“Manc Stories”: a location-based game to connect with the city and its people.

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Abstract

In the modern world, millions of people tend to move from one place to another, constantly forming new friendships and creating new experiences. This generates a demand for new ways of staying connected with people who become close and places that become home. As the world develops, technological advancements allow for evermore personalised and creative solutions to meet human needs. However, this rapid progress also creates new problems that negatively affect human well-being.

This project intended to develop a multimedia location-based game web application to connect people and places through personal stories and street art. The web app was designed as a platform for creativity and discovery that encourages people to add their original content and promotes physical activity and urban exploration.

To achieve this, both frontend and backend programming languages were used. A combination of HTML, CSS, and JavaScript, with two open-sourced libraries called Leaflet and Turf, allowed to create a dynamic and interactive location-based game. At the same time, the Python Flask framework provided the means to connect this game to the server and the database. This communication between the frontend and backend allowed for storing and retrieving user-created content.

During the testing, the web application received a lot of positive feedback, and it is hoped that in the future it will attract more users who will spend more time outdoors discovering and creating stories. As Jack White's song goes, "Every single one's got a story to tell" (2003).

Chapter 1 – Introduction

The modern world is highly globalised and mobile. In fact, the 21st century is an era of the greatest human mobility in recorded history (IOM, 2011). This means that an increasing number of people form new friendships and relationships in different parts of the world. However, once an individual moves to a new place, these human links often break, and their experiences become forgotten (Marlowe et al, 2016).

In response to this problem, both start-ups and juggernauts of the internet age provided social media solutions that were meant to bring people closer through digital activity (Bayer et al, 2020). This was enabled by the unprecedented spread of smartphone devices, where, by the latest estimates, 83% of the world's population or 6.6 billion people, own a smartphone (Statista, 2022). Today, information and telecommunication technologies are more widespread than electricity (Zuboff, 2019), and an average person in the developed world spends over 3 hours a day on phones (Zalani, 2022).

While digital connectivity brings people closer, it also creates many problems. A growing number of researchers argue that habitual involvement with social media platforms may have a negative and lasting impact on users' mental health (Wilmer et al, 2017, Denche-Zamorano et al, 2022). Moreover, the extensive use of digital devices has created a sedentary screen-based culture and for the one-third of digital technology users, messaging and status updates are often more natural than having a live conversation (Kaya et al, 2021).

One way of addressing the need for human connectivity without promoting the inactive lifestyle can be through location-based games (LBGs) development. These games provide an engaging social outdoor activity (Laato et al, 2020) and encourage users to move around physically (Asghar et al, 2014). LBGs use digital mapping technologies to modify the gameplay according to the user's current location (Spallazzo and Mariani, 2018). By blending smartphone-enabled digital experience with a real-world physical one, LBG can transform an individual's perception of the place, turning specific sites into spaces for relationship-building and play (Leorke, 2019).

With the widespread incorporation of the Global Positioning System (GPS), navigation has never been easier. At the same time, the use of sound has become

increasingly common, enabling the development of multimedia cartographic applications. These apps use different sonic elements to transform physical places in ways which cannot be achieved solely through visualisation (Edler et al, 2019). All these technological advancements allow for the development of evermore precise and personalised solutions (Zuboff, 2019). This dissertation presents an LBG multimedia web application addressing the need for connectivity, personalisation, and an active lifestyle.

Consider the experience of walking the steps of a departed grandfather or a close friend who currently lives on another continent. Imagine discovering and listening to important events of their lives in the exact locations where these events happened to them. Consider the digitally enabled possibilities of reconnecting with these close people by following in their footsteps around the town where they spent important years of their lives searching for hidden stories directly related to them. Imagine that these stories are narrated by familiar voices. Modern technology can help provide such experiences, bringing people closer in an interactive way that encourages creativity and physical activity.

Chapter 2 – Literature review

2.1 Connectivity in the information age

Network connectivity is one of the dominant transformative forces in the early 21st century. In technological terms, connectivity can be defined as an internet protocol that transports packages between the source and the destination hosts (van Dijck, 2012). This process allowed to build an interconnected space for information exchange and provided opportunities to engage in online social interactions (Bayer et al, 2020; Light and Cassidy, 2014). Today online activity creates a sense of presence and participation in each other's lives (Schwab, 2016), often being the only avenue through which friends and family can stay connected (Brewer et al, 2021).

People worldwide expand their online presence and create huge digital content to satisfy the desire for close relationships and attention (van Dijck, 2012). Taylor et al. describe three main relational behaviours online (2021):

- social contract: reacting to someone's digital activity to attract attention;
- response seeking: broadcasting messages to gain an individual partner's attention;
- relational assurances: communicating intentions to preserve the relationship.

Interestingly, in all three relational behaviours strategies, there is a specific person with whom an individual desires to build some relations.

As web infrastructure matured, data were increasingly transported through specialised social media applications (van Dijck, 2012). This process continues in an ever-evolving portfolio of web and mobile apps (Bayer et al, 2020). The effects of these applications on close relationships and human well-being are being discussed among scientists. Still, most research reveals that social media can negatively impact human well-being (Taylor et al, 2021).

2.1.1 Impact of digital activity on human health

Smartphones have become the most preferred mobile devices in the world. And their daily usage causes what scientists call a 'smartphone addiction' (Kaya et al, 2021). Social media services and online gaming are among the chief reasons for the rise of this addiction (Ayd, 2019). Some researchers reveal the emergence of a sedentary screen-based culture, which comes from excessive smartphone and laptop usage,

leading to an exponential rise in various health hazards (Prescott et al, 2022, Kim, 2015). There is evidence that the problem became so severe that it should be viewed as a public health issue (Kaya et al, 2021).

While every technology has its pros and cons, and smartphone technology has numerous positive aspects (Rather, 2019), the lack of movement facilitated by it results in eye strain (Choi et al, 2018), musculoskeletal system issues, hypertension, and stress (Rather, 2019). Overall, there is a consensus in the literature that excessive online activity can cause many health problems, including anxiety, depression, and sleep disorders, and is negatively correlated with various conceptions of well-being (Horwood and Anglim, 2019, Kaya et al, 2021).

Thus, there is a need for new ways of interacting with digital technology that would use its advantages but mitigate disadvantages. This is the niche that some location-based games aim to fulfil.

2.2 Location-based games and experiences

LBGs are games that use device location awareness to provide players with a contextual game experience. This type of game mixes a digital experience, accessed through a smartphone device, with a physical one, explored in the real world (Spallazzo and Mariani, 2018).

Location-based mapping and media technologies, on which LBGs rely, are increasingly being studied by various academic groups, which explore the possibilities of using them in the urban context. These studies view the city as a complex spatial system that acts as a platform for actions, interactions, and communication processes (Tarachucky et al, 2021). Location-based technologies allow personalising urban experiences using various recommendation systems, navigation tools and location-based services, effectively allowing the information to be generated and accessed on the go (Wilken, 2012). Consequently, the user's position in the world also influences the exchange of information and generates spatial data that can be used in the LBG (Klinkenberg, 2003).

Interdisciplinary contributors have reviewed the literature on the use of location-based technologies in individual and social activity (Olsson et al, 2020), for commercial (Asghar et al, 2014), educational (Malegiannaki and Daradoumis, 2017), and recreational (Oppermann et al, 2011) purposes. Many examples show how

location-based technologies underpin engaging new experiences and opportunities. Self-guided tours aim at improving understanding of historic sites (Abowd et al, 2006); video games merge physical and digital worlds to engage active players (Cheok et al, 2004); serious games seek to enhance teaching and learning experiences (Benford et al, 2005); social LBGs seek to foster social interaction by bringing physical and digital worlds together (Fonseca et al, 2021), etc.

Lehmann distinguishes four common game patterns of the use of location in the LBGs (Lehmann, 2012). The graphical overview of these is provided in the figure below.

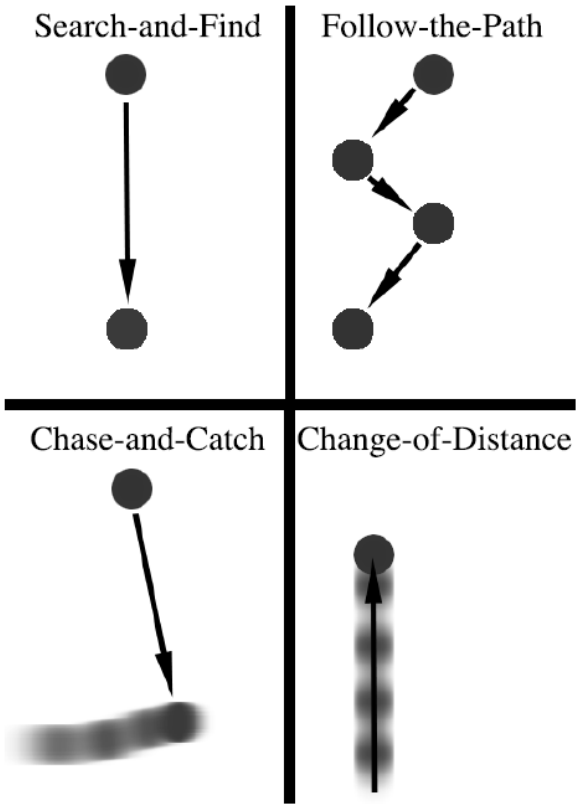

Figure 1 Location-based game patterns (Lehmann, 2012).

In Search-and-Find design, players need to find specific geolocation. The follow-the-Path pattern is similar; however, players focus more on the journey than the destination (Lehmann, 2012). In a Chase-and-Catch pattern, players "hunt" a moving object in the game world (Misund et al, 2009). Finally, the Change-the-Distance design emphasises movement. An LBG can use any of these patterns or a combination of them (Lehmann, 2012).

LBGs provide an engaging way to share different perspectives through a first-person, personalised experience: they put control in the player's hands with

interesting potential outcomes in terms of understanding and reflection (Spallazzo and Mariani, 2018). In addition, studies show that there is a social benefit in playing LBGs (Fonseca et al, 2021). Since players often encounter in the real world, it is easier to establish friendships and foster social connections outside the game (Lehmann, 2012). Finally, different findings prove that LBGs can motivate people to exercise, increase the time players spend outdoors, and contribute to healthier lifestyles (Althoff et al, 2013).

Thus, there are numerous opportunities to use LGBs to motivate people to go out, explore, connect to places, and strengthen old and form new relationships (Laato et al, 2020).

2.2.1 LBGs examples

No literature review that involves LBGs can avoid discussing "Pokemon Go". It is by far the most successful and most researched LBG (Andone et al, 2017). The app was released in 2016, and currently, it has over one billion downloads (Ku et al, 2021). In the game, players search for imaginary creatures hidden in the physical world. The player's real-world location is integrated using GPS technology with the digital information that appears in the user's real environment through augmented reality via the mobile camera (Caci et al, 2019).

Numerous studies have examined Pokémon Go users' motivations, and outcomes (Thongmak, 2020, Hamari et al, 2019) and results indicate that the game brings users mental, social, and physical benefits (Zsila et al, 2018) (figure 2). Moreover, there is evidence that Pokémon Go can promote users' physical activity by motivating them to get outdoors (Marquet et al, 2018). Like many other LBGs, it combines attractive features of online games with exciting real-world physical activities (Ku et al, 2021).

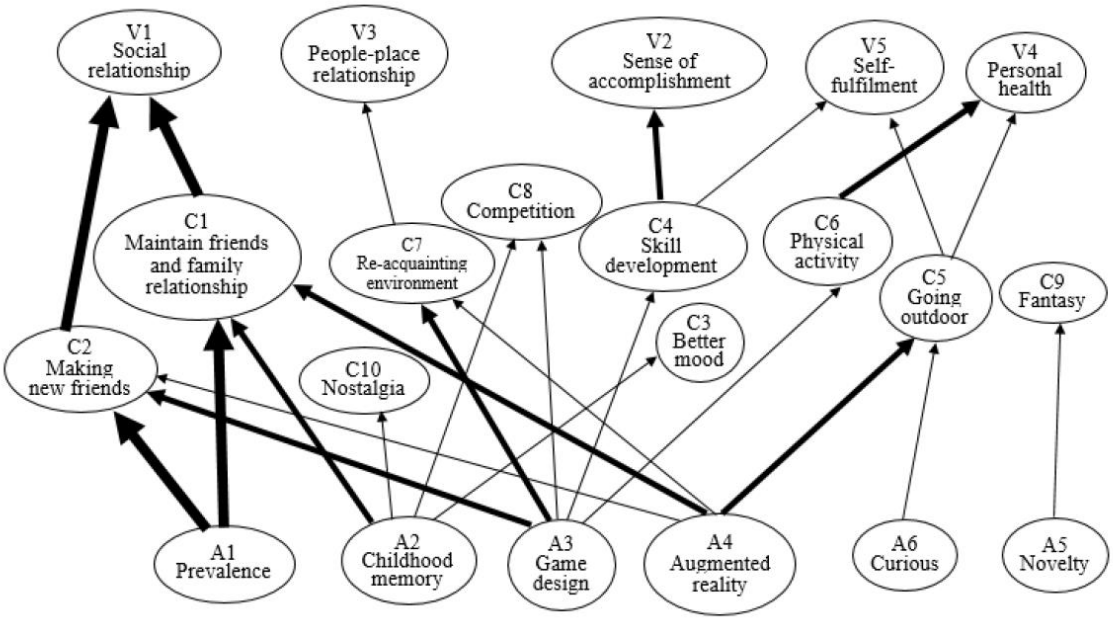

Figure 2 Hierarchical Value Map for Pokémon Go Experiences. (Ku et al, 2021)

Another example of a popular LBG that encourages users to get outdoors is "FlashInvaders". This app combines an LBG with street art. Currently, it has over 100 thousand active users (space-invaders, 2022).

Started back in the 1990s when a French urban artist, known as "Invader", began creating mosaic-style ceramic tiles in the image of the Space Invader aliens from the eponymous 1980s video arcade game (Márquez, 2020). Branded as "invasions", he visited different cities installing his artworks on buildings and creating maps of the approximate locations of these art pieces (figure 3). Currently, over 4000 'invaders' are scattered across 80 cities around the globe (space-invaders, 2022). This created a foundation for the future LBG.

"FlashInvaders" was launched in 2014 (Wendling, 2017). This app took the act of "art-hunting" and turned it into a game of points (Estima, 2017). The game's objective is to walk around one's city and snap photos of street art. These photos are then compared against a database of all created invaders and if there is a match player receives points (FlashInvaders, 2022).

Figure 3 Space Invaders Amsterdam (Prénom, 2016).

The app doesn't generate revenue, which sets it apart from most other LBGs. Like Pokemon Go, it encourages people-place relationships and provides a feeling of accomplishment (figure 2). It also brings people together (Poll, 2020). In the international community formed around the game, players share the real-world locations of space invaders and even restore the damaged artworks (Márquez, 2020).

These two LBGs are a great example of a successful combination of a real-world environment with a virtual space. Both follow the "search-and-find" pattern described by Lehmann (figure 1) (2012), and both engage people in interactive activities, facilitate interhuman connections, and encourage physical activity. However, other LBGs use many techniques mentioned above but add another element – the audio. These games often use a "follow-the-path" pattern but can also be of a "search-and-find" design. They often focus on the history and culture of the place where they are deployed (Nisi, 2018).

“Fragments of Laura” is a mobile app that aims at enhancing the tourists' experience on the island of Madeira. The mobile tour offers visitors an entertaining way to explore different historical times on the island through a location-aware multimedia story enhanced with mobile virtual reality (Dionisio et al, 2017).

“StoryPlaces” is an open-source web application that enables location-aware narratives to be created, deployed, and experienced in the real-world environment, specifically on the campus of the University of Southampton (Hargood, 2018).

“Inside Outside Battery” is a mobile application that uses GPS to narrate walking visitors through the Battery, a neighbourhood of St. John's (Newfoundland, Canada). In this "follow-the-path", LBG users ramble around the area, and the app triggers various stories and sounds based on the user's location (Galloway, 2018).

Numerous other examples of exciting LBGs combine location-based technologies with the audio element to facilitate interhuman and people-place relationships (McCartney, 2014, Fonseca et al, 2021).

2.2.2 Audiovisual element in LBGs.

Maps often impose strict points and lines where no rigid structures actually exist or where the certainty of the exact location magnitude is low. However, the real, ever-changing world is full of uncertainty which is difficult to represent only using visual variables. A possible solution to this problem is the addition of the "sound space" to LBG, this can allow a fuller representation of the physical environment (Krygier, 1994).

The possibilities of audiovisual maps and their use in various thematic applications were first introduced in 1994 by John B. Krygier when cartography rapidly shifted to digital solutions (Martínez, 2020). Since then, many audiovisual maps and applications have been developed and published in academic papers. Based on this literature, Edler et al. distinguished a set of specific variants of how the sound has been used in available applications (2019). Those include:

(1) computer-generated abstract sounds;
(2) human or computer-simulated speech;
(3) recorded or computer-generated music;
(4) 'audio realistic' recordings of the real 'soundscape'.

Many popular location-based applications utilise the power of the sound, especially the first and third sound-use variants, which is only logical as the auditory dimension is the most prominent among all the non-visual dimensions (Edler et al, 2019). Consider that human communication is primarily carried out by speech. The close relationships and the exchange of ideas between people would be impossible on a large scale without sound (Krygier, 1994). These sonic possibilities to facilitate interhuman connection is unappreciated by available LBGs (Martínez, 2020). Those LBGs that currently use recorded human speech rarely use it to foster personalised

social interaction. They often tell a story related to a place, but rarely a story related to an individual who listens to it (Galloway, 2018). This contrasts sharply with how social media platforms use multimedia stories to connect people and strengthen their relationships (Taylor et al, 2021).

2.3 Web GIS

The "WWW," known as the web, is a collection of hypertext documents connected to other documents stored on computers around the globe (Agrawal and Gupta, 2017). It was invented in 1991 by Tim Berners-Lee along with the HTML (Hypertext Markup Language), HTTP (Hypertext Transfer Protocol), and URL (Uniform Resource Locator) (Berners-Lee, 1994).

A web application is application software that runs in a web browser. To make it work, a browser launches software programmes by sending HTTP requests to a server housing the data via a URL. The server responds by supplying the resources or carrying out the user's requested functionalities (Swift et al, 2019).

Web GIS started as simple web mapping websites and evolved into massive platforms solving various spatial problems from navigation to entertainment. It revolutionised the GIS, giving it new directions as huge and complex GIS applications were made accessible to the public via the web (Green and Bossomaier, 2002). This became possible because of decreasing cost of laptops and smartphone devices, as well as the continuous development of the web and numerous software technologies (Agrawal and Gupta, 2017).

Today web GIS programming allows the creation of the web, mobile, and desktop applications. These apps often focus on solving a specific GIS problem involving spatial data analysis and geospatial processing services (Swift et al, 2019).

The accessibility and development of the web, Web GIS, and GPS resulted in an unprecedented growth of the open-source software (OSS) and the volunteering geographic information (VGI). The OSS is computer software that allows users to use, study, modify, and share the software and its source code with anybody for any reason (Corbly, 2014). The VGI is spatial data collected globally by volunteers who act as sensors (Goodchild, 2007). The most popular examples of VGI websites

created using OSS are OpenStreetMap, Flickr and Wikimapia. These services have grown in importance and significantly impacted most web GIS applications (Agrawal and Gupta, 2017). OpenStreetMap is especially popular in web GIS apps as it provides a precise and reliable basemap (Haklay and Weber, 2008).

2.3.1 Web GIS and web app architecture

In Web GIS, the client-server architecture mostly adheres to conventional network architecture. Where the web browser typically serves as a client for sending the requests, and the web server, comprised of map servers and databases, responds to the requests. The most common techniques include thin and thick client architectures (Agrawal and Gupta, 2017).

A thin client is primarily designed to communicate with a server. In contrast, a thick client implements its own features and remains mostly functional when disconnected from a server (Gunnulfsen, 2013). A combination of both is referred to as hybrid architecture.

One of the most common programming languages used in web GIS is JavaScript. It is a scripting language for rendering dynamic content to create interactive user interfaces (Nascimento et al, 2020). JavaScript is frequently linked to libraries which are applied programming packages designed for specific purposes (Edler and Vetter, 2019). Among the most popular in Web GIS are leaflet.js and turf.js. Both are open-sourced and client-sided. Leaflet supports a simple integration of maps and multimedia content (Edler and Vetter, 2019), whereas turf is primarily used to expand web app capabilities in spatial analysis (Piyathamrongchai, 2018).

To assist web development, programmers often use frameworks that provide ready-made components to speed up development on the server-side. One of the most flexible such frameworks is Flask. It has the core functionality that all web applications need but allows the developer to add some of the many third-party extensions to be able to customise web applications (Grinberg, 2018).

2.4 Conclusion

In this literature review, the latest developments in the fields of LBGs and web GIS were introduced. Special attention has been paid to the role of connectivity and audio dimensions in enhancing this connectivity. The research gaps were identified

in the use of audio in LBGs as it is often used to provide information about the place but is rarely used to foster social interconnection and enhance close relationships.

Chapter 3 - Aims and Objectives

This dissertation aims to create a web application that combines the entertainment aspect of an LBG with the relationship-building possibilities of social media—producing space to showcase one's creative stories to others and a platform to search for stories and art created by others in the real-world urban environment.
Objectives:

- Create a location-based game web application using open-source JavaScript mapping libraries.
- Enable participants to add independently created location-based stories to a database.
- Use the Python Flask framework to deploy a web application on the web.
- Make the LBG adaptable in different cities around the world.

Chapter 4 - Requirement specification

4.1 Identification of the problem

The problem being addressed is the lack of personalisation in most of the current LBGs and the fact that the combination of LBG's outdoor entertainment and social media's relationship-building possibilities is rare (Galloway, 2018).

To address this issue, a location-based story-sharing web application is designed to increase users' sensory engagement with the place by discovering and creating personal stories that happened in the city where the users live.

This web app means to be a platform for creativity, exploration, and connection-building based on real memories of real people in real locations. As outlined in the literature review, it will address the connectivity and sedentary issues of the modern way of life and target LBG's topics most appealing to the questionnaire participants.

Many LBGs that use audio dimension typically have a "follow-the-path" design, resulting in an experience comparable to self-guided tours (Dionisio et al, 2017). These LBGs often concentrate on exploring the history of cities, which can be broad and complicated. While there is a demand for touring apps (Spallazzo and Mariani, 2018), the questionnaire results suggest that a group of people are interested in personalised experiences and do not want to listen to something they find irrelevant (figure 11). This pattern of personalisation of individual experiences has been emerging throughout the 21st century and has been exploited by social media platforms to satisfy individuals' needs (Zuboff, 2019). The author believes that this demand for personalisation can be successfully used in LBG.

4.2 Questionnaire results

A questionnaire was created to identify various aspects useful in designing an LBG web application. The questions focused on people's perception of places, walking habits and the use of audio. There were 36 questions (Appendix), which can be divided into three blocks: place perception questions, stories questions, and game design questions.

In total, 88 young adults from at least 21 different countries participated in the questionnaire. However, only 64 actually completed it since participants had a choice

not to respond to some questions. Out of those participants that provided answers, fifty-four grew up in a different hometown from the city where they currently reside, and only nine remained in their hometown (figure 4). Although on a small scale, this proves the human mobility trend mentioned in the literature. Those participants that moved to a new city currently reside primarily in Manchester, Beijing, and Rome.

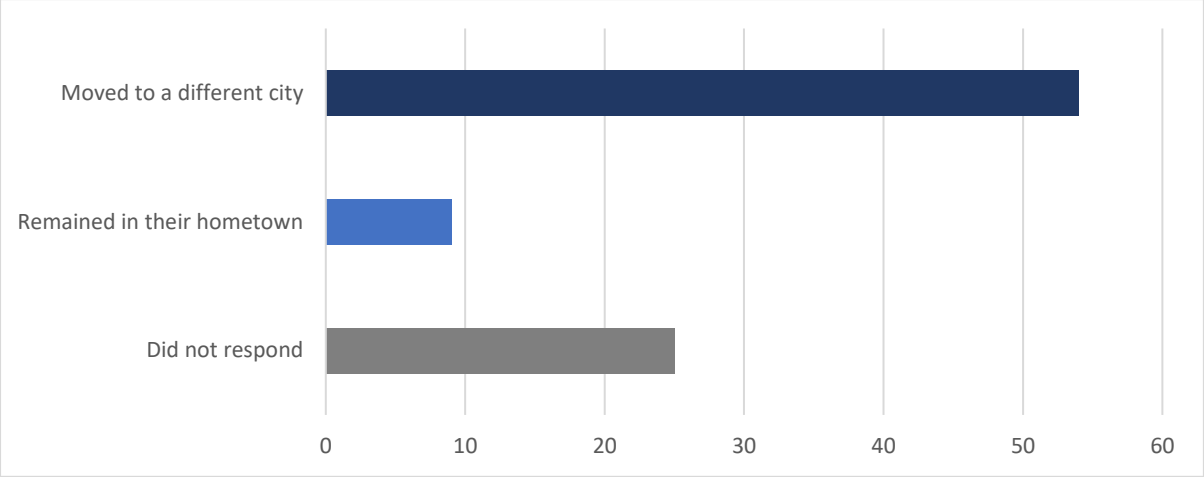

Figure 4 Number of participants that currently reside not in their hometown.

Several questions were about stories that are either related or not related to the participant's life. These questions were designed to highlight the difference between stories related to one's life and those not related, as well as between stories from one's hometown and the city where a person currently lives. As was anticipated, people generally remember stories from places where they lived well (figure 5).

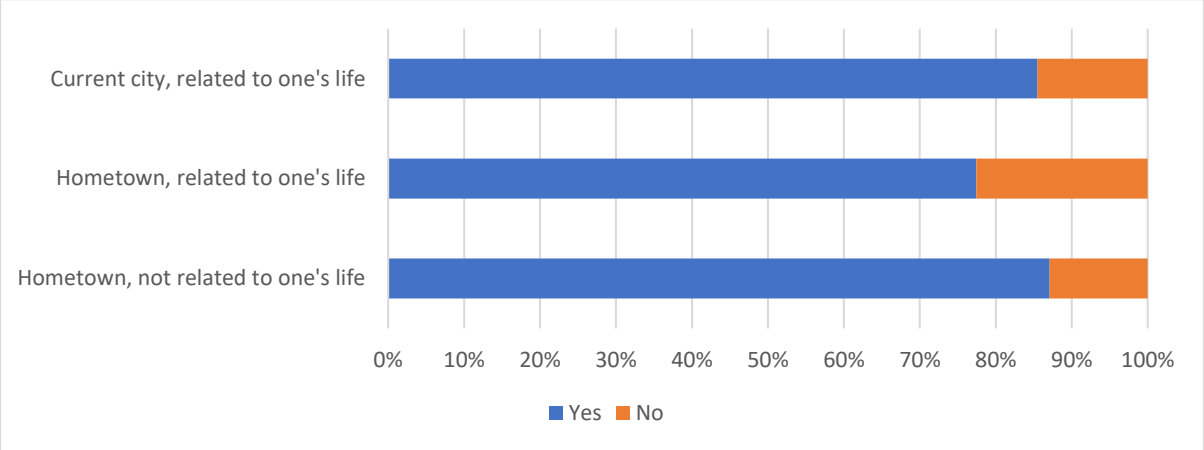

Figure 5 Can you tell a story to a stranger about some *buildings/establishments/places* that *are not directly related / that are related* to your own life?

People tend to remember the exact location where something happened to them or related to a memorable hometown event (figure 6). This is important as it allows us to link a virtually created story to a specific physical location.

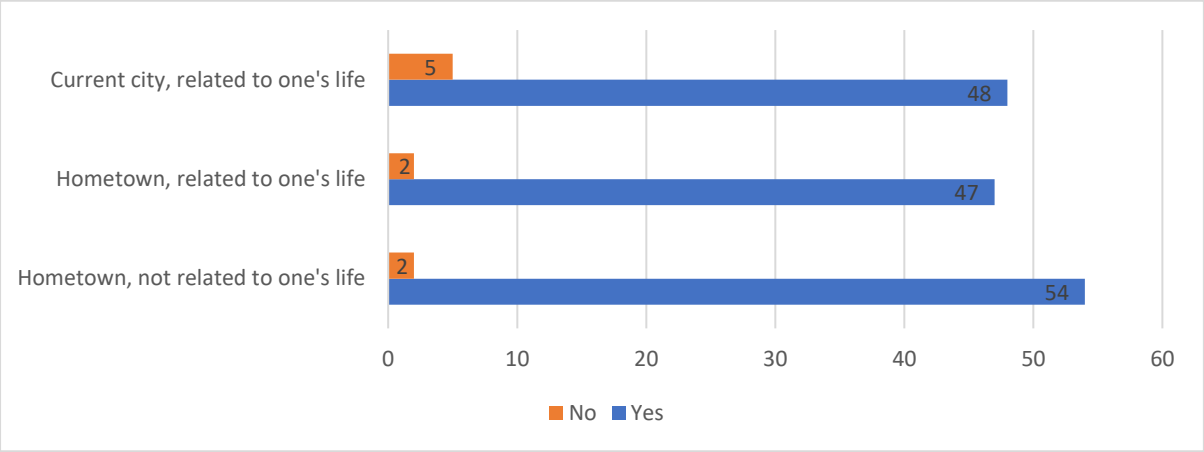

Figure 6 Number of participants that can show an exact location related to a personal story on Google Maps.

Answers related to a personal perception of memorable stories were unexpected. On a scale of 0 to 100, many participants did not rate their stories highly. Nevertheless, most people do believe their stories to be interesting.

As was anticipated, most participants agree that various stories influence their perception of the place, proving the point discussed in the literature (Martínez, 2020). (figure 7)

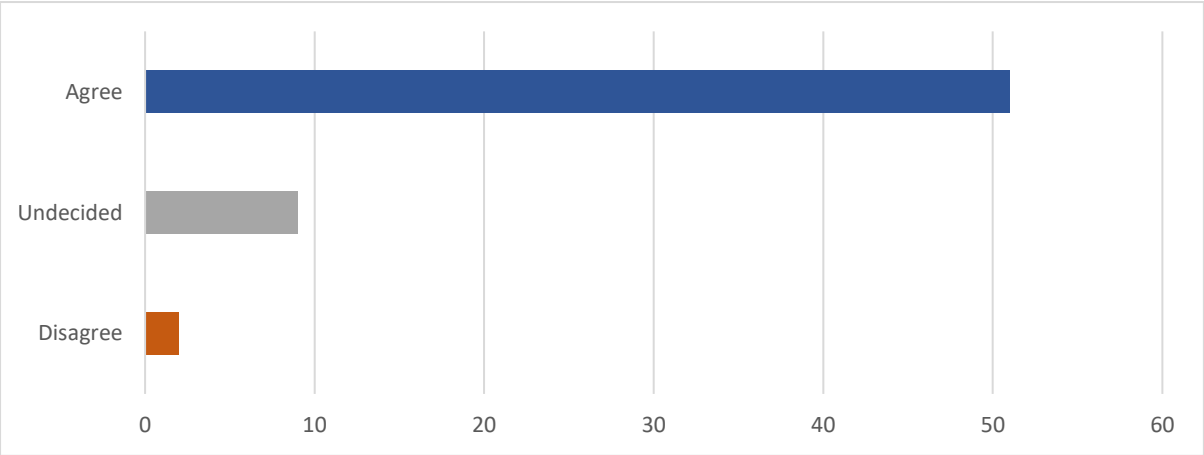

Figure 7 Stories influence perception of the place.

Another essential piece of information that was directly used in the design of the web application was the most interesting story topic. As was expected, most participants chose personal stories of friends as the most appealing. Art and crime

stories were also rated highly, unlike football stories, in which most participants seem to be least interested (figure 8).

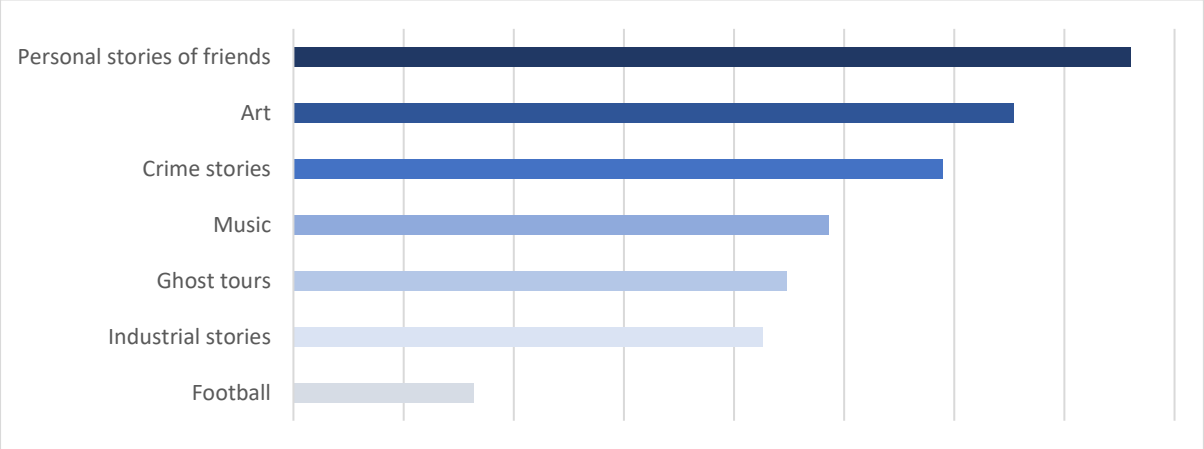

Figure 8 Story topics rated from the most interesting to the least.

100 % of participants are convinced that walking more benefits their health and that having some goal increases their chances of going for a walk (figure 9).

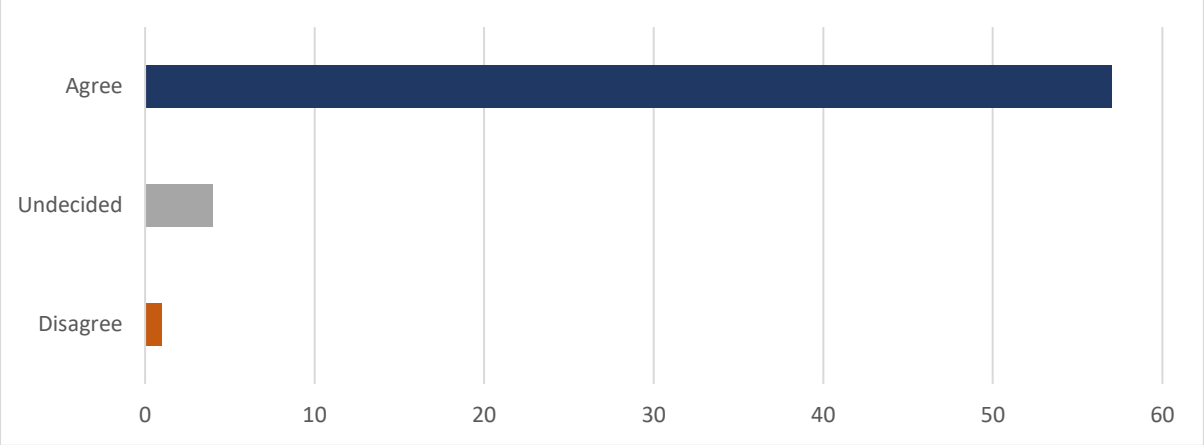

Figure 9 Having a goal increases the chances of going for a walk.

Most participants tend to use navigation tools whether they walk, and, interestingly, most claim to explore cities on their own (figure 10) frequently. This makes the use of LBG more likely.

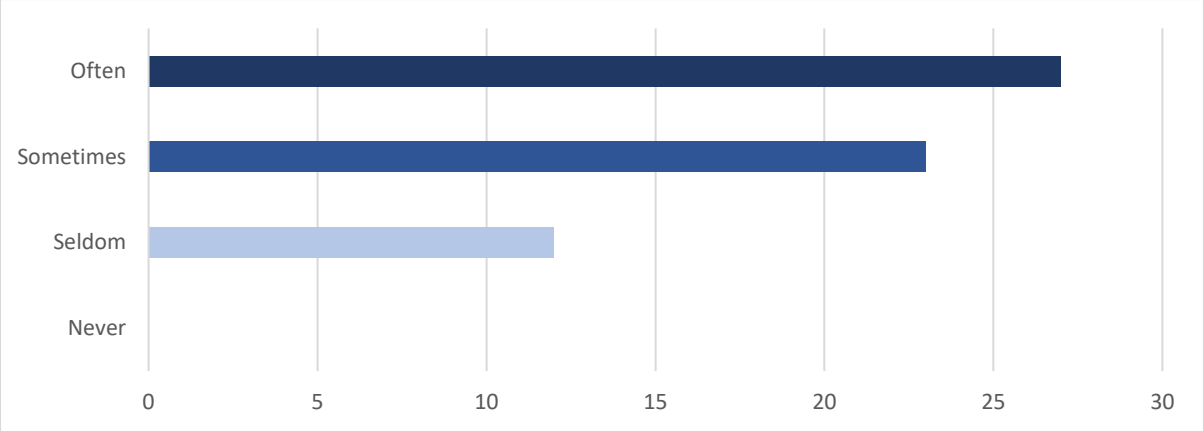

Figure 10 How often do you explore cities you travel to on your own?

Most of the participants have joined walking tours, and the questionnaire results indicate that a group of people does not find typical walking tour information relevant (figure 11).

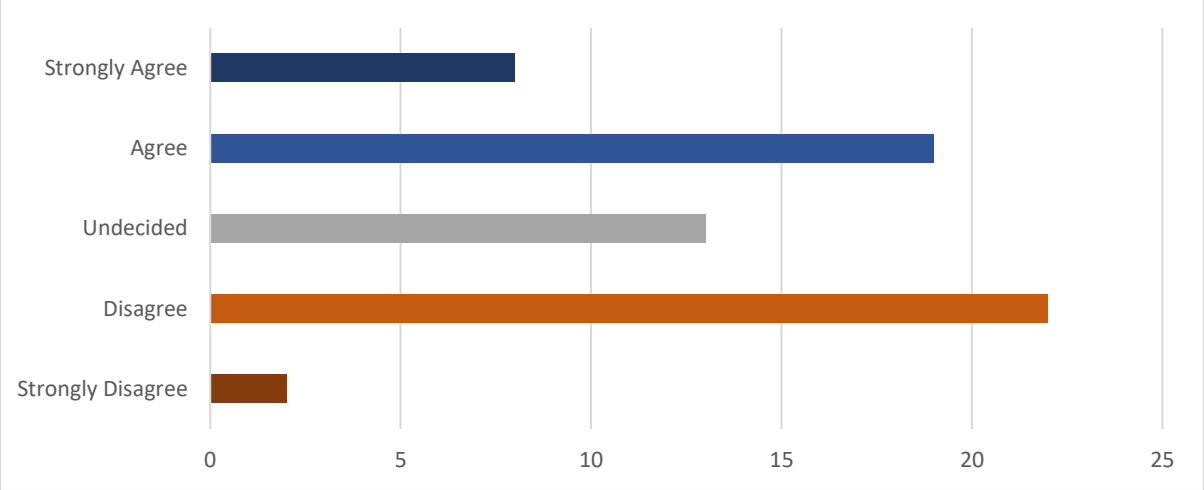

Figure 11 Walking tours often have too much irrelevant information.

In a block of questions related to web app design, people preferred to receive hints as visual popups rather than short audio messages (figure 12). However, when it comes to the story itself, most participants prefer to listen to it on a device.

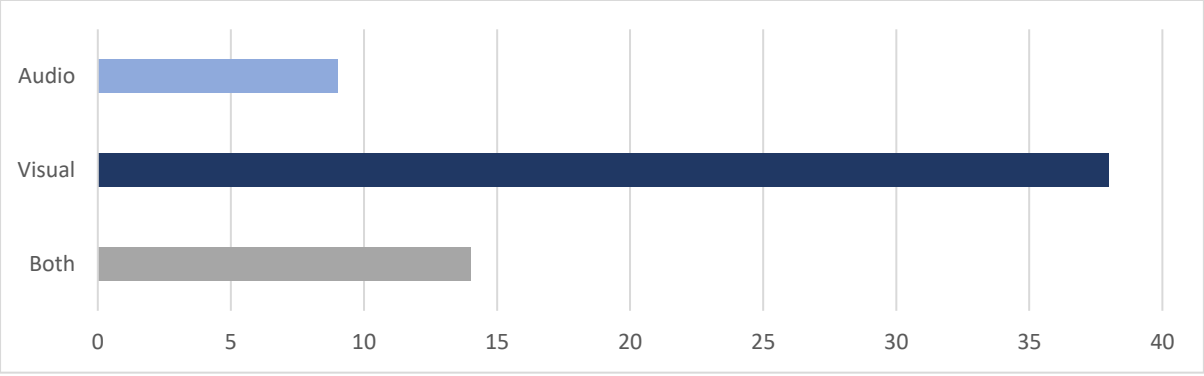

Figure 12 LBG hints popup preference.

As for the length of a story, most people agreed that it should not be long, with an average time provided being 3.2 minutes. As for the distance that participants are willing to walk while playing the game, the average answer was above 5 kilometres, which is ambitious considering that the typical Brit walks less than 3 kilometres a day (Caba, 2021). This is interesting as there is an apparent mismatch in people's perception of time between a digital activity (listening to a story) and a physical activity (walking).

Finally, for half of the participants, it is either not important that the story is historically accurate, or they think it depends on a story (figure 13).

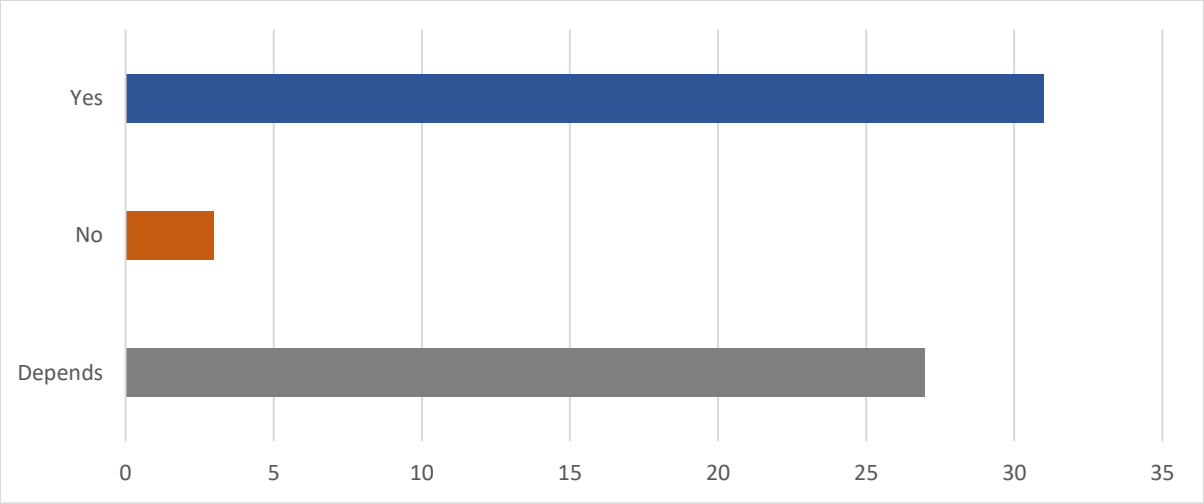

Figure 13 Importance of historical accuracy.

4.3 Application requirements

Table 1 Web application requirements.

Requirement	Source identified from	How the problem is addressed	Importance
Playable through mobile browser	Literature	The interface is designed with mobile devices in mind.	High
Ability to upload multimedia files to a database	Questionnaire / Literature	The backend functionality ensures that multimedia files can be stored in the database.	High

Game hints as visual pop-ups	Questionnaire	Once a user enters a geofence, the hint appears on the screen.	High
‘Search-and-find’ game pattern	Literature	Stories/artworks are hidden within the invisible geofences that the player needs to find.	High
Supplement “FlashInvaders” native app	Literature	All 35 “surviving invaders” were hidden in the LBG, and hints are provided to help users discover these art pieces.	Medium
Easy to use interface	Literature	The frontend languages are used to make the game easy to use and pleasant to look at.	Medium
Appealing to the people of Manchester	Questionnaire / Literature	Local street art and stories that happened in Manchester are added to LBG.	Medium
Ability to search for hidden stories	Questionnaire / Literature	All stories are hidden, but the user has an option to uncover any story using a story-specific search bar.	Medium
Promote walking	Questionnaire / Literature	Ensure that the most convenient way to discover hidden stories is by walking. Show the distance walked.	Medium
Use of visual and auditory senses	Questionnaire	Two gaming modes appeal to different senses.	Medium
Restrain the area of LBG to the town centre	Questionnaire	Added an additional layer that covers all the areas where something can be found within the LBG.	Low

Chapter 5 - Detailed Solution design

5.1 Conceptual design

The web app has been called 'Manc Stories' as it is centred around the city of Manchester at this stage of development. However, the game was designed with scalability in mind, and two other cities (Ternopil, Ukraine and Beijing, China) were also added to the game. The app was inspired by 'FlashInvaders' (FlashInvaders, 2022) and 'Inside Outside Battery' (Galloway, 2018). This is reflected in the attempt to supplement 'FlashInvaders' by hiding artworks on a map and in the use of pre-recorded personal stories in a similar fashion as historical stories were used in 'Inside Outside Battery'.

Conceptually, the game is divided into three parts: "Home", "Play", and "Create" (figure 14). The "Home" page includes:

- A brief introduction of two different parts of the web app.
- A detailed explanation of the rules.
- Some general instructions.
- Useful links.

The user can always return to the "Home" page using the navigation bar at the top or a button in a collapsible sidebar.

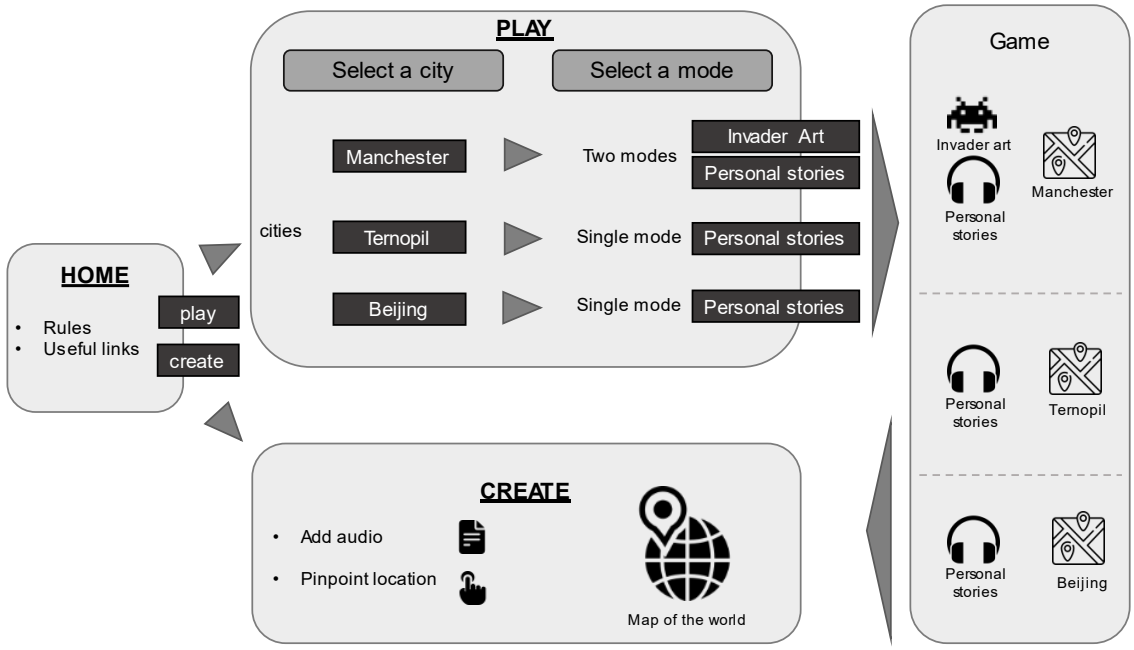

Figure 14 Conceptual design of "Manc Stories".

The "Play" page gives the user a choice between three different cities. After the user selects a city, she is forwarded to a page where two different modes of the game are explained: "Invader Art" and "Personal Stories" (figure 15c). These modes represent different topics, as discussed in chapter 4 (figure 8). "Invader Art" allows the user to explore central Manchester and do "art-hunting", looking for little mosaics on buildings and bridges. It supplements the 'FlashInvaders' app, improving players' chances of discovering those art pieces that still exist in Manchester as of August 2022. This mode is only available for Manchester as there are no 'space invaders' in Ternopil and Beijing. "Personal Stories", on the other hand, allows the user to explore the city from their friends' perspectives, looking for hidden personal stories. Both modes are based on tracking the user's location to detect when a player enters a geofence. Once inside, a visual hint appears as a pop-up providing the information of where a 'space invader' or a story is located.

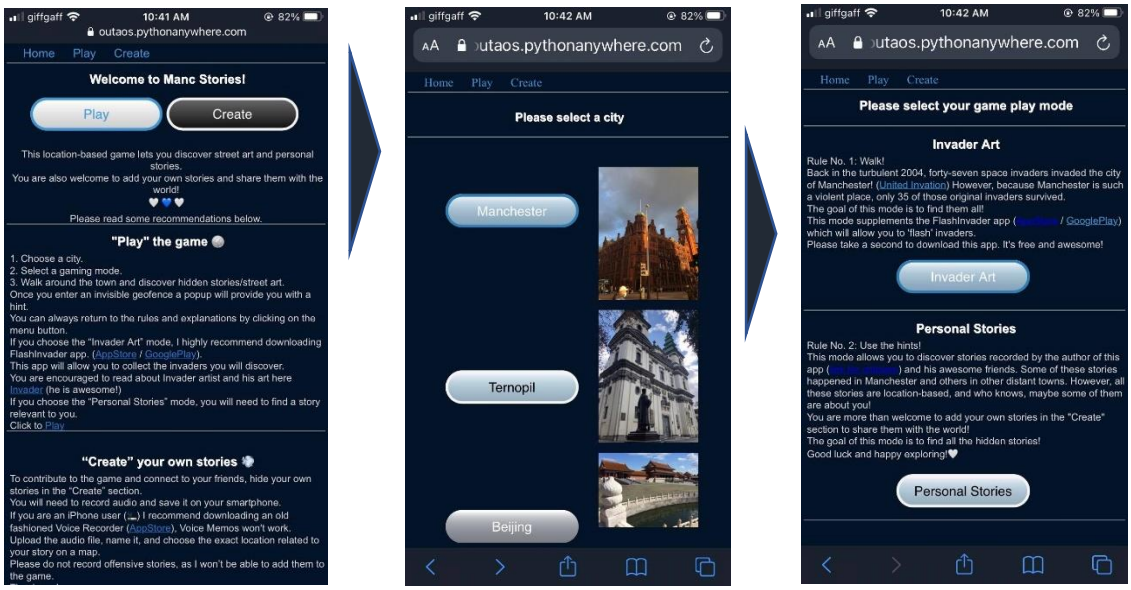

Figure 15 Structure of the app. A) "Home", B) "Play", C) " Play-Manchester".

Both modes include a map that helps players navigate in virtual and physical environments (figure 16). "Personal Stories" mode has a shadow layer that shows an extent of the area with hidden stories. When players discover all the hidden artworks or stories, they are invited to create their own.

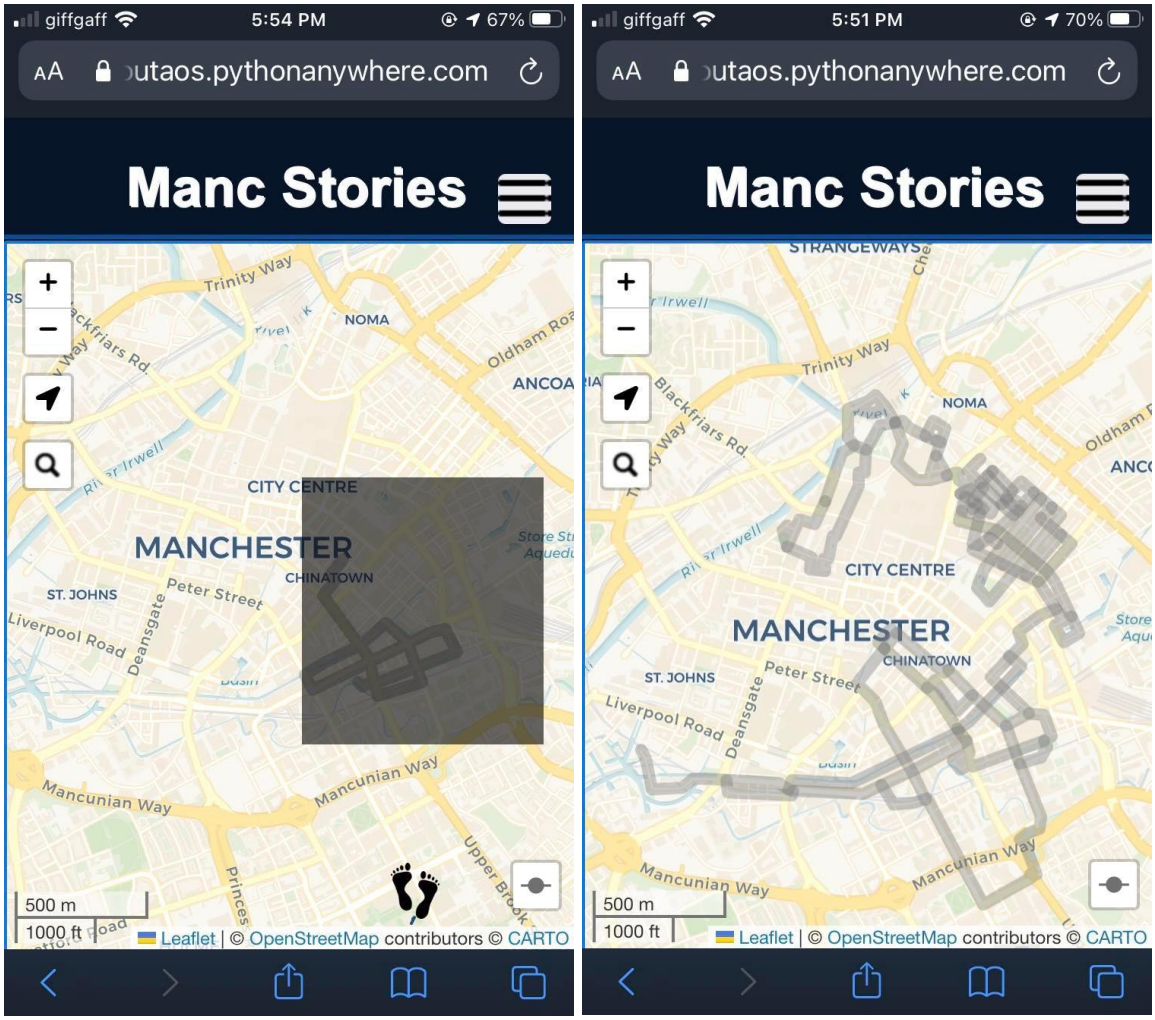

Figure 16 Game page for A) " Personal Stories " and B) "Invader Art" modes.

On the top-right side of the screen, there is a collapsible sidebar, and it can be expanded at any time by clicking on the menu button. The sidebar contains the count of discovered stories/invaders, the distance walked by a player, a brief explanation of the rules, and links to external resources (figure 17). All this information can be helpful while playing the game. A legend and a search bar are also available and can be used if a player needs additional hints.

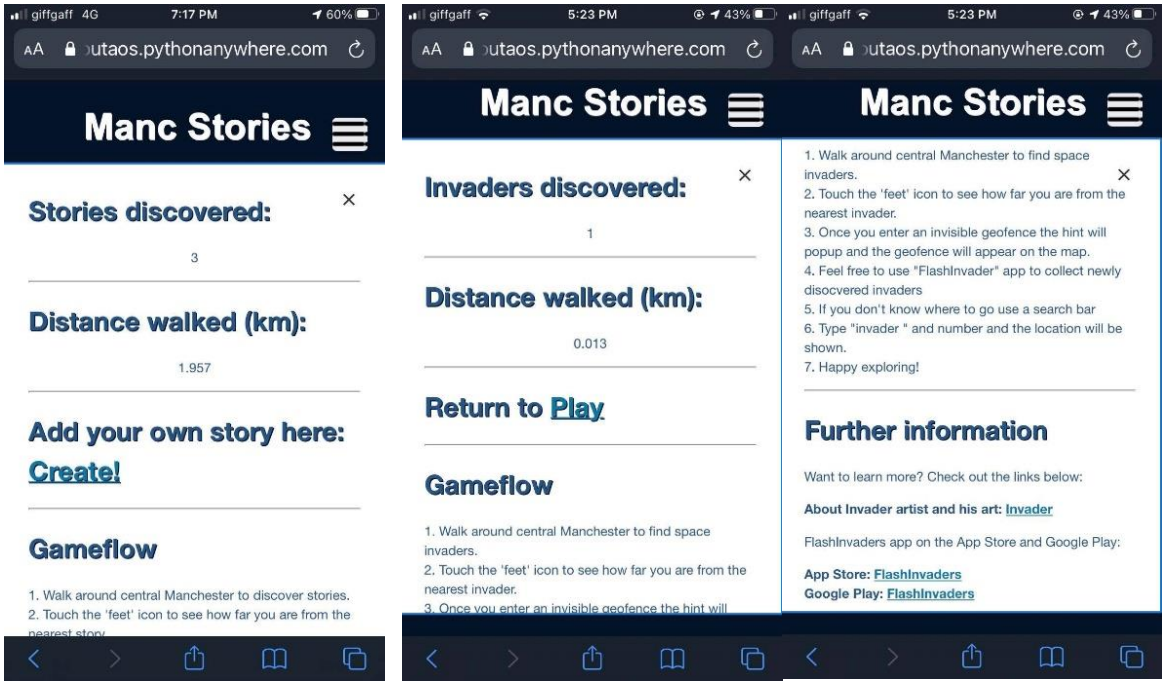

Figure 17 Sidebar content for a) "Personal stories" and b) "Invader Art".

The final part of the web app is "Create". It forms a separate page and can be accessed through the navigation bar or a sidebar button. "Create" is not a part of the game and is there so users can add their original content. Specifically, it allows the user to upload an audio file with a pre-recorded story, name this story, and pinpoint its coordinates on the map (figure 18). Once submitted, this data is stored in a database and, if its content is not offensive, can be added to an LBG by the administrator.

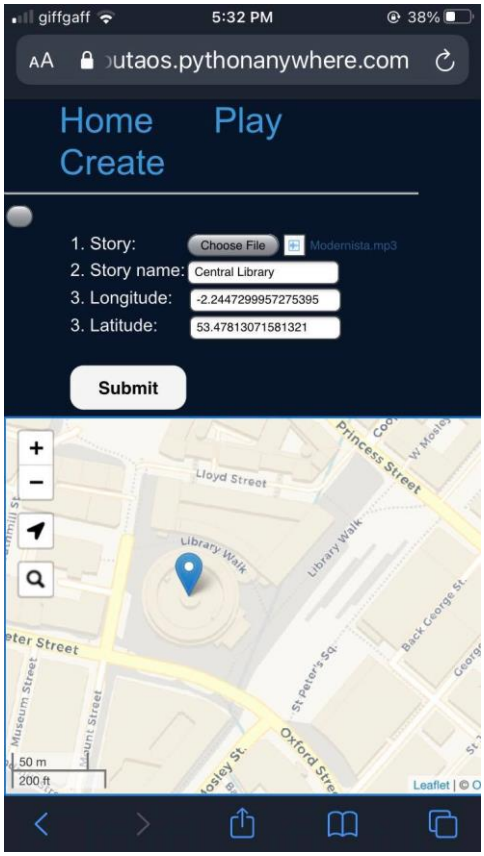

Figure 18 "Create" page.

It was decided not to add stories to the "Invader Art" mode to make the experience more visual. However, audio stories can be easily added in the future. The purpose of this mode is to improve the 'FlashInvaders' app, as, although this LBG is popular, it does not show the locations of invader mosaics and does not provide any hints. As a result, numerous poor-quality invader maps of Manchester and other cities popped up online. However, they are unreliable and difficult to use (Prénom, 2016). Only one available app helps find invader mosaics, but it is restricted to Paris, is not free, and does not offer any interactivity (ParisInvadersMap, 2022).

The "Personal Stories" mode combined with the "Create" functionality seeks to integrate the LBG's entertainment with social media's possibilities. Once the user uploads the original content through the "Create" page, it is reviewed and added to "Personal Stories". All stories created by the user will have unique names, and by sharing the web application, the user can share them with friends and family members.

5.2 Game architecture

There are features common to all LBGs (Lehmann, 2012). These include the following:

- The game is played on a device in motion.
- The game dynamics change based on the user's location.
- Some form of navigation is incorporated into LBG (Andone et al, 2017).
- The game encourages users to move around physically (Laato et al, 2020).

All the above features were used in the design of "Manc Stories", alongside the ability to add audio files and listen to their content.

A web application design was chosen for LBG, as web apps run in-browser, can be accessed on multiple devices, and can be mobile-friendly (Li, 2014). Unlike mobile apps, the web app allows for dynamic and quick updates. Once the changes are pushed to the web server, they become immediately available to the users (Gupta, 2020). Finally, web apps do not require App Store or Google Play approval and can be deployed quickly with the help of web hosting services, such as PythonAnywhere or Heroku (Amunategui and Roopaei, 2018).

As is typical for web applications (Li, 2014), "Manc Stories" is multilingual, which means that two primary components of the game, a server-side backend and a client-side frontend, are implemented in different programming languages.

A client-side was built with the help of three languages: HTML (HyperText Markup Language), CSS (Cascading Style Sheets), and JavaScript. These languages supplement one another and are common in standard web development (figure 19). HTML is a programming language that controls the structure and content of a web page, CSS controls the look and feel of a web page, and JavaScript allows to implementation of complex features on web pages adding dynamic and interactive web content (Swift et al, 2019). Two open-source JavaScript libraries were used to improve web app functionality: Leaflet.js and Turf.js.

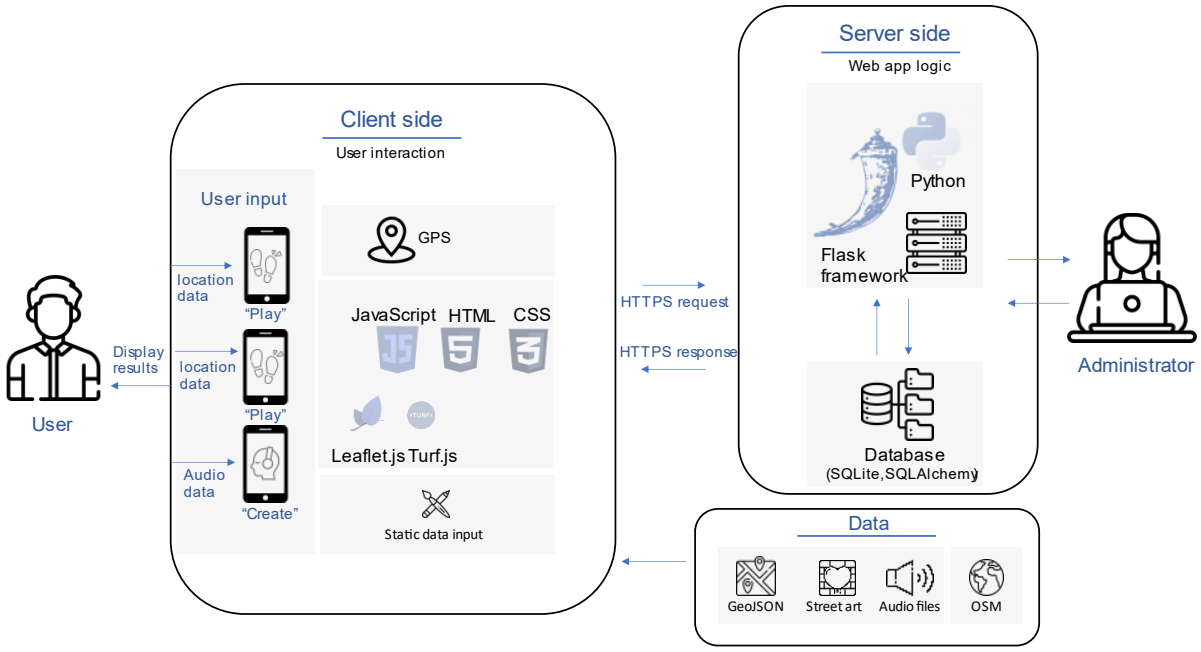

Figure 19 Detailed solution design architecture.

A server-side consists of a Python Flask framework (figure 30). Python is a general-purpose programming language with an extensive collection of standard libraries which allow for simple and short code (Vyshnavi and Malik, 2019). Flask is a web framework written in Python that does not require any particular tools or libraries and has an inbuilt database (Singh et al, 2019). The main advantages of Flask are that it makes web development and testing efficient and straightforward with minimal coding and a lot of open resources to learn from (Grinberg, 2018). Flask uses the Jinjia2 template engine, which supports template inheritance, meaning that one template can inherit from another (figure 20). This allows not to repeat the same code and, consequently, saves time and reduces work (Jinja, 2022).

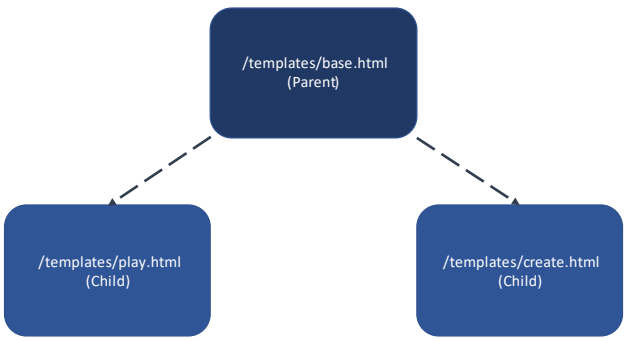

Figure 20 Structure of Template Inheritance.

The database design and interface were implemented in Python using Flask-SQLAlchemy (figure 30). SQLAlchemy is a Python SQL toolkit and Object Relational Mapper (ORM) that allows using SQL for database operations (Fredstam and Johansson, 2019). SQLAlchemy abstracts database connections and provides connection maintenance automatically (SQLAlchemy, 2022). This makes SQLAlchemy a convenient package for loading and querying databases. Flask-SQLAlchemy is just a special extension of the toolkit for Flask, which provides valuable defaults and extra helpers for everyday tasks (Flask-SQLAlchemy, 2022).

SQLAlchemy was used with SQLite database management system (DBMS). DBMS is software that uses database models and allows creating and managing databases to store and organise data electronically (Elmasri and Navathe, 2011).

Finally, the data side includes graffiti-like mosaics, GeoJSON street grids, stories, and OSM map tiles (leaflet-extras, 2022). All the invader images used were either collected by the author or downloaded from FlashInvaders. All these images are freely available and intend to popularise street art (space-invader, 2022). The icons used in the web app were downloaded from the flaticon website and are also free for non-commercial purposes (Flaticon). The author created the audio stories used.

Chapter 6 - Implementation

As discussed in chapter 5, a client-side was built with the help of HTML, CSS, and JavaScript. Two JavaScript libraries, Leaflet and Turf, were used to make the code simpler. Leaflet was used because it allows the creation of professional interactive web maps with high performance (Edler and Vetter, 2019). Turf was used because it takes advantage of proficient algorithms, which saves processing time (Timothy, 2019). The use of these libraries allowed to satisfy one of the fundamental requirements of the game – interactivity.

The web app was constructed and deployed using the Python Flask framework. This allowed satisfying another crucial requirement – the ability to save and utilise user-created content.

The code for two modes of the LBG in the "Play" section was built at the frontend and is mostly identical, apart from the data used and some minor differences. The code for the "Create" part was created at the frontend and the backend.

The functional structure was used to organise the application into several distinct components (figure 21). This structure sorts out the pieces of the app by what they do (Explore Flask, 2014). The routes were stored in the main.py file, and the templates and static files served on those routes have been added to separate folders.

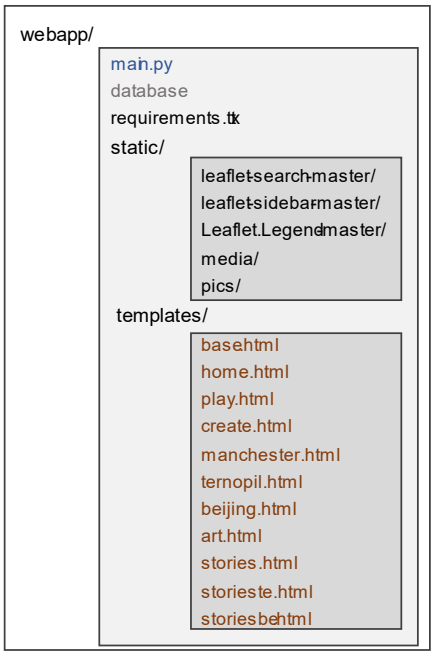

Figure 21 Project folder structure.

6.1 Geolocation

To make the LBG work, tracking the user's location during the game was necessary. This was achieved by the Leaflet function that uses the Geolocation API to track the user's location (Leaflet, 2022a). (figure 22)

```
map.locate({setView: false, maxZoom: 16, watch: true, enableHighAccuracy: true});
```

Figure 22 Leaflet Geolocation function.

If the geolocation is successful, a "locationfound" event is fired. Otherwise, a "locationerror" event occurs. To continuously track location changes and update the location when the user moves, the 'watch' option should be set to 'true'.

For privacy reasons, the user is asked for permission to report location information. In most modern browsers, this information is available only in secure contexts (HTTPS), meaning that the geolocation will be blocked if the application-layer protocol is HTTP.

To allow the user to follow her track visually (figure 23), I pushed updated user location coordinates into an array and connected them with lines. This was done with Turf's lineString() function. Next, I simplified it with Turf's simplify() function to avoid unnecessary processing of very close coordinate pairs.

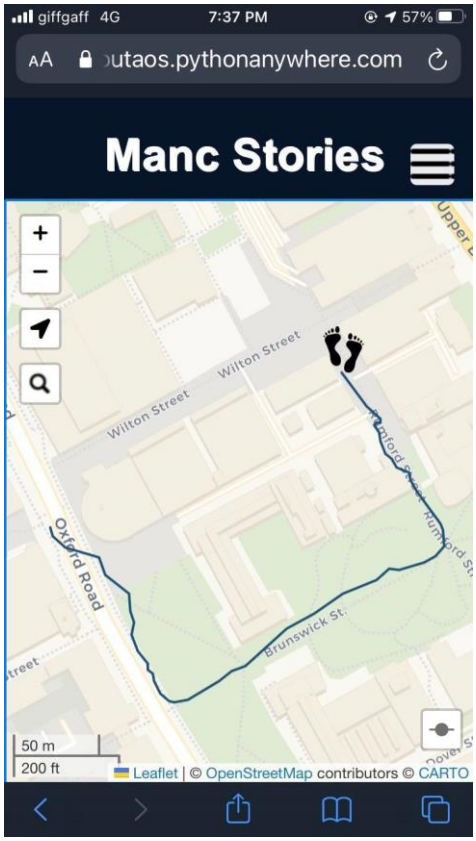

Figure 23 User track on a map.

6.2 Geofences

Another key feature of the game is geofences. Geofence is a virtual boundary set around a real-world geographical location that typically uses a GPS to define geographical boundaries (Rahate and Shaikh, 2016). A pre-programmed action is triggered when a user enters or exits this boundary.

In "Manc Stories" geofences were used in two modes of the game. In the "Invader Art" mode 70 circular buffers were created around every location where an invader mosaic can be found in Manchester. In the "Personal Stories" mode 32 buffers were created around story locations in three different cities. In both cases, inner and outer circular buffers were created using Turf's buffer() function. It takes the coordinates of the circle's centre, desired radius in specified units, and "steps", which represent the distance between vertices of the circle's circumference (Turf, 2022).

The outer geofences were designed to provide users with simple general hints, such as the name of the street where an invader or a story is located. This hint is opened as a popup when the user enters a buffer 50 meters in radius (figure 25b).

Inner geofences notify the user when she is within 10 meters of a point of interest. This information is also provided in the form of a leaflet popup (Leaflet, 2022b). Once the inner geofence is activated, a little icon of the invader or a story appears in the exact location where it is hidden (figure 25b).

Figure 24 Outer buffer popup.

Popups were added based on the bindPopup() method and were activated using openPopup() method. Popups were used as tools to guide the map user to a specific location (Edler and Vetter, 2019).

At the beginning of the game all geofences are invisible, but when a player crosses the buffer boundary the geofence becomes coloured and appears on a map (figure 25).

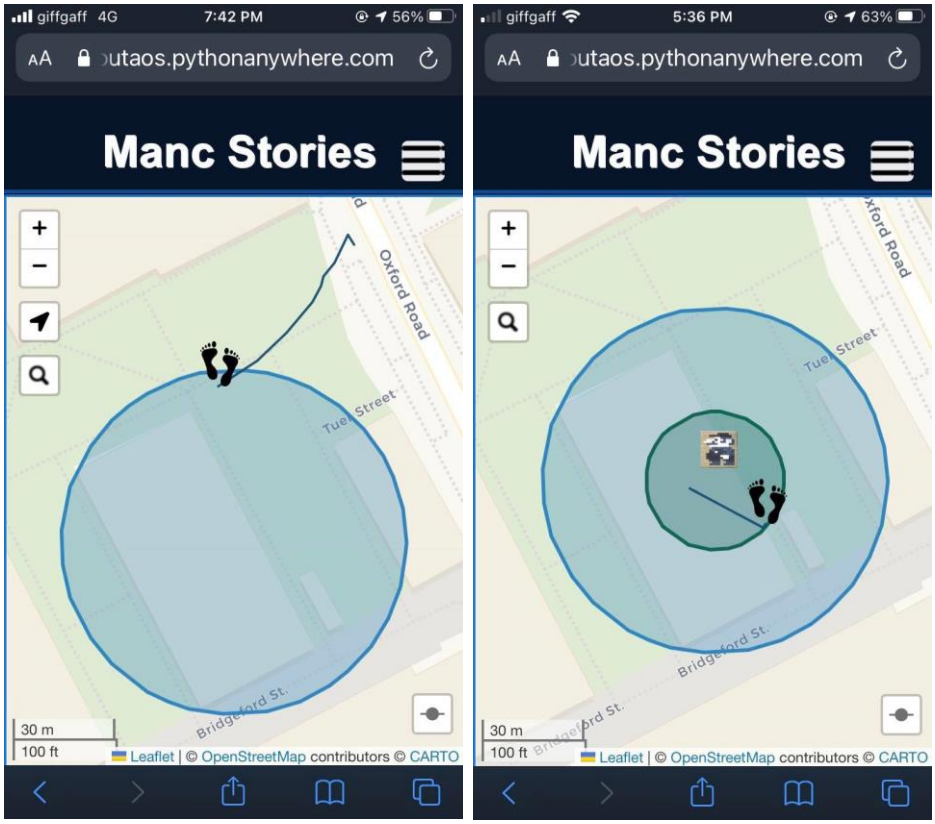

Figure 25 A map after entering (a) outer and (b) inner geofence.

A flag variable was used to avoid the constant opening of the same popups when a player is located within a geofence. A flag variable is a boolean that has one value until some condition is met. It allows checking for certain conditions while the function is executing (Ferguson, 2019).

Two global flag variables were created to account for inner and outer buffers. Once the user enters a buffer, the flag variable is updated to 'true' and Leaflet popup function is executed. If the user leaves the buffer, the flag updates to 'false', changing back to 'true' if the user enters the same buffer again.

6.3 Geospatial operations

As the player moves, the geospatial data produced by this movement is analysed, and then presented to the user on a sidebar or in the form of a popup.

The nearestPoint() function was used to find the nearest story/invader to the user's current location (Turf, 2022). Once the closest point is detected, a distance to this point is calculated and presented as a time to the nearest invader/story (figure 26). This calculation is geodesic, meaning that it accounts for the curvature of the Earth (Rahate and Shaikh, 2016). The issues associated with this method of

distance calculations are discussed in the limitations. However, it is worth noting that for the purposes of this LBG, the exact distance is not essential.

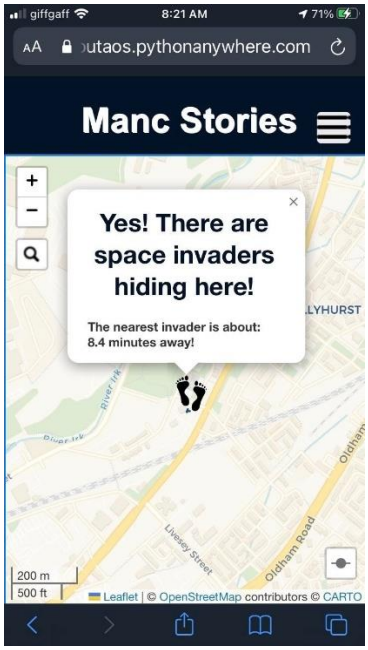

Figure 26 Time to the nearest point.

The length of the user track is calculated using Turf.lineDistance() function. The result updates as the user moves and can be checked on the collapsible sidebar (figure 17).

The stories/invaders that the user has discovered are also counted. This was achieved by a function that adds a point to a variable every time the inner geofence is entered. It is hoped that the ability to see one's results will encourage players to continue the game (Sutton and Barto, 2018).

6.4 Audiovisual web mapping

Audio files, in the form of language recordings, were added to the "Personal Stories" mode. For this purpose, Leaflet was used, which allows for a simple way of adding multimedia content to a web mapping application (Edler and Vetter, 2019). As a player enters the inner geofence, a music icon appears in the story's location. This icon is a simple L.marker, and by clicking on it, a popup window opens up, which is bound to this marker (figure 27). The audio content is built in using the HTML <iframe> element that supports mp3, wav, and ogg formats (Edler and Vetter, 2019).

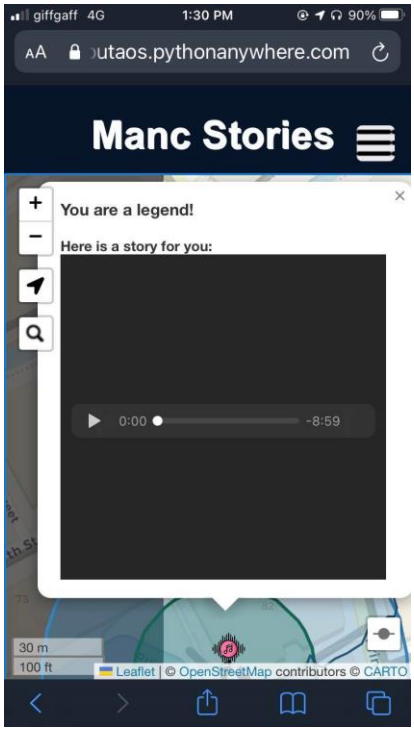

Figure 27 Audio popup.

6.5 Leaflet controls

Search functionality was added to the web app. For the "Create" section, a general address search was added to allow users to quickly find any city around the world. However, for the game itself, a Leaflet Control search for a specific marker location was coded (Cudini, 2022). This Leaflet plugin allows searching only for specific locations which are predefined in the source data. For this purpose, an array of JavaScript objects was created to hold the coordinates and unique names of all the invaders and stories. Once a player types the name of the invader/story in a search bar its location is highlighted on a map (figure 28). All names are listed in the legend in the bottom right corner of the map.

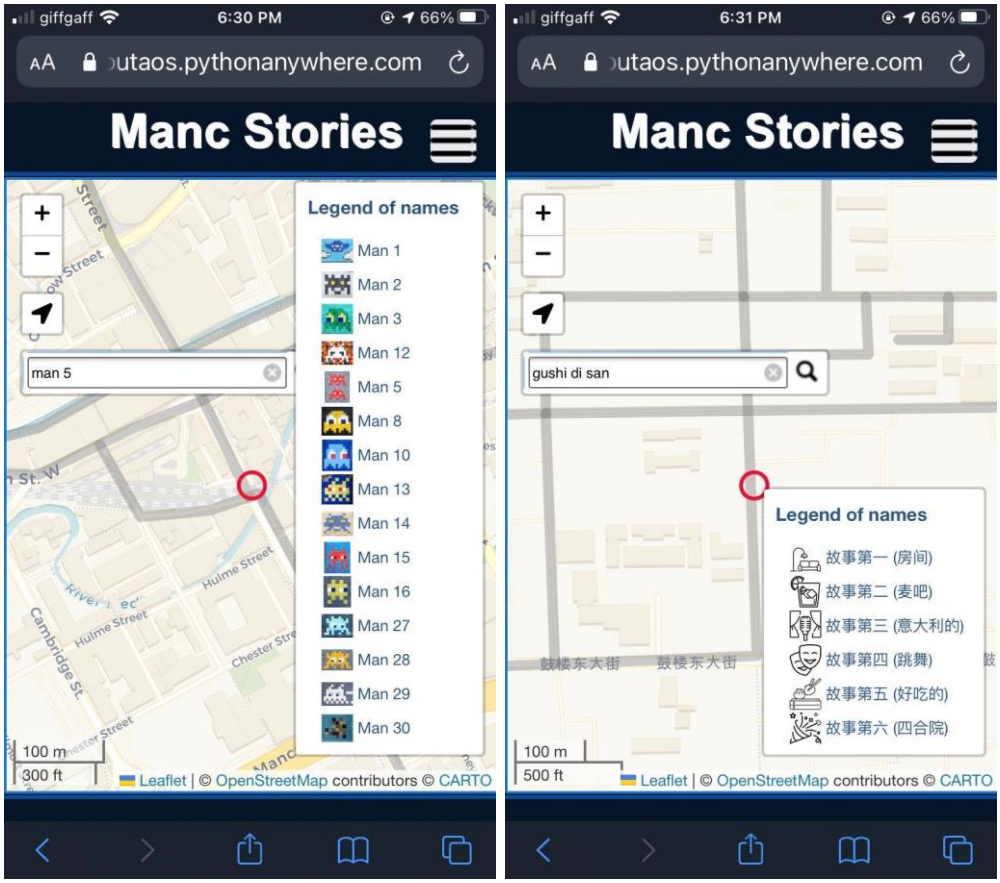

Figure 28 Leaflet Control search for A) Manchester invaders and B) Beijing stories.

In addition, a leaflet geolocate control was added to allow players quickly discover their current location.

6.6 Grid layer

To make the game more challenging, the grid layer was added to the "Personal Stories" mode. Turf squareGrid() function was used that creates a square grid from a bounding box (Turf, 2022). The square grid coloured in a darker tone covers the area of central Manchester where stories can be found. Once a player enters any square of the grid, this square becomes transparent. In this way, the player can visually see an explored area (figure 16a).

6.7 Leaflet markers

To allow the user to provide coordinate information to a personal story a leaflet marker was used. It allows to display clickable and removable icons on the map, update longitude and latitude information, and with the help of Flask send this data to the database once the user submits it (figure 29).

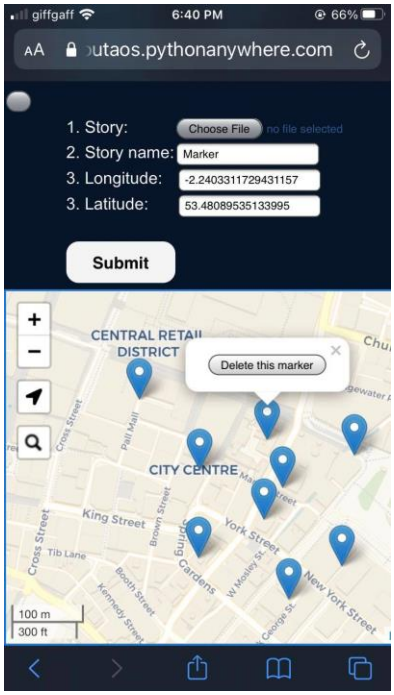

Figure 29 Leaflet markers.

6.8 Flask application

Flask is a trendy Python-based web framework which was mainly used for server-side processing (Villalon, 2018). Flask is often referred to as a micro-framework because of its flexibility and because it implements a bare-minimum web server (Vogel et al, 2017). A simple Flask "Hello World" web service, for instance, can be created in just a few lines of Python code (Flask, 2022).

The primary function of Flask was to receive HTTP requests from client-side, interpret them and figure out what response to send back to the user (figure 30) (Villalon, 2018).

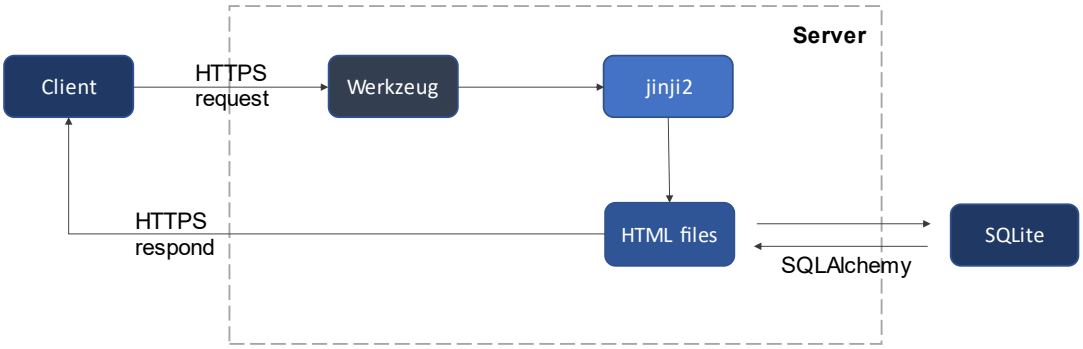

Figure 30 Webpage response under the Flask framework (Liang et al, 2021).

6.8.1 Flask routes

An example below allows for the creation of a simple web application. Line 2 creates an instance of the web application where a special variable "__name__" refers to a current python file, and line 3 defines the default route (figure 31).

```
1. from flask import Flask
2. app = Flask(__name__)
3. @app.route("/")
4. def hello():
5.     return "Hello World!"
```

Figure 31 Basic web application in Flaks.

All routes created for "Manc Stories" are connected to relevant HTML files, except for one which the administrator can use for downloading media files from the database. To add a new route, the route() function with the desired path is called, and then a view function is created for it (Grinberg, 2018). Flask looks for HTML files in a special folder called "templates". The main python file should always be located outside the templates folder. An example below takes the inputs on a specified web page and displays the route on the same web page (figure 32).

```python
@app.route('/home')
def home():
    return render_template('./home.html')

@app.route('/play')
def play():
    return render_template('./play.html')
```

Figure 32 Flask routes.

A navigation menu was created to connect different pages, and the url_for() function was used. This function enables access to different URLs, such as those of the HTML files, inside the Flask application (figure 33).

```
<a href="{{ url_for('home') }}">Home</a>
```

Figure 33 url_for() function.

6.8.2 Flask-SQLAlchemy

Flask-SQLAlchemy was used with the SQLite database to add media content to the database. SQLite was chosen as it is the most widely deployed database in the world. In addition, SQLite is serverless and lightweight in terms of setup, database administration, and required resources (SQLite, 2022).

The Flask-SQLAlchemy helps to handle a database connection across the app, and this database connection, model, and app are all located within the main.py file.

Only one model was created for one table to store media files, data type, file names, and file coordinate information. To upload an mp3 file, an "anctype" was specified as "multipart/form-data" in the "create" template. Once the user attaches the file, names it, pinpoints related location, and submits it the data is sent to the database (figure 34).

	id	filename	data	story	lng	lat
	Filter	Filter	Filter	Filter	Filter	Filter
17	17	Dragon_2.mp3	BLOB	Dragon 2	-2.24417209625244	53.4817891903392
18	18	Kempinski_2.mp3	BLOB	Hotel 2	-2.24530935287476	53.4817381143322
19	19	Frog_2.mp3	BLOB	Frog 2	-2.24530935287476	53.4817381143322
20	20	Natalie_2.mp3	BLOB	Natalie 2	-2.2433352470398	53.4821594895505
21	21	Shy_guy_2.mp3	BLOB	Shy guy 2	-2.24530935287476	53.4817381143322
22	22	Choir.mp3	BLOB	Choir	-2.24391460418701	53.4819679558792
23	23	Hutong apartment.mp3	BLOB	Hutong flat	-2.24526643753052	53.4817636523434
24	24	Kostel .mp3	BLOB	Kostel	-2.24286317825317	53.4818658042343
25	25	Mai bar.mp3	BLOB	Mai bar	-2.24584579467773	53.4819679558792
26	26	Modernista.mp3	BLOB	Modernista	-2.24438667297363	53.4816742692371
27	27	MusicSchool.mp3	BLOB	MusicScool	-2.24597454071045	53.4816742692371
28	28	Nina bar.mp3	BLOB	Nina	-2.24342107772827	53.4816359621339

Figure 34 SQLite database table with uploaded stories.

To retrieve the file, a send_file() function was used. It helps to transfer the contents of a file to the client and uses the BytesIO method, which takes binary data from the database and converts it to a format Flask can use to regenerate the media file (figure 35).

```
return send_file(BytesIO(upload.data), attachment_filename=upload.filename, as_attachment=True)
```

Figure 35 Function to download a file from the database.

6.8.3 Deployment of flask application

To deploy the web app to the cloud PythonAnywhere was used which is a web hosting service (Platform as a Service) based on Python. It allows for a delivery of an application over the internet without downloads or installations (Villalon, 2018).

To host the app on PythonAnywhere, it was necessary to create an account, configure the web app, upload the code from my local machine, and configure the root file (Dillikar, 2021).

6.9 User interface

To design web app pages in simple and familiar manner, HTML and CSS were used. In accordance with Herbinski (2021), different collapsible buttons were added to make the game more interactive. These include the menu and the legend. They purposefully have different positions on the screen to separate them visually to avoid cluttering. On the map itself, different icons were used, and the effort was made so the user would intuitively associate these icons with specific functions. For example, the user location icon appears on a map as an image of two feet, which intends to encourage walking, and the icon for stories is musical notes, which are commonly associated with audio.

The game intends to be interactive and up-to-date, updating in real-time as the user moves around the city. To achieve this, popups were used, which activate and display additional information as the user enters geofences. The popup content was sized and coloured appropriately with the help of CSS.

The user interface was designed for smartphones, and some important buttons were 'fixed' with the help of CSS, which made them movable as one scrolled up and down and, thus, noticeable. The basemap used is "CartoDB.Voyager", which

consists of modified OSM tiles (OSM, 2022). The map intends to be user-friendly and excludes unnecessary information.

Chapter 7 - Testing and Evaluation

To ensure “Manc Stories” performs as anticipated, both internal and external multi-device testing (iPhone, Android) was carried out (Vilkomir et al, 2015).

Firstly, the web app was tested in the Green Quarter area of Manchester and on the campus of the University to identify bugs and ensure the LBG performs as intended. Secondly, external testing was done by eight volunteers in three different cities. Three people tested the game in Manchester, three in Ternopil, and two in Beijing. These cities were chosen because the author lived in each of them and could create personal stories related to specific locations in those cities.

7.1 Internal testing

The initial testing allowed to identify issues and bugs. Those resulted in the incorporation of the flag variable, the improvements of the user-track function and the graphical user interface. The search function was also updated, and locate control was added. The initial evaluation also influenced the decision on the size of the geofences.

In the beginning, the app was deployed on GitHub Pages, but as the server-side functionality improved, the app was moved to PythonAnywhere.

7.2 External testing

To ensure scalability, the game was tested in different cities. The volunteers were encouraged to add their own stories.

A lot of positive feedback was received. People liked the stories, physical activity, and some app functionality.

Table 2 Positive feedback.

Name	City	Comment
Luan	Manchester	“I recorded a story myself. You inspired me!”
Tom	Beijing	“It was fun! I like the concept, and it was nice to hear your stories.”
Veronika	Manchester	“Good for physical activity, the brain is focused on discovering things, and so I could walk more.”

Olia	Ternopil	“It was difficult to stop. I only stopped because it was late.”
Naz	Ternopil	“It’s fun to see my track. Even though it is not very accurate, but still good.”
Armaan	Manchester	“I liked that I could walk and listen to a story simultaneously.”

Most complaints were related to a GPS location, need to reload the web app, the fact that the information couldn’t be saved, and the battery.

Table 3 Negative feedback.

Name	City	Comment
Olenka	Ternopil	“The user track looked a bit funny sometimes. It moved when I did not.”
Veronika	Manchester	“I had to reload the game a couple of times.”
Tom	Beijing	“The app logged me out when I checked something else on my phone.”
Luan	Manchester	“It’d be cool to see all the invaders I found.”
Dough	Beijing	“Only downside of the app was it drained my battery like crazy.”

Overall, the feedback was predominantly positive. The web app passed the external evaluation, encouraging participants to walk and connecting them with friends and family through stories.

7.3 Limitations

Several limitations and issues could be resolved given more time and resources. The GPS sometimes performed poorly in areas where there were many high-rise buildings.

The distances calculated using GPS were also imperfect. This is because GPS records the user position by the temporal sampling rate (Ranacher et al, 2016). However, as the distances walked were not significant, the distortion was minimal. A more serious problem was the inability to save some user-generated data to the server. As a result, story count and distance data are lost every time the web page is reloaded.

Some functionality did not perform as intended when players did not actively use the smartphone. This caused an overreliance on the device screen during the gameplay (Huck et al, 2014).

The legend did not include the scroller, and some invaders were not visible when the player opened the legend. This caused some inconvenience as the names in the legend were tight to the names in the search bar.

The audio files were stored in the database as blob data. The more reliable solution would be to store them as a partial path to the file (URL) (Jennings, 2017); this was not done as it was buggy.

Finally, the game didn’t allow for rating the stories. This would require storing additional information on the server and was not done due to time limitations.

Chapter 8 - Conclusion

8.1 Summary

The aim of this project was to develop a multimedia location-based game web application to connect people and places through personal stories and street art. To achieve this the web app combined location-based game entertainment with social-media style story-based relationship building possibilities. The game made use of both visual and auditory senses. Open-source JavaScript libraries were used to make the game interactive and engaging. And the web app relied on the Python Flask framework to deploy the app and enable users to add independently created location-based stories. The game was made adaptable in different cities providing long-distance friends, partners, and family members with a chance to connect in an engaging, creative, and active way. Overall, “Manc Stories” achieved its objectives by encouraging users to explore their cities and share their stories.

The web app was designed to bridge the gap in an underappreciated area of LBGs. That is to ensure personalised digital communication between people during the game. The results suggest that the experience of searching for and listening to stories of close people and creating one’s own stories for them contributes to relationship-building and promotes physical activity and urban exploration.

8.2 Further development

To make “Manc Stories” more personal for the users, it would be logical to develop it into a native app, an application specifically created for a mobile operating system. Native apps have several advantages over web apps and are generally more suited for content creation due to performance, software integration, and hardware access (Jobe, 2013).

Adding user authentication to the app would be a big step forward in “Manc Stories” development. This would allow the user to make some stories visible only to selected people, resulting in a more personalised experience and encouraging users to create more personalised content. However, this will also necessitate improvements in security and personal data protection (Chandra et al, 2019). Consequently, a more robust database will be necessary to allow storing and analysing of a large dataset of multimedia files.

Additional functionality could also improve the app. For example, allowing the user to mark a certain area where the geolocation tracking is prohibited would be interesting. This would protect sensitive location information, like the specified area around the place of the user's residence or work.

Another potential improvement would be allowing users to walk in the footsteps of a cult figure that the user admires. Users could select a famous person from a list of names, and the app would generate a route related to that person's life, adding stories to locations of importance. This would require extensive data collection but could encourage users to explore their cities and create/share new content. This cult figure option could attract new users and help to shape the vast amount of information into narrated, personalised stories giving a new meaning to old places and a "new life" to forgotten people (Dourish and Gómez Cruz, 2018).

The web app is available at:

https://outaos.pythonanywhere.com/home

(It is recommended to access the web app through a mobile device. You are welcome to add your own stories)

A full copy of the code is available at:

https://github.com/Outaos/Web_App_SQLAchemy

(The most important code is in main.py, create.html, and art.html)

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Appendix

A Questionnaire completed by potential users.

My research intends to develop a location-based game (LBGame) smartphone app where players explore their city by searching for hidden multimedia stories in the real-world urban environment. LBGames are games played in the real world using handheld devices. I believe that by combining location-based services, audio narratives, and navigation tools, a personalised experience can be achieved, which will facilitate the emotional connection with previously unnoticed places and help the users to discover their city in a new and memorable way.

1. What is the name of the city/town where you currently live?
2. How many years/months have you been living in this city/town?
3. What is the name of the city/town/village where you grew up?
4. Do you often walk around the city/town you currently live in? (Often / Sometimes / Seldom / Never)
5. Can you tell a story to a stranger about some buildings/establishments/places in the city/town where you currently live that is **not directly related to your own life**? (yes / no)
6. How interesting do you believe this story is? (0 - 100)
7. Would you be able to show an exact location related to this story on GoogleMaps? (yes / no / I can't think of any story)
8. Can you tell a story to a stranger about some buildings/establishments/places in your **hometown** that is **not directly related to your own life**? (yes / no)
9. How interesting do you believe this story is? (0 - 100)
10. Would you be able to show an exact location related to this story on GoogleMaps? (yes / no / I can't think of any story)
11. Can you tell a story to a stranger **related to your own life** that happened somewhere in the city/town where you currently live? (yes / no)
12. How interesting do you believe this story is? (0 - 100)
13. Would you be able to show an exact location where this story happened on GoogleMaps? (yes / no / I can't think of any story)
14. Would you agree that these stories influence your perception of a city/town? (Agree / Undecided / Disagree)

15. Would you agree that walking more benefits your health? (Agree / Undecided / Disagree)
16. Would you agree that having some goal increases your chances of going for a walk? (Agree / Undecided / Disagree)
17. When you commute/walk somewhere, do you often listen to something (music, podcasts, audiobooks, etc.) on the way? (Often / Sometimes / Seldom / Never)
18. When you listen to something, and it gets interrupted by a navigation tool or a message, how annoying do you find that? (0 - 10)
19. Do you often use some navigation tools when you walk in the city/town you live in? (Often / Sometimes / Seldom / Never)
20. Do you often use some navigation tools when you travel to other cities/towns? (Often / Sometimes / Seldom / Never)
21. How many cities/towns do you typically visit per year (given that there is no pandemic/war)? (0 - >10)
22. How often do you explore cities you travel to on your own? (Often / Sometimes / Seldom / Never)
23. How often do you use a compass (including the one on your smartphone) to navigate the city? (Often / Sometimes / Seldom / Never)
24. Which neighbourhood / neighbourhoods would you recommend a visitor who wants to explore the city/town you currently live in? (Please type commonly used name/names)
25. Have you ever joined a walking tour in any city/town? (yes / no)
26. Would you agree that walking tours often have too much historical information irrelevant to you? (Strongly Agree / Agree / Undecided / Disagree / Strongly Disagree)
27. Do you prefer contemporary stories or historical stories?
28. Please rate the following topics that can be potentially used in the LBGame from the most interesting to the least. (Personal stories of friends, Music, Football, Art, Ghost tours, Crime stories, Industrial stories)
29. Can you name three famous people who lived/live in the city/town where you currently reside? (Please type their names)
30. A hypothetic situation: while playing a LBGame, would you prefer to receive hints as short audio messages or visual pop-ups?

31. A hypothetic situation: while playing a LBGame, would you prefer listening to a short story or reading it on your device?
32. Does it matter to you that this story is historically accurate? (yes / no / depends on the story)
33. If you discover a story while playing the LBGame, how long should this story be? Please specify the time in minutes.
34. Would you agree that including interactions with strangers in the LBGame makes the final experience more fun?
35. What distance are you willing to walk while playing the LBGame? Please specify the length in kilometres or miles.
36. Would you agree to participate in a focus group discussion organised by the author on the campus of the University of Manchester?