The Importance of Interior Wayfinding and how Technology can Enhance this Crucial Aspect of Urban Navigation

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Declaration of Originality

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Abstract
This project addresses the critical need for improved interior wayfinding systems, particularly focusing on the difficulties of navigating indoor spaces for a diverse range of users, including those with disabilities, various age groups, and different gender identities. Despite advancements in technology, interior mapping tools often fail to provide adequate support, leading to challenges and frustrations. This project aims to change the way people find their way around buildings through inclusive and accessible wayfinding within the digital humanities paradigm. It involves studying the crossroads between technology and human behaviour as well as spatial cognition to gain a better understanding of how people go about finding their way indoors. The broader purpose of this study is to help develop a more universal digital world by highlighting flaws in current mapping systems and suggesting new revolutionary approaches. This project advocates for a more diverse and welcoming environment where everyone, regardless of their unique needs, can navigate interior spaces with ease.

1.0 Introduction

1.1 What is Wayfinding?

Wayfinding is defined as “the cognitive and corporeal process and experience of locating, following or discovering a route through and to a given space”. (Symonds et al, 2017) Interior wayfinding therefore refers to the process of navigating through indoor spaces efficiently. It includes various elements such as signage, maps, digital displays, and spatial design, which are all aimed at guiding individuals towards their destinations seamlessly. The importance of interior wayfinding goes beyond just convenience, it has an influence on one’s user experience, safety, accessibility, and overall satisfaction within built environments.(Hariram 2023)

In busy environments, it can be difficult to find one’s way around an interior space, buildings such as shopping centres, hospitals, airports, etc. This can be even more difficult for people with disabilities, as well as the preferences for different ages and genders. While most of the mapping systems today work well outside, they don't always work as well when it comes to interior spaces, leaving many people feeling lost and frustrated.

1.2 How is this relevant to Digital Humanities?

The field of digital humanities centres around studying human experiences and behaviours using technology. When considering this field and the relation it has with geography, it uses digital tools and technologies to study geographical landscapes and spatial relationships. It uses these tools to analyse the spatial data, study the cultural and historical landscapes, as well as examine human interactions with the environment. In the field of geography within digital humanities, researchers frequently utilise Geographic Information Systems (GIS), remote sensing, and spatial analysis methods to study patterns, connections, and shifts in geographical data. These tools are essential for mapping and displaying spatial occurrences, understanding spatial arrangements, and recognizing spatial connections.

This project specifically aims to acknowledge and cater to the diverse needs of individuals, including those with disabilities, age groups, as well as gather an understanding of different gender perspectives, in line with the human-centred approach of digital humanities. Inclusivity and diversity are key themes within digital humanities, as scholars examine how technology can enhance representation and inclusion in different cultural and societal contexts.

By addressing the flaws in existing mapping systems and comparing these systems to highlight what could be done for accessibility for all users, this project contributes to the information that is needed for the creation of more inclusive digital spaces within the geographical space. In digital humanities research, customisation and adaptability are key factors when it comes to developing digital tools and interfaces to meet the diverse needs of users.

1.3 Motivation for this Project

During a recent visit to Japan these issues were highlighted while trying to navigate through large train stations such as Shibuya and more specifically Shinjuku as well as other buildings such as shopping centres, and airports. While many people see Japan as a very technologically advanced country, these buildings often rely on traditional methods of mapping such as following the limited train lines that are painted on the floor, using maps that can be found on the walls or asking staff for assistance there isn’t much else provided by the stations.

Despite the availability of digital mapping tools like Google Maps, navigating interior spaces still proved to be quite difficult. Google Maps lacked the detailed interior mapping that is needed to navigate these buildings, leading to challenges in navigating the train stations and multi-storied buildings. This highlighted the need for more sophisticated interior mapping solutions.

1.4 Original Idea:

The original plan for this project was to create an interactive mapping system for Shinjuku where the user would be able to enter their information such as their gender, age, and any disabilities they have that would impact their interior wayfinding abilities. The mapping system would also inform the user of any areas that require them to use their fare card as well as indicate if any area was blocked off to the public due to construction, maintenance, etc. Finally it would allow users to select whether they require lifts or escalators due to disabilities, travelling with a pram or luggage, etc.. However given the timeframe for this project this was simply not achievable, as well as this, there are simply no tools available yet that are able to achieve these goals. This then led me to my current project as it highlighted the lack of accessibility within mapping tools as well as the lack awareness when it comes to the importance of understanding interior wayfinding.

1.5 Project Goals:

One of the main focuses of this project is the understanding that indoor areas are not unchanging structures but they are constantly evolving environments that are influenced by the specific requirements and the different viewpoints of the people who occupy them. By recognising that there is a wide spectrum of individuals who use these spaces, from those with disabilities to people of different ages and gender identities, and oftentimes a generalised mapping system will not fit the needs of many users, this can help to create a system that is able to undo the complicated intricacies one has when moving around inside and also pave the way towards a more diverse and welcoming tomorrow.

This project aims to not only highlight the problems with current mapping systems but also promote accessibility and inclusivity as key aspects of navigating spaces in today's technology-driven world. This project is focused on revolutionising interior wayfinding using

digital mapping technologies. It prioritises customisation and adaptability, so users can personalise their navigation preferences based on their own various factors like disability accommodations, age-related needs, and gender-specific spatial preferences. Through studying how people navigate spaces, there can be a better understanding of the cognitive processes at play. By combining research on spatial cognition with practical observations, as well as focusing on accessibility it can highlight the importance of creating mapping interfaces that cater to a variety of users based on their gender-specific navigation tendencies.

Moving towards a future that aims to have a more inclusive environment, it is important to acknowledge that making interior navigation accessible is not a simple task due to the lack of current technology, the legal issues that some buildings may have as well as the lack of attention there is on interior wayfinding. By utilising digital mapping tools and taking a comprehensive approach that takes into account the needs of everyone, it would be possible to create a world where all individuals, regardless of age, ability, or gender, can easily navigate any interior space.

2.0 Literature Review

2.1 Introduction

This literature review will focus on the importance of digital mapping systems in enhancing people's wayfinding abilities. Wayfinding is mostly defined as the process of navigating from one point to another, and has evolved significantly with the advent of digital mapping technologies. While traditional methods of navigation relied on physical landmarks and paper maps, digital mapping systems have revolutionised how individuals navigate indoor and outdoor spaces. This review will discuss the evolution of wayfinding research as well as the impact of digital mapping. With the increasing reliance on digital tools for navigation, due the “remarkable rise in the prevalence of complex indoor environments, such as hospitals, airports, and shopping malls around the world, which highlights the necessity of better-designed strategies and decision-making” it is important to have an understanding on the implications of digital mapping systems as it’s crucial for improving wayfinding efficiency and enhancing accessibility. (Ghamari et el. 2021)

2.2 How research on indoor wayfinding evolved and the developments made.

The literature on indoor wayfinding has seen a slow start, with limited publications specifically focusing on indoor navigation before the 1990s. However, there has been a “rapid increase in the number of publications over time, the wayfinding in indoor environment literature”. Initially, research in indoor wayfinding focused on spatial knowledge acquisition through maps, route knowledge, survey knowledge, and landmarks. Studies also explored individual differences in wayfinding behaviour, such as gender differences. Over time, the research has diversified to acknowledge the multi-dimensional characteristics of indoor wayfinding, and is currently examining the importance of augmented reality (AR) and virtual reality (VR). The use of these technologies as well as eye-tracking, and artificial intelligence (AI), has become “much more prevalent in investigating the complexity of indoor wayfinding in real and virtual environments”. These technological advancements have opened up new avenues for research and understanding of indoor navigation challenges (Ghamari et el. 2021)

2.3 The impact of digital tools on interior wayfinding

Digital mapping has significantly impacted interior wayfinding by enhancing navigation, accessibility , and user experience capabilities within indoor environments. Digital mapping technologies provide precise indoor positioning systems (IPS) that enable users to accurately locate themselves within complex indoor spaces and “to generate paths inside buildings that may avoid stairs, and/or to provide paths to points of interests ”. By integrating sensors, Wi-Fi signals, and Bluetooth beacons, digital mapping systems offer real-time navigation guidance and wayfinding assistance. Digital mapping solutions also support inclusive design principles by providing accessible navigation options for individuals with disabilities or special needs. Features such as voice-guided directions, tactile maps, and customizable routes enhance the accessibility of indoor spaces for all users, including those with mobility impairments. Digital mapping allows for personalised wayfinding experiences tailored to individual preferences and requirements. Users can customise their navigation settings, choose specific points of interest, and receive route recommendations based on their unique needs, enhancing user satisfaction and efficiency. Interactive digital maps and AR applications, one of the most recent developments with digital mapping, provide engaging and intuitive interfaces for indoor navigation. Users can interact with 3D maps, overlay digital information on physical spaces, and engage with

multimedia content to enhance their wayfinding experience and spatial understanding. Digital mapping has transformed the tourism industry by providing interactive maps, location-based services, and virtual tours for travellers. Tourists can explore destinations, discover local attractions, and plan personalised itineraries using digital mapping applications, enhancing their travel experiences. (Prandi et el. 2023) (Brena et el. 2017)

2.4 Gaps in current literature

Despite the increasing number of publications in the field, there may be understudied topics and themes that have not received sufficient attention. As AR, VR as well as biometric technologies - such as eye-tracking, are relatively new to interior wayfinding it has not yet been thoroughly researched on how these technologies can be implemented into the current mapping systems we currently have. There is a need to further explore the integration of these technologies into practical applications for improving navigation in complex indoor environments. Understanding how these technologies can enhance wayfinding experiences and support decision-making is an area that requires more attention. Another aspect of this would also be for future research to explore ways to integrate indoor and outdoor navigation technologies to offer users a cohesive and uninterrupted navigation experience as they move between indoor and outdoor spaces. Allowing people to navigate swiftly from inside to outside or vice versa as this is something that would benefit many people as some may get disoriented when entering or leaving a building from a new entrance/exit. (Prandi et el. 2023) (Brena et el. 2017)

As stated previously there has been a rapid increase in the wayfinding literature over recent years, however this research has come from the same nine countries “comprise 67.1% of all publications”. This dominance of certain countries in indoor wayfinding literature raises questions about the representativeness of the knowledge surrounding the advancements of interior wayfinding. More research is needed in developing countries and in more diverse settings to understand how cultural differences impact perceptions of environmental factors related to wayfinding, such as signage, maps, spatial layout, as well as navigation strategies. While there has been a focus on tracking the evolution of indoor wayfinding literature over time, there is a need for more longitudinal studies that examine how trends, themes, and research priorities in the field have evolved over extended periods, “lack of knowledge in investigating

the evolution as well as trends of indoor wayfinding over time" (Ghamari et el. 2021). Longitudinal studies can provide valuable insights into the trajectory of indoor wayfinding research and help identify persistent patterns or emerging trends. (Ghamari et el. 2021)

2.5 Definitions and Theories of Interior Wayfinding

Over the course of its study, the concept of interior wayfinding has been defined and studied from various perspectives. Roger M. Downs and David Stea, who wrote Maps in Minds: Reflections on Cognitive Mapping, in 1977, define wayfinding as the ability to "orient, monitor, choose a route, and recognize a goal while navigating an environment". (Downs et el. 2017) Which puts emphasis on the cognitive processes involved in spatial navigation and decision-making during wayfinding tasks. Ebru Cubukcu, who has been studying wayfinding since the early 2000s, defines wayfinding as "the spatial knowledge about one's current location and destination, and the spatial relation between them." (Cubukcu et el. 2009) This definition highlights the importance of understanding one's position in relation to the destination and the spatial context in which navigation occurs. Finally, Arthur and Passini,who wrote Wayfinding: People, Signs and Architecture back in1992, define wayfinding as an "outcome of both cognitive functions, such as problem-solving and decision-making, and behaviours, such as navigation and decision execution".(Arthur et el.1992) This definition highlights both the interactive nature of cognitive processes and physical actions involved in wayfinding tasks. These definitions collectively underscore that wayfinding involves not only cognitive processes but also behavioural actions, and it requires spatial knowledge, understanding, and awareness to successfully navigate through an environment.

One of the key theories in wayfinding research is the theory of spatial knowledge acquisition. This theory posits that individuals acquire spatial knowledge through various means, such as maps, landmarks, route knowledge, and survey knowledge, a "person finds a way through different processes, such as estimating turn angles, segment lengths, and directions of movement". Understanding how individuals build and utilise spatial knowledge is essential for effective wayfinding. Cognitive mapping theory suggests that individuals create mental representations of spatial environments to aid in navigation and wayfinding, "cognitive skill improvement in spatial understanding". (Ghamari et el. 2021) These cognitive maps help

individuals organise spatial information, plan routes, and make decisions during navigation tasks. Cognitive mapping plays a crucial role in understanding how people navigate indoor spaces. Another theory in wayfinding research focuses on environmental cues that guide navigation. Environmental cues include physical features like signage, landmarks, architectural elements, and spatial layout that provide information and cues for wayfinding. Understanding how individuals perceive and interpret environmental cues can enhance wayfinding strategies and design interventions. The theory of spatial orientation explores how individuals establish and maintain a sense of direction and orientation in physical environments. This theory examines the cognitive processes involved in determining one's position, heading, and relationship to surrounding landmarks or reference points, which are essential for successful wayfinding. (Ghamari et el. 2021)

By studying these definitions and theories of wayfinding, researchers can gain insights into the cognitive, behavioural, and environmental factors that influence navigation in indoor spaces. Understanding the underlying mechanisms of wayfinding can inform the design of effective navigation strategies, interventions, and technologies to support individuals in finding their way in complex indoor environments.

3.0 Environmental Scan

3.1 How did/ did not this project address the accessibility/usability needs of users in indoor mapping applications ?

Experiencing User-Centred Design (UCD) Practice (Case Study: Interactive Route Navigation Map of Bangkok Underground and Sky Train)

The Interactive Route Navigation Map of Bangkok Underground and Sky Train, did address some accessibility and usability needs to help make the application more user friendly. The project used a User-Centred Design (UCD) methodology, which involves understanding the users requirements, their preferences, as well as their behaviours to create a more user-friendly and accessible product. “Interaction design tries to understand certain users' requirements and then designing to gather and go above them by observing who wants to use it, and how they

would like to use it." (Siricharoen 2010) The project also incorporated interactive features such as route distinction, price information, travel time, station names, as well as connection points between the BTS and MRT systems based on user feedback. As "this research intends to apply the user-centred design methodology to create the interactive route navigation map"(Siricharoen 2010), these features were able to enhance usability by providing clear and relevant information to users. The project held user testing with two different groups of users, one was those unfamiliar with the transportation systems and the second was those who were frequent travellers, to gather feedback on important functions and information needed in the map interface. By involving users in the testing process it helped identify accessibility barriers and improve usability for all users. However there were some aspects that were not considered and did not address the accessibility needs of users with their indoor mapping application. The case study did not mention having any accessibility features that would be tailored to users with disabilities**,** which are essential for ensuring accessibility and inclusivity of all users, including those with disabilities. In conclusion, while the project demonstrated efforts to address accessibility needs through user-centred design, interactive features, as well as user testing, there may be opportunities to further enhance accessibility by incorporating specific features for users with disabilities and prioritising inclusive design principles throughout the development process. (Siricharoen 2010)

Indoor Wayfinding: Developing a Functional Interface for Individuals with Cognitive Impairments

The project on indoor wayfinding for individuals with cognitive impairments effectively addressed the accessibility needs of users in indoor mapping applications through various strategies. The project actively involved individuals with cognitive impairments, caregivers, and researchers in the design and evaluation process, ensuring that the technology was developed with a user-centred approach. As well as this the project provided a multi-modal interface that had text, audio, images, and graphics, allowing the project to be catered to diverse user preferences and cognitive abilities, offering great flexibility in how users could receive guidance. It was stated in the report "Through user studies, we evaluated various configurations of the user interface for accuracy of route completion, time to completion, and user preferences". (Liu et el.

2006) There was a strong emphasis on customisation as well as adaptive strategies that allowed the system to be tailored to each individual user's needs, which enhanced the usability and effectiveness of the indoor mapping application to a wide range of people. The project also incorporated psychological models of spatial navigation that helped align the interface design with users' cognitive abilities as well as spatial orientation skills, improving the accessibility of the indoor mapping application. Overall, the project made significant strides in addressing the accessibility needs of users in indoor mapping applications, there may be opportunities for further enhancements in the future. (Liu et el. 2006)

Mobile Three-Dimensional Maps for Wayfinding in Large and Complex Buildings: Empirical Comparison of First-Person Versus Third-Person Perspective

The project focused on comparing the effectiveness of different perspectives, first-person versus third-person, in mobile 3-D maps for indoor wayfinding in large and complex buildings. While the study provided valuable insights into the navigation experience and preferences of users in such environments, it did not specifically address accessibility or usability needs of users in indoor mapping applications. Future research and development could help this indoor mapping application as well as this it could also benefit from incorporating features that enhance accessibility for a wider range of users. By considering the diverse needs of individuals, indoor mapping applications can become more inclusive and user-friendly for all users, regardless of their abilities or limitations. (Burigat et el. 2017)

3.2 What were the main challenges encountered in this project when developing this mapping system and how were they addressed. Were any issues not addressed and if so why?

Experiencing User-Centred Design (UCD) Practice (Case Study: Interactive Route Navigation Map of Bangkok Underground and Sky Train)

The Interactive Route Navigation Map of Bangkok Underground and Sky Train, several challenges were encountered during the development of the mapping system. There was a lack of

clarity in the development stage and the requirements were not met by developers, as well as this the development team did not have experience with developing a mapping system. “The first problem occurred in this phase is that the requirements are not clear to developers.”(Siricharoen 2010) This lack of clarity could lead to misunderstandings and potential gaps in the functionality of the mapping system. To address this issue the developers studied existing interactive train maps from other cities, such as Paris, Seoul, and Tokyo, to gather insights on design and functionality. The project aimed to simplify the map interface based on user feedback, however the potential challenges related to cognitive accessibility, such as information overload or unclear navigation paths, were fully resolved. While the project was able to address challenges through user-centred design, collaboration among developers, as well as learning from existing systems, there are areas such as specific accessibility features and cognitive accessibility that were not fully addressed. Enhancing accessibility considerations and ensuring clarity in requirements could further improve the overall usability and inclusivity of the mapping system. (Siricharoen 2010)

Indoor Wayfinding: Developing a Functional Interface for Individuals with Cognitive Impairments

One of the challenges was to create a system that could be widely customizable and adaptive to meet the diverse needs of users with cognitive impairments. They were able to provide this by integrating location technology, such as GPS and wireless connectivity, to provide accurate indoor navigation posed technical challenges “integrate a wi-fi-based location system on that platform and augment it with a digital compass to provide approximate location and orientation” (Liu et el. 2006). Ensuring that prompts were delivered in a timely manner was also an important factor to consider for the users. This was addressed by designing the system to provide prompt confirmations and timely guidance to users, enhancing the usability of the indoor mapping application, “timeliness of prompts is crucial, as well as providing appropriate confirmations to the user” (Liu et el. 2006)

Mobile Three-Dimensional Maps for Wayfinding in Large and Complex Buildings: Empirical Comparison of First-Person Versus Third-Person Perspective

One of the key challenges was determining the most effective perspective, first-person versus third-person, for the mobile 3-D maps. This required careful consideration of user experience and navigation efficiency, this was done by examining participants using different sample applications to navigate through an indoor space. The study involved using three different map conditions: a mobile 3-D map with first-person perspective, a mobile 3-D map with third-person perspective, and a traditional mobile 2-D map. By comparing the performance between the first-person and third-person perspectives, the researchers were able to analyse the effectiveness of each perspective and were able to conclude that the third-person perspective was better suited for indoor wayfinding in large and complex buildings. While the project addressed challenges effectively, some issues were not fully addressed. The project did not specifically focus on addressing accessibility needs for users with disabilities, as well as this the study involved a specific sample of participants, mostly young, male Computer Science students, which generalised the results. The results of the study indicated that the mobile 3-D map with a third-person perspective outperformed the first-person perspective. (Burigat et el. 2017)

3.3 What were the successful factors and best practices identified in this project for enhancing mapping technology? If this project has none, why?

Experiencing User-Centred Design (UCD) Practice (Case Study: Interactive Route Navigation Map of Bangkok Underground and Sky Train)

The Interactive Route Navigation Map of Bangkok Underground and Sky Train, several successful factors. It incorporated interactive features such as route distinction, price information, travel time, station names, and connection points between the BTS and MRT systems based on user feedback. These interactive elements enhanced the user experience and provided valuable information to users navigating the transportation systems. This feature is something that is necessary for a mapping system for any train station, airport etc. By prioritising the user feedback throughout the whole project they were able to create an application that would

aid not only locals but also those unfamiliar with the station and train lines. “The objective is to reduce frustration and increase user productivity and satisfaction”.(Siricharoen 2010)

Indoor Wayfinding: Developing a Functional Interface for Individuals with Cognitive Impairments

This project had many successful factors, especially in relation to accessibility, involving individuals with cognitive impairments, caregivers, and researchers in the design and evaluation process, this ensured that the mapping technology was tailored to the specific needs and preferences of the target users. Implementing a multi-modal interface with text, audio, graphics, and photographs, providing users with cognitive impairments multiple ways to receive guidance, catering to diverse cognitive abilities and preferences. “The most important aspect of a guidance system for persons with cognitive impairments is that it be widely customizable and adaptive” (Liu et el. 2006)

Mobile Three-Dimensional Maps for Wayfinding in Large and Complex Buildings: Empirical Comparison of First-Person Versus Third-Person Perspective

The study highlighted the importance of perspective in mobile 3-D maps for indoor navigation. By comparing first-person as well as third-person perspectives, the project shed light on the impact of perspective on user performance and experience. This understanding can guide future mapping technology development by emphasising the significance of perspective selection. The project also employed a user study approach to evaluate the effectiveness of different map perspectives. This user-centred design approach is a best practice in enhancing mapping technology as it ensures that user needs, preferences, and performance metrics are considered in the development process. (Burigat et el. 2017)

3.4 What were the limitations/ shortcomings of this project in terms of accessibility, usability, inclusivity, etc?

Interactive Route Navigation Map of Bangkok Underground and Sky Train

The Interactive Route Navigation Map of Bangkok Underground and Sky Train, there were many limitations and shortcomings in the project in terms of accessibility, usability, inclusivity, and other aspects due to that area not being one of priority. As the case study does not explicitly mention specific accessibility features within the mapping system there is nothing tailored to users with disabilities. The lack of emphasis on accessibility considerations, such as screen reader compatibility, colour contrast for visually impaired users, and other accessibility standards, has limited the inclusivity of the mapping system for users with diverse needs. The project aimed to simplify the map interface based on user feedback , but potential challenges related to cognitive accessibility, such as information overload as well as unclear navigation paths, were not fully addressed. Ensuring that the information presented is easily understandable for all users, including those with cognitive disabilities, is essential for improving usability and inclusivity as well as enhancing the system overall. The case study states that two user groups were involved in user testing, including those unfamiliar with the transportation systems and frequent travellers. While this approach captures some user perspectives, the project may have benefited from a more diverse user sample representing a wider range of demographics, abilities, and preferences to ensure inclusivity and usability for all user groups. (Siricharoen 2010)

In summary, the limitations and the shortcomings of the project in terms of accessibility, usability, inclusivity, as well as other aspects highlight areas where further improvements could be made to enhance the overall user experience and ensure that the mapping technology is accessible and usable for a diverse range of users. Addressing these limitations through targeted improvements and considerations for accessibility and inclusivity can help create a more user-friendly and inclusive mapping system for navigating Bangkok's transportation systems. (Siricharoen 2010)

Indoor Wayfinding: Developing a Functional Interface for Individuals with Cognitive Impairments

The project on indoor wayfinding for individuals with cognitive impairments had some limitations as well as shortcomings in terms of accessibility, usability as well as inclusivity. The study involved a small group of participants with cognitive impairments, which may limit the

generalizability of the findings to a broader population. Including a more diverse and larger sample size could provide a more comprehensive understanding of user needs and preferences. The project found that users had varying preferences for different modalities of receiving information, indicating a lack of consensus among participants. This variability in preferences could pose challenges in designing a one-size-fits-all solution that caters to all users' needs effectively. This is highlighting once again that mapping systems need to become more diverse in a range of aspects as seen from this study that even a mapping system that is catered to those with cognitive impairments still is not as diverse as is necessary. Cognitive impairments encompass a wide range of conditions with varying degrees of severity and cognitive abilities. The project did not fully address the diverse needs and challenges faced by individuals with different types and levels of cognitive impairments, which ended up limiting the applicability of the mapping technology, as seen with the general response to the user response. (Liu et el. 2006)

Mobile Three-Dimensional Maps for Wayfinding in Large and Complex Buildings: Empirical Comparison of First-Person Versus Third-Person Perspective

The study primarily involved young, mostly male Computer Science students as participants. This limited demographic representation raises concerns about the generalizability of the findings to a more diverse user population, including individuals with varying levels of spatial knowledge acquisition and smartphone use abilities as well as this the project did not account for considerations for accessibility needs in indoor mapping applications. The lack of focus on accessibility features may limit the usability of the mobile 3-D maps for users with disabilities or special requirements. (Burigat et el. 2017)

3.5 Why are these projects relevant to this project?

From looking at these three different mapping systems, each had an important factor that this project wanted to highlight, creating a user friendly mapping system for a train station, creating an accessible mapping system for those with disabilities and allowing them to select certain information to suit their own requirements for their disability, and finally creating a 3-D mapping system of an interior space. These key aspects of these mapping systems combined would provide a diverse user mapping system. As seen from what is stated above these systems are still being experimented and are yet to be incorporated into the mapping systems that are used by

people daily. By highlighting the potential of urban navigation, a demand could be created for a more diverse and user friendly navigation system.

4.0 Data and Information Gathered

4.1 The Effects of Age on Interior Wayfinding

Age can have a significant impact on one's wayfinding abilities. Research has shown that older adults may experience challenges in wayfinding due to age-related changes in cognitive functions and spatial abilities. In older individuals there is often a decline in certain spatial abilities such as mental rotation, visualisation, as well as memory for locations. This can then affect their ability to create mental maps, remember landmarks, and navigate unfamiliar environments. As spatial abilities play a crucial role in understanding as well as navigating spatial environments effectively those in older age groups are at a disadvantage especially when this information is not considered when a mapping system is being developed. Older adults also have difficulty remembering knowledge of spatial layouts, landmarks, and routes, as well as this other factors such as general cognitive function, health status, and familiarity with the environment can also influence one's wayfinding abilities. Understanding these age-related differences is essential for developing strategies to support older adults in navigating their surroundings effectively. (Kirasic et el. 2000)

Younger individuals also experience specific effects on their wayfinding abilities, children and adolescents that are still developing their spatial cognition and wayfinding skills lack the ability to navigate and understand spatial relationships in their environment may be influenced by their stage of cognitive development.this can also be in relation to a lack of experience with navigating through complex buildings and the limited exposure to these situations can have a significant impact on their interior wayfinding abilities. (Kirasic et el. 2000)

4.2 The Effects of Gender on Interior Wayfinding

The study found that males navigated significantly faster than females in wayfinding tasks. This suggests that males may have a tendency to navigate more quickly and efficiently in virtual environments compared to females.as well as this males were more likely to track one's position

in relation to geographical reference points. This study indicated that gender differences play a role in wayfinding performance, with males exhibiting better overall performance than females. However, the study also noted that appropriate navigational support systems can help improve navigational outcomes as well as eliminate gender differences. (Jamshidi et el. 2020)

This research has shown that males tend to outperform females in certain spatial abilities, such as mental rotation and spatial perception, these skills are important for creating cognitive maps, understanding spatial relationships, and navigating through complex environments, which can contribute to better wayfinding abilities in males. Males may exhibit more risk-taking behaviour compared to females, which can influence their navigation strategies in virtual environments. This can lead to faster navigation times and more efficient route planning. Males are also more likely to have a heightened sense of environmental awareness, allowing them to quickly adapt to changes in the virtual environment as well as make spatial judgments more effectively. Being male can influence various aspects of interior wayfinding ability in virtual environments, including spatial skills, risk-taking behaviour, and environmental awareness. (Chen et el. 2009)

Females were shown to be more likely to adopt the route strategy in wayfinding tasks, focusing on specific landmarks and distinct features along a route. This strategy may involve a more detailed and localised approach to navigation, which can impact decision-making and route planning in virtual environments.(Jamshidi et el. 2020)

Research has suggested that females have more potential in tasks requiring detailed spatial memory as well as object location recall in comparison to males. The study indicated that females were more likely to use guide signs support mode based on the route. This preference indicates a reliance on visual aids and detailed information for navigation in virtual environments. Females may have a different response to environmental cues and spatial information in virtual environments, influencing their navigation behaviour and decision-making processes. This sensitivity to environmental details and cues can impact how females create mental maps, interpret spatial relationships, and navigate through unfamiliar virtual spaces. Females approach wayfinding tasks with a different focus on details, landmarks, and contextual information, which can affect their navigation efficiency and route planning. This attention to

specific features along a route may influence how females navigate through virtual environments and make decisions based on visual as well as spatial cues. (Chen et el. 2009)

4.3 The Effects of Disabilities on Interior Wayfinding

People with disabilities, especially cognitive disabilities, are more likely to face challenges with interior wayfinding due to various factors that affect their spatial orientation, navigation, and ability to find their way in indoor environments. Individuals with cognitive disabilities may have difficulties perceiving and processing information related to their surroundings, such as understanding maps, signs, or directions as well as problems with short-term and long-term memory can impact their ability to remember routes, landmarks, or instructions, making it challenging to navigate unfamiliar indoor spaces. This is a point that many mapping systems fail to consider as they are created for the average person. Those with disabilities can also experience difficulties in problem-solving which can hinder their ability to find alternative routes or and make it difficult to adapt to changes in their environment, leading to confusion during navigation. Physical limitations or mobility impairments can also impact their movement within indoor spaces, affecting their ability to navigate efficiently. As many mapping systems fail to incorporate a section to select whether the user may have a wheelchair, cane, etc, it may give the user a non accessible route that may include stairs instead of allowing them to request a route with ramp, lifts etc. (García-Catalá et el. 2022)

Individuals with sensory sensitivity, such as those with autism, can be triggered by various factors in indoor environments such as bright lights, loud noises, or crowded spaces. These sensitivities can impact their ability to focus on wayfinding cues and navigate effectively. They may also have challenges with spatial awareness, making it difficult for them to understand their position in relation to their surroundings. This can lead to disorientation and difficulties in following directions on a mapping system that does not cater to them. Changes in routine, unfamiliar environments, or crowded spaces can trigger anxiety and stress in many individuals, affecting their ability to focus on wayfinding tasks and navigate effectively. (García-Catalá et el. 2022) (Lin et el. 2019)

Individuals who struggle with hearing rely on visual signage as well as cues, clear and accessible visual information is essential for effective wayfinding as well as this these individuals may not be able to hear auditory signals or alarms commonly used for wayfinding or emergency evacuation. Mapping systems that would be able to include vibrating alerts or visual notifications can be beneficial for alerting deaf individuals in emergency situations or providing directional cues. Blind individuals face challenges in detecting obstacles or hazards in their path while navigating indoor spaces. Technologies like screen readers or navigation apps designed for visually impaired users can offer audio cues and directions to support blind individuals in wayfinding tasks. (García-Catalá et el. 2022)

4.4 The Future for Interior Wayfinding

Future mapping systems can include child-friendly interfaces, voice-guided navigation, and AR overlays to make navigation more engaging and intuitive for younger users.
Implementing larger fonts, high-contrast colours, voice commands, and audio descriptions can improve the accessibility of mapping systems for older adults with visual or cognitive impairments. Clear and simple navigation instructions can enhance usability for older users. AR overlays displaying real-time navigation cues, landmark identification, as well as safety alerts can assist older adults in navigating complex environments. VR simulations of familiar routes or challenging scenarios can help older users practise wayfinding skills in a controlled setting.

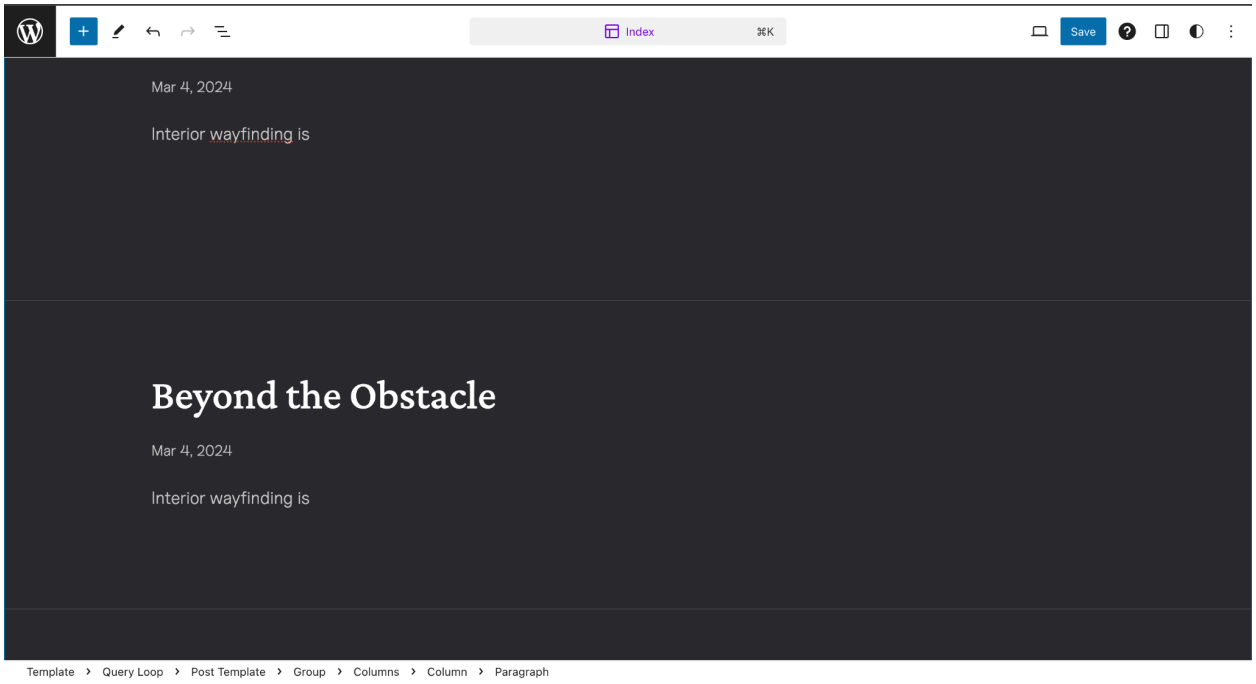
In the future, mapping systems can be designed to address gender-specific challenges and preferences in wayfinding to enhance navigation experiences, this could be done by customisable navigation modes that cater to different wayfinding strategies preferred by males and females, this could have mapping systems using a combination of detailed landmarks for females and spatially relevant cues for males to enhance navigation efficiency. Mapping systems could utilise user data and preferences to offer personalised route recommendations based on individual navigation styles and tendencies. By tailoring navigation suggestions to gender-specific preferences, users can receive more relevant and effective guidance during wayfinding tasks enhancing the system overall.

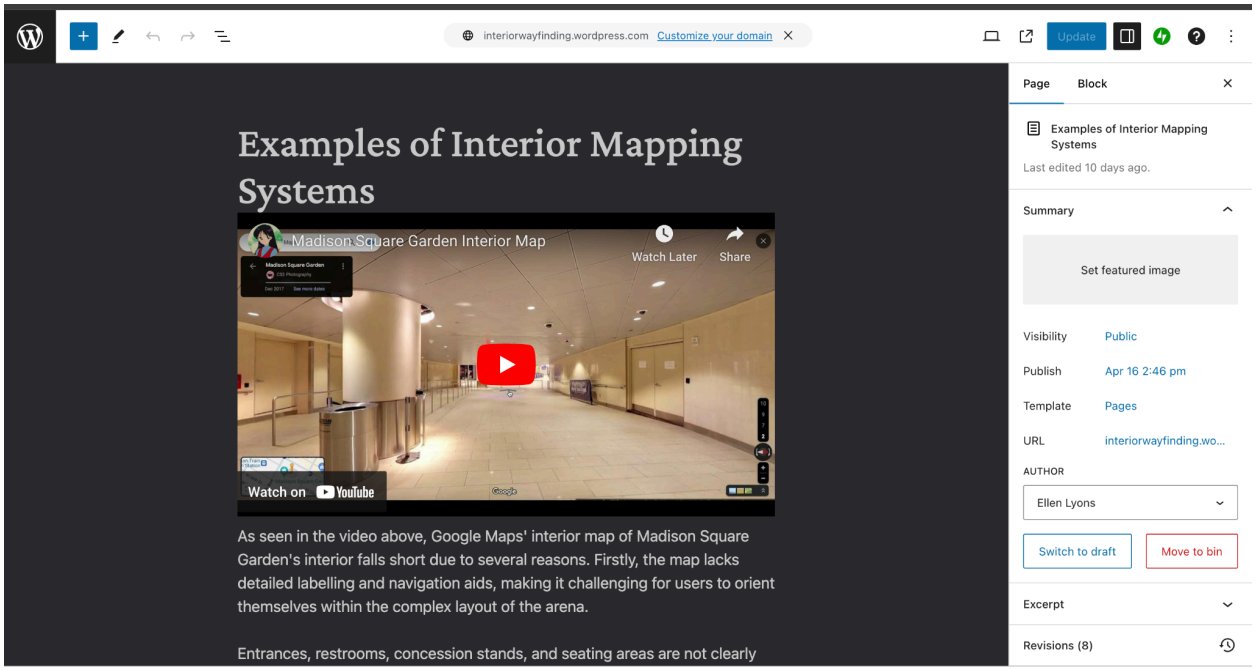
When developing future digital mapping systems it should provide detailed accessibility information about buildings, including the location of ramps, elevators, accessible entrances, as well as restrooms. With this information an individual should be able to create a customised route based on their personal needs by entering information, such as whether they require a wheelchair, this would enhance the mapping system greatly and make the system more accessible to a wider range of users. Incorporating real-time navigation assistance features, such as turn-by-turn directions, audio cues, or haptic feedback, can guide individuals with disabilities through complex indoor environments and help them stay on course. Future digital mapping systems should include features for evacuation support in the case of an emergency, such as creating instant evacuation routes for individuals with disabilities as they may not be in the position to follow the route nearest to them, real-time updates during emergencies, and communication tools for emergency responders to assist those in need.

5.0 Tools and Methods

5.1 Considered Tools and Creating the Website

There were a few different options that were considered, experimenting with different platforms such as wordpress and wix. While originally this artefact began on wordpress, it proved to become quite difficult to operate while trying to create a home page as it would not allow the freedom to fully customise it as well as this it would duplicate itself regardless of what was done to try and fix the issue. Without a subscription there was no way of creating a menu for the website required which meant users were unable to access the rest of the pages that had been created.



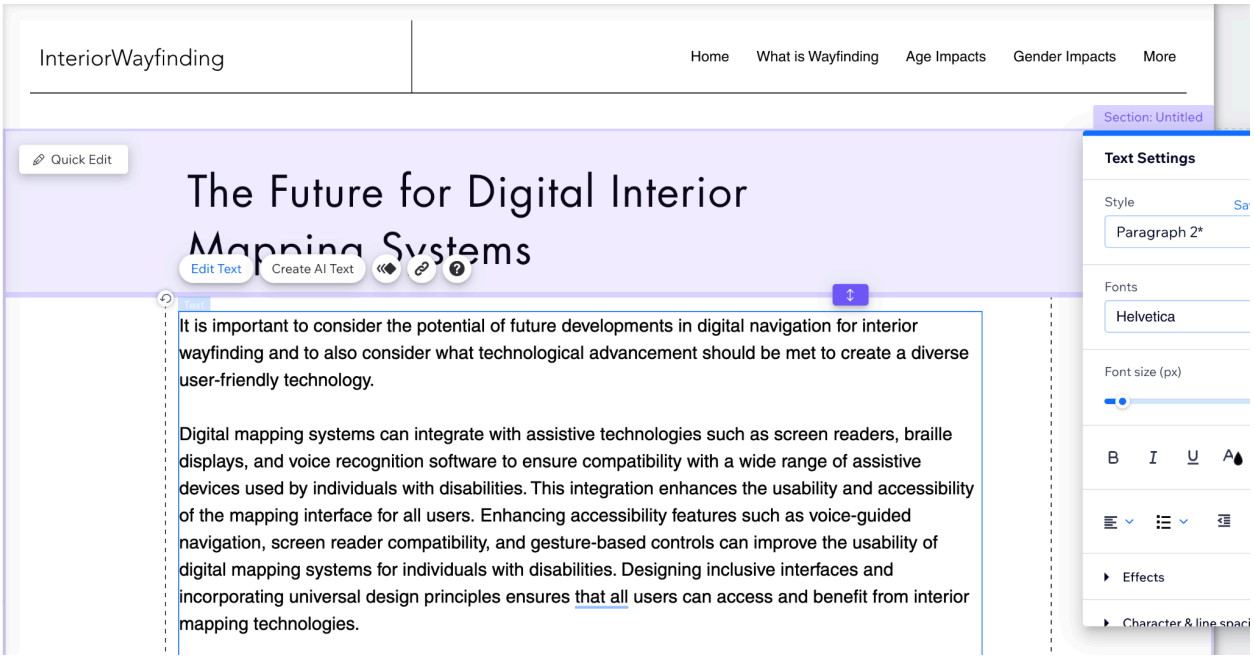


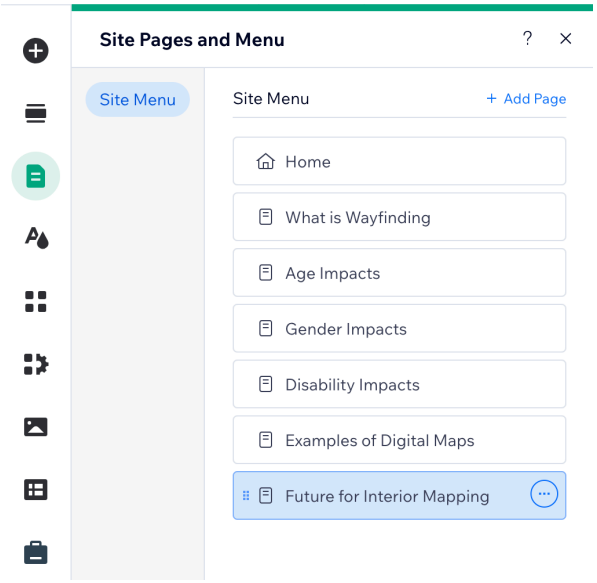
The next option was Wix which proved to be the better option as it allowed for much more customisation of the website overall. After creating an account, Wix gives the option of choosing a premade template, designed for different types of websites, from portfolios and blogs to online stores and business websites or using a blank template. By choosing the blank template there

were more options to go with in relation to layout of the pages. Choosing how to display the information was important as to not overwhelm the user with too much text as well as selecting an appropriate font and size so it was accessible.

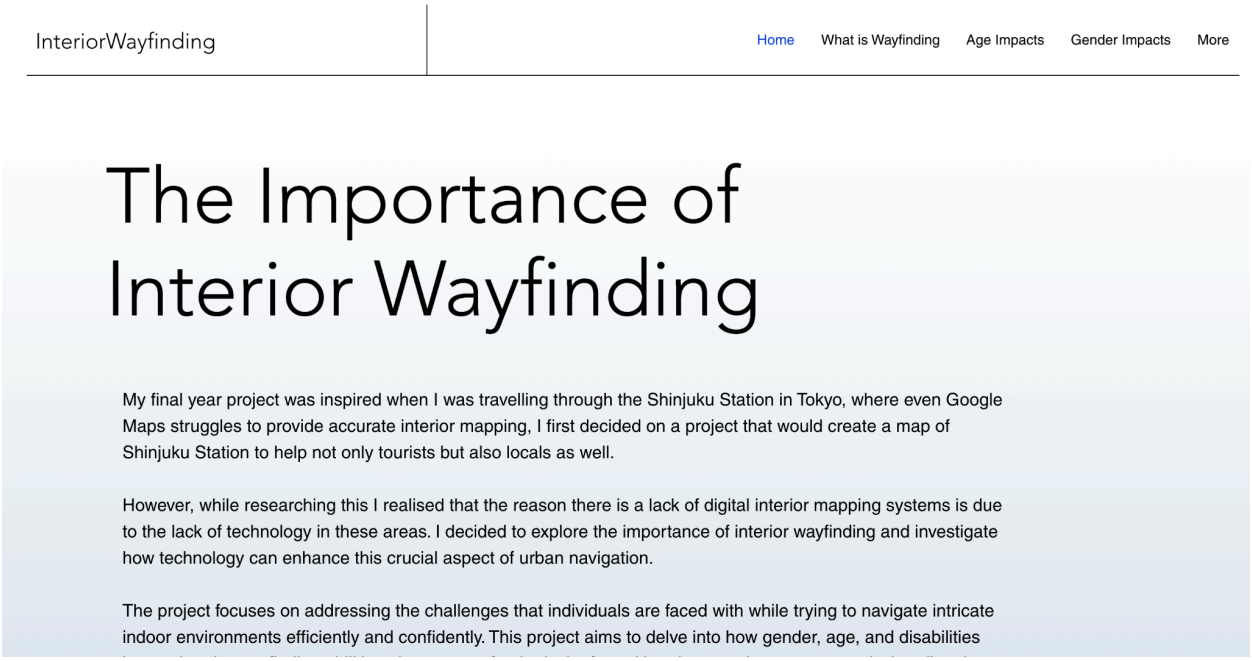
5.2 Designing Pages

The website has seven pages overall, the home page, "What is wayfinding", "Age Impacts", "Gender Impacts", "Disability Impacts" "Examples of Digital Maps" and "Future of Interior Mapping". It was important to keep these pages coherent with each other as it maintains a consistent look and feel across the web pages and avoids confusion or inconsistency for the user. The font throughout the pages was helvetica, as it has clean lines, appearing neutral and simple efficiency, it is compatible with any kind of content and doesn't detract from the design. The font size for paragraphs was 20 which allowed the users to see the information clearly.





The home page displays a brief introduction of the project, where the idea originated from and what the project focuses on, from this the user gets an overall feel of the website. The next page “What is Wayfinding” provides a definition of wayfinding and more specifically what is interior wayfinding and the reasons it is important such as, enhancing the user experience, how it enhances efficiency as well as productivity, the role it plays in relation to safety, space optimisation and finally accessibility. This allows the user to get a brief yet effective understanding of what interior wayfinding is and why it is important.



The following three pages displayed information on how age, gender and disabilities affect one's interior wayfinding abilities. These pages discussed how different genders interpret wayfinding, this information included spatial strategies, information processing, preference of navigation, anxiety and confidence. How age has an impact on people's wayfinding, this information included spatial memory decline, spatial orientation challenges, and their navigation and speed efficiency. Finally how disabilities impact one's wayfinding such as visual impairments, auditory impairments, cognitive disabilities as well as mobility problems. The following page demonstrated different examples of interior mapping systems and the pros and cons of both allowing the user to get an understanding of what they should look for in an interior mapping system. The final page displayed information regarding the potential future of interior mapping systems, such as AR and VR, and making mapping systems more accessible to those with disabilities by allowing these systems to be more customisable to each individual user. Creating these pages involved selecting an appropriate title for the menu, as well as creating an interesting title for the page to make users want to continue interacting with it.

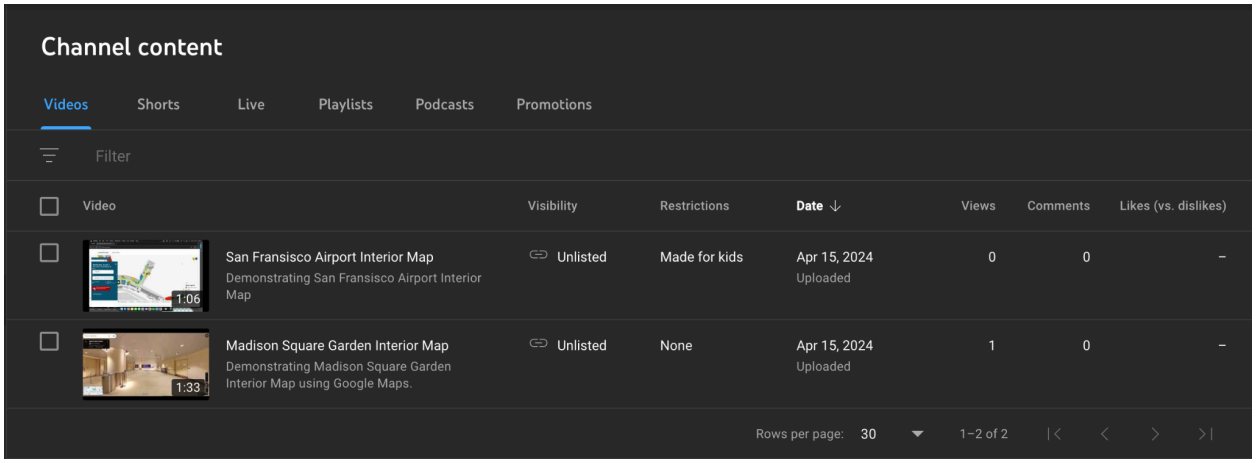
5.3 Examples of Interior Wayfinding Applications

For the “Examples of digital Maps” page, it was important to display two examples of both a good example and a poorer one, highlighting issues as well as showing what a good example should look like. The two examples chosen were San Francisco Airport’s mapping system and Google Maps’s Interior Map of Madison Square Gardens. While using the San Francisco Airport map it displays essential details such as the terminal layouts, gate locations, amenities, and navigation assistance, which are crucial for travellers navigating a busy airport environment. It has an intuitive interface that ensures ease of use for passengers of all technological proficiency levels. The map is regularly updated to reflect any changes in the airport layout or amenities, ensuring accuracy and reliability. Overall, after using the San Francisco Airport's interior mapping system it is clear that its efficiency, clarity, and accessibility make it a valuable tool for travellers navigating the airport.

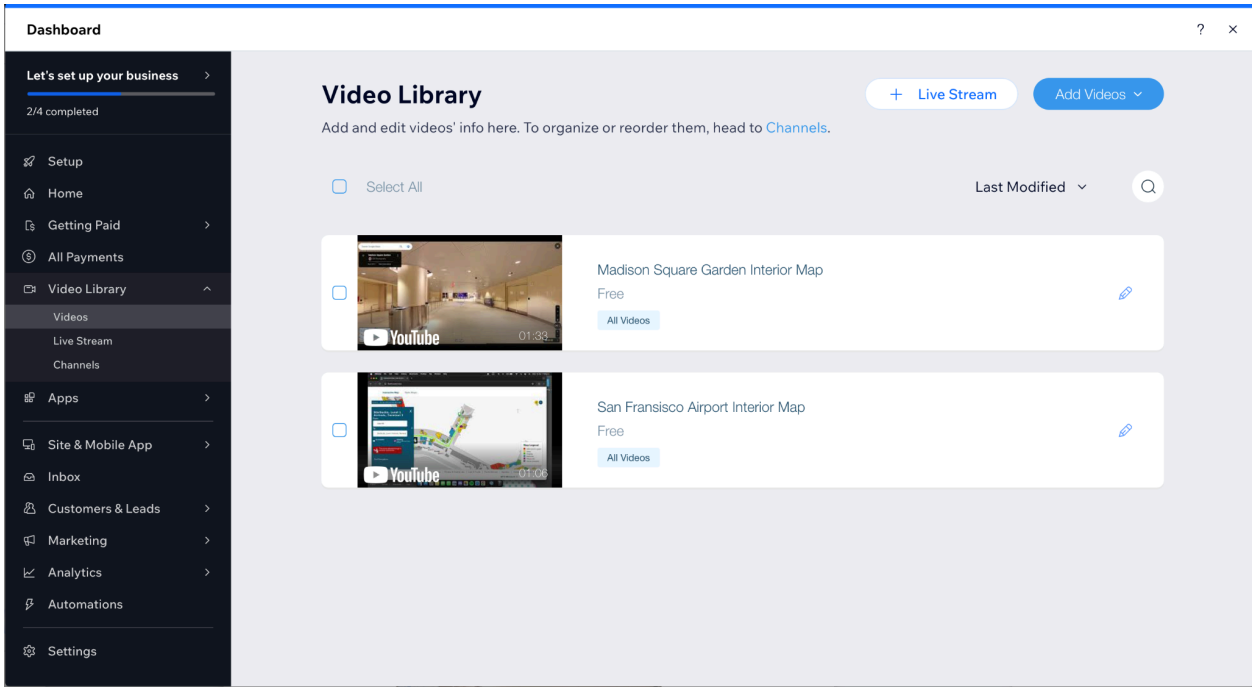
However Google Maps' interior map of Madison Square Garden's interior falls short due to several reasons. Firstly when using the tool it was discovered that the map lacks detailed labelling and navigation aids, making it quite challenging for users to locate themselves within the confusing layout of the arena. Entrances, restrooms, concession stands, and seating areas are not clearly marked, hindering the users' ability to efficiently navigate the space. The map fails to provide real-time updates on events, seating availability, or any temporary closures within the venue, crucial information for visitors attending events. Users are also randomly placed when going up floors, not showing any lifts, stairs, or escalators, meaning that users who are unfamiliar with the venue would not be able to figure out where they are. While it's clear that Google excels at exterior mapping using the same system for interior maps, it lacks the necessary detail, functionality, and user-friendliness required for effective indoor navigation.

The best option to display these on the webpage was to create a screen recording while using these mapping systems to give a more visual aid to what was being discussed about each system, exploring different aspects of the maps, and highlighting the features that each of them had. It was important to keep the videos to a one to two minute time length as to not have the user lose interest. Uploading the videos to YouTube was next, giving the videos an appropriate title and a

brief description and selecting that they can only be viewed if the user has the link before uploading them.

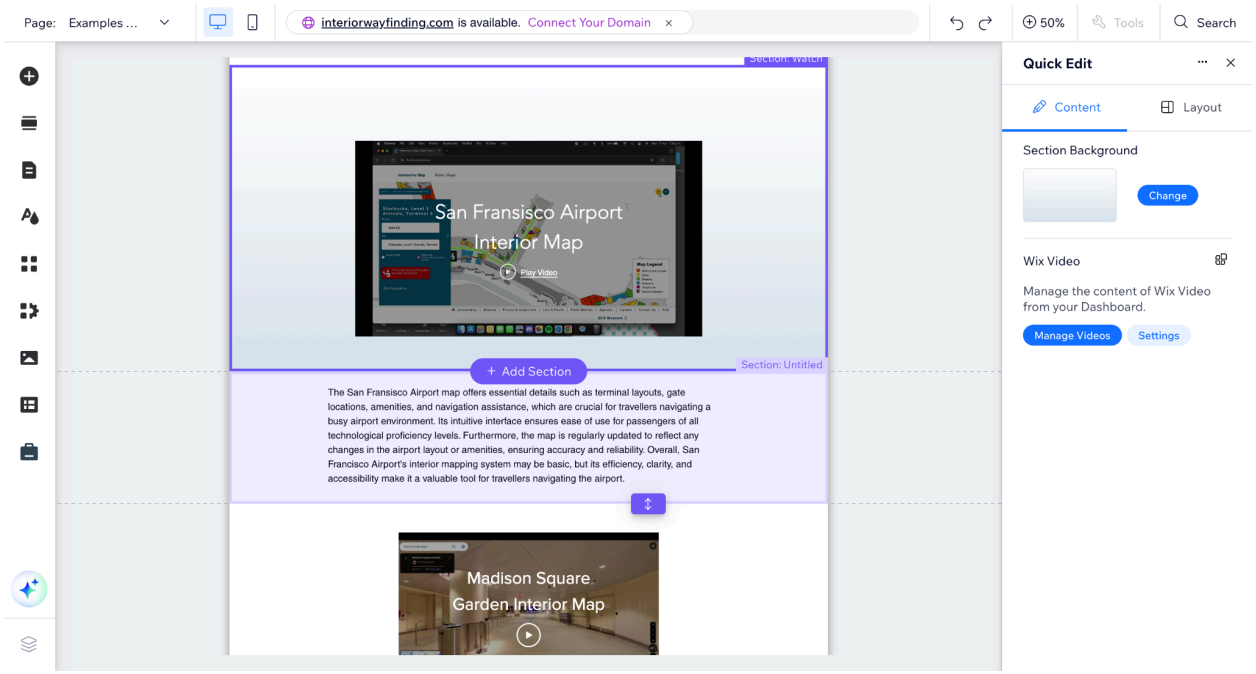


To embed the first video, it's required to enter the video URL in the "Embed any video from YouTube, Vimeo or Facebook" field and select "Click Add Video", then paste the YouTube link that then stores that URL to the video library. To add additional video, it follows the same steps by selecting "Click Add Videos" at the top right and enter the video URL in the "Paste video or playlist URL" field and click "Add to Library".



Figure

Then adding the videos to the page requires selecting “a single video”. Next was to insert the links onto the webpage, by selecting a blank section and adding in video elements to the section. After the videos were uploaded it was important to insert the information that was gathered from using these applications to highlight to users what a good example of a digital mapping system should look like and these issues that these mapping systems had. The links to both wayfinding tools were also available on the page for users to try for themselves.



5.4 Final Details and Deploying the Website

The final step was to examine the pages and information once more to make sure that it was clear and concise, and did not have an overwhelming amount of information that would cause the user to lose interest while reading. Finally to make the website live, all that was needed was to select publish which then deployed the website. To receive feedback, the link was shared to a group of people to ensure that the website could be accessed as well as to receive feedback on the layout and contents of the site.

6.0 Conclusion

In conclusion, this research highlights the importance of addressing challenges associated with interior wayfinding in today's built environments. Through the exploration of different concepts of wayfinding and its relevance to digital humanities, this research has highlighted the significant impact of inadequate interior mapping systems on user experience, safety, and accessibility. The project goals have shown the importance of recognising the dynamic nature of indoor environments and the diverse needs of individuals who navigate them. Through a human-centred approach, this research advocates for the customisation as well as the adaptability of mapping interfaces to cater to a wide variety of users, including those with disabilities, different ages and gender identities. By emphasising inclusivity and accessibility, this project aims to revolutionise interior wayfinding using digital mapping technologies. Ultimately, the goal of this research was to allow people to envision a future where all individuals can navigate interior spaces confidently and independently. By leveraging digital mapping tools and adopting a comprehensive approach that considers the needs of everyone, this research can highlight the way for creating more inclusive and welcoming environments where accessibility is prioritised for all.

Given more time the approach would have gone more in the direction with the original idea. Developing a mapping system for Tokyo's Shinjuku Train Station that would be able to cater to the wide range of users, following similarly to San Francisco Airport mapping system how that indicates how a user would have to go through passport check, security, etc., on the route, it would include whether a user was required to use their fare card during the route and give a possible suggestion to an alternative route if needed, i.e if a user wished to not use their fare card they could select a similar destination that wouldn't require them to use their fare card. The user would also be able to enter their information such as their gender, age, and any disabilities they have that would impact their interior wayfinding abilities, allowing the system to create the ideal route for them, such as selecting a route with a lift rather than a route with stairs. The mapping systems would utilise the user's data and preferences to offer personalised route recommendations based on individual navigation styles and tendencies. However as the research continued it was highlighted that there isn't enough of a discussion in relation to the factors that impact one's wayfinding, this then led to the current project as it highlighted the lack of

accessibility within mapping tools as well as the lack awareness when it comes to the importance of understanding interior wayfinding.

From hearing feedback from those who interacted with the website, the project goal of highlighting issues with today's mapping systems were clearly met. The users were able to gain more insights into what should be included in their mapping systems as well as learn the possible potentials for future developments in urban navigation.

7.0 Appendix

https://ellenlyons111.wixsite.com/interiorwayfinding
https://youtu.be/Madison SquareGardenInteriorMap
https://youtu.be/SanFranciscoAirport

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