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Coláiste na hOllscoile Corcaigh, Éire
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Final Year Project Report

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Title: Exploring How Technology Impacts the Safety and Enjoyment of Recreational River Kayaking

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Abstract

The aim of this project is to digitise river kayak routes, and to make these routes as accessible, safe and enjoyable as possible, regardless of kayaking proficiency, in an effort to prove that technology can have a positive impact on the safety and enjoyment of recreational river kayaking. There is a sincere lack of river kayaking resources in Ireland, and this project seeks to amend this. This project was created using ArcGIS, WordPress, Python and JavaScript, among other digital tools. The creation of the maps involved highlighting and marking obstacles and areas that might require more caution, as well as perhaps lesser-known sites of cultural and historical interest. These sites – castles, bridges, churches and ruins - have been colour-coded, photographed and have their story told on a digital platform. This website is complete with live weather and tide updates, to ensure the utmost experience and ease of planning.

In essence, this project aims to enhance understanding and appreciation of the natural beauty and history that surrounds us in Ireland, to make the river kayaking experience as safe and accessible as possible and to see it all from a new perspective, the point of view of the river, encompassing both the Humanities and IT aspects of the BA Digital Humanities and Information Technology.

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Introduction

In recent years, and especially during and post the Covid-19 pandemic, technology has played a role in making outdoor recreational activities more easily accessible, safer, more appealing and therefore more enjoyable. Digital applications, GPS devices and smart-watches have changed the way people interact with the outdoors, offering real-time weather information, tidal information and an easy way to contact emergency services, among other features. There is no doubt that an overall increased feeling of safety leads to a more enjoyable experience overall, as when worry is eliminated it allows for the experience to be enjoyed without limitation.

In Ireland, while there has been a significant push to enhance and sustain outdoor recreation, as is evident in the National Outdoor Recreation Strategy 2023-2027, there is a distinct lack of resources for those who wish to partake in river kayaking, especially those with no prior experience and for less-explored rivers in more rural areas, which are often some of the most beautiful. While there are some resources available for proficient canoers and kayakers, it is mainly based on sea kayaking/canoeing rather than river, which is a huge oversight as in Ireland there is an abundance of rivers and waterways that are waiting to be explored. This is also a great tourism opportunity and a way to bring footfall and income to smaller, rural, riverside communities. The aim of this project is to address this lack of resource and to create a comprehensive and accessible digital guide for those of any level, but with emphasis especially on complete beginner level, to be able to experience the beauty of Ireland by river, with a focus on the rivers and corresponding historical sites of North Cork. This encompasses the River Awbeg and the River Funshion, which are both tributaries of the Munster River Blackwater. Part of one route also ventures onto the Blackwater, which brings in the tidal element as part of the Blackwater is tidal.

The National Outdoor Recreation Strategy 2023-2027 aims to create awareness of outdoor opportunities and how to enjoy them responsibly, while also being environmentally conscious and protecting the environment through better planning. This project is much in line with this, aiming to enhance the experience of recreational river kayaking whilst being mindful of environmental implications, and serving as a way to experience the rich culture and history of Ireland from a new perspective. This is achieved through the meticulous digitisation of river kayaking routes, with the start and end point clearly marked with instructions and pictures, as

well as areas that require more skill, obstacles e.g. shallow water or rapids and historical and cultural sites along the route. With safety in mind, there is also live weather and tidal information embedded into the site, allowing for ease of access and therefore maximum enjoyment. These maps aim to provide a multi faceted view of history

In the fast-paced modern world, it is becoming increasingly important to slow down and reconnect with nature, for both mental and physical wellbeing. Rather than looking at the river from the land, the essence of this project is to look from the perspective of the river back at the land. All imagery is used is original and from the point of view of the river, in an effort to switch from the land-based narrative is the norm. From the point of view of the river, nature can be experienced in a new way, and a different light can be shed on history . This is encapsulated so well by David Gange, in his book 'The Frayed Atlantic Edge: A Historian's Journey from Shetland to the Channel' as he writes that "British and Irish histories are usually written inside out, perpetuating the misconception that today's land-bound geographies have existed forever…the significance of coasts is consistently underestimated, and the potential of small boats as tools to make sense of their histories is rarely explored." This offers a transformative lense through which we can view history. Rivers, much like coastlines, have served as vital arteries of communication, trade, defence and cultural exchange throughout time, an often overlooked constant in historical narrative. This project looks at rivers as their own entity with their own history and stories, rather than just an accessory to the history of the land.

Tools and Methodologies

The primary aim of this project was to create an accessible and interactive digital map of river routes, with an emphasis on a water-to-land perspective and useability. In this section, we look at the tools and methodologies that this project is made up of, including ArcGIS, Reclaim Hosting, Python and WordPress. There were several tools which could've been employed to achieve the objective of this project, and this section aims to outline the reason the selected tools were the most suitable in achieving the desired outcome and why the toolsthat weren't selected were deemed unsuitable. There are many open-source tools available today, but as there was a definite vision in mind it immediately limited the options from the beginning, as well as a limited timeframe and budget, due to this being a project completed at Undergraduate level. Below are tools that were employed in this project, as well as tools that equally could've been used but lacked certain elements that were required.

ArcGIS – Story Maps

ArcGIS is a comprehensive geographical information system (GIS) designed to create, manage, analyse and map any type of geographical data. It includes several components, from ArcGIS desktop to ArcGIS Enterprise but the one that is implemented in this project is ArcGIS Story Maps. ArcGIS Story Maps provides a user-friendly interface that allows for seamless integration and because of the storytelling element it allows for narrative images and text which fit in with the vision of this project. As described by (Walshe, 2016), story maps combine interactive maps (created in ArcGIS Online) with content, such as text, photographs or videos, to tell the story of a place, event, issue or pattern in a geographic context. This project aims to tell a historical story of Ireland's rivers by incorporating cultural sites into the map and also a story based on the point of view of the river, which could be achieved through adding river based images to the map, and this tool immediately seemed to be in line with these aims. Maps created using this tool are extremely easily embedded into a web page, and equally aesthetically pleasing to look at and easy to interact with. It is a semi opensource tool, though to access some more advanced capabilities there is a subscription needed. It is also part of Esri, the market leader in geographic information system (GIS) software, which offers access to an extensive library of geographic information which makes it easier to represent aspects of the routes, e.g. safety features and cultural sites, in a more detailed and informative way. As well as this, Esri offers benefits such as user guides, technical support and a large community of users which can be extremely useful for inspiration and education, as well as if any issues occur. This makes the process more smooth and cuts down time spent troubleshooting and problem solving. ArcGIS Story Maps made it easy to colour code the digital river map, to keep the route blue where there were virtually no challenges and at a beginner level, to mark it in red for any more challenging areas and to put in a pointer for where those areas begin and end. Orange markers were used for the historical sites, along with a picture taken from the point of view of the river, and a description of the site in question, many of which cannot be seen from the land. It made it easier to mark the entry and exit points in a clear and obvious manner, and to include pictures of exactly where to go so as to ensure utmost safety and useability.

Arc GIS – Heritage Data Maps

ArcGIS also provides various datasets and tools for mapping sites of historical and cultural significance, with lots of information on each site as well as the exact coordinates, which

allows for effective mapping. It has details on every site, from castles to burial grounds, and as one focus of this project was on such sites, this was a valuable tool to help achieve that goal. Each site is marked on a map with a red or blue circle, which made it easy to go along the river bank and find the information on the historical landmarks which were to be included in this project. The detail included on each is also really helpful as it shows which way each landmark is facing, how many doors and windows it has as well as more general information. This made it easier to identify each site in order to photograph them.

Leaflet

Leaflet is a JavaScript library which can be used to develop interactive maps, and can be integrated into non-JavaScript environments, for example Python, using the library 'folium', although it adds another layer of complexity to the process. Leaflet, though a viable option, proved too time consuming if used to create the entire map for this project, especially considering many of the more advanced features require external plugins and a lot more hand coding. There are several elements to the map that would've required a lot of work to create the desired result. For example, for images to pop up when certain points of the map are pressed, to give more detail on different points and sites along the route and to show a consistent route down the river with colour coding to highlight areas where more caution is recommended, which were all non-negotiables in reaching the end goal of this project. For this reason, leaflet didn't fit the requirements for this project, especially within the limited time frame. However, though the main maps were not created using Leaflet, it was still employed for elements of the project. One very important element of river kayaking is knowing exactly where to enter and exit the water. Sometimes the entrance can be quite hidden and not obvious as a way to get on to the river, and could lead to users entering or exiting at the wrong place, which could in turn lead to a significantly less safe experience. This project employed Leaflet to display markers with the direct co-ordinates of the entrance and exit of each route, with the aim of making it as easy as possible for users to input these values into Google Maps and be brought to the exact location. This involved a small bit of JavaScript, and the result was a very clear and readable map, which aided hugely in adding to the accessibility element of the overall project.

Open Street Map

Initially, Open Street Map seemed like the best platform for creating digitised river maps. Upon some further research, there were some limitations which prevented it from being the

ideal tool to produce the desired result. OSM provides a strong foundation for general land mapping and planning, with a wide community. It is a collaborative project which aims to create a free and editable map of the world, based on contributions from volunteers all over the globe. Its used for many diverse applications, from global planning to humanitarian aid and is undoubtedly valuable tool that allows individuals and organisations alike to create, share and utilise maps, while tailoring them, to their specific needs. However, for this project, based on rivers that run through a less-mapped area in rural Ireland, it might not work so well. The quality of OSM data can vary significantly depending on the region and relies on the knowledge and accuracy of the contributors. As this project was about mapping rivers and therefore based on primary research, the tools offered by Open Street Map were less applicable. This project aims to have the river as the main focal point, and with OSM the focus is more centred around land with the river as a secondary point of interest, therefore it was decided that OSM had some limitations which meant it would not achieve the desired result of this project.

Reclaim Hosting

The tool used to host the digital artefact is reclaim hosting; a cloud platform that provides an easy solution to web hosting, and is specifically tailored to host WordPress sites, with a relatively low annual fee of $45, which compared to the usual WordPress annual fee is extremely reasonable, and makes it one of the cheapest hosting services. As defined by (Matthew Hunter, 2023) born out of collaborations between professors, instructional designers, and educational technologists, Reclaim Hosting is an LLC that provides flexible, scalable web hosting that is marketed primarily to the education sector. It has a user-friendly interface and a straightforward hosting process as well as excellent and fast-responding technical support, allowing users to focus more on content and less on any technical issues. For these reasons, it seemed to be the obvious choice when deciding what to use to host a WordPress site, especially as a student, for a university project.

WordPress

WordPress is a content management system that has an extremely user-friendly interface, robust community support with a lot of plug-ins available to create a platform tailored to specific needs. Though relatively simple to use, to increase the technicality of this project plugins were acquired. One element that dictates how safe and therefore enjoyable the river kayaking experience is weather. One aim of this project was to make the live weather of each route available to aid in planning and to increase the safety of the experience. This was

achieved by installing the Location Weather plug-in, setting the coordinates to the desire location and configuring to suit the page which created a block with the live weather for the specified location. SurveyMonkey is a plugin which allows for the retrieval of information based on the useability of the site and the maps, how the routes affect the safety and enjoyment of river kayaking and the level of the person answering these questions, allowing for the improvement of the service. The plug-in Limit Login is designed to enhance security by limiting the amount of login attempts from a single IP address within a set period. This adds a level of security, as if the number of login attempts exceeds the limit, the plugin temporarily blocks further attempts from that IP address. It also notifies the admin as to the amount of failed attempted logins, when they were attempted and the IP address that was behind the attempts. Another benefit of WordPress is that Story Maps are easily embedded into the site, by simply copying the iframe embed code, which is HTML from the ArcGIS Story Maps website and adding it as a custom HTML block, where the iframe code is then pasted. Once it is pasted, the width and height parameters have to be adjusted to suit the page and ensure the whole map is visible. Then the [page can be published. This embeds as an interactive map, with the ability to zoom, view the images and read about the various sites of historical and cultural interest. The background of the map has been set to highlight the river and to make it the main focus, as is the aim of the project, by making the land white and the river blue. On each route page, there is also a short description of the route, the history of the area, estimated completion time, estimated level, estimated length in km and the location weather widget displaying the real-time weather and the forecast for the next few hours. This ensures that users can plan the safest time to kayak this route and how long they should expect to be on the water. The rivers used in this project are not entirely tidal, but if the rivers tidal another plugin displaying the tide times would be another way to ensure utmost safety and therefore enjoyment. A plugin that fetches tide data and presents it in a widget format is the “Tide Times” plugin. The river Awbeg isn’t tidal, but it once it reaches the river Blackwater it becomes tidal, and although the entirety of the river Blackwater is not currently part of this particular project, it still holds significance in the overall experience as the river Blackwater is an integral part of the North Cork network of waterways. These plugins demonstrate an added level of technicality to the WordPress site as well as increased useability and adds an extra layer of safety to the overall experience, which in turn contributes to the enjoyment.

HTML and CSS

An alternative means of creating a website for this project would be to hand code it using HTML, CSS and JavaScript for interactivity. For this project, the aim was to create a platform that made river kayaking an accessible, safe and enjoyable process. One of the key ways to ensure this was to have plug-ins, such as weather widgets and tidal information. Weather data would change hourly, and maintaining up to date information on a hand-coded website could prove extremely labour intensive without the use of plug-ins. To hand-code this project would be an extremely time-consuming process, as well as requiring knowledge of APIs and possibly server-side scripting. Hand coding is more susceptible to bugs and significantly more labour intensive. While it is a great way to highlight a more technical aspect to this project, it did not fit into the time limit of this project and was not necessary to achieve the goal in mind. Because the aim is based on safety and enjoyment, the use of plug-ins was the most effective way to ensure those goals were met which would have been much more difficult to accomplish had it been hand coded. However, HTML was implemented in this project when it came to embedding interactive graphs and the river maps from ArcGIS. The reason for this is that Python does not run on a browser without a plugin, and an easier way of achieving this was to use a small bit of JavaScript within a HTML script. This allowed the graphs to be added into the custom HTML blocks on WordPress, as shown in image 1 below.

```
<!DOCTYPE html>
<html>
<head>
    <title>Map</title>

    <link rel="stylesheet" href="https://unpkg.com/leaflet/dist/leaflet.css" />
    <script src="https://unpkg.com/leaflet/dist/leaflet.js"></script>

<script src="https://unpkg.com/leaflet-fullscreen/dist/Leaflet.fullscreen.min.js"></script>

<script src="https://unpkg.com/leaflet.markercluster/dist/leaflet.markercluster.js"></script>
</head>
<body>

<div id="map" style="width: 100%; height: 300px;"></div>

<script>
    //Coordinates for Fermoy and Castletownroche
    var fermoy_coords = [52.138942, -8.275524];
    var castletownroche_coords = [52.173195, -8.460147];

    //Map centred on Fermoy
    var mymap = L.map('map').setView(fermoy_coords, 10);


    L.tileLayer('https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png', {
        maxZoom: 19,
    }).addTo(mymap);

    //Markers
    L.marker(fermoy_coords).bindPopup('Exit - Fermoy; 52.138942, -8.275524').addTo(mymap);
    L.marker(castletownroche_coords).bindPopup('Entry - Castletownroche; 52.173195, -8.460147').addTo(mymap);

 L.control.fullscreen().addTo(mymap);
</script>

</body>
</html>
```

Image 1: showing HTML snippet required to embed interactive map in WordPress site.

Python – Pandas

The Python library ‘Pandas’ provides provides integrated, intuitive routines for performing common data manipulations and analysis on such data sets. It aims to be the foundational layer for the future of statistical computing in Python. (McKinney, 2011)
In this project, Pandas was employed to analyse data and display it in a way that would highlight the dangers of river kayaking and water sports in general and also in a way that could aid those who wish to partake in river kayaking to be able to do so easily, and in the safest way possible. This was achieved by using Pandas to create a bar chart showing the mortality rate as caused by drowning, a graph showing tide times, a pi chart showing percentage of drowning mortalities by gender and an interactive graph that show the safest time to go kayaking in relation to daily high tide times. This is an example of how technology can be used to increase safety in river kayaking, by increasing awareness and increasing ease of access, which also would lead to an increase in enjoyment.

Literature Review and Environmental Scan

Introduction

In recent years, the world has witnessed massive advancements in technology that have permeated most aspects of society. One such area is recreational outdoor activity, both on and off the water, and technology has impacted both how it is experienced and how it is enjoyed. This review aims to explore and analyse the multifaceted relationship between technology and recreational outdoor experiences, more specifically river kayaking,

and how technology could be used to enhance the safety of these pursuits and make these experiences more accessible and enjoyable. Though society has been altered by the presence of technology in most aspects of daily life, (BAYRAKTAR, 2023) confirms that despite this fact, more and more people are still choosing to chase outdoor thrills through outdoor recreation opportunities provided. This influx of interest in outdoor recreational activity, according to (Zhiyong Wang, 2018) creates a growing need for spatial information to support a wide range of applications, such as route guidance, emergency management, cadastre and land management. This is certainly true in Ireland, where there is a distinct lack of detailed

information on river routes and mountain trails, making these experiences much less accessible, less safe and therefore less enjoyable - especially for those with little-to-no experience.

Weather Forecasting and Monitoring

In the world of outdoor recreation, weather forecasting plays a huge role in terms of safety and has changed and improved exponentially in more recent years, with the advent of technology. As explained by (Marzieh Fathi, 2021), weather forecasting has been developed from a human-intensive task to a computational process, and to this end, it requires high-tech equipment. (H. Saima, 2011) echoes that with the newly advanced technology today's weather forecasting models are more accurate. This in turn means that people can plan their outdoor recreational activities with very specific weather information in mind, which leads to increased safety. Although all weather forecasts involve uncertainty, many important weather-related decisions in diverse domains such as agriculture, water and energy management, and boater safety are based on deterministic forecasts (Joslyn, 2017). One common methodology when it comes to weather forecasting in the modern age is the analysis of big data. As explained by (Jain, 2017), big data is a term that describes the large volume of data - both structured and unstructured, it refers to the huge data sets obtained from various sources such as social media, sensor data, public data, transactions and data warehouse appliances. When this is applied to weather forecasting, it is datasets of atmospheric data that are used. Datasets of atmospheric data consist of rainfall, humidity, air pressure, radiation, sunlight intensity, data collection, etc. (Marzieh Fathi, 2021). All these factors allow for an accurate and detailed weather prediction. This especially valuable for water-based recreational activity, as it is pointed out by (Joslyn, 2017) who says that in the context of weather forecasts, Recreational boaters constitute high-stakes end users because weather has a huge impact on almost all aspects of boating.

OSM and GIS

The creation of OpenStreetMap (OSM) and Geographic Information Systems (GIS) has revolutionised the way individuals engage with outdoor recreation worldwide. Ireland too has seen major changes and improvements in how outdoor enthusiasts navigate, plan, and

experience recreational activities, which in turn has helped make this experience easier and safer to engage in. OpenStreetMap, as defined by (Ludovico Biagi, 2020), is a project that aims to create a free and open database of geographic information of the whole world, acquired by volunteers. It is easy to use, has a vast community and is an effective way of mapping the accessibility of outdoor terrain both in Ireland and worldwide. Though (Goodchild Li, 2012) argues that this community and voluntary approach could affect the homogeneity and quality of the data, some actions in order to improve the collected data are taken into consideration by the community behind the project, as stated by (Minghini et al., 2019). (M. Wang, 2013) echoes that large volume crowd sourcing geographic data provides a new solution for geospatial database updating while it needs to solve the quality problem of crowd sourcing geographic data obtained from the non-professionals.

Geographic Information Systems (GIS), like Open Street Map, offer a powerful toolset for mapping and analysing spatial data, which can be effectively applied to nature tourism. (Prem Chhetri, 2008) explains that recreational features, such as walking tracks, scenic vistas, waterfalls, unique geomorphic features and historical and cultural sites of interest can be stored as spatial objects, along with their attribute information, in a geographical database. While this is a step in the right direction, the fact that the tools are available does not mean they have been used. Much of Ireland's most beautiful rivers remain unmapped and undiscovered, which is something this project is aiming to amend.

Environmental Implications

Now, more so than ever, outdoor recreation should be planned with sustainability in mind. (Roovers, 2005) defines the fundamental principles of sustainability as postulating multidimensional approaches, incorporating ecological, social and economic aspects. There are certainly ethical issues when it comes to nature tourism and the use of technology. (Patricia L Winter, 2020) explains that rapid growth in nature-based visitation can lead to challenging changes in local communities, impact on local infrastructure and facilities, create competition for scarce resources, lead to unwelcome marketing of indigenous products and traditions. They continue to say that while nature-based tourism can serve to expand the constituency of support for biodiversity and conservation efforts, increasing recreation and tourism visitation can bring lasting changes to the natural and social environment.

When used ethically, technology can provide tools that aid in planning outdoor recreation with increased sustainability awareness, which in turn increases the safety and enjoyment of the sport by promoting conservation, enhancing visitor experiences, and mitigating environmental impacts. One such tool, as previously discussed, is GIS. (Bahaire, 2019) states that GIS can play a role in auditing environmental conditions, examining the suitability of locations for proposed developments, identifying conflicting interests and modelling relationships. GIS gives planners the opportunity to assess environmental features - sensitive habitats, water bodies, and cultural sites – and aids in identifying suitable locations for recreational activities while minimising ecological disruption.

Benefits

It is, without a doubt, a well-known fact that both indoor and outdoor exercise have positive impacts on both mental and physical wellbeing. However, a study performed by (J. Thompson Coon, 2011) found that there has been an increasing awareness of the positive impact of exposure to natural environments on mental wellbeing. This is echoed by (Patricia L Winter, 2020) who says that there is growing recognition of the positive benefits of outdoor recreation and nature-based tourism. Participants in Thompson's study also reported greater enjoyment and satisfaction with outdoor activity and declared a greater intent to repeat the activity at a later date. This could be as simple as a walk in the forest or as impressive as a 30km kayak upriver, but it is imperative that the information would be easily accessible to make achievable even to beginners. The mapping of small vessel water trails would provide the infrastructure for people to engage with water sports, attracting more people into the Irish countryside, and in so doing facilitate healthier lifestyles, social interactions and economic development (Ireland, 2013). There is no doubt that nature based recreation is so important for mental wellbeing, and so the spaces that make this possible should be valued, and this has been known for years, as written by (Kelly, 1983) " Outdoor recreation environments are demonstrably special, and the experiences made possible by those environments are highly valued because of their contributions to the lives of participants".

Conclusion

In conclusion, the relationship between technology and outdoor recreation, particularly in the context of kayaking in Ireland, is multifaceted and impactful, but definitely with room for improvement, particularly when it comes to accessibility and safety. While advances in technology have certainly influenced these factors positively to a certain extent, there is still work to be done. This review has identified a gap between the increasing demand for outdoor recreation opportunities, and the accessibility of spatial information that could make certain river routes and mountain trails more accessible. Weather also has an impact on both the safety and enjoyment of outdoor and water-based activities, and as seen in this review technology has brought a significant transformation in the field of weather forecasting. By leveraging technology, big data and machine learning, meteorologists can make more accurate predictions and provide timely information for various sectors (Tharran, 2023). This includes outdoor recreation and is especially important for water-based recreational activities e.g. river kayaking.

As outlined by Waterways Ireland, in a report completed in 2013, inexperienced water-sports participants and visiting tourists often lack the knowledge, experience and confidence to sample new activities or new locations in the absence of support. The aim of this project is to develop a means of making river kayaking an experience that is accessible to anyone, and provides the support required to enjoy this experience in a safe and immersive way.

Environmental Scan

Mary Kelly-Quinn et al., 2018. Reconnect - Assessment of the extent and impacts of barriers on hydromprohology and connectivity in Irish rivers, University College Dublin: EPA Catchments Unit

The Reconnect project, led by University College Dublin researchers and supported by the Environmental Protection Agency (EPA), is an initiative that attempts to thoroughly evaluate the frequency and effects of flow barriers in Ireland's river systems. Clarifying the complex interactions between these obstacles and their effects on freshwater biology, hydromorphology, and connectivity is essential to its goal. Taking a comprehensive approach, Reconnect aims to create a strong system for mapping these obstacles, which

include man-made structures e.g. dams, weirs, and bridges as well as natural elements, for example waterfalls and fallen trees. Acknowledging the complex effects of these barriers, which go beyond natural domains to include outdoor recreation such as canoeing and kayaking, the project takes an inclusive approach. Taking use of "citizen science," Reconnect encourages users to actively engage in data collecting from a variety of backgrounds, such as walkers, kayakers, canoeists, and fishermen. By means of an intuitive smartphone application associated with the UK River barriers initiative, users can record and capture images of river barriers that they come across while on their travels, regardless of how far away they are. The incorporation of GPS technology enables accurate geolocation mapping, providing an extensive dataset that is essential for comprehending and addressing the difficulties presented by flow obstacles. This project is very much in line with certain aspects of this project, as one main goal of this project is to highlight obstacles and flow barriers on the river routes. However, the crowdsourcing technique employed in Reconnect was not one that was used in this project, especially within the allocated timeframe, but could be explored in the future.

A Guide to Planning and Developing Small Vessel Water Trails in Ireland.

Waterways Ireland, Irish Sports Council/National Trails Office, & Irish Leisure Consultants (ILC). (2013). (https://www.sportireland.ie/sites/default/files/2019-10/guide-to-planning-and-developing-small-vessel-water-trails-in-ireland.pdf).

This project is an example of an integrated approach to the design, construction, and enhancement of small vessel water trails around Ireland, with a focus on community involvement and sustainable tourism. The initiative aims to assure adherence to safety standards and legal requirements while fostering environmental stewardship and cultural appreciation by providing clear guidelines for the planning and implementation of these routes. One of the main goals is to give users a clearly defined path that is enhanced by thorough information and infrastructure, which in turn helps users make well-informed decisions and improve accessibility for participants with different levels of experience. By directing users away from delicate areas, the project also prioritises environmental protection and reduces ecological harm. This project highlights the value of sustainability and cultural preservation in outdoor leisure activities while simultaneously advancing tourism and safety. The core ideas aline, as it is based on creating routes in a similar way to this project.

Environmental preservation is emphasised heavily, with a focus on the value of outdoor leisure and environmental responsibility which is something that is delved into in this review and is an important component of any project that aims to promote increased footfall in natural areas.

Blueways Ireland. [Online]
Available at: https://www.bluewaysireland.org

This project is a collection of trails, on or alongside some of Ireland's canals, rivers and lakes. For kayaking, it includes the River Shannon, Lough Allen Canal and the Jamestown canal among others. In the same website, it includes trails for walking and cycling also. It includes an interactive map, created using Open Street Map, which shows the routes in relation to one another, and allows it to be filtered by location, which is very useful. It includes an element that this project lacks, which is showing various food options in the area, and this is definitely something that should be considered, especially for longer routes, and certainly would add to the enjoyment of the experience. It has trails divided into tables which show the distance and estimated duration of each route but does not include what level the kayakers should be or any obstacles that could be encountered along the way, which seems to be a bit of an oversight. Similar to this project, it includes the exact co-ordinates of each route to increase accessibility and allow the use of Google Maps. Another useful element to the Blueways project is that when users press on a trail on the map, it lists the services available at each location e.g. bathrooms, parking, restaurants or bars, fresh water and whether or not the route is wheelchair accessible etc. This is something that this project could definitely benefit from and should be added in the future. It also includes hotels and B&Bs along the various routes, which is a good addition. While the routes that were mapped in this project aren't long enough to warrant an overnight stay, it would certainly add to the tourism aspect. Overall, this is a very well thought out project with all the elements necessary to make these experiences enjoyable and easy to achieve. It is similar to this project in ways but doesn't actually map the routes as it just details the start and end points, without including any obstacles that could be encountered along the way, or indeed any details on bridges, castles or other areas that might be of interest to the users.

O'Callaghan, D. J. P. &. K., 2024. Paddlesport Safety Culture in Ireland, Cork: Sport Ireland.

This report, completed in MTU in 2024, looks at the safety practices of paddle sports (canoeing and kayaking) in Ireland, with an aim of identifying what additional supports might be required to increase the safety of paddle sports and who they would need to be provided to. This report is in line with this project as one of the focal points of this project is how safety practices can be increased, and why water safety is so important. This report didn't focus just on canoe/kayak clubs, but also on the individual paddlers – there was a survey for clubs which received 14 responses and a survey for individual paddlers which received 247 responses.

From this survey, a startling 32% of the overall number of responses were from paddlers with only 0-5 years of experience, as seen in the bar chart below. This was extremely useful information that could be applied to this project as it just further highlighted the need for digitised routes that would be possible for those of any level and shows that not everyone who partakes in river kayaking has been doing it for a long time.

Artefact Description and Implementation

The platform used to display this artefact is WordPress, hosted by Reclaim Hosting, and within this website there were several tools implemented which came together to achieve the desired result – an interactive, accessible and engaging website with interactive river route maps, embedded safety features and visual aids. These tools were all imperative in bringing the vision to life, and answering the question of how technology can be used to increase the safety and enjoyment of river kayaking. The tools used in achieving the desired result are as follows: ArcGIS Story Maps, ArcGIS Heritage Data Maps, Reclaim Hosting, WordPress, Location Weather, Python libraries 'Pandas' and 'Folium', JavaScript libraries 'Leaflet' and 'Plotly' and HTML. Some of these were developed over 4 years in university, and some were learned and used for the first time for the purpose of this project.

The home page of the WordPress site consists of an original picture taken of the river from a kayak on the river Blackwater. At the bottoms of the page there is an About section, which includes a description of the project, why one would want to river kayak and a description of the levels the project used. The three levels are Beginner, Intermediate and Advanced, and while the primary focus of the project was on users at beginner level, there were elements of

all three levels in both of the routes that were mapped. This was all put in one place in order to give users a summary of the site all in one place, to show why river kayaking would be a worthwhile pursuit and to inform them as to what level would be suited to their own needs, when venturing into the Routes section. On the Routes page, there is an interactive graph at the top, which shows the optimal time to kayak vs high tide times. The safest time to kayak is an hour before high tide, as the currents are lessened, and the water is calmer. Using the JavaScript library Plotly, an interactive graph was created that would show the optimal kayaking time when the high tide time was selected, as pictured below.

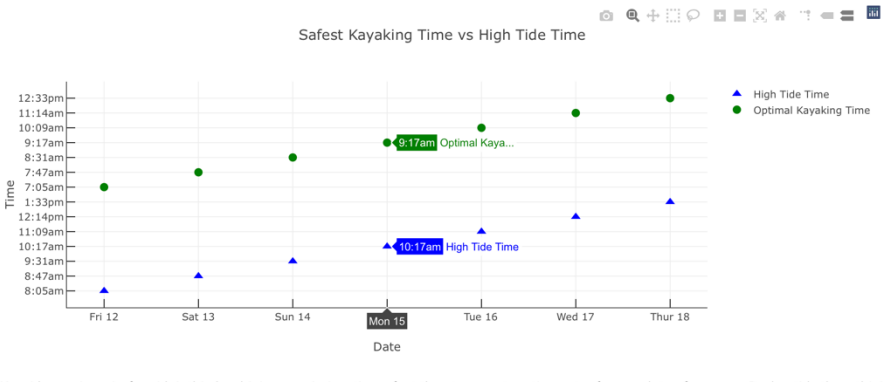

Image 2: showing interactive map of high tide times vs optimal kayaking times

This adds to the safety element in a way that it is effective and easy to use and comprehend. It is they first thing a user sees before progressing to the routes, which aims to highlight the importance of practising water safety.

The first route Castletownroche to Fermoy, boasts an impressive array of historical sites along the banks of both the Awbeg and Blackwater Rivers. The map, created on ArcGIS Story Maps, show the entry and exit as blue markers, obstacles as green, areas requiring extra caution as red and historical and cultural sites as orange markers. The main route, which has been categorised as a beginner level route, is traced in blue while a small area that requires more caution is traced in red. When the user hovers over each marker, it shows an original picture and a description of what that marker is highlighting, as seen below. All the historical infromation was taken from ArcGIS Hertiage Data Map, which shows each site as a red dote with the corresponding information available once you click into it. Each picture was taken as part of this project, as the aim was to have every photo from the perspective of the river. Useability was one of the primary aims of this project, and this is achieved through the

simple graphics and interactivity within the map. Each map has a legend showing the colour coding and the specifics of the map - where alternative exits from the river might be, the level of each stretch and half-way marks - in a way that is simple but effective and increases the useability of these maps, for users who may not have much experience when it comes to either technology or kayaking. To embed these river route maps from ArcGIS Story Map the iframe embedding mechanism was availed of. The process begins with visiting the pre-published ArcGIS Story Map and ensuring the permission are set for it to be a public URL, followed by obtaining the iframe embed code from the Story Map interface's sharing options. This iframe code, which includes properties for size, frame, and scrolling settings, is then methodically put into the appropriate location inside the website via the “custom HTML” block in the block editing. The code sample includes necessary characteristics such as width, height, frameborder, scrolling, marginheight, and marginwidth, allowing for responsive integration adapted to the website's layout. After insertion, a thorough verification process is required to assure seamless functionality and visual consistency across multiple browsers and devices, specifically handheld devices as these would predominantly be what users would be viewing the website on. Once the maps have been embedded, the website seamlessly integrates the immersive storytelling features of ArcGIS Story Maps, allowing users to easily connect with the dynamic spatial narratives. ArcGIS Story Maps is the ideal tool for this project for that very reason – it tells a story and allows the user to experience and navigate that story in whichever way they please, from whichever device they want.

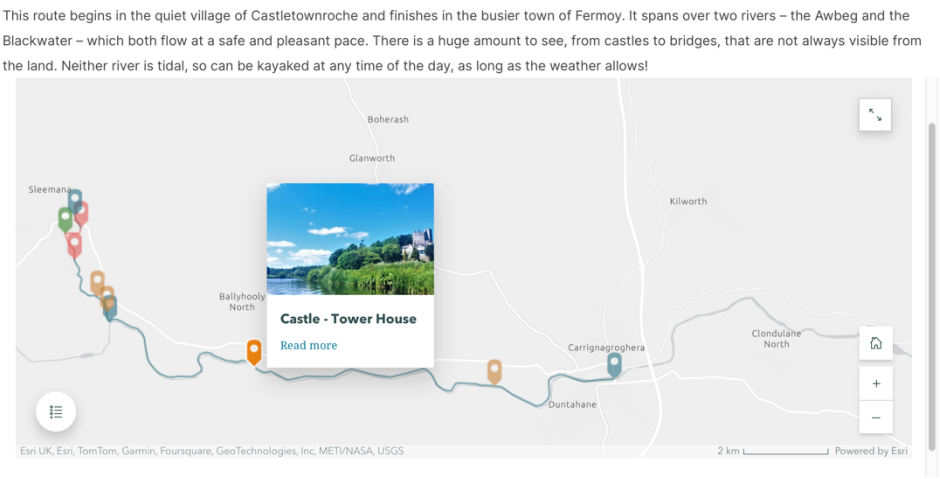

Image 3: showing example of site of historical interest on river map

The addition of original photos to these maps improves the users' experience by adding visual context and elevating the navigational aids' aesthetic appeal. These photographs, which were taken with the iPhone 13 phone camera, are taken from the point of view of the river looking out, providing a new viewpoint on natural environments and historical landmarks. The images were intentionally taken on days when visibility was optimal, ensuring clarity and vividness in portraying the architectural and natural beauty along each river route. The photographs were carefully curated to exhibit the historical landmarks in all their glory. Through the use of photographs taken in ideal conditions, the maps not only facilitate navigation but also inspire admiration for the natural beauty and cultural legacy that define the rivers' surroundings. Users' overall enjoyment and engagement as they explore the river and its surroundings are enhanced by this intentional attention to visual aesthetics, which also aims to build a stronger connection with the historical and natural beauties depicted within these digital maps.

Also featured on this page is the Location Weather plugin, which displays live weather updates for the area. It shows the current temperature, humidity, wind gusts, visibility, and more. This is important for ensuring safety and making activities along the river easier to plan. With this plugin, users can quickly check the weather conditions before heading out, helping them stay informed and prepared for any changes in the weather. This feature enhances the user experience by providing valuable information that will enhance the safety of the experience.

At the bottom of the page, a map interface built using the JavaScript library Leaflet improves the website's accessibility and usability by giving precise geographical data. The map has only two different markers: the location of the entry to the River Awbeg in Castletownroche and the exit in Fermoy. When a user clicks on a marking, its coordinates are revealed, providing the maximum accuracy and clarity and by providing users with latitude and longitude coordinates the integration ensures cross-platform interoperability, allowing users to easily transfer geographic data to mapping services such as Google Maps for additional research or navigation.

The below map was created using leaflet, a JavaScript library for interactive maps, to show the exact coordinates for both the entry and exit of the river, to make the route as accessible as possible.

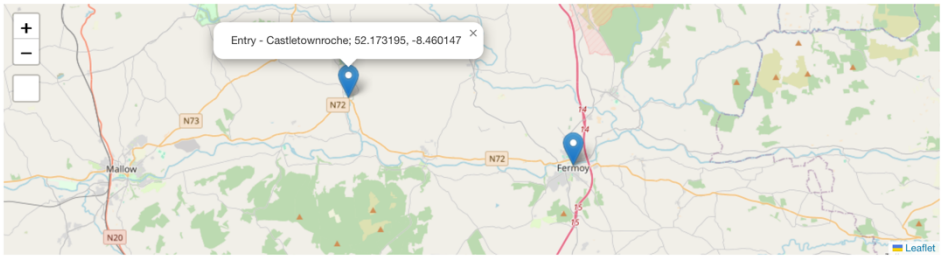

Image 4: showing co-ordinates of entry point to river, coded using Leaflet

The second route, from Kildorrery to Glanworth, uses the same colour coding techniques and is mapped the same way, the only difference being that it is of a slightly more difficult level, grouped into the 'beginner/intermediate' level, leading to having larger amount of the route that require increased caution. However, it is by no means more dangerous or hugely more difficult. It is also a shorter route, to make it a viable option for users who may have limited time or who might want to try out the activity without signing up for a longer journey.

```
import pandas as pd
import matplotlib.pyplot as plt


data = {
    'Year': ['2007', '2008', '2009', '2010', '2011', '2012', '2013', '2014', '2015', '2016', '2017', '2018', '2019', '2020', '2021', '2022'],
    'Total': [173, 146, 147, 133, 131, 154, 126, 143, 143, 136, 110, 145, 125, 106, 102, 84]
}


df = pd.DataFrame(data)


plt.figure(figsize=(10, 6))
plt.bar(df['Year'], df['Total'], color='darkgreen')
plt.xlabel('Year')
plt.ylabel('Number of Mortalities')
plt.title('Mortalities Caused by Drowning Per Year in Ireland')
plt.xticks(rotation=45)
plt.tight_layout()

plt.show()
```

Image 5: showing how Pandas was used to create a dataframe of water-based mortalities

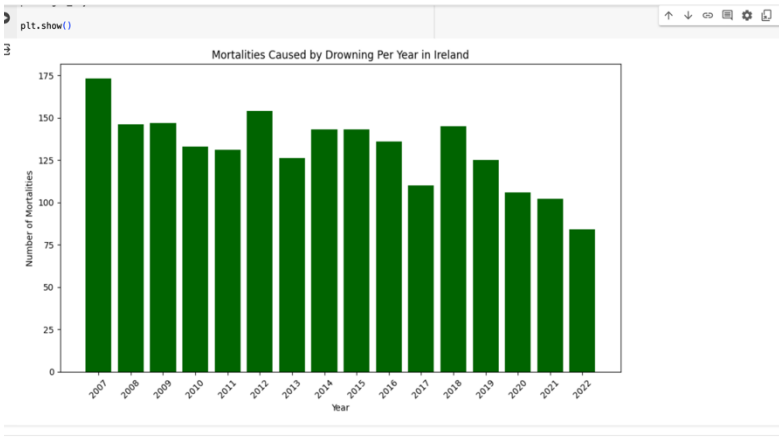

Image 6: showing bar chart visualisation of above Pandas code

This first visualisation is a bar chart showing the number of water-based mortalities per year in Ireland from 2007 to 2022, based on data from Water Safety Ireland. While it has decreased by a significant amount in recent years, it is unclear as to why this might be. Pandas as used to create this graph by inputting the data manually into a data frame. While it is unclear why these numbers have decreased, it is still a significant amount of people per annum and so works well to show users the importance of water safety, and how things can happen even with all precautions taken.

The following visualisations were created in a similar way, but to show a pi chart rather than a bar chart. Both of these visualisations could have been more informative if more information had been available e.g. ages, more specific causes, times of year. It allows us to see in a very broad way how common of an occurrence it is and in that sense aids in increasing awareness but does not allow for much further analysis.

```
import pandas as pd
import matplotlib.pyplot as plt

#Create data frame
data = {
    'Gender': ['Male', 'Female'],
    'Count': [79, 24]
}
df = pd.DataFrame(data)

df['Percentage'] = (df['Count'] / df['Count'].sum()) * 100


plt.figure(figsize=(8, 6))
plt.pie(df['Percentage'], labels=df['Gender'], autopct='%1.1f%%', startangle=140)
plt.title('Water Based Mortalities by Gender')
plt.axis('equal')
plt.show()
```

Image 7: showing how Pandas was used to create a dataframe of the genders of water-based mortalities.

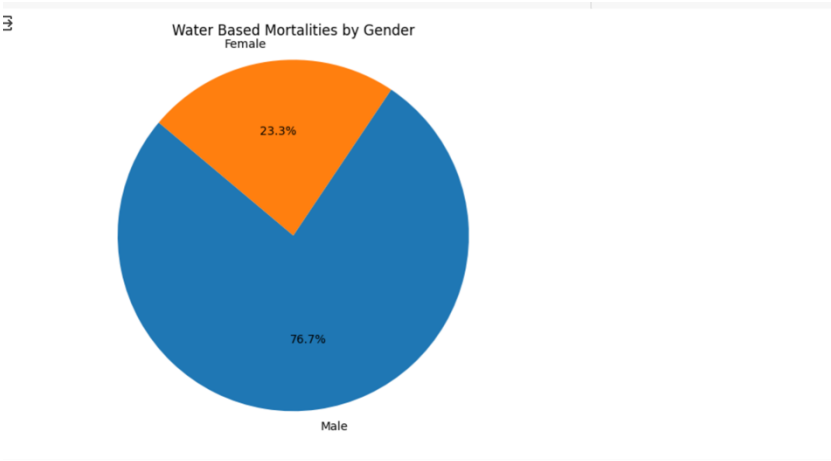

Image 8: showing visualisation of above Pandas code, in the form of a pie chart.

The following is an interactive graph, created using the JavaScript library Plotly, which shows the high tide and the corresponding low tide or vice versa when either one is selected. This graph shows the tide times for the current week but would have to be updated each week to show the corresponding tidal data, as it changes week by week. This makes it quite a labour-intensive addition and not extremely useful, and a plug-in would be a more reliable option as it is uses live updates so does not have to be manually updated every week.

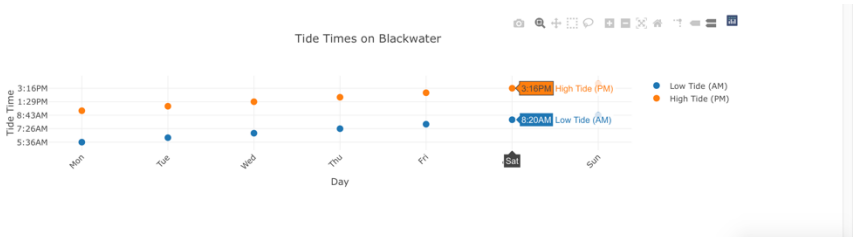

Image 9: showing interactive graph, created using JavaScript Plotly, of both high and low tide times

On the "Coming Soon" page, there is an array of routes that this project aims to tackle next. Mostly in Cork, but some in other areas e.g. on the River Shannon in Limerick and the River Suir in Tipperary. The Suir already has a route coined the "Blueway" mapped from Cahir to Carrick-On-Suir via Clonmel, so this project could add to this and increase the accessibility of the already-created route. This page uses ArcGIS Story Maps to show these routes on the

map, with the same colour coding as discussed previously. Orange marks routes that might require more experience and blue marks the routes that would be suitable for total beginners.

This website was built with the intention of being easy to navigate and understand, so the information was kept concise and readable, as well as the maps being clear and easy to use. The website is functional on mobile devices as well as desktop, to make it easy to use on the as users navigate the waterways, they can use the map to see what obstacles to expect and what sites to keep an eye out for, along with the corresponding information and visual aids, all while actually partaking in the activity.

Analysis

This section delves into the intricacies of what was learned throughout the entire process – from reviewing the literature and the environmental scan, to designing and constructing the artefact. It's an overview of new skills that were learned for the purpose of this project, what elements worked and what needed to be changed, and how this affected the final result.

Literature Review and Environmental Scan

Having reviewed literature that relates to river kayaking in Ireland, several issues became known. Firstly, it was evident that while there was a lot about kayaking/canoeing in other countries, not a lot of research had been conducted in Ireland on the subject. The main question here was why? There certainly is not a lack of waterways in Ireland. There have been projects outlining kayaking routes, for example the Blueway project based on the River Suir in Tipperary, projects that have mapped obstacles/flow barriers in canals, for example the Reconnect project, but none that would make the experience very accessible or safe for beginners, none that mapped the exact routes to make it accessible to people who may not know the area at all, and none that were based in County Cork, despite it being host to some of the most easily navigable and beautiful waterways. One issue is the lack of spatial information to support these pursuits. While the technology is definitely there to achieve it, lack of detailed information on river routes and surrounding areas can hinder accessibility and safety, especially for less experienced individuals.

One element that presented itself during the review of literature was that of environmental concerns. This was not something that had been considered at the beginning of the project,

having never looked at the topic before, but of course it is a very real concern and should be taken into account in every project that plans on increasing footfall in natural environments such as woodlands and rivers. It is unfortunately not fair to assume that every user would be mindful of the wildlife and nature in and surrounding rivers, so there should be an emphasis on the safeguarding of these natural features, for example when it comes to littering, risking the safety of endangered species and especially during nesting season. Technology, such as GIS, can assist planners in accessing environmental conditions and identify suitable locations for outdoor recreation, or similarly identify unsuitable areas that should not be used, with the aim of minimising ecological disruption. One thing that was noticed throughout the creating of the river maps was that there is a distinct lack of facilities to dispose of rubbish along some of these rivers, and though a solution was not reached for this problem within this project, it is definitely something that should be developed on, even within the surrounding towns and villages. If the aim is to bring more touristic interest to rural areas, that would be one thing that would definitely require more work and planning and is not something to be neglected.

ArcGIS – Story Maps

The use of ArcGIS Story Maps was a decision that was made further into the development of the project, after using JavaScript library Leaflet (or Python library Folium) was deemed too labour intensive for the timeframe and it really succeeded in bringing the vision to life, but not without its issues. Once the maps were created, the next step was to embed them into the website (as discussed above). To do this, it turned out that a premium membership was required that was not only $100, but not available to purchase in Ireland at that moment in time. The maps had been created, while unknowingly using a free trial and without knowing this free trial had ended, and so the maps were unable to be edited, exported or embedded. After some discussion with Esri Ireland technical support, whom are a fantastic resource, a temporary free trial was granted, and the maps were able to be embedded successfully. However, this trial only lasts 60 days so if development were to continue there would have to be a better and more long-term solution. Perhaps if the premium version were made available to purchase in Ireland or another platform could be employed, the JavaScript library Leaflet for example, should the timeframe allow.

JavaScript - Leaflet

While the maps were not created entirely using the JavaScript library Leaflet, it was employed to add to the accessibility of the routes. This required more work than other aspects

of the project, as it required a knowledge of JavaScript which had not been previously developed. This could have been done using the python library 'Folium' too, but as it needed to be contained within HTML to display the end result in a Custom HTML block on the WordPress website, using JavaScript proved to be an easier approach, despite lack of proficiency. This proved to be a bit more of a challenge, requiring some time and effort, but the result was two very clear markers showing the exact co-ordinates of the entry and exit to each route, on an interactive background. Keeping this separate to the main river maps was done intentionally with the aim of making it even more clear and as easy as possible for users to follow.

Python - Pandas

The use of Python 'Pandas' was very valuable in displaying data on water safety in a clear and impactful way. Using Google Colab was a simple and effective way to code the graphs, using Pandas, and immediately see the outcome, as well as for fixing any errors in the code. This tool had been used in previous Pandas-based projects, and its versatility makes it easy to draw insight and visualise the information. However, due to the gap in research, the actual data itself was sporadic and difficult to find, which certainly limited what could be achieved from using Pandas. The sporadic data did not provide a comprehensive picture of trends or patterns when it comes to kayaking or water safety in Ireland. For example, while the data on water-based mortalities was available, there was no data on why these occurred or why in recent years the values have been decreasing. It made it difficult to analyse and draw any conclusions from these visualisations. Instead, they were used to increase awareness to the sheer number of mortalities occur on or near the water every year and emphasise the fact that water safety should be taken very seriously. Additionally, the inconsistencies in the little data that was available made it more susceptible to bias and uncertainty and did not allow for much of a definite conclusion to be drawn. This was not surprising considering the lack of research when it comes to river kayaking in Ireland that was discovered during the literature review, but disappointing from a data analysis point of view. More than anything, it highlighted the need for increased research and surveying of this field.

WordPress

While WordPress was a good platform to display the maps on, there were some initial issues regarding plugins. One of the most vital plugins, Location Weather, clashed with the first theme that was used and caused the initial site to crash and stop responding. This was likely a

theme issue rather than a plugin issue, as when external plugins are added they may introduce additional code that interferes with theme's existing components. Once the theme was changed, the plugin worked with no additional issues and integrated seamlessly into the pages. Another plugin that would've added to the safety and accessibility of the kayaking experience is Tide Times, but as it had not been updated in 3 years it was deemed safer to not employ it in this site as it might contain security vulnerabilities, compatibility issues and performance concerns. Instead, an interactive graph was created to display the tide times, however this would have to be updated weekly.

Human Reaction

At the open day, this project received a lot of valuable feedback. Two members of the UCC Canoe and Kayak club reviewed the project and expressed enthusiastic support. They highlighted the practical benefits, such as easier navigation and improved safety on unfamiliar waterways, emphasising how having detailed maps readily available would significantly enhance excursions, especially for members who are of beginner level. Additionally, accurate spatial information would not only streamline the kayaking experience but foster a greater confidence among less experienced club members. One issue that was highlighted was the lack of more advanced routes as club members would be interested in whitewater kayaking and slightly more difficult courses. This could certainly be developed over time, as the focus on beginner routes was mainly because of the limited time allowed for the completion of this project.

Conclusion

Through the development and completion of this project, there were some changes in direction, a few problems and some compromise. While all the tools employed in this project were instrumental in achieving the desired result, there were certainly shortcomings to each, and some trial and error was definitely necessary in choosing the correct tools for this project. One crucial factor was the relatively short amount of time allowed for the completion of this project, which somewhat limited the tools that could be successfully learned (if necessary) and applied, for example using HTML to hand code the platform on which the maps would be displayed proved too labour intensive for the allocated time period.

Had there been more time, implementing the website using HTML, CSS and JavaScript would have offered several advantages in terms of flexibility, customisation and scalability. The use of these technologies would offer further control over layout and design, which would allow for customised and aesthetically pleasing user experiences. Additionally, the modular design of HTML and CSS makes it easier to maintain and grow the website in the future. Efficient coding can lead to optimised performance, and though it would be more time and labour intensive, the final result would be more polished and tailored to the specific needs of the target audience. While WordPress delivered in terms of useability and with the use of plugins, the implementation of HTML and CSS would've been preferable had there been more time.

Another issue that was encountered was the lack of data with regards to river kayaking, correlating with the sparse amount of research on the subject, which led to data analysis that didn't reveal much insight. This could've been amended to some extent by carrying out a survey on both kayaking clubs and individuals, which might have revealed more patterns and led to more informative and useful visualisations. Surveys provide a structured approach to collecting feedback and allow for targeted inquiries into more specific areas of interest e.g. preferences, needs and experiences. Had this data been collected it could've been analysed to reveal patterns, correlations and trends which then could've been converted into visualisation tools such as graphs and bar charts. Incorporating surveys into the research methodology would certainly have enhanced these projects findings and would've led to a deeper understanding of the target audience. This is something that should be completed in the future, to lead to more effective strategies in promoting river kayaking as a recreational pursuit that is accessible to all.

An additional element that could've enhanced this project is the addition of water level data, and a live update of what level the water is at. A significant aspect of river kayaking is water level, as if it's too low or too high it becomes unsafe to partake in the activity. The monitoring of water level can inform route planning by allowing users to assess the current conditions and identify potential hazards, for example rapids, submerged objected or shallow areas that may be more difficult to kayak. It could highlight areas where river levels may be too low or too high to allow safe kayaking. By incorporating water level information into this project, it could've provided users with up-to-date insights into river conditions and allow them to plan routes that offer optimal kayaking experiences while avoiding areas of more concern. While this information is available at waterlevel.ie, it was impossible to integrate the

live updates into this website, especially within the specified timeframe and with limited resources. It is definitely something that will be added in the future as it would significantly enhance the safety and therefore the enjoyment of the river kayaking experience and would provide an additional layer of accessibility to less experienced users.

In conclusion, this project serves as a small but significant step towards enhancing accessibility, safety and enjoyment of river kayaking as a recreational pursuit. By leveraging technology such as GIS mapping, heritage data, weather data, and tools such as HTML, Python, ArcGIS Story Maps and JavaScript, this project succeeded in fulfilling the original aim, the aim of addressing key challenges that prevent users from experiencing river kayaking in Ireland, such as limited spatial information. While obstacles were encountered throughout the process and challenges presented themselves unexpectedly, the final result reflected the initial vision and succeeded in accomplishing everything that it had set out to accomplish. Moving forward, this project can serve as foundation for further advancements in promoting river kayaking in Ireland, and help to create an inclusive, safe and enjoyable environment for river kayaking enthusiasts of all levels. This project seeks to be an example of how technology can impact the safety and enjoyment of recreational river kayaking, in a positive way.

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