Building Digital Content for Ciudad del Saber: Casa Museo

Ciudad del Saber
Centro de Innovación

WPI

Building Digital Content for Ciudad del Saber: Casa Museo

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Submitted to:

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Abstract

Casa Museo is a museum on Ciudad Del Saber's campus located in Panama that encompasses vital history on the Panama Canal. The problem is that there is no technological material to make the exhibit more immersive and all the content is written in Spanish. After research on the content of the exhibit, the users and options for designing an application, we implemented a web application that has audio components for the museum in Spanish and English.

Executive Summary

The goal for Ciudad Del Saber's Casa Museo was to create digital material for their Casa Museo. This digital material would help them diversify their language options. In the beginning, they only had the majority of their information only in Spanish.

Our mission as a team was to gain as much knowledge as we could about Ciudad Del Saber's Casa Museo and Panama's overall history. While doing those two things we had to include the knowledge of our sponsors and the visions they had for this IQP. Our sponsor's vision was to add multiple languages (like English and French), have a physical/functional mobile app and an audio component that would be tied to the app.

After getting a better understanding of the goal and mission of this IQP, we started to do some research and planning. To start off our research section, we looked over the virtual self-tour, Izi Travel, which at the time was hosted by a third-party website and could be accessed through a QR code as well. The Izi Travel website and app then gave us the idea of looking into what other museums' tours look like and which features we could implement into our own creation. We examined three museums, The Metropolitan Museum of Art in New York City, Alcatraz Island in California, and the Art Institute of Chicago. As we examined each, we wrote out their pros and cons. Then we made one full list of what are the pros and cons to using a mobile app. The overall pro to a mobile app is that it isn't too difficult to navigate as a user and the cons we considered were only towards situational events. For example, the lack of internet and cost, not everyone in Panama can have the means for those two resources, even if the app itself was free.

The turnout of the pros and cons list for a mobile app pushed us in the direction of continuing to look into outside data. One set of data we came across was on the "Mobile Operating Systems" and its percentage. Android had the highest percentage of 83.8% and iOS had 15.89% (WorldData). Even though Androids were the highest in percentage, we still felt that it could be best to look into an application that would benefit all smartphone users. With such realization, we moved on to what application could help us be this inclusive. We created a table of the Application, Advantages, and Disadvantages to each. The most promising application for our project was a web application with an audio component. The web application was best because of the fact we could make it into a cross-platform app, and it could hold the audio component we wanted.

To advance in our findings and development, our team adopted a popular software development strategy known as agile development. This meant that the structure of our development process shadowed this strategy. We had daily meetings about what we wanted to accomplish that day and if any questions were holding back our development process. Furthermore, this meant that we worked in iterations as we completed cycles of the development strategy and received much-needed data from our sponsors.

Our very first iteration of the project was decided to be a hybrid application or a web application. At this point in the project, our team was working with very little data and sense of what we were doing. The general concept of this iteration was to develop a web application with a web shell encapsulating the project. Not only would this application be available across all platforms, but the web shell would allow it to be downloadable from both the google play store or the app store depending on the operating system each respective visitor was using. However, after reconsidering this option, we realized that this would not be the best development path. We

quickly realized that we did not have enough time as a team to collect the necessary data, develop the application, and implement the application within the web shell within the allotted seven weeks of our project.

This leads to the second iteration of our deliverable. Since we realized that implementing a web shell for our project would not be feasible, we settled on developing a mobile-friendly website. By this time in the project, we received the visitors' guide currently implemented in Casa Museo as well as a video walkthrough of the museum itself. With this much-needed information, our team began the development process. We created a prototype of both the mobile and desktop versions of the application. While this prototype did help to solidify our design process, new questions arose at this stage in development. We now needed to know how we would implement our application in terms of the already existing Ciudad del Saber website and how the structure of our application would help to supplement this.

This leads to the third and final iteration of the deliverable. From the data which we collected from the sponsor, we realized that the current website of Ciudad del Saber was hosted off a continent management platform called WordPress. Though this shifted the project slightly once again, it made the actual development process easier for our team as there was little to no code involved by using this software. It also automatically scales the website we created to fit nicely when using it on a mobile platform. In addition, we could preserve the structure and function we created with the previous iteration when developing on this platform.

Our final product is a mobile-friendly website created with WordPress that has audio summarizing different areas of the museum in both Spanish and English along with transcripts. We held a meeting with our sponsor where we handed over ownership of the website and the files, we used to create it to our sponsor liaisons ownership. We recommend the IT department at

Ciudad Del Saber keeps the website updated. We recommend the next IQP team create advertisements and instructions for using the technological component. We also recommend that as a next step the next IQP team creates an app that is downloadable from the app store.

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1. Introduction:

Over the course of Panamanian history, both the people of Panama and the historical events have been shaped by other countries. One event, in particular, is the creation and usage of the Panama Canal. Both the United States and France were involved in the development of this passageway. The Panama Canal has been vital in helping quicken the cultural diffusion around the world and has shaped Panama's culture. Not only has the Panama Canal served as a major historical landmark, but the remnants of history continue to be a center for learning and innovation. Because of this cultural diffusion, Panama is known for being diverse and having a rich history.

Museums are the most traditional way to engage people in learning about the history of a place, its people, and its culture. The Ciudad del Saber ('City of Knowledge' in English) has a remarkably interesting and important history that is integral to the culture of Panama. What was once a U.S military base that was up and running for about 80 years, has become a historical hotspot after its restoration and refurbishment. Since the old fort no longer has use as a function of the US military and control now lies with Panama, it has been being remodeled into a center for education and innovation by Ciudad del Saber.

Casa Museo, on the campus of Ciudad De Saber, is a museum with a permanent exhibition that tells the history of the Panama Canal site. The campus lies within what used to be Fort Clayton, a US military base during the US occupation of Panama. Originally, this building was created for the commander of Fort Clayton but now serves to educate people about the

historical importance of this site. It has an open library, a small souvenir store, and Wi-Fi access in addition to the exhibition.

Even though this site did help people learn about a key part of Panama's history, it was flawed in its accessibility, and this has been proven to be a long-lasting challenge with the museum. They only had the text panels that existed to inform the visitors on Casa Museo but not having a digital aspect for these panels, were their biggest challenge at the time. Our sponsors wanted us to help them to relate to today's modern digital technology and having access to this would assist them with the process of sharing their amazing history. While also staying aline with the rest of the world.

In addition to the missing technological advancements of the site, the accessibility was sadly hindered by the fact that the information is currently only in Spanish. Without the translated information in other languages, such as English, many of the visitors wouldn't be able to understand the importance that this site holds. Without improved accessibility and permanence, this crucial information to Panama's history risks being lost and forgotten. As it stands currently, only people who are fluent in Spanish can enjoy the true scope of what Casa Museo has to offer. Resulting from this factor, Casa Museo only attracts a limited number of people, and the historical importance of the site is only appreciated by a fraction of those who could enjoy the experience.

Therefore, by addressing the aforementioned issues we will be able to make this museum a more fulfilling experience for those who choose to visit and expand the potential audience of visitors. To achieve this, the goal of our project is to create a technological application accessed through a mobile phone. This will allow the visitor to have a more dynamic experience with the museum rather than only text panels being offered. This project will also serve to create greater

importance for Casa Museo within the City of Knowledge while simultaneously attracting a more diverse audience to the campus itself.

We set several different objectives to complete our goal. The first was to research the contents of Casa Museo. This involved working with the sponsor to understand what information is necessary to implement into our mobile application. The second objective was to understand our prospective users designing an application that best matches their experience. Due to the ongoing covid-19 pandemic, we had to use our sponsor and external research because there were no guests to survey on Ciudad Del Saber's campus. We were able to understand in more depth the differences in phone software for the people of Panama and visitors of the museum that directly impacts how we implement it. Our third objective was to create an environment for design. We completed this by using a software development methodology called Agile Development that helped us openly communicate and stay on task. Our next objectives were designing the application and implementing the application. We completed both several times in 3 different iterations. We would uncover something new each time and restart the process. Our final product was edited on Word Press as we identified the Website Editor to be most effective in our goals for the project. Our product was handed over to our sponsor liaison with the resources needed to maintain the website on google drive.

2. Background:

In this chapter, we will first present some background on our sponsor, Ciudad De Saber, and provide some insight into their goals and ambitions. Next, we will cover the history of the Casa Museo (Museum House) specifically, delving into what the exhibits contain, what current technology is available, and the accessibility requirements. Based on what we found in our research, we will then discuss the importance of self-guided tours and explore implemented tours. Next, we will outline some potential solutions for Casa Museo, and discuss the strengths and drawbacks of each. We will conclude this chapter by defining our project's criteria for success, and how our solution addresses each aspect of the problems faced by our team.

2.1 Our Stakeholder Ciudad Del Saber

The founding of Ciudad De Saber started in 1993, with 11 Panamanian businessmen who wanted to make a Socratic Plaza (Ciudad del Saber). Ciudad De Saber has the mission to uphold an innovative community that combines humanism, technology, and industry to make social change. They craft a comprehensive approach to social problems, bringing scientists, artists, businessmen, and people from other fields together. Currently, the Ciudad De Saber. has over 100 employees and branches dedicated to sustainable urbanism, business, entrepreneurship, and most importantly innovation. Ciudad De Saber is an organization at the center of Panama. Over 200 buildings encompass the old Clayton military base (Ciudad del Saber). Encompassing a park, the land rises and falls along with the Panama Canal.

2.2 History of Casa Museo:

The exhibition in Casa Museo is one of the newest permanent exhibitions parts of Ciudad De Saber. The Ciudad del Saber occupies the former cited of Fort Clayton; a U.S. Army base created in 1922. As most buildings are part of the Ciudad De Saber campus, Casa Museo is part of a historical fort created from the US occupation of the Panama Canal. Fort Clayton was first created in 1922, taking inspiration from killed-in-action US army member Bertram T. Clayton. This fort was crucial during WWII (World War II) as it served as the hub for Panama's Mobile Army as well as the Security Command. However, the United States no longer had use for this fort post-WWII so, so control was returned to Panama in the 1970s under the Carter Administration. Since Fort Clayton no longer has use as a function of the United States military, it has been transformed into a center for education and learning ough the use of museums for example. Casa Museo is a colonial-style house built in 1922. The house was built by Samuel M. Hitt, to reside as the head commander's family during the United States Occupation. This house was a residential property until 2010 (Ciudad del Saber).

Figure 1: *"Interpretation Center", this image was cited from Ciudad del saber website. The Interpretation Center is where it all began, it was once the Clayton military base in Panama and now it is the City of Knowledge project.*

2.3 Contents of Casa Museo:

The layout of the exhibition is broken down into four areas (Scope one, Scope two, Scope three, Scope four). This material was provided by our sponsors and is contained in a visitor's guide which is distributed at the museum. Each scope is contained within the guide provided. The guide has a Spanish as well as an English version. "Scope one," begins with a narrative in the old town of Río Grande during the period of the construction of the Panama railway in the second half of the 19th century, continuing with the project of construction of the canal by the

French, then the construction of the canal by the United States and the first fortifications for defense sites during the First World War, with an emphasis on the old Clayton base.

For scope two, there is information containing the expansion and maximum growth of the base during the Second World War, daily life, the social system within the base, and the change that the architectural and urban style undergoes, both in the structures and in the internal spaces of the same.

For Scope three, the guide contains information on the last days as an installation post WWII for military use, the ceremony of transfer of the 120 hectares that the Panamanian state made to the Foundation in 1999, and the development plan and administration of the project following its plan teacher.

In Scope 4, all this narrative of the three areas is linked through a transversal room. This room is referred to as the zero areas, which summarizes the different interventions and relationships that the United States has had in Panama, from 1856 with the watermelon slice incident to the present day.

2.3.1 Current Technological Approach of Ciudad Del Saber and Casa Museo:

The current technological approach on Ciudad Del Saber's campus is a self-guided tour. The application is hosted on a third-party website called Izi Travel those guests can access from their mobile devices. The tour has audio and written content in both Spanish and English. There are 16 points all over Ciudad De Saber's campus currently accessible to tour this way. This includes the building that hosts the Casa Museo referred to as the Interpretation Center. For all these tours, there are photos of the external buildings along with background knowledge.

Through the Izi Travel Website and App, there is a feature where you can access a map view of these sites generated by google. The virtual self-tour is accessible through a QR code.

For Casa Museo specifically, there is text on the walls only in Spanish. QR codes link to the overall Ciudad De Saber's self-tour mentioned previously, but there is no specific information about the contents of the museum. While Casa Museo is listed as one of the points, it only has general information about the house's history. Only having Spanish text and third-party English material makes Casa Museo a missed opportunity for a bigger global impact.

While the campus itself has a guided tour, the museum within the campus is lacking a dynamic and digital component. Visitors of the museum could greatly benefit from a tour like this being implemented alongside the text panels in Spanish that they currently have. With a digital component in multiple languages, Casa Museo could not only benefit a wider range of audiences, but also enhance the visitor experience. With information both in Spanish and English, as well as digital material, this can be accomplished.

2.4 The Importance of Virtual Tour:

Many museums around the world have opted to have content and self-guided tours online. Parry Ross (year) in his book *Museums in a Digital Age*, describes how museums in our current society are adopting digital technologies for exhibitions, as well as for navigation and exploration of the museum building(s). Museums in the past considered technologies like this to be overly expensive and requiring too much effort to maintain and alter if needed. However, these same museums can also point to other areas within the institution that use digital technologies regularly. Museums today wholly embrace the digital culture and now view their

digital audience, whether on or off-site, as important as their physical ones. Digital technologies have provided museums with the ability to query, connect, and share their collections a lot more easily than they would have been able to in the past.

The idea of "visiting" a museum has also been conceptually redefined as we are reimagining how people can navigate museums and experience museums without ever stepping into the premises of a museum. This is done by creating entirely virtual experiences that can be viewed through a mobile device or even a desktop or laptop computer. Ross also mentions a phrase by Andre Malraux which was a concept of "Le musée imaginaire" which translates to the "museum without walls." The concept was an analysis of how the different media we view art through help to redefine and transform the art itself. Hence, sometimes providing them with an entirely new meaning. Ross emphasizes the idea of liberating the museum from the medium of a presentation we are typically used to; an item on the wall, or a piece of art hanging from a wall.

The first iterations of what would become virtual museums were seen as early as the 1990s and were hosted entirely on CD-ROM. The user would be able to interact with a 3D-rendered virtual environment that would have art displays as you would see in a regular museum. The limitation of these products, however, was in the fact that they never actually attempted to simulate the physical experience of being in a museum. They instead serve more like a digital repository of the artworks you would typically be able to see in the museum.

Bernard Means and Vinod Nautiyal in Chapter 8 of their book titled *Himalayan Heritage in Danger*, describe how Uttarakhand which is one of India's states was at risk of losing its cultural heritage due to disasters such as earthquakes, and floods. The government also did not care much about the preservation of the state's heritage. Part of the steps that need to be taken to ensure the preservation of the history of this state include increasing awareness and education

about the history amongst politicians, as well as the public. There are works currently located in the Garhwal University Museum of Himalayan Archaeology and Ethnography. However, as Ross highlighted earlier, these museums are bounded by their physical location, and access is restricted to the people who can physically visit these museums. To make up for this the Garhwal University partnered with the Virtual Curation Laboratory at Virginia Commonwealth University to implement strategies that allowed them to digitally preserve art pieces that have been extracted from Uttarakhand.

One specific way this was achieved was by creating replicas of the objects excavated from Uttarakhand by 3D scanning and then printing these objects. These replicas, however, were just surface-level captures of the originals of these objects. There is no history to these replicas. These replicas also tend to lose some important characteristics of the object they are replicated from. A lot of times they are made from different materials from the original and using an entirely different manufacturing process. In a lot of cases, the replicas are made from plastic using hues that can represent any color in the rainbow spectrum.

Another issue Ross brings up is connectivity. Even if the museum has a website, to utilize the website whether on or off-site, the user needs access to the internet. These collections can only truly serve as a resource for the public if they are accessible to the public. Another accessibility issue that arises would be regarding people living with disabilities and/or impairments. For some users, it is particularly difficult to operate websites due to disabilities that bar them from access. However, digital technology has begun to make strides towards bringing down those barriers to access that people living with disabilities face.

A lot of the points raised by Ross et al. lead back to our project and the overall goals of Casa Museo as a museum. They are trying to provide visitors with a glimpse of history whilst

keeping up with the current trends of modernism and digitization. Virtual tours add an important layer of immersive-ness to the museum experience, and for some people, it may be the only way these museums can even be explored.

2.5 The Implementation of Virtual Tours:

Our team has investigated examples of virtual tours implemented in other museums. We examined The Metropolitan Museum of Art in New York City, The Californian Museum of Alcatraz, and the Art Institute of Chicago.

The Metropolitan Museum of Art is a globally renowned gallery with more than 2 million works of art. In the spring of 2015, the museum introduced an Audio Guide web app. The app is advertised to contain about 60 hours of tour guide content and be translated into 10 different languages. The purpose of the app was both to encourage remote users to visit the Museum and to enhance the experience of users already in the Museum. Some Audio Guide material is available in ten languages, and it was important to extend that respect to our international users online. An important feature of the app is its language preference. Since the majority of the museum's translated content is found inside the tours, introducing them to the Audio Guide web app was an important move in making the app more available to a wider audience. The way that language preference is chosen is through the settings bar where a pop-up window will ask for a language to be selected. Once the language is chosen, the guides are interpreted to match. This language customization tool is similar to the Audio Guide on-site and is anticipated to be a very useful option for our foreign community. Another important feature of the app is to be able to search for artworks by their number. Most artworks in the museum are numbered with

corresponding audio pieces. When the user taps a search bar on the front page and inserts an artwork's audio number, they will be brought to the corresponding audio. In this way, users can get information directly tailored to the artwork they are looking at.

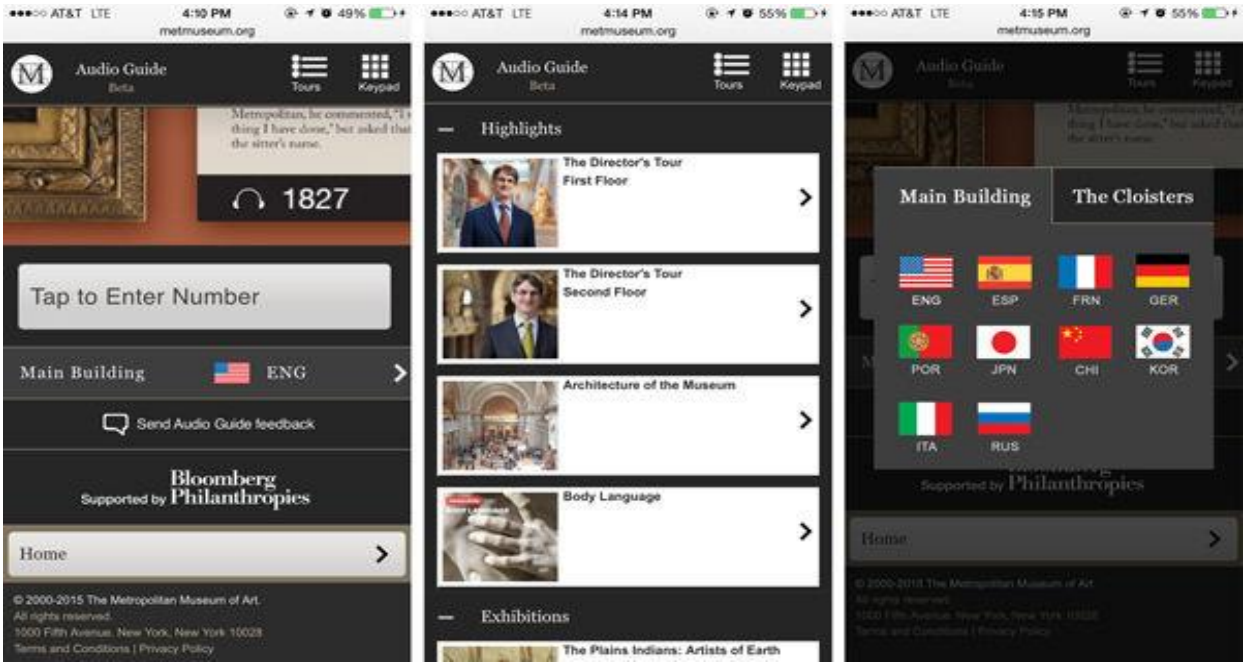

Figure 2: *Screenshots of "The Metropolitan Museum of Art in New York City" app, represent what the mobile app looks like and the sections we believe were helpful to the users.*

One of the possibilities which we can implement is an audio aspect within our app. While not necessary for the development of the app, an audio aspect may prove to have an additional element of attraction to those who are looking to visit the museum. To better understand how this additional component could benefit our project we examined a famous historical site with an available audio tour.

Alcatraz is the name of an island located off the coast of San Francisco in California. This island was previously a prison before it was shut down and subsequently made into a historical site thus allowing visitors to go to the island. It housed the most dangerous inmates because it was deemed “inescapable.” To give visitors a dynamic experience when visiting the island, an audio tour embedded within a mobile app was created. Once visitors arrive on the island after taking a ferry from the mainland, they have the option to purchase the audio tour. If they choose to do so, they can listen to the tour which is pre-loaded on the app with the convenience of their own devices. This tour is self-guided so visitors can proceed at their own pace through the prison, but also has visual queues which serve as guidance and recommendations on important or interesting features. It even has audio clips from “prisoners” to give the listener a more immersive experience. This allows visitors the freedom to explore while also providing them with crucial information to understand the history of the site.

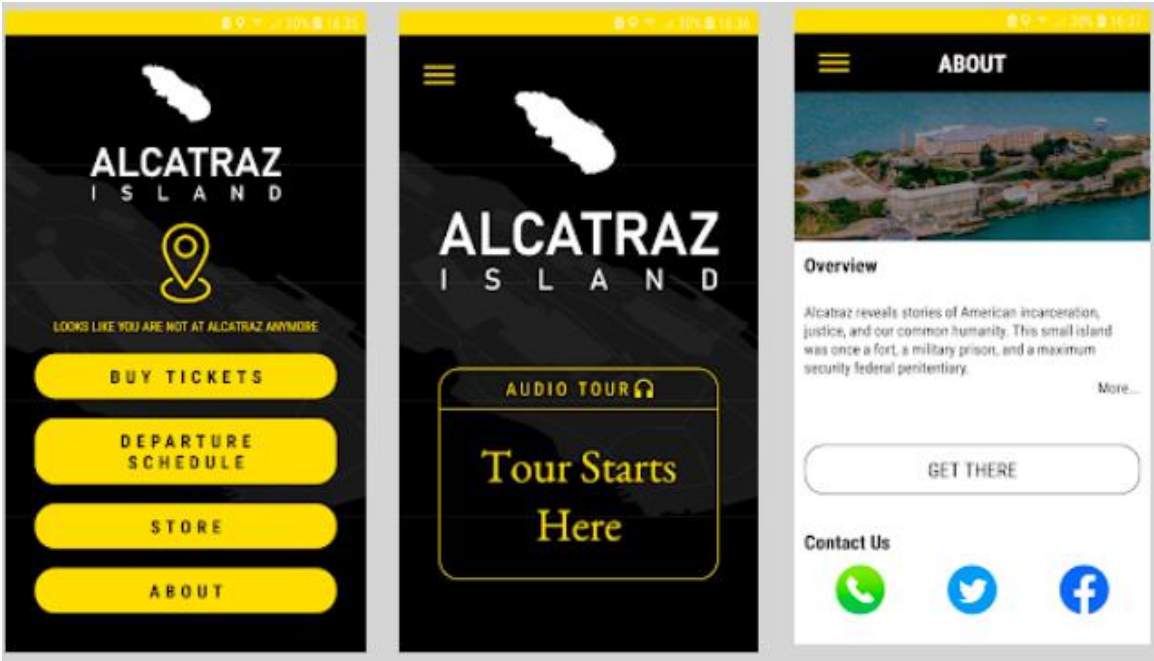

Figure 3: *Screenshots of the "Alcatraz Island" app, represent what the mobile app looks like and the sections we believe were immensely helpful to the users.*

While the challenges faced by the developers of this mobile application did not focus on translation, the audio tour aspect of this app proves to be a feature that promotes the attraction of tourists. The app overall has incredibly positive reviews and is available for both Android and Apple users. It has a four-star rating on the Google Play Store and a five-star rating on the Apple store.

The Art Institute of Chicago is one of the well-known Museums in the US and they have a section on their website that focuses on making touring possible. Two ways they have made this possible is through their free app, which has engaging audio tours featuring behind-the-scenes stories, a variety of expert voices, and music to transport you into the artworks. They have a "Look It Up" feature that allows you to learn more about the artworks that interest you, a location-aware interactive map to help you navigate the galleries, find old favorites, and discover new ones, and a digital member card so members can enjoy all their on-site benefits. Not only do they have an app, but they also have an audio tour, where the provided languages are English, French, Spanish, Chinese, and Korean. Having such a variety of languages not only makes them diverse but it helps them reach a bigger group of people, who will become connected to their art and history.

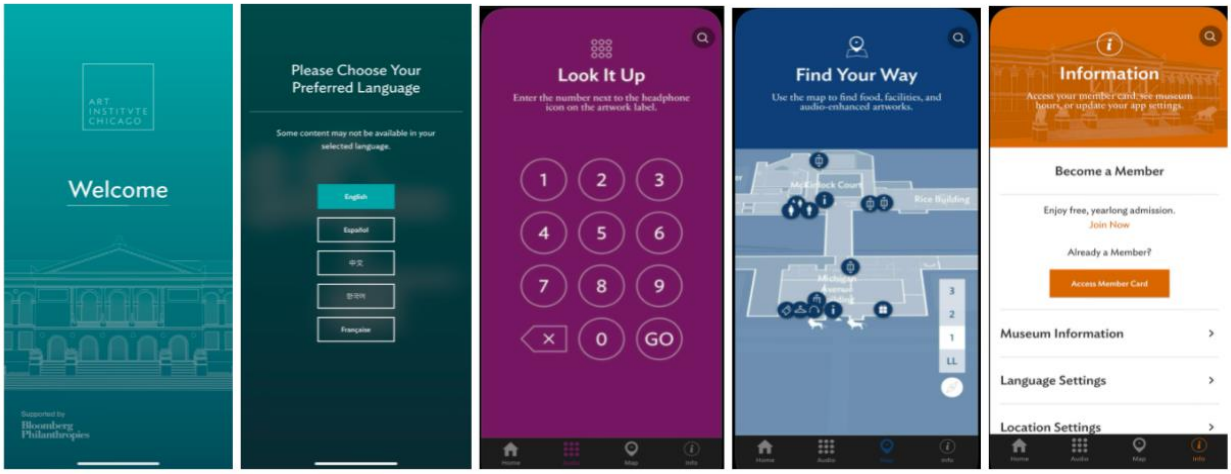

Figure 4: *Screenshot of "The Art Institute of Chicago" App, representing what the mobile app looks like and the sections we believe were extremely helpful to the users.*

A few things that could be considered pros to mobile app usages would be the visual side, from the images below, it is not hard to access or navigate. Another pro would be how inclusive they are with the languages, both the app and the audio tour have made it possible for those who do not speak English or Spanish. For the cons side of the mobile app, it is more situational rather than the app itself. Some people may not have access to a stable internet or could even afford a phone. Not having an alternative, mobile-friendly review way of working around this issue could be the few coins out there.

Application	Pros	Cons
Mobile App	• Not difficult to navigate. • **Inclusive:** Having multiple languages and an audio feature to help guide the visitors.	Situational Base: • Difficult with the lack of access to a stable internet connection. • **Cost**- Affordability, users not being able to buy a smartphone device.

Table 1: *"Pros and Cons to all the Museums Mobile Apps", this table gives you a simple visual perspective on what we thought about each outside museum that had a mobile app.*

2.6 Strengths and Weaknesses of Different Implementations of App Features

2.6.1 QR Code Systems Strengths and Weaknesses

Since Ciudad Del Saber has a pre-existing QR code system, our team saw that continuing a QR code system for Casa Museo specifically was a viable option for our application. In planning to implement a QR Code System, our team planned to combine two different technologies. The first being an app that has a web-view capability and that will be able to go to a web page after scanning the QR code. The second technology would be the website that the QR code pulls up. For this Ciudad Del Saber currently uses a third-party app. However, our team planned to make a new website for the QR code to connect the users with. The strength of these implementations would be that the QR code system already exists at Casa Museo's wider campus, Ciudad Del Saber, and because of that, it will make embedding the system into Ciudad Del Sabers' pre-existing technologies easier. A weakness would be that we would be dependent on the guest camera capabilities.

2.6.2 Numeric System Strengths and Weaknesses

In planning the implementation of a non-QR Code System, our team planned to make an app that uses a numeric system because of the research on the leading museums around the world. This approach will require us to categorize different parts of the museum exhibit. In doing so, users would experience virtual content on the app that matches where they are in the museum with the use of a numbering system. A strength of this approach would be that without a QR code system we could implement a more immersive virtual experience without worrying about how many times the users are using their camera. A weakness is that we would have to recreate more of the Ciudad Del Saber system in place.

2.7 Types of Mobile Applications

2.7.1 Types of Applications:

The standard approach to mobile development is to write native code for a specific smartphone platform, which is typically Java for Android and Swift for iOS. This will provide the best results, but the downside is that you will have to manage two codebases, (Jones). Hence it is not cross-platform and requires all adaptability to different environments to be hard-coded. A positive aspect of this application design is that it completely runs offline. This is done by having the app work on the power of the device's processor.

2.7.2 Web Applications:

Web Applications (Web Apps) are websites that look like native applications; however, they are not apps that can be downloaded from a browser. These applications can be accessed through a web browser. They are accessed by going to a URL. With the new popularity of HTML5, increased websites are becoming Web APPs in the sense that they are more mobile-friendly. What makes this option a viable alternative to others is that it is cross-platform. There is no need to create a native application for both IOS and Android if the way of accessing the application is through the internet.

2.7.3 WebView:

A WebView is a software that is embedded into a native application. Whereas, a Web Application (Web App) is an application program that is typically stored on a remote server and can be delivered through a browser interface.

The native application itself has all the components of a native app. However, it encompasses a browser engine (Kirupa). WebViews are a way to create 'hybrid' applications, which are simply web pages made within an app shell. The user interface is restricted, as it depends on a JavaScript 'bridge' to communicate with native resources, which can slow things down, (Jones). However, flexibility allows more code reuse. The JavaScript your website uses can use native system APIs (Kirupa).

2.7.4 Progressive Web Application:

One potential future for mobile development is to fully abandon the native climate. Online APIs allow for much more extensive connectivity between websites and computers than before, and support staff allows pages to be saved and worked offline (Jones). This thought process has led to the creation of Progressive Web Applications (PWA). They are essential to web apps that use HTML, CSS, JS but also a complex number of frameworks and tools. PWA's are faster, more responsive, and adaptable than regular web apps (Kirupa). For example, they can easily change accessibility mode and adapt to different screen sizes. A big positive about this application design is that they can run a limited version of the website features offline. PWA is a web app that does more in network and application capabilities than a regular web app.

2.7.5 Pros and Cons of Solutions:

The different ways of creating an app have different tradeoffs. Keeping in mind the criteria for our sponsor, we looked at a mobile application that has an easier way of transferring what has already been done for our project. Hence, native applications would not be as viable as a solution because they do not naturally incorporate website material. Additionally, more code would have to be created for implementation across several types of devices. While web applications would be easy to incorporate, there is a missed opportunity in using a website. This is what makes a review application seem more viable. There is a way to incorporate previous online material and have a physical app tied to the museum. While Progressive Web Applications would run faster than a WebView, they may propose more challenges for the complexities that are involved in working with their network mode. However, there is a great benefit in having a website that can function offline.

2.8 Criteria for success

We have established the particularly crucial details of how Casa Museo has come about at the beginning of our paper, including where the Casa Museo originated and how the people of Panama have tried to include its community in the latest version they have.

In our background section, we spoke about the organization behind Casa Museo, our technical approach to helping to create their mobile app, the importance of mobile apps, the importance of virtual tours, other museums that created mobile apps or audio tours, and mobile applications to our solution. With our solution, Casa Museo can have a bigger impact in sharing vital history with the global world.

3. Methodology and Findings

Our overall goal is to provide a technological component for Casa Museo in Spanish and English, to achieve this we plan to design an implementation of the app. In this chapter, we explain how we explored our options. Additionally, we will document what we did to accomplish our goals and the reasonings for such. In the process of our research, we aimed to answer the questions: Is it possible to design our app in a way where it can be built upon to be a central app used for a tour of all of Ciudad de Saber? In what way can we design our application to be most efficient for our sponsors? To accomplish our goal, we set out to complete the following objectives:

- Objective One: To Collect Information on the Contents of Casa Museo
- Objective Two: Understanding users from Ciudad Del Saber to have more insight on How to create the App
- Objective Three: Creating the Environment for Design
- Objective Four: Designing the Application
- Objective Five: Implementing the Application

3.1 Collect Information on The Content of Casa Museo

As a group, we communicated with our new sponsor liaison about his vision for the Casa Museo. And what we hoped to get out of this project. Our past sponsor liaisons have given us an example site for the text panels, to guide us on creating the digital version of it on our app. They also gave us a QR code that led us to a tour guide of Ciudad Del Sabers campus overall. Our new sponsor liaison helped clarify that what Ciudad Del Sabers wanted is not a technological tour but a technological component. This helped us understand how in-depth our application must be. At this time, we collected a walk-through video of the exhibit. Getting access to this helped us visualize the experience of guests at the museum. We could then see how to add on to the guest experience using our technological component. Additionally, we were given Casa Museo brochures in Spanish and English. This was the first time we received material that could go directly into our component. After discussing the possible outcome of our technological component, our sponsor offered to annotate the brochure by hand with what he wanted us to include in our technological component.

3.2 Understanding Users from Ciudad Del Saber to Have More Insight on How to Create an App

To make the best decision on designing the app, our team wanted to scope the resources, limitations, and preferences users had with their mobile devices. Our original idea for data collection was to implement a survey. The plan was to distribute the survey to those who visited Casa Museo to gather information like what operating system their phone used and if they had easy access to the WiFi on the campus itself. However, after discussions with the sponsor, we

realized that this path would not be feasible. As mentioned before, due to the ongoing pandemic, not only were we not allowed to travel to the campus, but Casa Museo remained closed for the duration of our project. Thus, distributing a survey would be impractical and provide very little feedback regarding this much-needed information.

Due to the circumstances that we are faced with, we resorted to gathering information from the sponsor. Although this information did not come directly from the visitors of Casa Museo, it was retrieved from a reliable source with extensive knowledge of those who would typically visit. We worked alongside the sponsor at every step during development to ensure that our deliverable was the best product possible and the information which they provided us adjusted our project goals along the way. The feedback and insight from our team's sponsors allowed us to understand what visitors to the museum were currently lacking and how our deliverable could improve their experience.

3.3 Understanding Resources and User Experience

It was important to understand the resources of our project site, Casa Museo, and the broader Ciudad del Saber campus, to narrow down our design possibilities. We used our Sponsor Manuel Rivera and The IT Department as sources of information. The Ciudad del Saber campus has strong WiFi and a lot of bandwidth. Therefore, we decided that having more online features is possible. Another resource on Ciudad Del Saber's campus is their Information Technology Service Group. We learned that their team has experience keeping WordPress pages up to date. Based on this information, our team has decided to go with a WordPress website for our deliverable to have future revisions to the website easier. Lastly, our sponsors confirmed that

Ciudad Del Saber has their own server. This gave our team a better understanding of what security concerns to plan for. We decided that if the data is permanently on their server, that is not something we have to account for. Additionally, our Sponsor confirmed that the museum has access to its own domain name. With both the server and the domain name being part of Ciudad Del Saber initially, our team did not have to consider buying or creating either.

3.3.1 Discovering Mixed Amount of Different Phone Platforms

During our IQP sponsor meeting, we were told the people who visited the museum usually have a mix of smartphone software. The percentage was estimated as 50/50 for Apple versus Android. However, when we compared this with data from StatCounter (2021), (2019), we found substantial differences. This dataset showed that 84% of smartphones in Panama run Android, while only 16% run iOS.

The World Data table in Figure 1 shows a high percentage of cellular phone use. We added this figure to show the importance of technology usage in Panama. Being aware of these numbers has helped us produce solutions to the overall issue.

Distribution in 2019	Panama Total	Panama percent	EU Total	EU percent
Internet users	2.70 m	63.63 %	382.04 m	85.43 %
Broadband users	523,530.00	12.33 %	158.30 m	35.40 %
Landlines	741,269.00	17.46 %	165.48 m	37.00 %
Mobile cellulars	5.60 m	131.85 %	542.60 m	121.33 %

Table 2: *"Chart from World Data", this table was sited from StatCounter Global Stat and it represents how many people in Panama have phones in 2019.*

Because of this recent outside data, we discuss how the 50/50 percentages of people who come to the museum with either or deceives may not be fully accurate. Our goal of moving forward is to bring awareness to these numbers and see which application would be hugely beneficial to all users.

Mobile Operating Systems	**Percentage Market Share**
Android	**83.8%**
iOS	15.89%
Samsung	0.29%

Table 3: *"Mobile Operating System Market Share in Panama - August 2021", this table was cited from WorldData Info and the purpose of this table was to highlight the percentage of Android users in Panama.*

3.4 How Do We Use What We found to Create an App

During this process, some considerations we made were in the mobile application we would end up developing. As stated earlier, there are general types of mobile applications. They are native applications, hybrid applications, and web applications. As they apply to our research and project, the type of application we would end up producing relies heavily on the factors stated above.

Native applications are time and resource intensive as we would have to go through every stage of development for each platform we intend to develop for. We would have to design, test, build, and implement entirely different apps for iOS and then Android devices. Some advantages

that native applications have, however, are that they are incredibly functional, as the platforms that they are created on provide a considerable amount of support during the development stage and allow for us to create the best possible app for each platform. They are also capable of running simply fine while being entirely offline.

Applications	Advantages and Disadvantages
Native Application - a mobile application that only applies to one operating software	**Pro:** easiest in terms of developing for our team **Con:** time constraints, group experience with iOS but from the data we gathered it seems as if most people use android, no cross-platform capability
Web Application - A mobile-friendly website, with more focus on specific material and less detail than an actual website	**Pro:** Cross-Platform **Con:** time constraints, No physical App • **Web Shell -** A native or cross-platform app that acts as a browser to the internet with select features offline **Pro:** Can encompass Web App, Gives the museum an App on the app store **Con:** Requires a native application or Cross-platform app
Audio Components	**Pro:** more immersive experience for the user, can have a self-guided tour through the museum, audible queues to point out most important aspects **Con:** Time constraints
QR Codes - Scan with a phone which directs to a website with information	**Pro:** probably the most simplistic approach **Con:** not necessarily an app, requires people to be constantly using their phones to take pictures which may not be the best approach at a museum

Table 4: *"Pros and Cons of Applications", A table of the Advantages and Disadvantages of each application we spoke about as a team. Creating this table helped us narrow down which application was best for our project.*

Hybrid applications, on the other hand, eliminate the disadvantages of the development of native applications, in that they are significantly less resource and time-intensive since we essentially design, test, and build the same app which will be released for both the iOS and Android platforms. The only notable disadvantage comes from the slight decrease in functionality as there would not be native support from both platforms during the production and release of the application. However, this is overcome using third-party platforms for application development that offer support during the development process. These applications are also capable of running entirely offline just like native applications.

The final type of application, web applications, also eliminates some disadvantages we see in the earlier applications in that they are not exactly designed for either platform, which means we would not have to be bothered about native support during the development process and beyond. Web applications essentially run on any compatible browser, so they are simply released by publishing them on a website. The disadvantage of web applications is in the fact that they are incapable of running offline, and require constant, and reliable access to use them. There are some variations of web applications such as Progressive Web Applications that do not necessarily require stable internet access and can essentially download most of the files necessary at startup and would not require constant internet access beyond that.

After examining each of these options closely, our team was able to decide to develop a web application for this project. From our research, we concluded that cross-platform capability

was essential, as visitors to the museum use a mix of iOS and Android devices. A web application would allow for those criteria to be met. In addition to a web application providing cross-platform availability, which is needed for the museum, the campus itself has a WiFi connection capable of supporting the use of the internet while visitors are at Casa Museo.

3.5 Creating an Environment for Design Using Software Development Methodologies

There are several different software development methodologies that are currently adopted by development teams ranging from indie developers to large-scale corporations. Some of which include Agile, DevOps, Waterfall, and Rapid application development. There are different pros and cons associated with all these development methodologies. Ultimately, our team decided to go with what is quite possibly the most used development methodology in the industry today.

We went with Agile development for our development methodology. The pros associated with this include the ability to work on and deploy our project in timed iterations. Agile development also improves the efficiency of our team as we can resolve issues earlier on in our project development as well and receive timely feedback on features of the application as we work on implementation. Some cons of Agile development would include it requires frequent and even sometimes real-time communication between the development team and the sponsors, which might be troublesome given the existing language barriers. Agile development is also quite labor-intensive as it requires the development team to fully complete a cycle before seeking approval from the sponsor.

Distinct roles ensure the effectiveness of an Agile team, some of those roles include the developer, who as their title implies, is responsible for the development of the product. These may be confused as meaning only the engineers on the team, but this also includes the designers, the writers, and of course, the programmers. Several people typically occupy the developer role on an Agile development team.

Another vital role on an agile development team is the product owner. The product owner is responsible for managing the release of the product and ensuring the quality of the product before each release. The product owner should understand what the needs of the sponsor are always and should always work to ensure that the team provides the most value in the product. They do this by staying in constant communication with both the development team and other necessary stakeholders. The product owner is also responsible for managing the scrum backlog which is simply the log of tasks the development team should be working on during any given sprint. A sprint is simply any predetermined duration of time for an iteration of development for agile teams. A sprint could be if the team chooses it to be. In our case, we will be working in week-long sprints.

The last significant role involved in an agile development team is the scrum master. The scrum master is simply the glue that brings agile development altogether. This is typically someone who understands how agile development is supposed to work and ensures that the team is working as they are supposed to. The scrum master can be described as a servant-leader for the development team. They help the product owner define the values for the product, and help the development team deliver on that value, and for the entire team to continuously improve through the iterations. The scrum master is also responsible for managing blockers and ensuring that any obstacles to progress on the team get resolved as soon as possible.

Some specifics of Agile development include daily standup meetings, where the team meets to discuss what everyone was able to accomplish the day before, what they intend to accomplish on the given day, and if there are any obstacles to progress. In the event of an obstacle, the scrum master is responsible for managing that obstacle. Another important part of agile development is the weekly retrospective, and sprint planning meetings. The team will be holding retrospective meetings to simply discuss what things went well, and why those things worked so effectively. We would also discuss what things did not go quite well, and some reasons why those things did not work as well as they should've. We would also discuss some areas we could improve as a team. At each sprint planning meeting, the product owner discusses with the team what the highest priority features to work on are. The team uses that information then decides what the goal for the sprint would be and will also create a detailed backlog of tasks to work on in that sprint.

3.5 Designing and Implementing the Application

The design and implementation of our application had three different iterations marked by new discoveries that made us restart certain parts of our project.

3.6 Iteration

3.6.1 Iteration I

When our team was initially planning on a deliverable, we brainstormed ways to improve upon some of the issues with the current method of touring Casa Museo. We decided that our solution should be accessible and functional to be the most viable product for this project. Our deliverable should be easy to use, have cross platform capability, and mobile friendly according to the information gathered from our sponsors. In the earlier parts of the project, we discussed

some necessary steps that will be taken before actually developing our solution. These steps while they aid in the actual development of the project, they also allowed us to decide on exactly what product we will be developing. Our initial decision was to create a mobile app, which would be a virtual tour of the museum.

To implement a mobile app as our chosen deliverable, there were a couple of factors to consider which we've also discussed earlier in the chapter. Some of these include the current accessibility of both the museum, as well as the accessibility of the intended application, the current state of connectivity at the museum (is their reliable internet access throughout the museum), the platforms we would be developing for (Android/iOS/Desktop), the technological capabilities of both the museum staff and the visitors, as well as the time and resource limitations we face as students developing this application over 7 weeks (about 1 and a half months). These are all crucial factors that we had to consider in the development of our application to improve the accessibility, ease of use, relevance, and functionality of the application.

During this process, some considerations we made were in the mobile application we would end up developing. We tried to think of how to get an app and a cross-platform device at the same time (as defined earlier in the chapter). We decided on a web app within a web shell. Our thought process behind this iteration was that not only would this be available across all platforms, but the web shell would provide visitors with a place to download the application for mobile operating software. For a visual of what we had in mind for our deliverable look at figure 3. With more insight from our sponsor, we realized the time constraints and settled on just a mobile-friendly app. It was a difficult decision because one of the sponsor's concerns but not requirements was making an app. However, we planned to recommend a web shell to later

iterations of our team. Since the sponsors were not opposed to a website for a deliverable, after this iteration we decided formally that this would be the route that our team pursued.

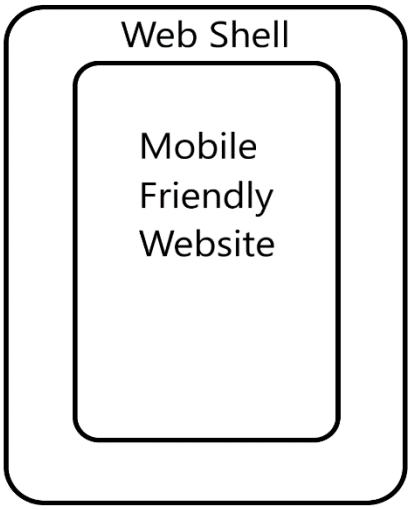

Figure 5: "*Web Shell to a Mobile-Friendly Website", represents how a web shell encompasses a mobile-friendly website.*

3.6.2 Iteration II

Our team initially began the process of making a website application by creating a wireframe for our application in Figma. This helped us decide on the base design for the application. This design was also heavily influenced by the guidelines imposed by Ciudad Del Saber for the development of websites for the organization. We used these mock-ups to create the front end of our application using a website called Framer, initially creating the application with mock data and information. We planned on using a programming language called React. The main purpose of React is to make websites more mobile-friendly. In later iterations, we then populated the application using the information in our database that was provided by the sponsors. This iteration of the prototype was created with very little information regarding the

wifi capability of the campus itself as well as the exact content that would need to be implemented in the final product. Rather, this served as a starting point for our team's design and the first attempt towards the creation. Our team began programming by working off of an Open-Source Code repository on GitHub. Open-Source Repositories are on a website called GitHub where people can store their programming files and share their files with others. The repository being open-source and public meant that it was open for everyone to use. We chose a particular Open-Source Application that used React.

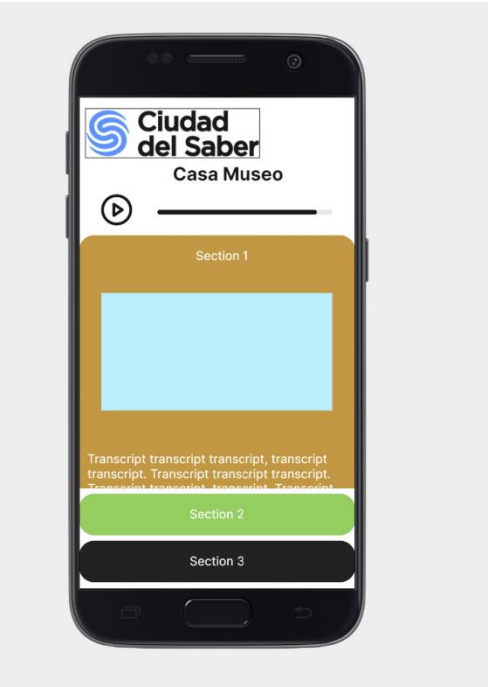

Figure 6: *"Android Version of Prototype", a screenshot of our mobile prototype*

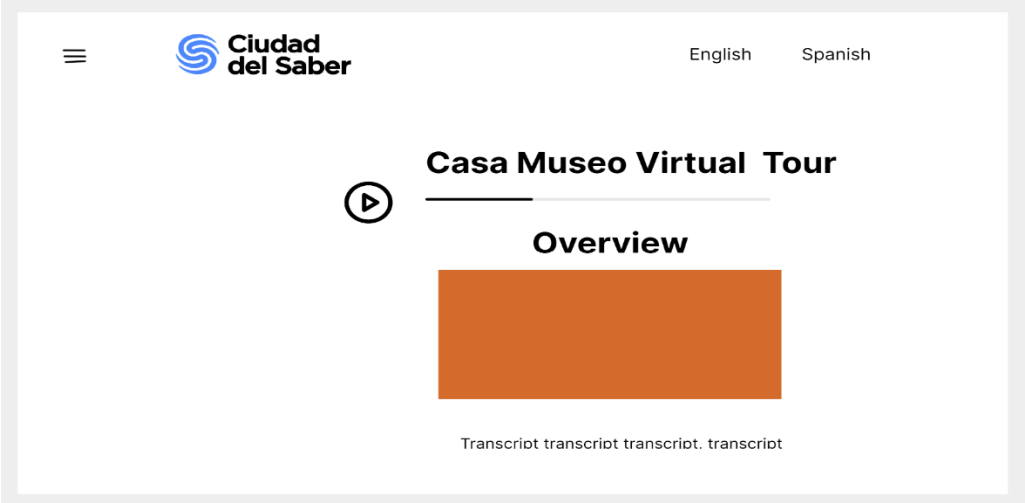

Figure 7: *"Computer Version of Prototype", a screenshot of our desktop prototype*

3.6.3 Iteration III

Towards the last two weeks of our IQP, Manuel, our sponsor, mentioned the usage of WordPress from their IT side at Ciudad Del Saber. We reached out to the IT department to get a better understanding of how they have used WordPress and to get a guideline on how we should use it for our IQP. As a group, with the new knowledge we received, we agreed on testing WordPress and hoped for it to be the best solution for our project. Although this eliminated the possibility of visitors being able to download the application from mobile operating software, it would still meet the requirement of being mobile-friendly while also aligning with the previously made technologies at the campus.

WordPress is best known for being free open-source content management (CMS). Most consumers use it for hosting and building a website. We planned to use WordPress to do something remarkably like the Ciudad Del Saber website, it is not only mobile-friendly, but it made all the additional features we wanted to add possible. WordPress automatically scales the

website when using it on a mobile device to ensure that it fits the screen, which in turn ensures that the visitors would have an enjoyable experience when using the app while at the museum. With this iteration, we bypassed the usage of programming by hand and turned the project into a more straightforward process. We formatted the website and input the data into the WordPress software. Once we received the information from our sponsor about the most important things to include on the website, we started the creation of it right away.

In deciding between a QR code system and a numeric system as mentioned in earlier chapters, we ended up choosing neither. Instead, we decided to have a drop-down menu as our application's navigation system (see **figure 8**). When the user wants to get from one section of the exhibit to another by clicking on the drop-down menu and selecting from the provided options.

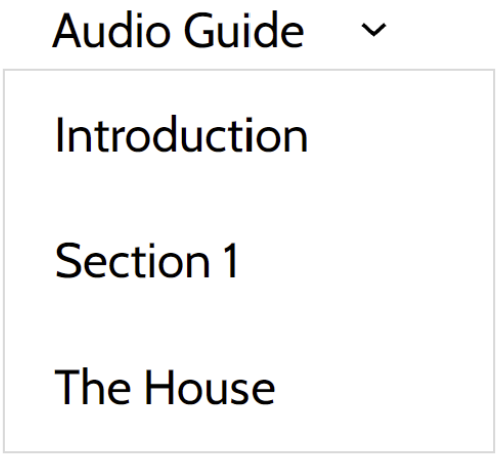

***Figure 8: "Drop** Down Bar", this screenshot is of the drop-down bar of our final product.*

Another component that our sponsor mentioned that would be important for the project was a dynamic component to give visitors an enhanced experience when visiting the museum. Our team decided that to best accomplish this we should develop audio clips which go through the text on the website. For the dynamic audio portion of this iteration, we used a text-to-speech website and converted it to .mp3 files which could be implemented inside of WordPress and supplement the text.

Figure 9: *"WordPress Mobile App (English)", this screenshot is of our final product with the audio component added in English.*

Figure 10: *"WordPress Mobile App (Spanish), this screenshot is of our final product with the audio component added in Spanish.*

4. Conclusion and Recommendations

Museums are the most engaging way to expose people from all walks of life to important cultural and historical events. Without Museums there would be no opportunity to explore and remember the history of past societies. Thus, Museums are vital to preserving the cultural and historical events that lead to a nation's identity. This is the case for Casa Museo, as the content of the exhibit goes into depth about the Panama Canal and thus a part of Panama’s cultural and historical influences. Given that Museums are so connected to engaging with a place's cultural identity it is a place of both social and political unity. Museums give people a way to explore a country's identity.

4.2 The Application Process

At the beginning of our process of choosing how to make an application our team chose between various options. Our options were Web Applications, WebView and Progressive Web Application. Web applications are websites that look like native applications (which are standard apps that have the full offline capability). WebView applications are native applications that encompass a window to a website. Progressive web applications are Web Applications with extra features to be more responsive and faster. We initially chose a WebView, but through further investigation of resources and time constraints, we decided to have a Web Application.

The decision to have a web application also stemmed from our deep research into the differences between Mobile Platform Software. There seemed to be a significant amount of both Android and IOS mobile phone users. Therefore, our platform had to work on both types of software.

This meant that we had to exclude Native Application Options like WebView. This is because Native Applications require separate implementations for both Androids and IOS.

Our team also decided between key features of the application. An audio component was initially something we viewed as optional, but with more discussion with our sponsor we found that it was vital. Our team also decided between a QR code system and a numerical system for organizing the exhibit content. Either option would dictate how a guest would navigate to a specific part of the museum. We found that QR codes were a vital option because there was already a QR code system in place for the campus encompassing Casa Museo. However, we decided to go with neither option. We found that for our applications ease of use, we could have a drop-down menu for navigation.

We went through several iterations of Designing and Implementing our idea. Each time we would discover something new and restart the process. We decided to use a software development methodology called Agile Development that helped us efficiently start over and stay on top of our goals.

In the first iteration we were still thinking of having a WebView application. Our conceptual design was a web-shell native app with a window to a website. The hope was to have an app as a deliverable for our sponsors. This was when as previously mentioned we realized our limitations of time and experience building such an application. That is when we restarted our design process.

In the second iteration, we decided on a web application because of our limitations. We began the process of prototyping a website design for both computers and mobile devices. We then began implementing the application by programming using a language that is the main purpose is

making websites more mobile-friendly. At this point, we began to wonder how our website would connect to the websites already established as part of Ciudad Del Saber. We reached out to our sponsor liaison with this concern. When our questions were answered we knew we had to restart our implementation process.

Iteration 3 was marked when we realized that Ciudad Del Saber's websites are run on WordPress Website Editor. This was when we discovered the importance of asking what is already implemented when wanting a more well-synced application. We preserved as much of the prototype as we implemented our website's content into WordPress.

4.3 Recommendations for the Sponsor

For our official hands-offs of the deliverable, we had a meeting where we gave our sponsor liaison full access to the WordPress website. We will also give our sponsor liaison a drive of all the material we used in creating the website. This includes audio pieces and the highlighted brochure pages we transcribed. The sponsor liaison plans to hand this off to IT services at Ciudad Del Saber. We recommend our sponsors fill the website with pictures more specific to each exhibit. We will also provide instructions on how the sponsors would be able to add additional content and information as needed.

Our final recommendation for our sponsors would be on how they would go about integrating the Casa Museo website with the rest of the Ciudad Del Saber website. Our suggestion would be that they add the website as a subdomain of the current "ciudaddelsaber.org" domain. Subdomains are essentially different parts of an overall domain that can be used for dedicated sites. They are reached by prepending the regular domain name

with the subdomain name for the site you are trying to reach. This would mean folks would navigate to the Casa Museo website by entering “casamuseo.ciudaddelsaber.org” into their browser, for example. While there are several different approaches to integrating the website with the current Ciudad Del Saber website, we find this to be the easiest and most intuitive way of doing so.

4.3.2 Recommendations for The Next IQP Team:

We recommend that the next team create advertisements and instructions on the application. This is to be able to encourage more users to use the website. Additionally, we recommend the next IQP team create an app that can be displayed on the app store. As explained previously in the chapter, due to limitations we could not create an app as the sponsors had initially hoped for. We recommend the next team use the same approach we had in mind based on our research, which is to create a Cross-Platform App.

4.4 Conclusion

Casa Museo’s exhibit is filled with extraordinarily rich history, from the location of the house to all the content it upholds. Our technological component helps make sure the scope of people who benefit from the exhibit has increased. This project emphasizes the way that technology can be used to cross barriers like language to provide a vital history to a wider audience.

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