities but also ubiquitous contexts and activities for users without having to be tied down to stationary locations and carefully conditioned environments, such as within medical fields or even manufacturing fields. The benefit that AR encompass is that it can be seen as a local search engine for the information embedded in the environment, while also providing a tangible interaction metaphor for utilizing the realms of digital information. However, the limitations it has, is that it provides a rather limited display size as well as a limited field of view. Which ties into the size of the smartphone device one acquires. (Sagaya Aurelia 2014) From a different perspective of technologies and their capabilities of preserving cultural heritage, the technology of GIS plays a prominent role in this discipline.

According to D. Randall-MacIver's studies, which coincidentally forever altered and affected the course of events in his field. He concluded that the ruins of the Great Zimbabwe were not built by the Israelites or the Arabs but rather by the Native Africans. Nations and ethnic groups, including ones of tribal and aboriginal heritage, in Africa, Asia, America, Australia, and Greenland have started to protect their sites. Now, the ruins of the Great Zimbabwe, a World Heritage Site, with its large enclosure, can also be viewed virtually through a 3D model produced by the Zamani project. (Michael Doneus, Three-dimensional view to the past 2016)

As a result, the practice of the integrated documentation of monuments includes not only the acquisition of all possible data concerning a monument which may contribute to its safeguarding in the future. But also, data that includes historic, archaeological, and architectural information, but also administrative data and past drawings, sketches and photos. (Michael Doneus, Cultural heritage 3D documentation 2016)

From a different perspective, 3D modelling has brought in a new scope for the availability of not only technologies but also methodologies that have left a rather promising impression in digitally recording heritage sites and objects. Communities not only benefit from this from the perspective of the adaptations of these approaches, but also due to the fact that the implementation of 3D modelling can be an extremely powerful tool in identifying, monitoring, conserving, and the restoration of pieces of history. These might, in turn, unveil hidden cultural heritage that is being affected by agricultural work and economic changes, such as expanding infrastructure, and are constantly vulnerable to destruction. At the landscape scales, digital 3D modelling and data analysis allow site managers and archaeologists to not only conserve and protect but also carry out integration processes without disruptions. (A. Rizzi 2007)

3.3 Preservation through Digitization

Threats such as extreme weather, global warming, and accidental fire incidents are the main reasons why museums and exhibitions are currently at risk. I would like to highlight the importance of cultural preservation and awareness of digitization and how it can play a key role in rectifying this issue. And so, through the implementation of my artefact, I will demonstrate how not only archiving but also digitizing information to make it more accessible to the public provides a suitable solution for the preservation of the cultural heritage and history of Cork City.

In a different context, fire accidents that result in artefacts and relics being forever lost due to damage and the lack of digitization also pose a justification for the importance of my artefact. Mentioning two catastrophic examples of such events in support of not only the preservation aspects that come into play but also the importance of preserving and digitizing cultural heritage. Not only does it prove to be a reliable source that cannot be easily damaged, but if it were to be put out on display, such as a painting or as a textbook, flames can easily engulf and forever destroy it. But rather have it made available to those who do not have easy access to such resources by applying it to an AR web application.

As the monumental and historical building, the Notre Dame got engulfed in a blazing fire that lasted for 8 hours the '19th-century spire and nearly all of the cathedral's 12th and 13th - century oak frames were burned which consisted of the frame wood hewn dating back to 1160's which was the oldest in the whole of Paris. (Keller 2019)

Following onto artworks and artefacts such as the depiction of a Gallic rooster being damaged, a grandiose organ consisting of 8,000 pipes while not directly affected by the fire but rather by the water damage that it has been exposed to. Four large-scale 17th and 18th - century paintings which were known to be depicting the apostles. A fragment of the 'Crown of Thorns' along with relics of two saints are known to be destroyed. (Katz 2019) All of these relics, unfortunately, cannot be restored to their original form and are forever lost. This brings me to the point of the importance of digitization and how it can be applied and, be useful for future generations.

Following onto a recent example where a fire accident not only damaged the Wyeth Art Gallery, which is based out in Maine, USA, but forever destroyed art pieces which can never be recovered, such as paintings from the artists known as Jamie Wyeth. Pieces such as 'Snapper', 'With Green Peppers and Red Tail Hawk', and NC Wyth's illustrations from Henry David Thoreau's book known as 'Men of Concord' (Reporter 2023) are forever lost to the blazing fires and have become ash.

Therefore, this leads me to conclude that adaptation of the practice of digitization and its application within different disciplines is of high importance. In return, inviting in a wider audience results in access to knowledge being much easier and more universally attainable. In

cases where unpredictable environmental or human-made accidents are to happen, we are ensured that backup of invaluable pieces of history does not get lost.

Returning to the discussion of AR technology applications, there are compelling examples that highlight its diversity and how it is applied to transformative uses.

Within the instance of the potential of AR technology being utilized within museums around the world. The most prevalent example would be the “Skin and Bones” mobile application, which has been introduced within the Smithsonian National Museum of Natural History in Washington, D.C., USA. For visitors to get a glimpse of how some specimens would have moved and looked when they were alive. The mobile application has catered for ‘each animal choice has a menu of immersive audiovisual experiences, including videos, animations, and activities’ and allows ‘visitors to watch an eastern diamondback rattlesnake skull sink its long fangs into a virtual rodent or play a game that challenges them to identify bat species by their calls.’ (Lavery 2015)

The mobile application features 13 skeletons with superimposed images reconstructing the creatures and allows users to gain interactive insight into skin, muscle, and coordinated movements. This interactive experience not only enhances user’s knowledge but also aids in artefact preservation and increases information accessibility by offering a dynamic digital platform for learning and analysis.

Furthermore, it can present a unique glimpse into the history of the pieces and helping displays come to life. For instance, users can see and experience a vampire bat take flight or an anhinga demonstrating how it would have fished. (Coates 2023) As a result, the application serves as an optimal demonstration of enhanced user engagement and understanding. Essentially, the mobile application combines education with interactive features, allowing users to learn about the past in a visually captivating and engaging way while also promoting the preservation of historical artefacts.

As we can see, AR technology, has emerged as a fascinating tool for cultural innovation at museums. Whereby it has transformed standard exhibitions into immersive and interactive experiences, but also by bringing extinct species to life, just as the National Museum of Natural History in Paris, France, was able to do.

By launching the project ‘REVIVE’ in the year of 2021 and adaptation of AR lenses with the collaboration of SAOLA studios, visitors are presented with a passenger pigeon which vanished at the beginning of the 20th century accompanying visitors on their journey around the museum and telling the story of extinct mammals such as the dodo, great sabre-toothed tiger, Steller’s Sea cow, Tasmanian tiger and many more. As visitors embark on this journey, the experience in itself also sheds light on current species suffering from anthropogenic pressure and tells us about the good practices of indigenous people from whom we can draw inspiration from. (Saola Studio n.d.)

For example, projects that followed a similar trend with regards to the adoption of AR technology, the platform ‘Dublin Discovery Trails’, which was created by Fingal County Council, where potential users are able to take a step into the ‘Doors into the Docklands’, its niche design and implementation through smartphone devices. Users are in for an immersive

experience through the use of AR at popular sites and attractions all while uncovering the compelling history of Dublin's culture. 'From not only telling the story of Captain Bligh from the year of 1800 but also being part of a 360-degree view of the Custom House fires blazing in the year 1921.' (Conlon 2023)

To further this point, Paul Keeley who is the Director of Regional Development at Fáilte Ireland stated during the launch of the application that 'this interactive Augmented Reality heritage trail will also help improve visitor flow to the area and will encourage visitors to stay longer both during the day and into the evening, further spreading the economic benefits of tourism to the local businesses.' (Leonard 2023)

An extension of the project was later launched, which not only covers Dublin city but also covers the area of Castleknock and Balbriggan where users are not only able to enjoy the histories and cultures but also the beautiful nature that it has to offer to locals and to tourists. (castleknocktidytowns 2023)

This brings me to the point of how the technology of augmented reality can be applied to both our cultural legacy as well as serve the public an immersive experience for potential users within Cork City. Which in return would also benefit the focal point of the preservation and archiving. As well as being accessible to users, based on my research, there is no application that tells the cultural heritage as well as the historical background of Cork City the way the previously mentioned applications have.

While locally, there is already an evident trend of utilizing the technology of VR within Spike Island in Cobh. Where users can take a step back into the history of Spike Island in 600AD to the prison riot in the years of 1980s. Not only does this new opportunity give users an interactive experience, but also, in return, attracts a 'world-class experience to the region and will further enhance tourism offerings and provide an economic boost for the region'. (Graham 2022)

A recent project within the discipline of Marine Geoscience research within UCC has taken a different approach by the approach of utilizing the technology of AR by means of developing a mobile application.

Cold-water coral reefs have a considerable role in the biodiversity of deep-sea environments, but they are subject to climate and anthropogenic threats. The use of remotely operated vehicles in combination with three-dimensional modelling, as well as AR, has enabled detailed visualisation of terrestrial and marine environments while promoting data accessibility and scientific outreach. By using structure-from-motion (SFM) 3D photogrammetric data and AR for the visualisation of cold-water coral reefs. The mobile application was developed to display 3D models of cold-water coral reefs from the Piggington Mound area, southwest of Ireland.

Their results indicate that the combination of 3D reconstructions of higher resolution SFM, AR, and mobile phones is a promising tool for not only raising awareness and literacy regarding cold-water corals and deep-water habitats but also showcasing cold-water coral habitats accessible to anyone from anywhere. (De Oliveira 2022) Resulting in an application that serves as a tool for visualizing the seafloor using smartphones.

There are promising projects being done locally by groups such as Digisoft that focus on software applications and are currently in the midst of pursuing work on applying applications to VR within workplaces, museums, and building sites to expand accessibility and knowledge. Companies that are further out, such as UtilityAR, which is based in Dublin, Ireland, focus on implementing and introducing new technologies for adapting to the new norms of working remotely. By the implementation of AR technology integrated within a pair of glasses. The company aims to ensure that speed, accuracy, safety, and data management are achieved by the collaboration of employees from various disciplines and work environments. It is evident that the technology of AR, especially within the discipline of working environments, is proven to be useful and effective.

3.4 Conclusion

In conclusion, having explored the potential of AR applications on smartphones for enhancing cultural heritage experiences. By using location services and 3D modelling, AR can digitally record heritage sites and objects, thus significantly enriching the benefits of location services. This technology enables users to have a more streamlined and engaging exploration, which can be accessed through the convenience of their smartphones. Furthermore, speaking about the protection of cultural heritage, AR proves to be an efficient tool to safeguard artefacts, relics, and historically significant buildings, which are tangible representations of our past and for future generations. As we previously analysed, these valuable treasures face threats from both natural and unnatural causes, including human-made ones. Nevertheless, current companies and projects are having a positive impact on this matter.

4. Literature Review

4.1 Introduction

Augmented reality continues to push the boundaries of interactivity and technology combined. There is no doubt that within the next few years, society as a whole will soon begin to traverse the digital way by the use of AR especially within the discipline of cultural heritage. Cultural heritage is part of who we are and what we have become and evolved over thousands of years through the evolution of culture, arts, and history. It is part of our own personal connection to the past and part of what forms our identities. Therefore, the importance of that heritage is indescribable. Every cultural norm is part of that cultural heritage identity that we carry with us in our daily lives and the preservation of that can be simply invaluable.

4.2 Similarities and Disparities

There was a royal interest in protecting certain historical buildings dating back to the earliest years of the 16th century. As in Renaissance Europe, within classical culture people's attention was focused on the scholarly world. But the more remote countries in Europe also paid attention to their own cultural heritages in the form of their prehistory, sagas of varying origins, and the alike. These nationalistic currents existed in Sweden as early as the 15th century. (Seling 1994) Which nowadays translates to a more digitized approach to preserving cultural heritage sites by means of using computer-generated systems and applications.

And while 'the reconstruction of cultural heritage sites typically is a time consuming and costly process. In addition, the possibility of damage to the remains during construction needs to be considered. With AR reality technology, it is possible to place 3D models that are designed following the originals on top of the ruins in cultural heritage sites without physically reconstructing areas. Using this technology for cultural heritage sites will be a very advantageous process to protect the remains and to save the time and cost of reconstruction. (Geroimenko 2021). It is said with the outmost emphasis that 'cultural heritage visits can be enhanced by showing 3D models of ruined ancient buildings on site. Historical structures built by ancient civilizations have often been destroyed or ruined by wars, earthquakes, and other disasters. Physical reconstruction is required to return these structures to their state when they were built. However, this is a very laborious and presumably costly process. Instead, it is much easier and presumably cheaper to superimpose virtual models designed in a computer environment on historical buildings or sites.' (Geroimenko 2021)

The risks and challenges faced by cultural heritage sites have not only proved to be a prominent issue but also significant and pressing manner. Therefore, the implementation of technologies such as AR can not only significantly alleviate the impact of current pressures on cultural heritage sites, but also eliminate some of the risks and challenges they face together. In return, being a depiction of traditional practices being shifted into more sustainable and efficient practices, all while embracing potential virtual reconstructions but also preserving the remnants of past civilizations for future generations to experience.

Exploring the capabilities of digital storytelling with the integration of AR and cultural heritage would prove to be a resourceful endeavour. As users would not only be provided with the connection to AR technology but also become part of an established world whereby a narrative model is followed alongside the real world where users can freely explore their surroundings in a non-linear way. Resulting in a 'point-of-view-based exploration that would involve the user in a first-person game experience, where, in return, they can delve into a story through the use of a web application. Space-based exploration, where the user can activate the playback of storytelling content that is associated with frame landmarks or markers in a real-world space. And ontological interaction, which has the possibility to alter the plot or the world of augmented reality narrative'. (De Paolis 2022) Resulting in an audience that can be in a 'more critically engaged with visual content' by means of 'recognizing the exploitative potential' (Topouzova 2021) by means of adapting to the use of smartphones that are integrated with AR web applications that not only provide a rich source of information for digital storytelling but also provide an enjoyable way of learning and enriching the knowledge of generations.

With regards to the cultural fields the technology of (SAR) Spatial Augmented Reality has "demonstrates its full potential by acting as an attractive mediator between users, cultural heritage, and urban context of reference. The aim is to exploit SAR together with other innovative contemporary techniques, in the functionality of a story that sees its protagonists in local people and traditions. Video mapping can foster new forms of urban awareness of architectural heritage. In return, SAR as a technology is very promising as it allows the simultaneous participation of multiple users in an enriched sensory experience, which, on one hand does not require the use of display devices for the use of the cultural asset, and, on the other hand, allows a genuine and shared visual enjoyment of the asset itself. Both spatial augmented reality and augmented reality can be used to narrate the story of a building of historical and artistic interest, as the narrative can begin as a projection on the outside and continue inside with an "augmented" tour of particular points of interest." (Doriana Cisternino 2021)

After touching on the nuances of the creation of AR applications should be followed by focusing on the importance of standards that need to be accounted for as 'guidelines for AR application development can go a long way into creating a taxonomy of applications of work. An AR tour for a museum exhibit can be entirely different from a similar tour of a city that includes cultural heritage sites. A set of guidelines that separate and distinguish various methods, frameworks, and practices will make it easier for both developers and stakeholders to choose and create the application that best suits them, with the tool best suited for a particular task. Quality is also a major attraction in an application that relies heavily on visuals, therefore some standards need to be set.' (Economides 2022) All while considering of taking into practice the visual-centric applications to ensure a captivating and high-quality user experience especially as 'AR can also substitute tourist guides by providing interpretation tourist guides by providing interpretation to tourists who are not well versed in local languages.' (Priyakashna Mohanty 2009)

It has been found that AR applications also add value to the heritage and destinations as they influence the destination's publicity content creation and are, in return, essential tools for tourism marketing management. Hence, their addition to communication strategies, means that tourist destinations are becoming much more appealing to tourists, in turn setting themselves apart from their competitors. Increasingly introducing these technologies to further promote the tourist experience has demonstrated that AR heritage enhances memorable tourism experiences. (Iglesia 2022)

On the note of interactivity and passing on cultural heritage within the discipline of craftsmanship. In a recent project, which focused on scanning objects, the system will get information about an image and, in return, would output a virtual 3D- lantern making a short video of how to make lanterns through AR applications. 'As there is a large variety of precious tangible and intangible cultural heritage during the long history of China. Protecting cultural heritage has always been a focus for not only social media platforms but also academic research. While lanterns are one of the most important elements in Chinese traditional festivals, such as the Lantern Festival. Lantern lights not only represent a bright future and family fortune but also a commemoration of people's memory and personal association with the ancient festivals.' (Xin-Zhu Li 2022)

When applied, it can be seen how AR's affordance of interactivity works well with cultural heritage and forever safeguards the realm of craftsmanship. Especially within Asian countries where the importance of craftsmanship is vital not only for future generations but is a representation of the people and carries out generational traditional practices in an unspoken precedent for future generations, all while ensuring that the personal connections to these ancient celebrations are forever remembered.

Finally, this project is not only a representation of the progression of craftsmanship but also is a representation of how application of the correct technology can enable the practice of digitally preserving and sharing cultural heritage in a modern context and can be utilized in a more universally accessible way.

When it comes to the importance of adapting to the use of AR technology and unlocking its capabilities by means of applying it to cultural heritage. One cannot forget what it represents as 'through historic buildings, we gain a profound understanding of our past and preserve an integral aspect of our cultural heritage. When a building is destroyed, it becomes our responsibility to reconstruct it and maintain it as best we can. Unfortunately, the world is currently losing heritage sites at an alarming rate, faster than we can preserve them. However, with advancements in 3D data acquisitions and modelling techniques such as Augmented Reality, it is now possible to accurately capture, store, and share the historical memory of built heritage in a digital format.' (Hartmanis 2023)

Not only do these technologies prove to be feasible, portable tools and methodologies that support the preservation of heritage sites as well as the dissemination of cultural knowledge

to a wider audience. According to research, they are also ‘virtual environments and platforms such as the metaverse, all carry the potential to significantly enhance learning and retention of information. By not only providing an immersive experience, users can also explore and interact with a virtual representation of a cultural heritage site to learn about its history and significance in a much more engaging and memorable way. Furthermore, the use of 3D reconstruction and optimization techniques can enable the recreation of cultural heritage sites that have been destroyed or damaged. This, in particular, is relevant in areas that are affected by conflict or natural disasters, where cultural heritage sites are at risk of being forever lost.’ (Hartmanis 2023)

The importance of safeguarding entities that not only represent our cultures but also our identities cannot be overstated. It's important to be vigilant in implementing technologies that focus on the protection and digitization of these characteristics that hold to the history that is in return represented by our cultural heritage and make sure that the continued representation and accessibility of the rich history for future generations is accounted for and understood in such a way that future generations would understand.

Heritage tourism is also a global ethics project that engages with community well-being and social justice. Local heritage tourism operators play a significant role in shaping the social fabric of heritage sites, especially in resource allocation, cultural interpretation, and spatial transformation. As in the case of a mismanaged development of heritage tourism, it might lead to a neoliberal injustice in the forms of economic exploitation and dispossession. (Zhu 2021) Therefore, it is important to consider the factors of safeguarding the heritage of not only countries but also cities. Especially considering the importance of representation for locals, the role it might play in their identity making, as well as representation of communities overall.

4.3 Conclusion

In conclusion, the relationship between AR and cultural heritage has proved to carry crucial importance not only when it comes to an understanding to enriching our understanding of our roots but also in the implementation of the technology that we associate with safeguarding cultural sites. As seen in the Lantern Festival example, from educating the generation of lantern-making to reshaping our approach to protecting and preserving entities that represent the power of a harmonious blend of Digital Humanities and Computer Science comes from a convergence of technologies. This blend enhances accessibility, engagement, and educational value, making it an essential element for achieving success, especially in today's digital world.

The use of AR in combination with digital storytelling has had a significant impact on cultural heritage. Augmented reality not only enhances the visual appearance of artefacts but also strengthens our connection to the past and our identities.

Incorporating technological tools is the key to preserving our cultural essence for the future. By embracing innovation, we can bridge the gap between tradition and modernity, and ensure that our culture is accessible and appreciated for the generations to come.

5. Design

5.1 Introduction

The AR web application “Lookback” was created to provide an interactive platform for locals and tourists to experience Cork City’s cultural heritage. By enhancing the AR web application, considerations such as standardization and pragmatism were vital to take into account. This approach would not only facilitate user’s interaction with the AR web application at their own pace but also ensuring a comfortable and immersive exploration experience.

While the concept and the initial goal of the web application was not necessarily utilized by the public, it still had and has tremendous potential. Especially with regards to an enhanced way of learning through means of digital storytelling with regards to Digital Humanities and in light of Computer Science, opening a gateway to taking advantage of the technology of AR and getting rid of the common misinterpretations that AR is commonly mistaken for VR.

However, it is important to note that visually impaired individuals are unable to participate in this AR web application due to health and safety concerns and, therefore, are excluded from the target user-based audience. Using a transcript to describe images is insufficient to convey the visual content accurately. Thus, the potential of the AR web application would not be able to portray its true potential.

Furthermore, iOS devices do not currently support the web application because a web XR has not been published to support it. Therefore, it is exempt from the implementation on iOS devices. However, this can be seen as a future opportunity for the potential of the web application to captivate a wider audience and the success of the AR web application.

5.2 Rationale behind the Ultimate Design Choice

In order to develop an AR web application that is accessible to everyone and compliant with the Web Content Accessibility Guidelines (WCAG), it is crucial to create a web application that is not only accessible to a broader audience but also complies with a single shared standard that meets the needs of individuals and organizations.

The AR web application contains information that is important not only for first-time users who are still getting familiar with the functionalities but also for regular users. It is important to consider how the information is presented. In this case, it is recommended to adopt a universal style where there is a clear contrast between the background and the text. As a result, ensuring that users have the best possible experience with the application.

The safety and health precautions are crucial when using AR web applications but even more so when exploring a simulated world through mobile devices. It's crucial to have proper guidance and protocols in place to prevent accidents. EDUCAUSE a non-profit association that aims to promote the use of technology to advance higher education standards have stated that “users may be prone to accidents during or after use. When first using a system, people can be disoriented and may have difficulty maintaining a situational awareness to avoid physical dangers such as traffic, buckled sidewalks, or other potential hazards” (Lewis 2018) And therefore, especially with the web application which is integrated with the technology of AR, this consideration is fundamental. Hence, through digital humanities initiatives, it is vital to ensure broad participation by means of inclusive access while taking this into consideration.

When determining the design element that would work best as an instructive source of information for users interacting with the web application, there are three possible solutions to consider: transcript text, videos, and images. These elements ensure that the web application meets WCAG standards for user interaction.

When considering the addition of a transcript, like a Frequently Asked Questions (FAQ) section, to a web application, it can be a helpful resource for users explaining how to interact with the AR web application. However, one major disadvantage is that it could be difficult to localize. This means that people in different regions or countries may not be able to understand it, which can be a significant drawback.

When deciding to use images to convey information, it is crucial to keep in mind that not all information can be effectively communicated through visuals. Moreover, the use of multiple images should be carefully considered to make sure that all vital information is conveyed clearly and understood by the user, which possesses to be a challenge.

When thinking of creating and delivering videos that offer users information on how to use an AR web application, it would not only serve as a symbolic representation for users but also make localization more universally understandable and tangible by incorporating multimedia. By incorporating symbolic representations and automation, the use of language can be avoided, providing a more informative element for users who may not speak English or other foreign languages. The use of language can be entirely avoided by using symbolic

representations and animations this would prove to be a major benefit. In response to this, creating a video that highlights the necessary precautions to take before interacting with the AR reality web application, particularly considering its AR elements, is crucial to ensuring the safety of users who interact with it.

Therefore, considering all factors and options of inclusion of a user guide, health and safety guide video to educate and provide users with information on how to interact with the AR web application proves to be the most effective as well as the best option as it ensures localization. Therefore, I have decided to move forward with this option, as it perfectly aligns with my objective of delivering concise and easily accessible information. Moreover, it adheres to the specified guidelines outlined in the WCAG standard. (Web Accessibility Initiative (WAI) n.d.)

As a result, considering all factors and options the inclusion of a health and safety guide video of what precautions users should take before interacting with the AR web application would not only prove to be an essential entity for the web application but also provide new users with information who may have never interacted with an AR web application before and outlining what measures to take.

The same considerations can be applied to the inclusion of a user guide video. Similarly, to the health and safety video. The video will aim to provide users not only information on how to interact with the web application but for instance how to position the mobile phone that they are interacting with the AR web application and essentially on what to expect as well.

5.3 User Journey

As illustrated in Figure 1 capturing and conceptualizing the function of the AR web application requires a great understanding of not only the design intent but also the layout of the AR web application. From a user perspective, it's important to outline the various functionalities and relationships they hold while also accounting for factors such as understanding and comprehension of the material that is included within the AR web application. Most importantly, outlining the clear representations of the sequential, step-by-step flow of the AR web application, as seen in Figure 1.

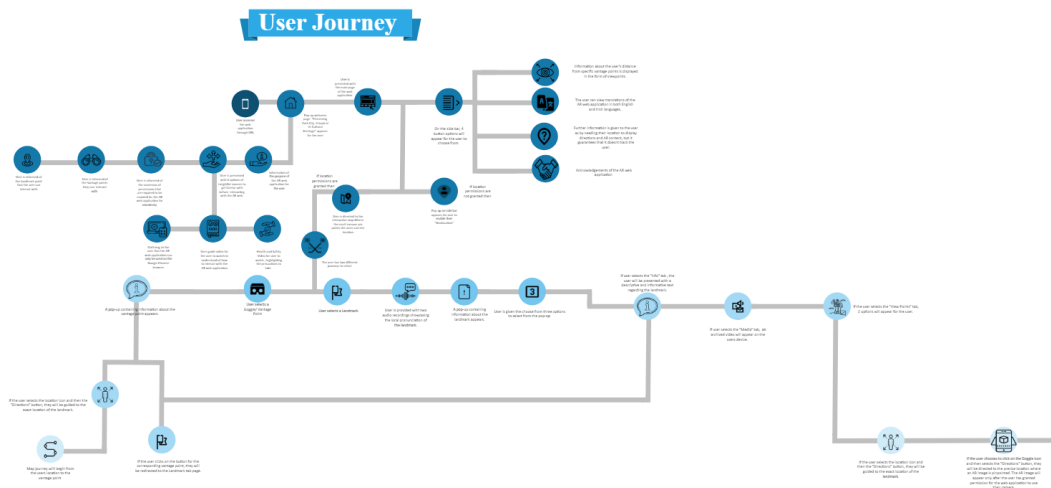


Figure 1

Before using the AR web application, users will receive a comprehensive overview of its core component, including a detailed explanation of its capabilities and functions. This will help users understand what they can expect from the application and how they can interact with it effectively, as seen in Figure 1.1

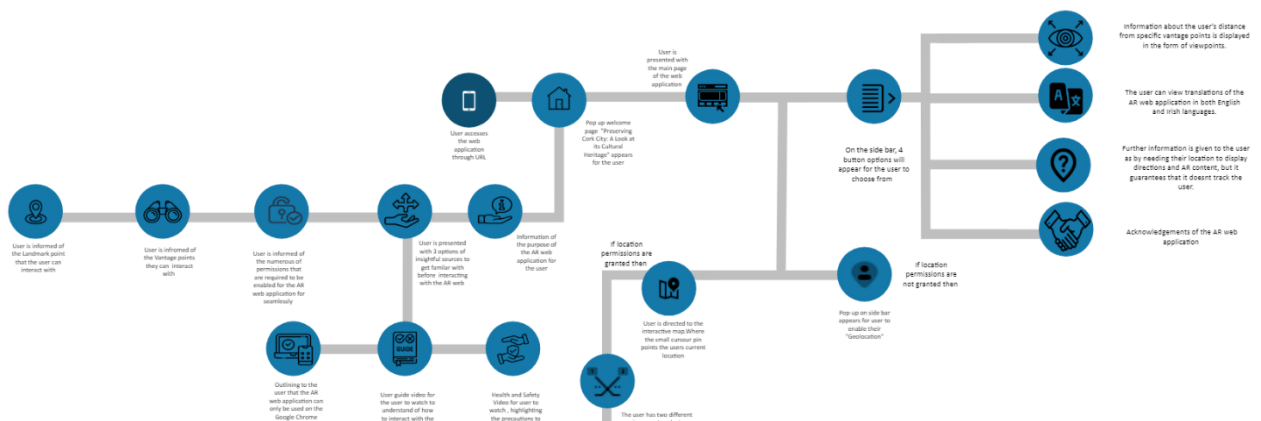


Figure 1.1

As seen in Figure 1.2, when the user is presented with the main page of the AR web application, followed by the pop-up homepage, the user is presented with the following key details, information detailing the purpose of the AR web application, what permissions to have enabled for seamless operation to ensure a smooth user experience, and what each landmark and vantage point represents.

Regarding the informative sources available to the user, they will be presented with a Health and Safety video that covers the necessary precautions to be taken while interacting with the AR web application. Additionally, there will be a user guide video that explains the functionality of the AR web application and what to expect. Finally, the user is informed that the AR web application is only compatible with the browser Google Chrome.

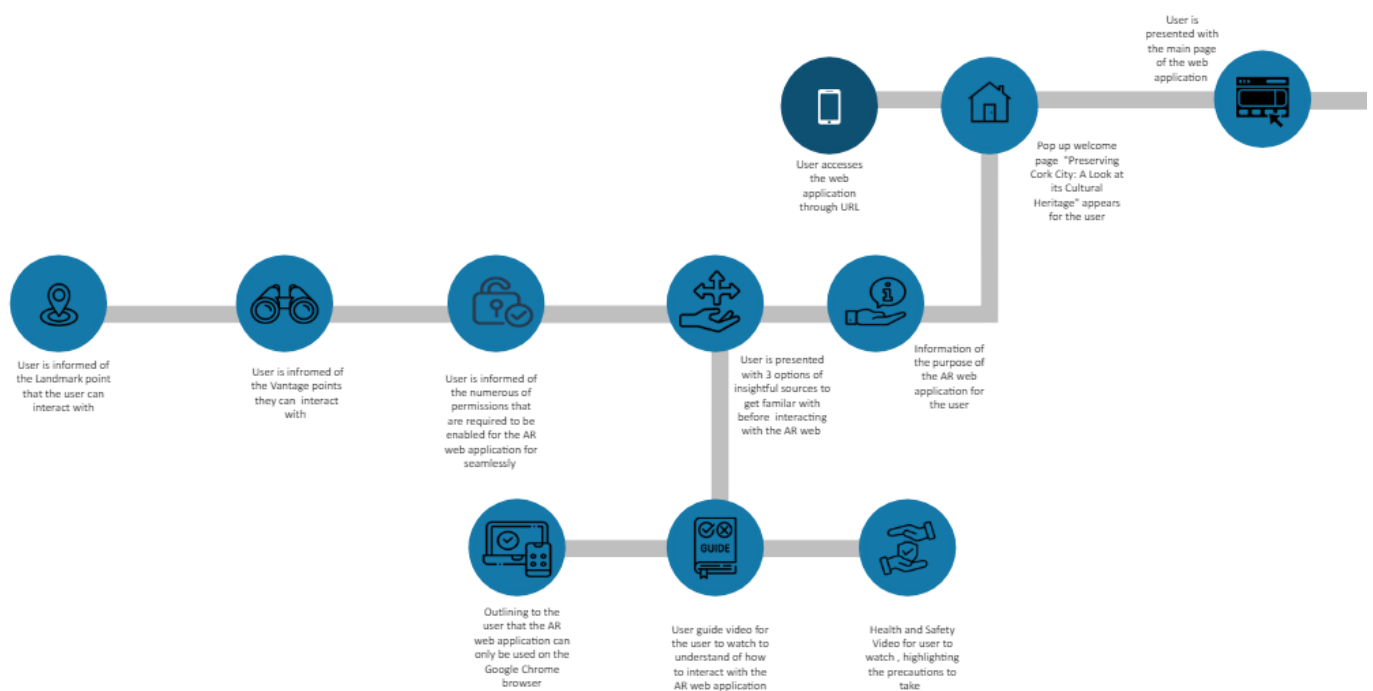


Figure 1.2

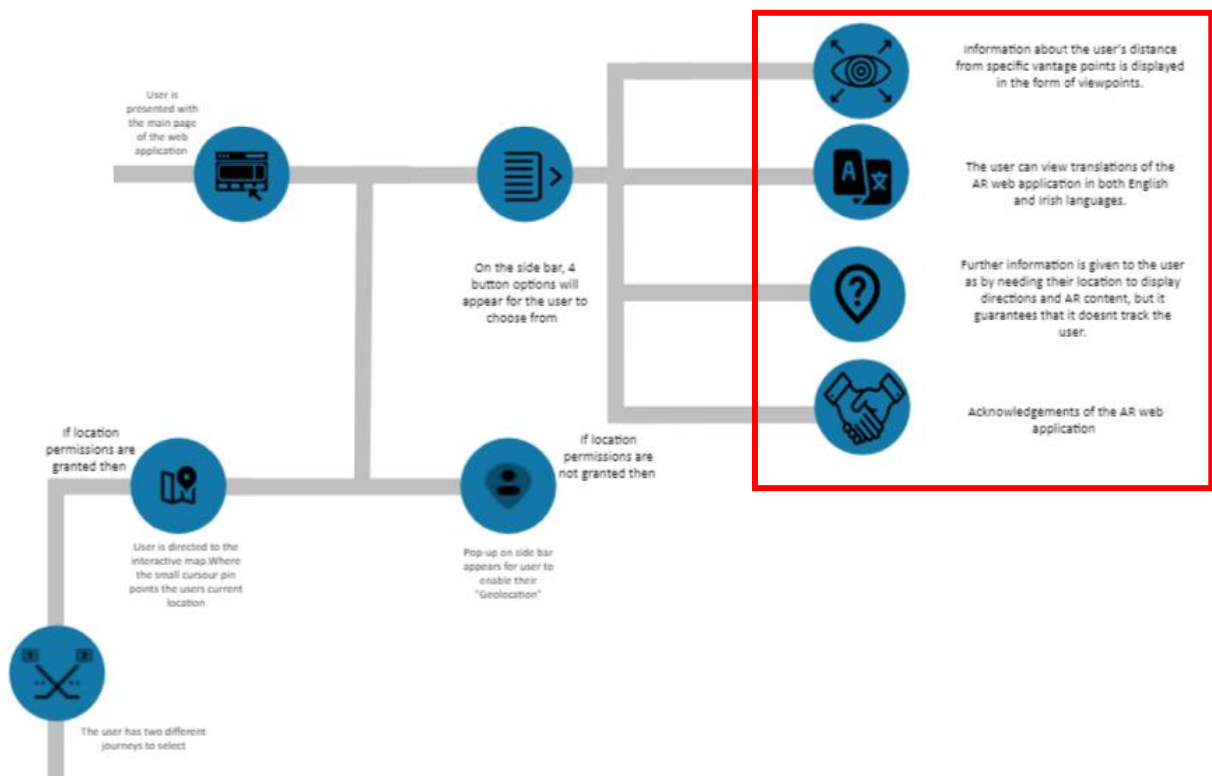


Figure 1.3

As seen and highlighted in red within Figure 1.3 the user is presented with 4 different buttons to interact with. The user will be informed of the nearest vantage points to them based on their geolocation information. They will also be provided with English and Irish translation buttons which would translate the entire AR web application. To ensure seamless operation of all functionalities, the user will receive textual support to enable their geolocation. Finally, the user will receive information regarding acknowledgements.

Users who haven't enabled location services for the AR web application will receive a pop-up message prompting them to do so for a seamless experience. They will then be able to explore the application.

Once the user grants the required permission, they will be immediately directed to an interactive map. On the map, a cursor pin will indicate their location, and they will have two different routes to choose from.

Users will be given the option to explore vantage points or landmarks within the web application, as highlighted within Figure 1.4

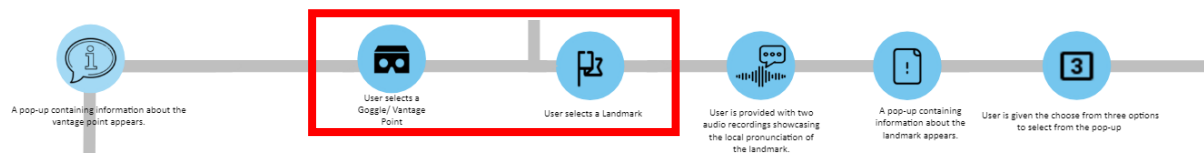


Figure 1.4

Starting from the point where the user is provided with navigational directions to reach a vantage point, they are also given information about another vantage point that they may be interested in visiting. This is followed by a map that will guide them to their desired destination, as seen in Figure 1.5

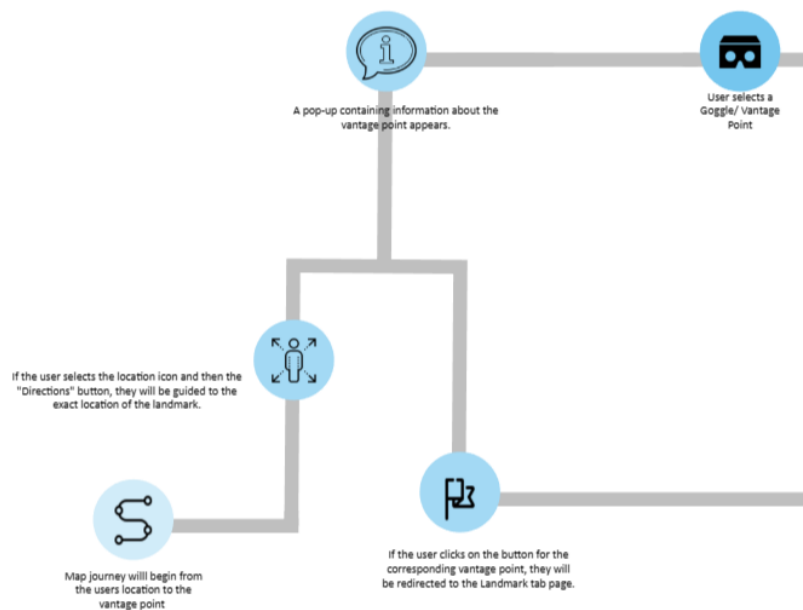


Figure 1.5

However, if the user decides to explore the corresponding viewpoint of the landmark, the button will direct the user to the corresponding landmark. As seen in Figure 1.6

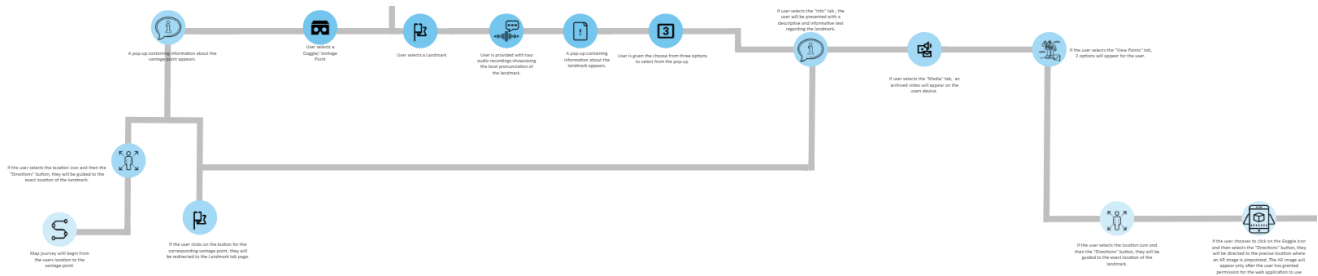


Figure 1.6

In case the user selects a landmark during exploration, a pop-up with information about the landmark will appear as seen in Figure 1.7

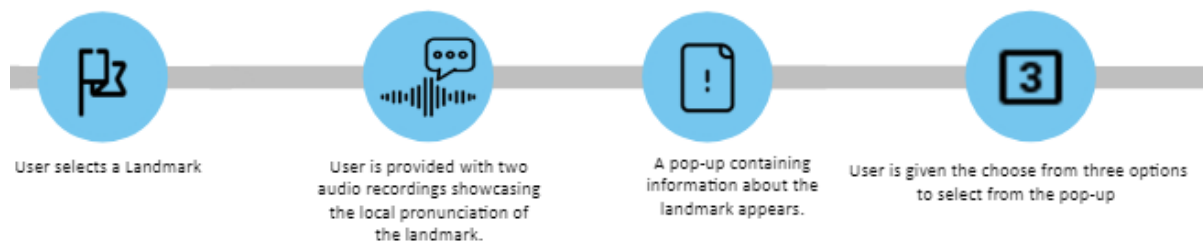


Figure 1.7

The user will be presented with three options to choose from. They can access an information tab that contains detailed and informative text about the landmark. Additionally, the user will be able to view a video of the landmark and also access the viewpoints as seen in Figure 1.8

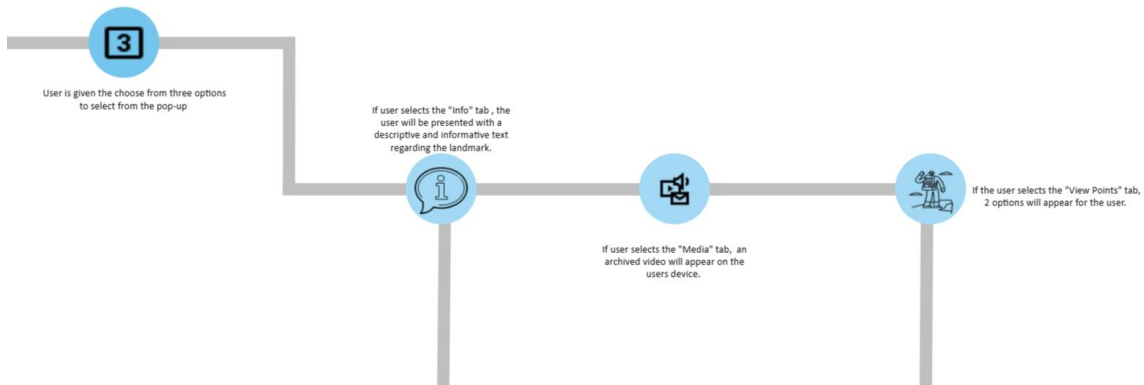


Figure 1.8

After selecting the Viewpoint option in Figure 1.9, the user can either be guided to the landmark or access an AR image from their device.

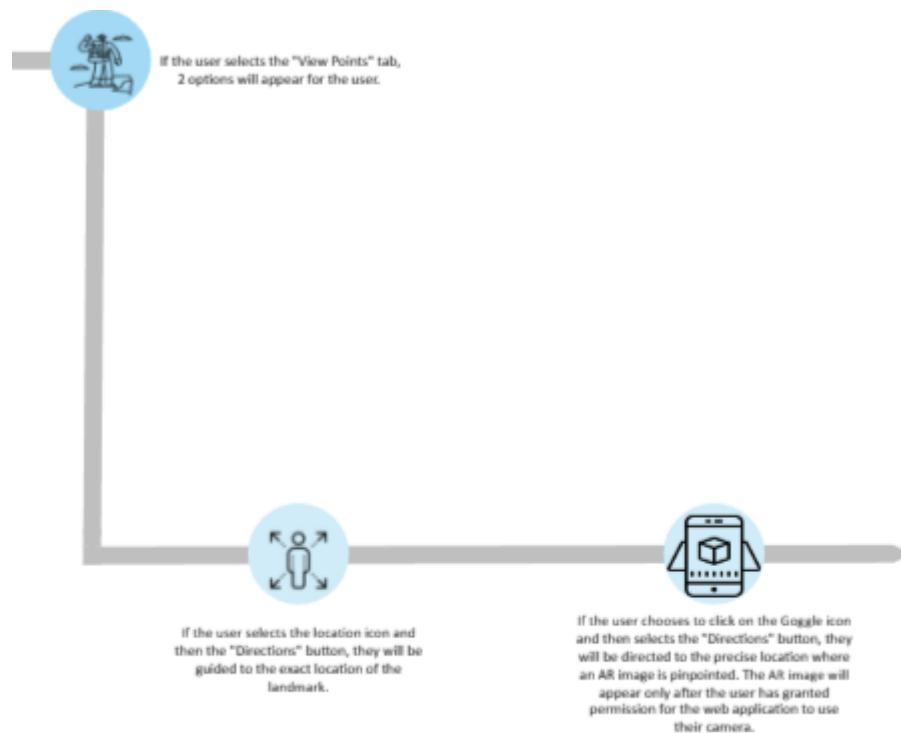


Figure 1.9

Therefore, in order to fully understand the functionality of the AR web application, a comprehensive approach is not only essential but of the greatest importance when taking into account the designer and experiences that the user would face when interacting with the AR web application. Therefore, the practice of mapping out the different features and how they relate to each other, as well as ensuring that the user can easily understand the information presented and the logical flow of the application. It not only effectively conveys major contributing elements of the body of the AR web application but also creates not only a functional but also user-friendly and intuitive.

5.4 Data Flow

By exploring the Data Flow of the AR web application, we are able to see crucial elements of the program and visually conceptualize how data not only interacts within the AR web application but moves through it. Not only does this offer visual clarity and a foundational understanding of the interactions among different components of the AR web application, but also serves as an essential component when making alterations to design entities, as illustrated in Figure 2.

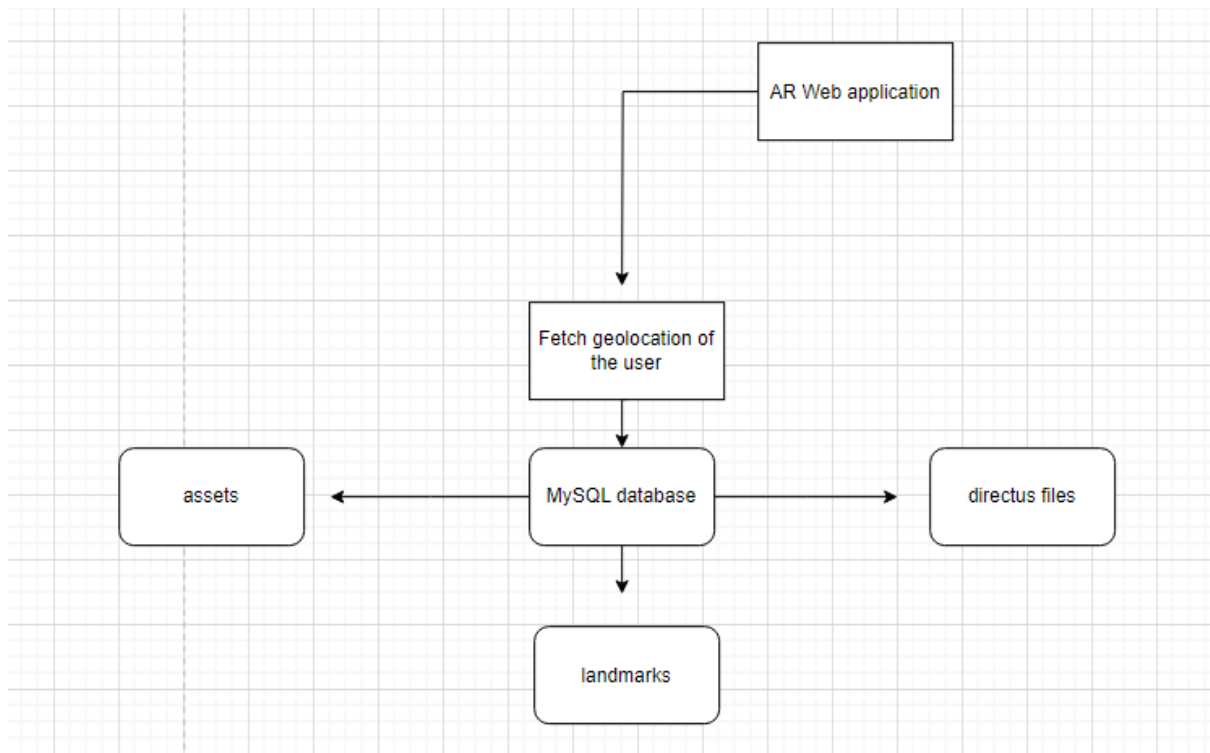


Figure 2

By considering, for instance, how landmarks would be represented within the data flow image representation, we can see the process in a chronological order similar to the User Journey flow. The first step of the AR web application would be to fetch the user's geolocation data. Which was previously explored in more detail from the User Journey. By exploring how the landmark objects appear on the interactive map. It can be observed from the data flow that the phpMyadmin, which in this case is supported by the MySQL database, handles the administration of the data and dependencies. The content and information first go into the "assets", as it's the main place where arbitrary files are kept. From there on, another entry is made within the "landmarks" table within the database, as the source code from Visual Studio Code fetches the information from that source from the database and pulls it into the AR web application. An additional entry in "directus files" explains and defines acceptable image formats and sizes for the landmark content to appear appropriately.

5.5 Technological Infrastructure and Tools

The application provides a historical overlay of certain landmarks and vantage points within the centre of Cork City, along with a map guidance feature to ensure easy navigation. The data integration within the web application was initially carried out by the Heritage Department in Cork City. On the note of overlaid images, this is carried out by the integration of AR technology within the web application where users have the option to view images and pre-recorded videos in a 2D overlay fashion, by the rendering code of web.gl which is embedded within the web application.

However, commencing the work on my contribution to the AR web application, it appeared to me that some significant landmarks were not accounted for despite them playing a major role in Cork City's cultural heritage. This was rectified not only to broaden its scope but also to promote preservation. The landmarks included are not just renowned, but also historically significant sites. This will help in promoting a comprehensive understanding of the city and the importance of preserving its past. The use of AR technology in this web application not only ensures active participation but also guarantees the accuracy and relevance of the information provided. With this technology, users can enjoy an immersive experience and learn more about the rich cultural heritage of Cork City.

The technological framework that this AR web application utilizes is WebXR. This framework serves as an API for web content and applications managing the process of rendering the views needed to simulate the 3D experience. Providing support for accepting inputs from control devices, it is important to make the distinction that WebXR is not a rendering technology and does not provide features for managing 3D data or rendering it to display. Instead, it manages elements such as timing, scheduling, and various points of view, relevant when drawing the scene. (contributors 2023) The AR web application, in particular, associates vantage points with images, and once the user is at the specific location, the image appears in association with the vantage point.

However, as previously mentioned, Apple has not created the necessary framework for iOS devices to support this AR web application. On the other hand, users with an Android-supported device would face no issues with launching the AR web application on their devices.

WebXR uses the content built by the 'three.js', the 3D web rendering engine. It is essentially a cross-browser JavaScript library that creates and showcases 3D computer graphics on web applications. Because of its effective implementation, it is supported within augmented and virtual reality.

The other technological framework that is utilized within the AR web application is Mapbox. Which is a location data platform that uses the API that is designed to create maps that ensure the location services and maps are available on a variety of applications. Mapbox as a platform, has the capability to draw up customizable and dynamic maps for use in web and mobile applications. Unlike traditional maps, Mapbox's technology does not rely on static map tiles that are run on a specific server. Instead, it uses location services from mobile sensors, computed cameras, and aerial images to collect map data. This data then is combined with proprietary sources and OpenStreetMap data to update the maps with every minor

change. As a result, the processing pipelines ensure that the maps are always up-to-date and accurate. (Howe 2022)

As it can be seen within the code of the web application, the implementation of Mapbox is carried out by file “mapbox-gl-directions.css”, which adds a geocoding control function embedded within the web application where users are able to select landmarks or vantage points in the course of their interaction with the web application. For the Mapbox technology to function properly, the user's geolocation must be enabled while using the application, as seen in Figure 3.

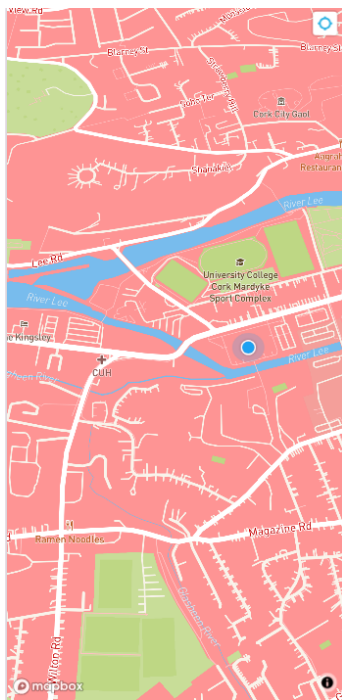


Figure 3

5.6 Conclusion

In conclusion, we have explored how the AR web application operates from a user standpoint, as well as the back-end and front-end perspectives, through the User Journey and the Data Flow diagrams. Undertaking these analyses was crucial not just for this dissertation but also for the possibility of future implementation of this AR web application to a wider audience and a better understanding of how the dependencies, as well as its intricacies, operate. On the point of applying and adhering to the WCAG standard, not only does it prove to be a significant decision when trying to optimize the experience with the AR web application for users, but it also ensures that the application is more inclusive and accessible for people of all abilities. Ultimately, the analysis and exploration of the different kinds of technological frameworks and technological integrations are crucial, for instance, understanding how the 2D overlay images are represented. To the exploration of how Mapbox, which is both an API and a mapping tool, operates in a streamlined way as a location-based functionality which contributes towards the infrastructure of the AR web application.

6. Implementation

6.1 Introduction

By taking ownership of an existing AR web application, I have downloaded not only the source code of the web application but also obtained the database onto my personal laptop. This was a crucial element as it allowed me to not only fully understand a complex system from both a front and back-end perspective but also enabled me to make planned changes that I have carefully articulated and thought out. For instance, the live server was using the node as a pathway of communication between the web server handled by Visual Studio Code and the database, which is powered through phpMyadmin for managing and running the MYSQL database. They essentially tied in together with each other, resulting in being connected to each other, as seen in figures 4 and 5. The intricacies are further discussed in the upcoming sections which outline the processes and undertakings within the web application that was taken.

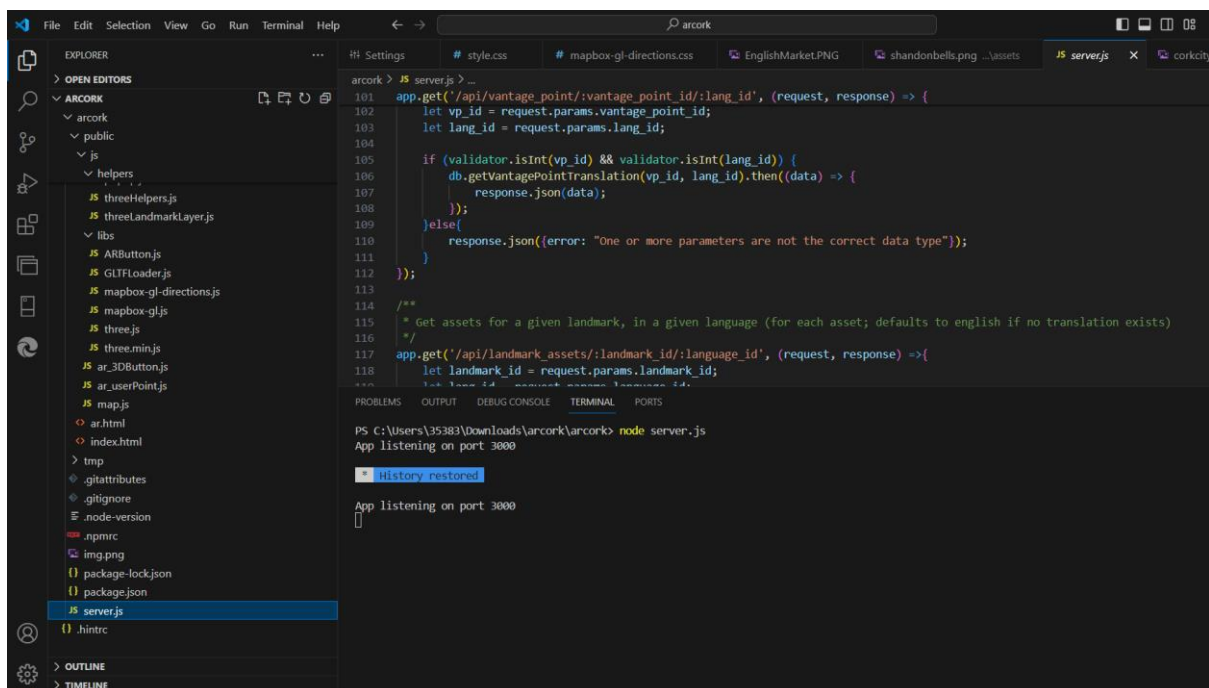


Figure 4

To further delve into the set-up of the AR web application within the server.js file, as seen in Figure 4. In the terminal window of server.js, by establishing the name of the directory “arcork” which is essentially the name of the database, I opened the terminal window and typed in the name of the directory, “cork”, which is the name of the database. Then, I entered the command "node" to run the server.js file and start the JavaScript. By carrying out these steps, it launched the AR web application as a local host all while being connected to the database.

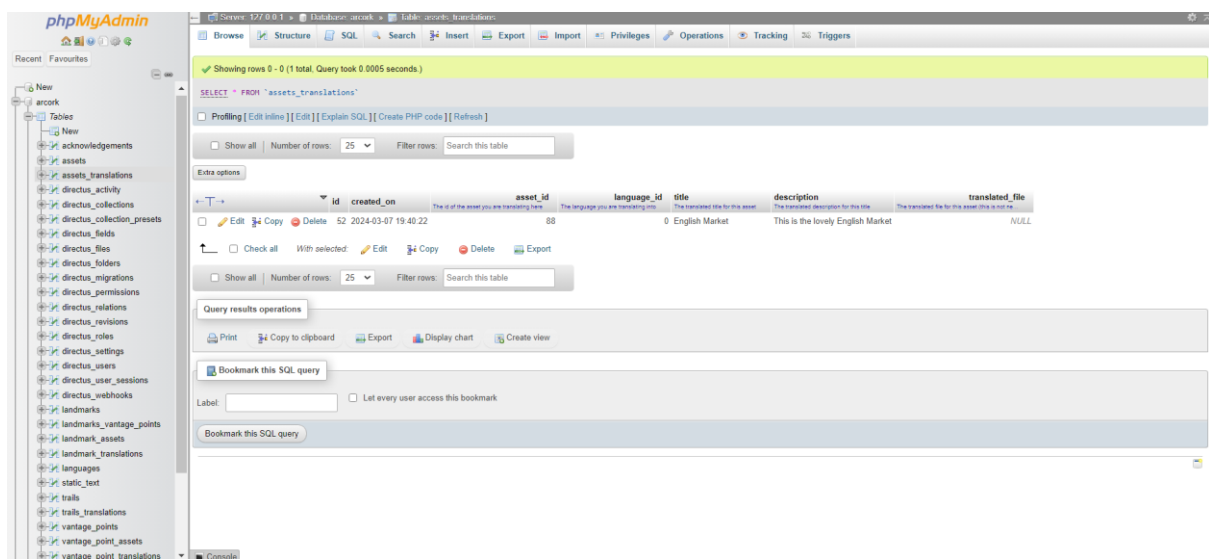


Figure 5

At a glance, tables within the database can be seen been playing a prominent role in managing and sorting data and the specifications that accompany it. The database essentially serves as the primary storage location for data, from which the web application retrieves the associated information to create content and functionality for users.

From a personal perspective, there were many intricate hurdles along the way to overcome in terms of understanding and conceptualizing the overall structure of the AR web application, in terms of understanding of how it operated as well as understanding the exchange within commands and demands from the database to the actual platform of the web application. This proved to be not only a lengthy task but also a new scope of challenge from a personal perspective to execute.

Additionally, when considering a user's perspective, understanding, and appreciating cultural heritage elements, combined with the great potential of the technology of AR, introduced a new way of not only learning but also represented an additional opportunity for deeper learning and richness through digital storytelling.

Therefore, as a result, I was able to carry out informed decisions about adding new features and content to the application that not only enhanced its current capabilities but also contributed to its overall improvement. The introduction of new additions was planned out and well-articulated before its implementation. The intended result was both great design and seamless operation within the existing functionality of the application. The ultimate goal was to provide a seamless and optimal user experience. Additionally, I considered ways of making it as widely accessible as possible, while considering the WCAG standard and keeping in mind the consideration of making the web application as intuitive and user-friendly as possible, all while accounting for the success of the AR web application.

6.2 Execution of changes

After the discovery of missing major elements within the web application an informed decision was made to implement them onto the web application. One of which was to enhance some of the visual UX elements of it by updating the colours on the landmarks and vantage points, making them more distinct. The colour of the map overshadowed these elements as they blended in too much together, and I wanted to make it more visually striking as seen in Figure 6.

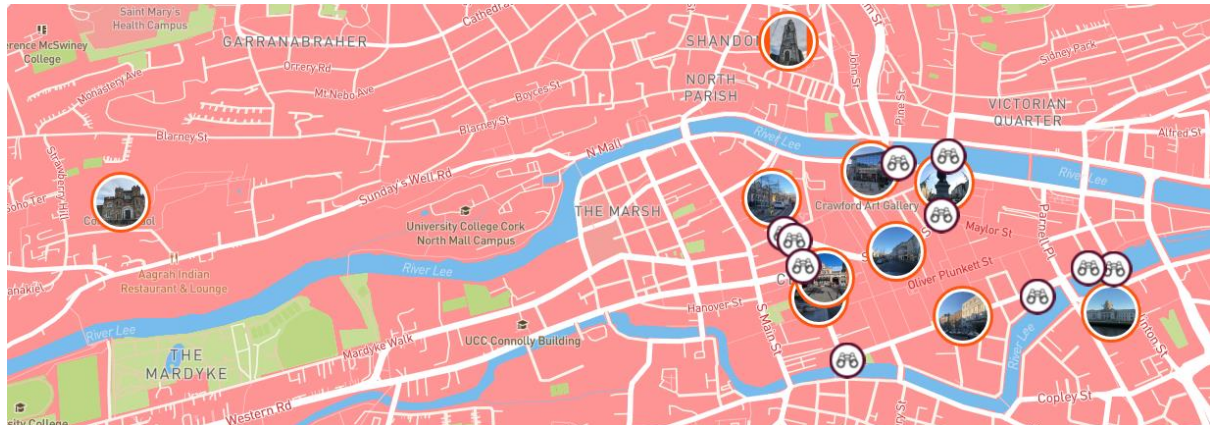


Figure 6

Furthermore, the idea of changing the CSS elements of the geolocation map was considered and further examined through testing. Upon further determination, I have concluded that the original design and layout were most suitable and, therefore, did not require further changes.

Following that, I conducted research in order to find the best platform to create the health and safety video and user guide video, I found 'Render Forest' to be the most suitable. After a lot of testing and prototyping with the platform to evaluate its capabilities as well as if it is aligned with the goal which I had in mind. An informed decision was made to proceed with the platform because the created video effectively portrayed the content in a universally understandable way but also contained as little text as possible so that it could be interpreted universally. This was crucial, especially considering my commitment to adhering to the WCAG standard as much as possible.

Additionally, other considerations had to be made about where the videos would be positioned in the AR web application. The end goal was that the user would see them at first glance from the home page. Therefore, as a result, it had been positioned and included as seen and highlighted in Figure 7 to ensure that the user's attention is grasped quickly and to explain the complex features in a clear and engaging way. This eliminates the need for users to research safety measures when using the AR web application and boosts their confidence in engaging with its features.

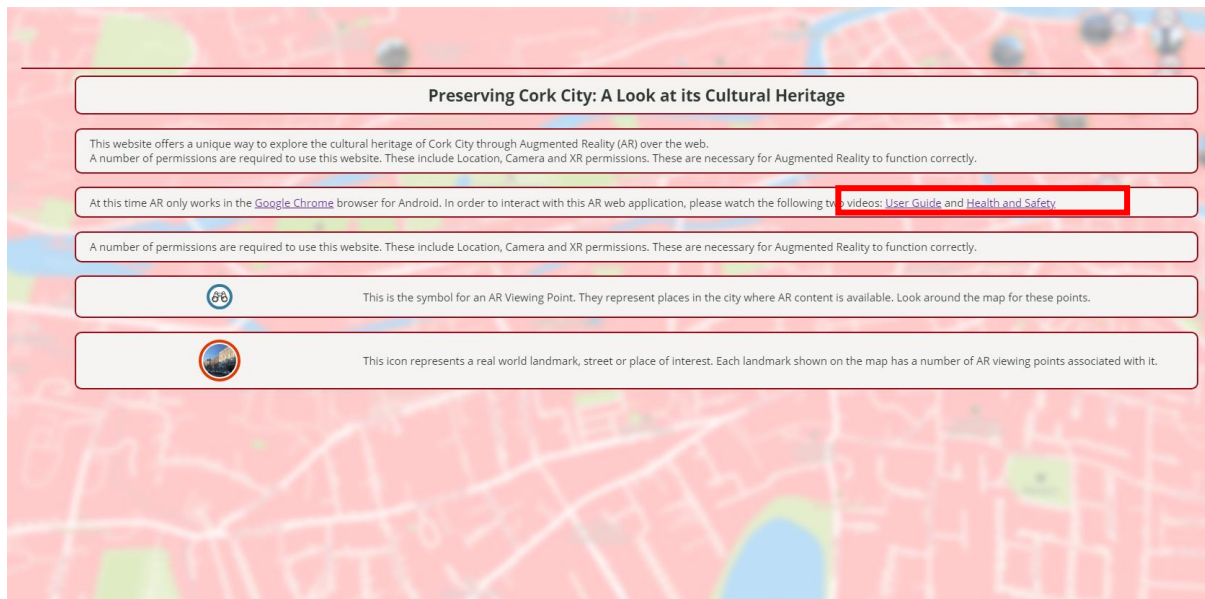


Figure 7

As seen in the highlighted text in the third section, both the User Guide and Health and Safety videos are presented as hyperlinks. This is because if the user selects one, they will be redirected to the YouTube page where I uploaded the videos, making them only available to those who access them via these links. (As highlighted in figure 7) Essentially, the videos have been set as 'unlisted', making them more private, as seen in figures 7.1 and 7.2.



Figure 7.1

The Health and Safety video is designed to guide users on the necessary precautions to take while using the AR web application. It emphasizes the importance of ensuring that their surroundings are clear and being aware of obstacles when navigating in busy areas.

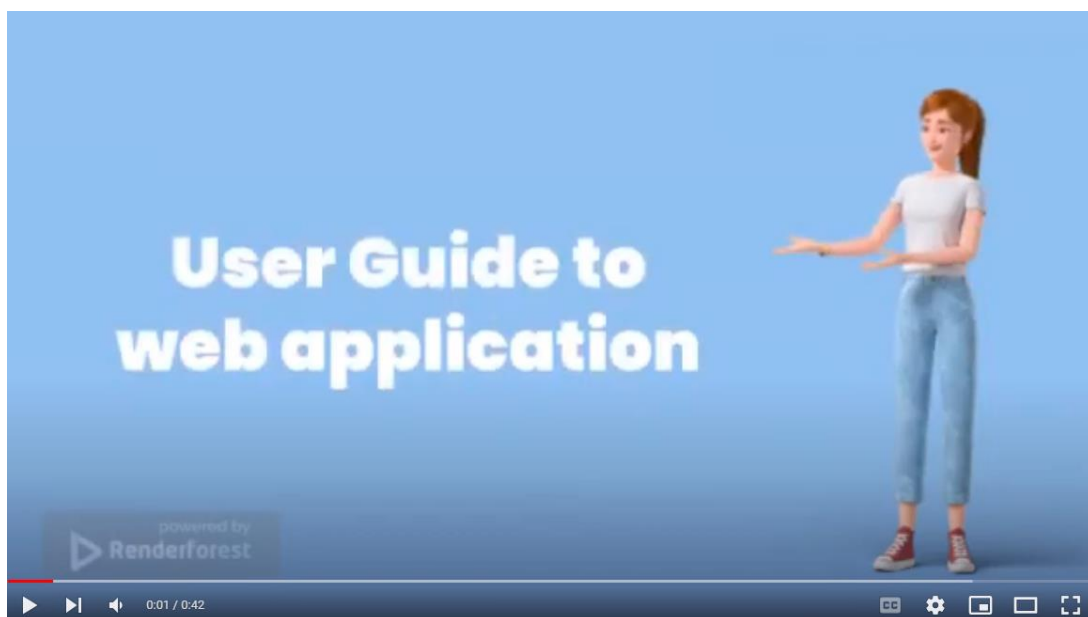


Figure 7.2

The User Guide to the web application, on the other hand, provides the user with information on the steps and preparations that they need to take for the AR web application to run properly. For example, users need to ensure that their location services are enabled and that their device's rear camera is not covered. Additionally, the guide instructs users on how to position their devices accurately to capture the operation of the AR image pop-up.

6.3 Content Creation and Duration

There were evident gaps in the historical and heritage descriptions of some of the already present landmarks, such as St. Patrick's Street, Cornmarket Street, Grande Parade and South Mall. The decision was taken to add more value to them by including relevant information to those culturally significant sites. This was carried out by doing my own extensive research and including the results of my research in the main body of the text for these landmarks. The reasoning behind it was to make the application itself more engaging yet concise so that users would not need to leave the AR web application and carry out their own research.

On the note of building and creating new content for the AR web application, it struck me that eminent landmarks that greatly represented Cork City's cultural heritage were not accounted for, and therefore, decided to include them in the web application. In order to add further value and make the AR web application more captivating as well as engaging for users, after visiting the sites myself in person, I took photos of the landmarks to include within the AR web application.

By enriching the content of the web application, the decision was made to new landmarks, such as the English Market, as seen in figures 8 and 9.

The reasoning behind this is that the English Market not only represents an important establishment within Cork City's food culture but also plays a pivotal role from a cultural heritage standpoint, having helped evolve the name of Cork City. Furthermore, it has now held a prominent position for generations, not only for the public in general but also for local businesses specifically.

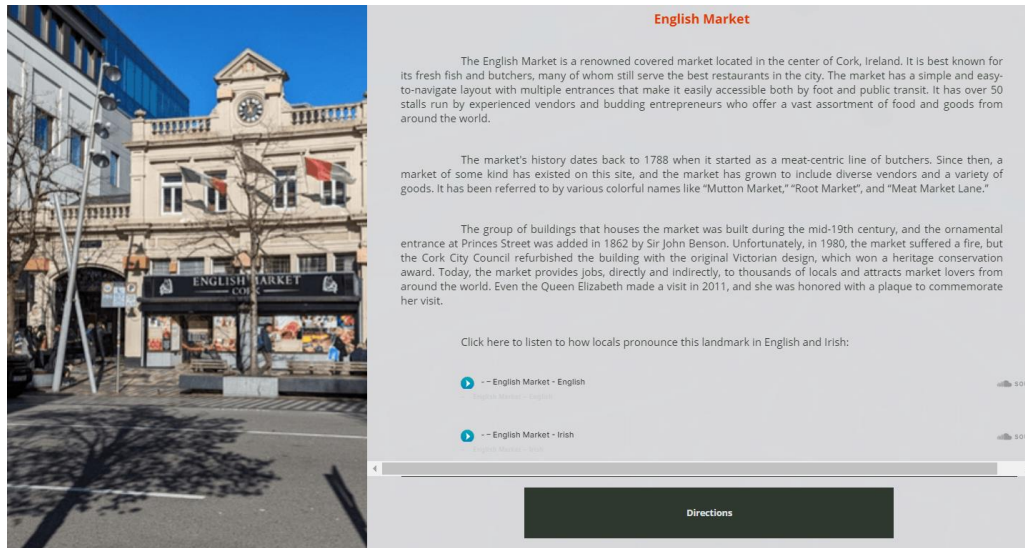


Figure 8

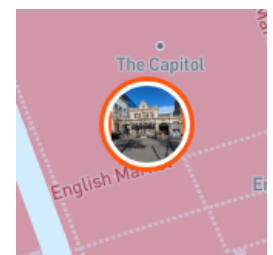


Figure 9

Shandon Bells is one of the most recognizable buildings in Cork City, and it holds significant cultural importance. Including it as a landmark in the web application not only enhances its relevance but also provides cultural context about the history of Cork City, as seen in Figure 10 and 11.

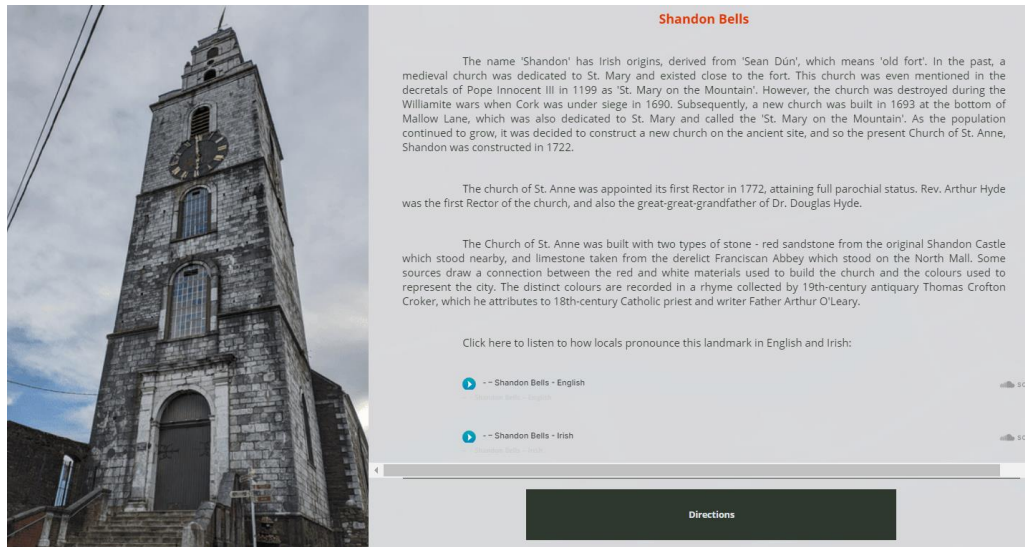


Figure 10



Figure 11

The final landmark that I have included in the web application was Cork City Goal. The rationale behind it was that as a building it holds a great deal of cultural value especially so within Cork city. Not only does it educate locals and tourists, but it also tells a unique story within the centuries-old walls and bricks, as well as the historical changes that it had went through over the years. As seen in Figure 12 and 13.

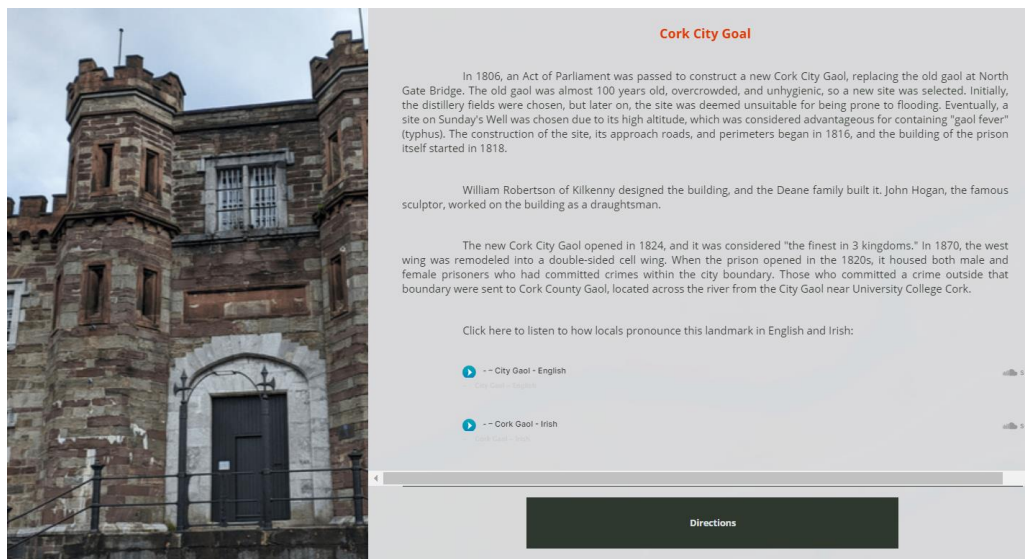


Figure 12

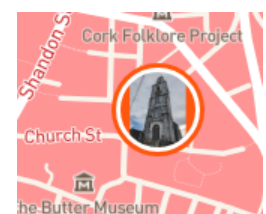


Figure 13

Adding audio recordings via a button function within the web application would not only captures the authentic pronunciation of various landmarks but also provide users with a richer and more immersive understanding of local cultures. This provides additional context for the

cultures represented through the web application and its content regarding the cultural heritage of Cork City.

The resulting audio recordings were captured in both English and Irish. Although the creation of additional translations in other languages was considered, it felt as this would have defeated the purposes of preserving the cultural heritage of Cork City, and as a result, decided to proceed with formulating English and Irish translations.

The way I obtained the recordings was by approaching the local people of Cork City and asking for their own interpretation of the pronunciations of the landmarks. From the collected audio recordings, some of them needed to be adjusted. Therefore, by importing the audio files into the application “Wave Pad” I was able to use my multimedia knowledge from previous modules and apply changes to the audio files by making changes to frequency levels, quietening out background noise and finally, adjusting the length of the audio files. Once the audio files were ready to go, I included them within the database to the corresponding landmark with which the pronunciation was associated with. In the case when a landmark is selected, a concise display of its image, text, and audio recording is shown. As a result, the whole display would be presented to the user as seen in figure 14.

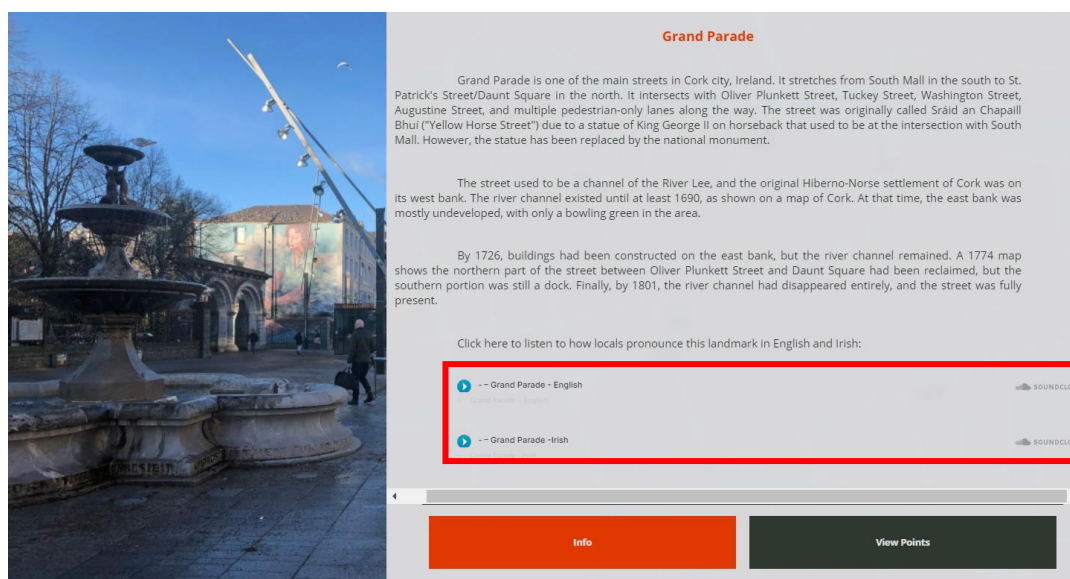


Figure 14

Furthermore, including Irish text translations via button control provides an extension of cultural heritage preservation. Offering both English and Irish text options for the user when interacting with the landmarks and vantage points, it provides a more inclusive and accessible learning environment. This fosters deeper engagement as well as an appreciation for not only the Irish language but also the resilience and revival of the cultural identity that it symbolizes. Showcasing Irish alongside English translations with the AR web application highlights the language’s role in preserving cultural traditions and identity, which is a vital aspect of heritage and the purpose of this project as well, as seen in figure 14.

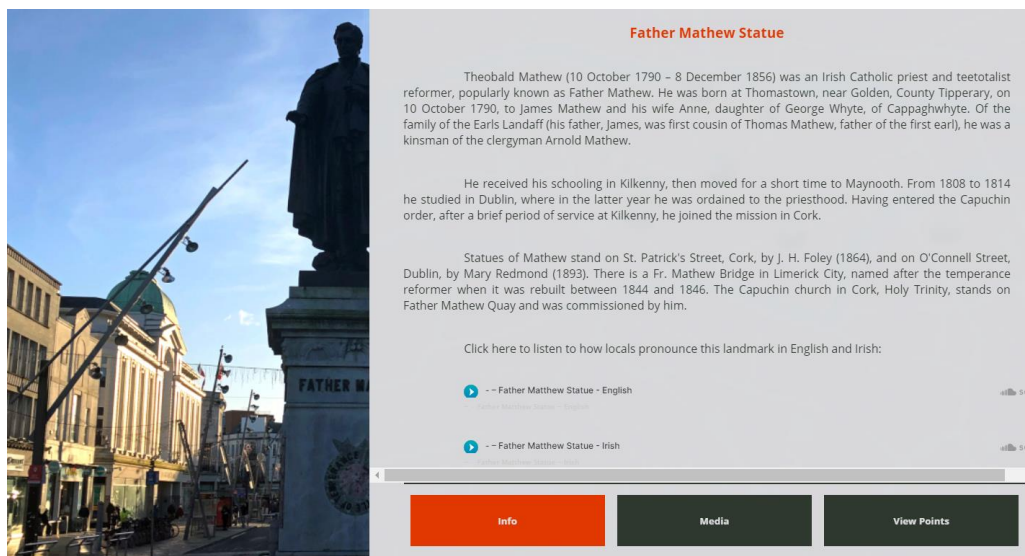


Figure 15

As can be observed from Figure 15, there is plentiful not only information but the historical background for the user to familiarize themselves with.

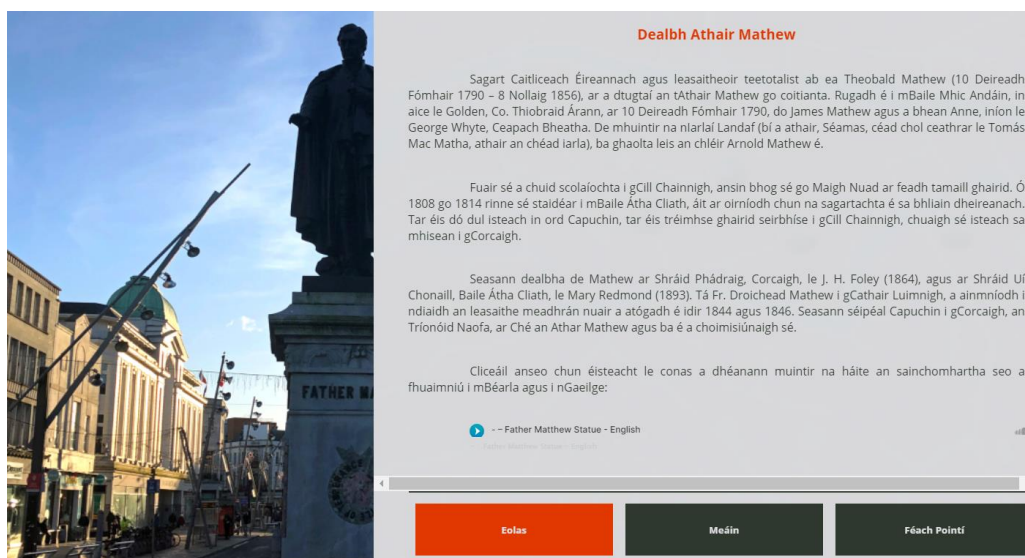


Figure 16

As it can be observed from Figure 16, the direct translation of the landmark of Father Matthew is presented to the user in Irish.

Followed by a button translation for the user as seen in Figure 17 to ensure smooth translation and interpretation experience.

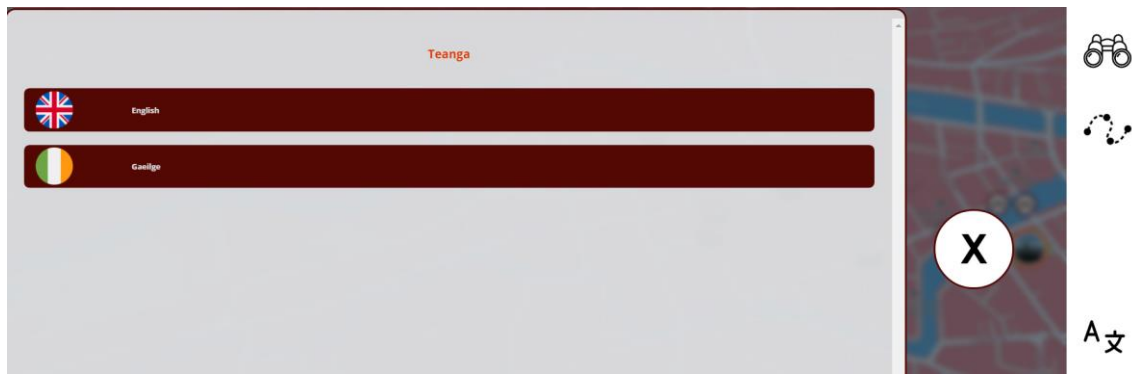


Figure 17

The consideration of including direct Irish translations for the vantage points was not only considered and further implemented. This was to ensure the further preservation of the language but also to follow the translation option was presented in a consistent manner, as seen in figure 18 and 19.

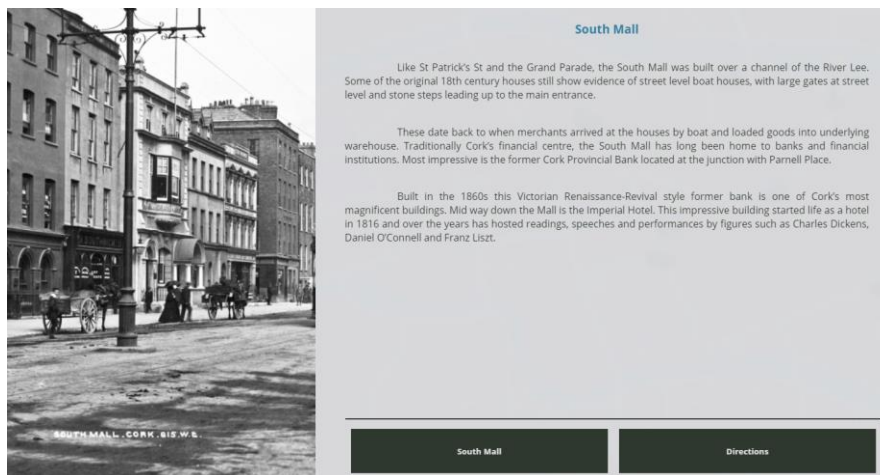


Figure 18

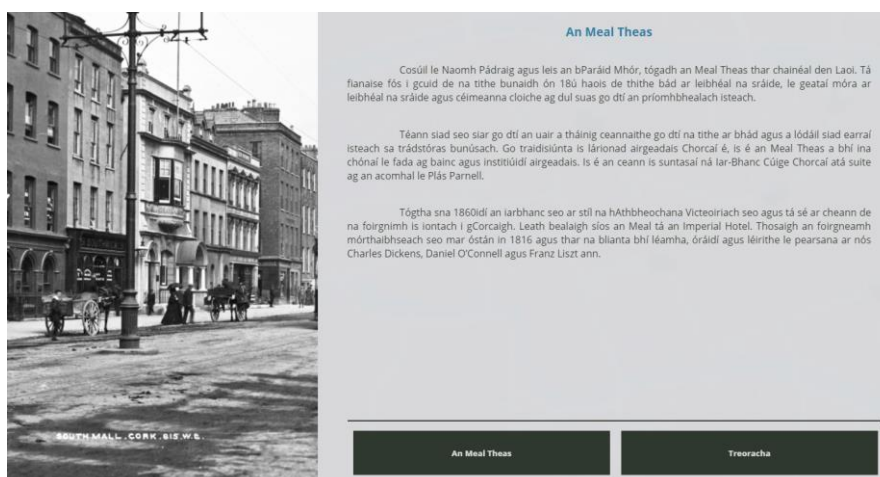


Figure 19

6.4 Technological Infrastructure and Tools

In order to incorporate additional sources into the AR web application, I executed this task in a maybe slightly unconventional way by adding new elements to the database phpMyadmin manually. Rather than using a CMS platform such as ‘Directus’ that would handle all of the ins and outs of uploading and maintaining content to the web application. Taking this approach, as a result, proved to be a very challenging and new scope of learning but, ended up being rather insightful when learning a new software tool that handles databases.

I established a connection between the node on Visual Studio Code where the infrastructure is based, components and architecture of the web application and the database through the application XAMPP which is a universal group that distributes all of the database languages. In the case of this project, I have used both Apache and MySQL modules to run my database. With the exception of MySQL having Admin control of the database, I have used MySQL as the mainframe to manage the database of the web application, which was through my phpMyadmin.

This allowed the web application to interact with the database to store and retrieve data, providing dynamic and persistent functionality. It also enabled it to display all live changes happening automatically by refreshing the web application.

7. Evaluation and Testing

7.1 Introduction

Part of my own contribution to this project was learning and active participation in the AR web application by not only building on my front-end but back-end development skills as well while ensuring that, as a result, a well-rounded AR web application created. In the end, it is necessary to evaluate it by means of testing further to ensure the success of the AR web application in terms of its functionalities as well as its possible future success.

In order to evaluate the effectiveness of the amendments to the AR web application, I have taken the decision to carry out a survey among a group of individuals. Seeking their insights through a series of questions carefully articulated by my own understanding from my own judgement and perception, I deemed to be relevant but also inspired by the System Usability Scale (SUS) (System Usability Scale (SUS) 2013). This was to clearly determine the effect the AR web application had on first users and the opinions they formed while interacting with the AR web application. Furthermore, I wanted to determine whether or not, as a technology, AR would prove to be useful when it comes to digital learning, especially regarding the cultural heritage aspects of Cork City.

7.2 Assessment Methodology

Ten participants were asked to interact with the AR web application and complete a survey afterwards detailing their takeaways from their experiences. The objective of this assessment is to evaluate the effectiveness of the AR features in engaging users and enhancing their experience of exploring Cork's cultural heritage. The assessment focused on the usability, functionality, and overall user experience of the AR features. Additionally, the success of digital storytelling was evaluated based on the level of immersion and interest it generated among users.

As the majority of the participants were currently undertaking a bachelor's degree in some discipline, it was interesting to observe that overall, participants felt that the AR web application was easy to use and interact with, as seen from the results from figure 20.

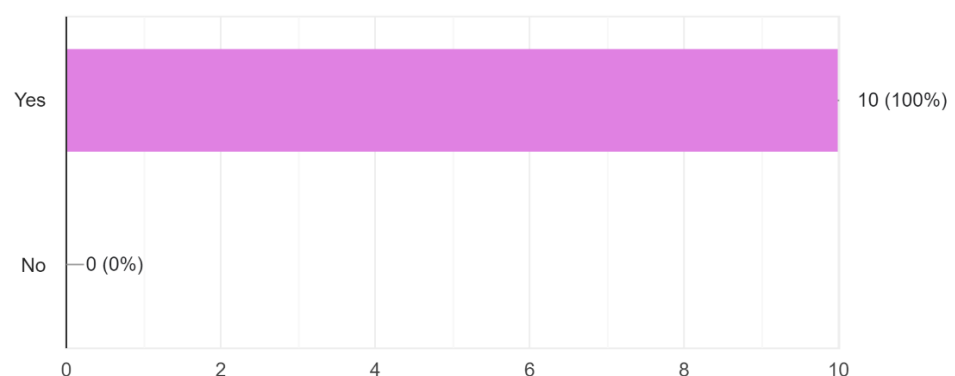


Figure 20

It was interesting to note that all users found the AR web application user-friendly. This indicates that the interface was well-designed, and the user experience was smooth. The users also found the various functions within the AR web application to be well-integrated, suggesting that the functionalities worked seamlessly together without any confusing overlaps, as seen in figures 21 and 22.

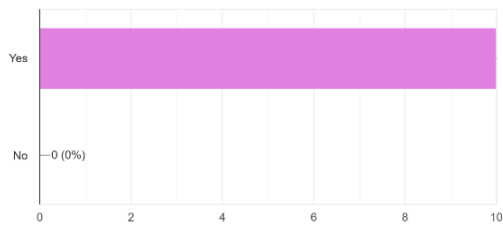


Figure 21

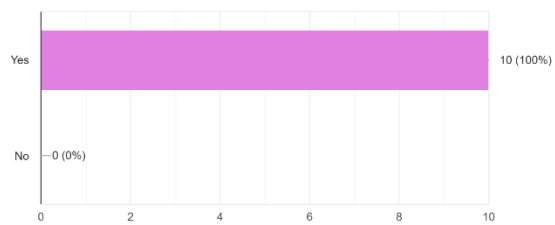


Figure 22

Although most users were able to navigate the AR web application without assistance, one participant expressed difficulties. This further suggests the additional usability functions can be considered to be included to avoid any future complexities, as seen in Figure 23.

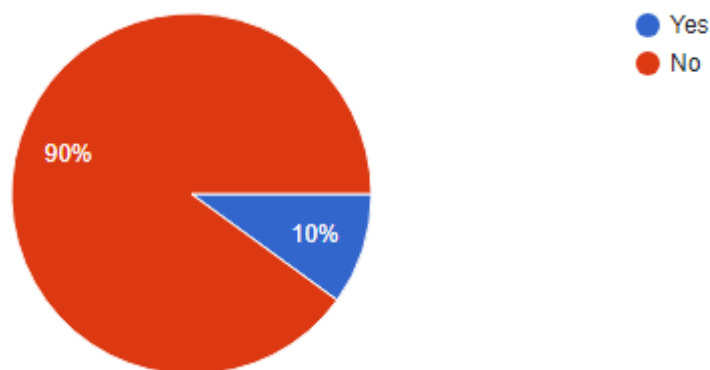


Figure 23

Furthermore, users were asked about their intention to frequently use the AR web application. While most showed interest in frequent use, one outlier had a different perspective. This possibly suggests that there may be a need for more refined functionalities within the AR web application to better suit user' preferences, as seen in figure 24.

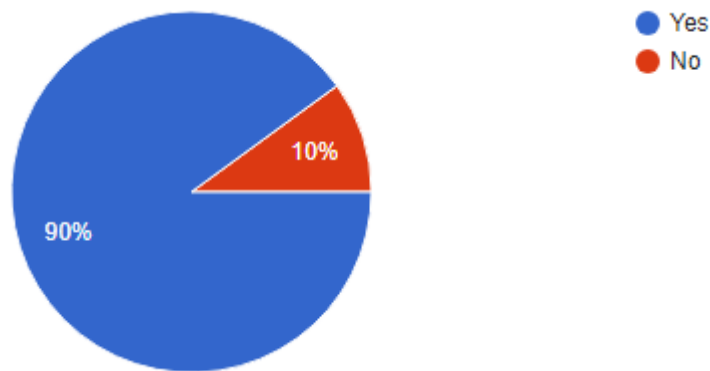


Figure 24

The results of the survey further revealed that the AR web application was successful in improving all participants' knowledge of Cork City's cultural heritage as well as that while interacting with it, the users didn't face any inconsistencies. This suggests that the success of the AR web applications that I developed is a testament to my skills and hard work, as seen in figures 25 and 26.

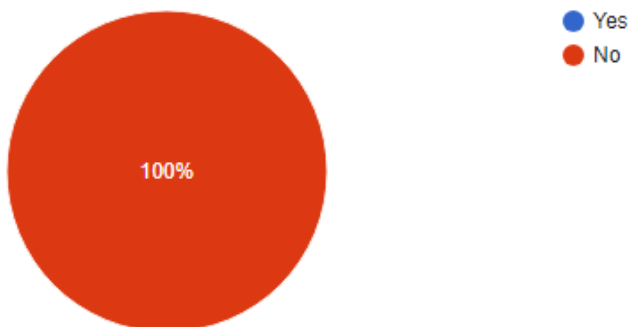


Figure 25

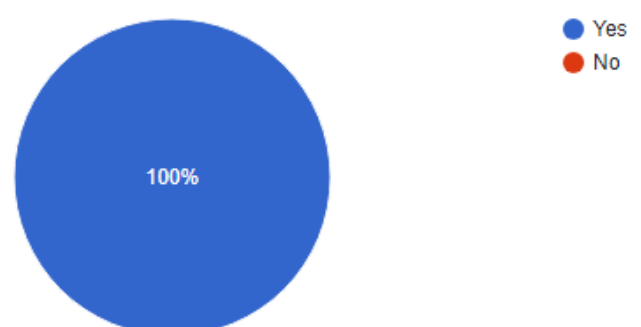


Figure 26

Finally, the participants were asked to further express any comments they would have had. As a result, the outcome came out to be overwhelmingly positive, with a strong focus on the response received “If this came out in the PlayStore, I would download it when I'm touring.”, “Liked the safety video links on the site to avoid incidents. Hearing the Irish words pronounced was very nice as I lacked Irish knowledge. Overall a great site for tourists and locals who want to see their city in more detail.” And finally, “Very easy to use. The recordings of both languages was clear and was a great addition and the new updated photos was a nice touch. Information given was accurate as well and very interesting.”

7.3 Conclusion

Based on my findings after implementing the changes, as being all pragmatic, it can be acknowledged that this practice not only adapts greatly but also a more enhanced experience while interacting with the AR web application. As evidenced by the survey responses, users found it not only more adaptable but also delivered a more enhanced experience. This suggests the application effectively captures the essence of preserving Cork's cultural heritage through digital storytelling and by the use of augmented reality.

8. Conclusion

In conclusion, from the past and the current progressions in the technology of AR, it can be noted that there will be a significant transformation in light of adapting and utilizing the technology in many more disciplines, especially as explored within the preservation of cultural heritage. Just as previously explored with the AR web application “Discovery Dublin Trails” which provides an immersive experience for users to experience the heritage of Dublin by telling the story of the monumental changes and developments featured by a number of trails for users to fully immerse themselves with. Furthermore, with more similar projects, such as “REVIVRE”, where users are brought to embark on a journey to learn and experience the stories of extinct animals. As a result, augmented reality can offer a means to make cultural heritage more accessible to a wider audience.

And how it all universally plays a role within the multidisciplinary field of Digital Humanities. Based on the contribution of the AR web application “Preserving Cork City: A look at its Cultural Heritage” the potential was greatly explored as an immersive and interactive experience to learn more about the cultural heritage of some landmarks and vantage points. Digital replicas were created to improve accessibility of landmarks by incorporating language support, localization elements, and images. In order to enhance the AR web application’s storytelling capabilities, comprehensive instructions were included, and detailed descriptions and translations of landmarks and vantage points were incorporated. On the note of the landmarks, each landmark had a corresponding cultural dialect audio recording included. By incorporating UX/UI improvements and the previous enhancements, the AR web application resulted in an exceptional tool for digital storytelling. And proved to by its ability to bridge the gap in understanding Cork City's landmarks and vantage points holistically.

The AR web application not only proved to be engaging and interactive, but the evaluation and testing by users who have interacted proved that the AR web application is useful when learning more about the cultural heritage of Cork City. Especially so in the context of digital learning of cultural heritage sites and learning in a more immersive and interactive way, as users would be guided to each landmark and vantage point if they were to select it and be guided to it.

Future considerations for ensuring the further success of the AR web application can include bringing forth historical commemorations by adopting a social media platform presence and advertising it. By building brand awareness, audiences will be able to stay on top of any possible future updates, strengthen their online reputation by opening up user feedback, and broaden the AR web application's presence. Furthermore, for the consideration of wider accessibility and audience, the AR web application could be implemented on Zapworks, which supports both IOS and Android devices.

While working with raw data and building on top of the AR web application, I faced a steep learning curve. However, this experience equipped me with valuable skills in understanding, implementing, and ultimately mastering the complex system. As far as multimedia skills are concerned, I had to employ problem-solving skills to figure out the dependencies that the database had with the presentation of the objects and to ensure that they appeared concisely

with the web application. Since the database had many moving parts, I had to work with the data in a raw format as the CMS tool that initially managed it had reached its end-of-life and posed a steep and rather time-consuming learning curve.

The interface of the AR web application, including the mapping system, localization elements, language support, and multimedia elements, were all designed based on my learnings from a four-year-long programme. This programme has equipped me with the knowledge and expertise needed to enhance and develop a well-rounded AR web application.

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