

# Einsatz von Augmented Reality zur Erkundung der Städte und deren kulturellen Erbe

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Wien, 19. August 2023

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# Using Augmented Reality to Explore Cities and their Cultural Heritage

DIPLOMA THESIS

submitted in partial fulfillment of the requirements for the degree of

**Diplom-Ingenieurin**

in

**Media Informatics and Visual Computing**

by

**Ana-Alina Faustmann, BSc**

Registration Number 0825905

to the Faculty of Informatics

at the TU Wien

Advisor: Associate Prof. Dipl.-Ing. Dr.techn. Hilda Tellioğlu

Vienna, 19<sup>th</sup> August, 2023

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# Kurzfassung

Kulturelles Erbe ist der Wert und das Wissen, welches von einer Generation an die nächste weitergegeben wird und hat eine große Bedeutung [KCD<sup>+</sup>20]. Oft wird allerdings vergessen, dass auch kleine Städte, vor allem in ländlichen Gebieten ein kulturelles Erbe besitzen und somit kann es vorkommen, dass Menschen, die schon lange in der Stadt leben, jahrelang an einem Gebäude oder Ort vorbei gegangen sind, ohne sich der Geschichte bewusst zu sein. Für diese Sehenswürdigkeiten gibt es meistens keine Stadtführer und es ist somit schwierig Touristen in kleine Städte zu locken. Kostopolou et al. [KJK<sup>+</sup>18] stellten fest, dass sich Menschen stärker zu Städte, Orte und Plätze verbunden fühlen, wenn sie etwas über diese erfahren. Ist ein Wissen über die Geschichte dieser Sehenswürdigkeiten vorhanden, dann ist man auch eher dazu bereit die Stadt zu erkunden. Aber die Erkundung der Nachbarschaft und des kulturellen Erbes einer kleinen Stadt kann sehr schwierig sein, denn die Suche im Internet nach berühmten Attraktionen ist in der Regel sehr zeitaufwendig [KCD<sup>+</sup>20]. *“... Eine gemeinsame Überzeugung ist, dass die Bedeutung von Denkmälern nur im Zusammenhang mit der Kultur und den Menschen, die sie umgeben, erfahren werden kann ...”* [KCD<sup>+</sup>20, S. 157]. Deshalb wollen wir den Fußgängerinnen und Fußgängern die Möglichkeit geben, durch die Stadt zu schlendern und diese zu erkunden, indem sie sich voll und ganz auf die Umgebung konzentrieren können.

Außerdem ist es für Menschen interessanter, wenn die Geschichte der Stadt von einer lokalen Person erzählt wird. Nisi et al. [NDBN] erklären, dass “die Wahrnehmung der Nachbarschaft sich positiv auf die Bereitschaft auswirkt, die Nachbarschaft nicht nur räumlich sondern auch auf sozialer Ebene, zu erkunden” [NDBN, S. 89].

Somit wollen wir in dieser Arbeit das kulturelle Erbe der Bewohnerinnen und Bewohner sammeln und mit Hilfe von Augmented-Reality-Ansätzen und -Technologien diese Geschichten nacherzählen lassen, so dass Fußgängerinnen und Fußgänger sich frei und sicher in der Stadt bewegen und sich auf die Umgebung konzentrieren können und dabei diejenigen Daten erhalten, die entsprechend ihrer aktuellen, geographischen Position in der Stadt relevant sind. Die Benutzerinnen und Benutzer sollen so wenig wie möglich von der Applikation selbst abgelenkt werden, sodass sie sich auch auf den Stadtverkehr, die Umgebung und andere Menschen in der Stadt konzentrieren und diese wahrnehmen können.



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# Abstract

Cultural heritage is the value and knowledge passed from one generation to the next and it is of paramount importance [KCD<sup>+</sup>20]. However, it is often forgotten that small cities, especially in rural areas, also have a cultural heritage. It can happen that people live in a place for ages and passed by a building or place for years without being aware of its history. Furthermore, city guides are not always available and it is difficult to attract tourists to small cities. Kostopolou et al. [KJK<sup>+</sup>18] state that people feel more connected to places if they know something about them. Then they are also better triggered to explore them.

Additionally, exploring the neighborhood and the cultural heritage of a small city can be really difficult, because searching the web about famous attractions in the city is usually time consuming [KCD<sup>+</sup>20]. “... *A shared belief is that monuments’ significance can only be experienced in the context of the culture and the people surrounding them ...*” [KCD<sup>+</sup>20, p. 157]. It is also more appealing for people, if the story about cities and their history is told by a local person. Nisi et al. [NDBN] explain that “*participants’ perception of the neighborhood was positively affected by the experience, which fostered curiosity and willingness to explore the neighborhood both at the spatial and social levels*” [NDBN, p. 89].

Thus, in this work we want to collect the cultural heritage of the users and let them retell these stories using Augmented Reality approaches and technologies. Pedestrians will be able to move freely and safely through the city and can focus on the surroundings while receiving the information from the application that are relevant according to their current geographic position in the city. The users should be distracted as little as possible from the application itself, so that they can also be aware of the city traffic, the surroundings and other people in the city.



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# Introduction

## 1.1 Problem statement

The cultural heritage of small cities, especially in rural areas, is often forgotten and overlooked by the public. Oftentimes, many people live in a city for decades and have passed by a building or a place hundred of times without being aware of its history. To mitigate this, city guides would be a great resource, however, they are not always available and attracting tourism to small cities is oftentimes difficult. Kostopoulou et al. [KJK<sup>+</sup>18] state that people feel more connected to places if they know something about them. It also entices them to explore their home independently. Furthermore, people prefer a local guide to inform them on the history and stories of the city, as this is apparently more appealing. Nisi et al. [NDBN] explain that “... *participants’ perception of the neighborhood was positively affected by the experience, which fostered curiosity and willingness to explore the neighborhood both at the spatial and social levels*” [NDBN, p. 89]. Location-based augmented experiences tempt users to venture into the outdoors, by motivating them to explore the neighborhood and by creating hybrid urban experiences. Hybrid urban experiences involve the physical location and the supportive digital media to enhance information about a place or a monument. The combination of being in the physical world and using mobile elements create hybrid experiences in urban space [KJK<sup>+</sup>18]. The usage of smart phones has reduced barriers to access cultural heritage of cities. Most of mobile devices are equipped with GPS, cameras and multiple sensors in order to enable the association of digital content with physically-located products, objects and/or locations [KJK<sup>+</sup>18] [NDBN].

We want to build upon these barriers and solve the problem of not knowing the cultural heritage of small cities by putting them in the spotlight and letting residents and visitors learn more about small cities. To achieve this, we want to collect the cultural heritage and the historical stories of the inhabitants connected to places in a city and retell them using an Augmented Reality (AR) application. AR technologies “... *significantly*

*contribute to preserving, sharing and experiencing local stories and memories that matter to people” [KJK<sup>+</sup>18, p. 118].*

We want to provide the user with an Augmented Reality experience, in which they can stroll through the city while an application tells the story of a building, a monument or a place. There should be no predefined routes as the goal is to enable the user to freely explore around the city. We want him or her to focus on the surroundings and buildings while make sure that there are none or minimal distractions caused by the mobile device they use. He or she should be able to safely move around in the city, even by night. We also want to maximize the experience of exploring the city, by giving the user a feeling of privacy and comfort when using the application through trying to attract less attention from other pedestrians [NDBN].

### 1.2 Aim of the work

To gather the information from the residents and retell them in a location-based Augmented Reality prototype we will put a spotlight on Neunkirchen as our small city and we will try to answer two main questions.

The first question is from a content point of view: *“How can we collect data from the residents, what is relevant data and how can we assure a given content quality?”* To work this out we need to solve the problem of how residents can enter data and how it is possible to motivate them to provide content. We will find out what is relevant content and also define criteria, which assure a given content quality. We also elaborate criteria, to identify some residents as content creators/editors and look at how reviewing, ranking and rewarding help us to define a good content creator.

The second question is from a city exploration point of view as we will look at how we can grant the best experience to explore the history of a city by using Augmented Reality. The goal is that a pedestrian can explore freely and stay in the narrative flow while moving safely through the city. So the question is: *“How can we maximize the exploration of a city, but take urban traffic, lighting conditions and the distraction of the mobile device into account? How can an Augmented Reality application support this?”*

### 1.3 Methodological approach

Museums and cultural spaces always look to improve the visitors’ experience. Cultural spaces are for example archaeological sites, art galleries, castles or historic churches [OPP13, p.629]. Therefore, we have a cooperation with the museum Neunkirchen.

To handle the first question, we introduce two different roles. The role of the “content editor” and the role of a “reviewer”. For this paper, “content editors” are residents of the city and our “reviewers” are employees of the city museum Neunkirchen.

The “content editor” can enter and edit content and the “reviewer” can assure a defined content’s quality and approve the work of the “content editor”. We want to establish

a user-centered iterative design process involving these two user roles in appropriate settings.

To identify relevant content and define our criteria to assure a given content quality, we will review the literature and have one “reviewer” as an interviewee during the design process. The criteria defining a “content editor” will also be elaborated by the literature review and the input from the reviewer.

For the “editor”, we will implement a prototypical application and have the users evaluate the content management by using the application and fill out a questionnaire. In addition, we plan to conduct a group discussion to get further insights. The “reviewer” role will only be defined far enough in order for us to define our content criteria to assure a given content’s quality and to help us refine our “editor” role.

To answer our second question we want to come up with a user-centered iterative design process including literature review to find a way to explore the city by focusing on storytelling. For this, we will define our personas by introducing a new role, the “explorer”, who is a pedestrian exploring the city by using our location-based Augmented Reality prototypical application. We want to focus on text-to-speech and controlling the story telling via voice commands. The narrative thread should be largely uninterrupted and there has to be the possibility for the explorer to concentrate on the history of the city as well as the traffic. Each user will then get a questionnaire, which he or she needs to fill out individually. After this a group discussion on the exploration will be held based on the answers to the questionnaires to find out how the Augmented Reality experience was and whether the user gets motivated to explore the city or not.

In the chapter State of the art we will give an introduction to technology to explore cities, provide detailed description to audio guides and location-based Augmented Reality for exploring and consider the safety aspects. Then we look at emotional aspects and motivational factor for collaborative content. In the next chapter, Implementation, we will define our personas, scenarios, create wireframes, mockups and implement a prototypical application. The feedback and results of our interviews will be discussed in this section. In the chapter Results and Critical reflection we reflect on our work concerning the topic and aim of this thesis. The chapter Summary and future work summarizes our work and gives an overview what work is left to be done as future work.



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# State of the art

## 2.1 Exploring cities

Places and historical venues are valuable assets and transport public knowledge to preserve previous national generations' life styles, ethnic culture, aesthetic value of buildings, monuments, gardens, places, scenic views and so on. The tourists' motivation to explore the city is multi-layered and there are two different approaches to look at the motivations. One of them is the socio-psychological approach and the other one is the cultural approach. The socio-psychological approach states that tourists strive to overcome the feeling of isolation and the desire for social interaction. The cultural approach deals with the destination itself [Lee17, p. 707].

If one is new to a city and he or she wants to explore the city, there are several ways to do this. One option is a tourist office as the information is vetted and oftentimes produced by an official committee. Alternatively, a great deal of tourist guides can be acquired at book stores. In cases where both previous options are not available or accessible, looking up information about a city on the Internet can lead to results. Other more adventurous and spontaneous methods that requires little planning are to ask a cab driver for the most important hot spots, to hop on a bus, train or ship for the city exploration, to join a guided tour or ask a local for interesting places. The third possibility is the so called serendipitous exploration. This means just walking around the area and getting inspired by the places. Here the focus is less on the biggest most famous hot spots but the often overlooked and hidden places with a deep cultural heritage [Lø11, p. 187].

## 2.2 Using technology to explore cities

The goal of using technology to explore cities is that tourists and citizens that live there and experience a space should get all the cultural information, so that the knowledge and awareness about the space improves [BB17, p. 240].

*“Storytelling in a pervasive and ongoing experience crossing seamlessly the boundaries between places of preservation and the historical remains spread in a territory.”* [BB17, p. 293]

The Internet and mobile applications do the job that information is accessible at any time, everywhere where you have an Internet connection. It is possible to retrieve the information in a planning way, so that you prepare yourself before you visit a place or you look after information during your visit or even after the visit [BB17, p. 240]. But mostly people don't look up for information and a serendipitous exploration is not possible.

A location-based application can help the tourists to find the way and offer information and media to be played corresponding to location by combining different features in one small device: of a GPS navigator, portable media player and a guidebook [Lø11, p. 187].

Digital guides have been one of the first genres, which used locative media [Lø11, p. 187]. In Cyberguide [AAH<sup>+</sup>97] they already implemented some context-aware prototypes, which moved paper-based information into hand-held, position aware units. They developed various indoor and outdoor applications and the authors view Cyberguide as a family of prototype so that they capture the essence of the mobile tour guide playing the role of a cartographer, librarian, navigator and messenger [AAH<sup>+</sup>97, p. 5]. They focused on tourism and the possibilities to offer greater services to the user. In 1996 Abowed et al. [AAH<sup>+</sup>97] already envisioned some scenarios for context-aware applications and a device that allows tourists to go anywhere they please and be able to receive information about anywhere a tourist stands. They suggest it for walking tours in cities by using GPS or markers or where no marker attachment is possible, for example, for identifying animals in a zoo or aquarium they envisioned a computer vision recognition and with assistance from the environment. For example, first identifying that this is an elephant cage and then identifies that it is an elephant [AAH<sup>+</sup>97, p. 3]. Abowed et al. [AAH<sup>+</sup>97] also envisioned context-aware devices as “user-agent”, a personal guide, for example, to translate something like a multilingual dictionary to translate phrases with the appropriate pronunciation to a taxi driver or as a scanner to read signs or menus and translate it. Or just as a guide to a specific point, suggesting the shortest way or function as an assistant, who does a reservation and alerts when the reservation is available. They also saw the possibilities of taking pictures and videos and connecting them to a location, so that this would result in a trail upon a map and create a sort of a “travel diary” [AAH<sup>+</sup>97, p. 4].

But guidebooks don't consider everyday spaces. A “locative” and networked application can contain any data, even hidden and on the first look not important places [Lø11, p. 187].

In Cyberguide [AAH<sup>+</sup>97] one of the prototypes allowed the user to add content about an interesting establishment and they envisioned that users and proprietor could be able to modify the information base [AAH<sup>+</sup>97, p. 15].

In Textopia [Lø09] Løvlie presents an application that allows user to walk through a city and listen to poems and stories which includes the space in the literary work.

He talks about how human communicates about physical spaces and places and how communication depends on people being present in the same place. For example, that “... young people from wealthy British families used to travel to Europe to visit the historical sites they had discovered in literature. Travellers have always been attracted by the sites described in novels ...” [Lø09, p. 251].

### 2.2.1 Audio Guides

The first mobile audio guides were used at the Stedelijk Museum in Amsterdam in 1952. The first “random access” mobile guide, where visitors could choose which exhibits to visit in the order they liked was called *INFORM* and was used at the Louvre museum in Paris in 1993 [OPP13, pp. 629-630]. Museums and cultural spaces (for example, art galleries, castles, archaeological sites, historic churches and so on) always look to improve the visitors experience [OPP13, p. 629]. Cultural spaces also encourage their visitors to use their own smartphones rather than renting dedicated mobile audio or multimedia guides because the organizations save costs for purchasing and maintaining the devices and they also save the related costs for the staff and space required to renting out and returning the devices. The visitors also benefit because they do not have to learn how to use different devices every time when they visit a different cultural space [OPP13, p. 629].

Since then the technology advanced, the functionality and usability increased and the devices became portable. Today mobile phones can serve as platforms for *Smart Travel Guides* by providing useful information anywhere and anytime and give directional guidance. When we look at smart tourism, then we have to deal with two aspects of it: the smart experience and the smart destination [Lee17, p. 706]. The guidance has a crucial role in maintaining the tourism market. The task is to create an enjoyable experience for the tourist by influencing the tourist to revisit the place. A tourist guide should be an animator, tour leader and intermediary. It has an instrumental, interactional, social and communicative role [Lee17, p. 706].

“Technologies such as tourist guides, audio guides and interactive displays have been used in order to facilitate heritage education. These technologies have been really useful but do not allow user interaction to enrich or improve the content they offer, is one of their limitations; furthermore, they reduce decision making among users on where to go or what to do” [GJBF15, p. 18].

Audio Guides in cultural heritages are used to conveniently deliver cultural information to the visitor and satisfy the needs of information, mobility and personalization [Lee17, p. 705]. The devices became smaller, smarter and more connected, so that they can provide information at any time [Lee17, p. 707]. But researches on usage of audio guides in scope of the cultural heritage of places is rare [Lee17, p. 706].

The guides in the cultural heritage are an educational tool, allowing the tourist to get personalized information and a learning experience at their own pace, according to their interests with the possibility of tailoring the tour to the visitors’ preference without waiting for a guided tour at a specific time with a predefined route [Lee17, p. 707].

Othman [OPP13] states that using the “free-choice” mobile guide, where visitors could choose which exhibit to visit in the order they preferred had an impact on the visitors’ engagement, learning and interaction with the museums’ multimedia guide [OPP13, p. 630].

During a visit, there is a knowledge transition and the experience quality can be described by the factors of hedonics, peace of mind, involvement and recognition. The conceptualized experiential quality has factors like immersion, surprise, participation and fun. Using audio guides, the heritage interpretation has a conservational and educational aspect although there is a trend of entertainment, learning and satisfaction [Lee17, pp. 707-708].

There are different intrinsic psychological and extrinsic situational parameters on when to use or not to use an audio guide. The study of Lee [Lee17] compared studies who provided audio guides and heritage interpreters and the reasons why or why not the visitors choose the audio guide over the heritage interpreters. The situational parameters to disregard an audio guide are, for example, a noisy or crowded environment, a lack of functionality regarding the service of technology and a user-unfriendly interface. Furthermore, in situations where tourists felt isolated due to the audio guides hindrance of communication with friends or companions, especially when the tour took a long time, they opted out and joined in company with other visitors [Lee17, p. 709]. Psychological parameters are, for example, that the visitor already had enough information of the site because of brochures and there was a lack of learning motivation because visitors mostly have “have a quick glimpse and take a whiff of the ambience, and then take photographs or walk the garden” [Lee17, p. 710]. Therefore the present audio guides have two roles: one of the path finding leader and the other one is the information provider. But these two functions are not sufficient to satisfy the complexity of a guide. The audio guides need to have interaction and sociality and they need to provide diversified content so that the user can choose his and her preferred content and a maximum of entertainment, for example, by dramatized effects such as Augmented Reality functions [Lee17, pp. 710-711].

The visitors with situational reasons are more likely to drop usage of the audio guide in the middle of a tour than the users with educational or other personal motivations [Lee17, p. 711].

In Bollini they had a project to “give back to the community the history of Milan as the centre of network of solidarity and social inclusion” [Bol12, p. 478] so that they developed different navigation systems, gathered information and knowledge from the inhabitants and made the documents open and accessible to the public. They represented the content from different perspectives considering different needs, motivations and behaviours of the user and also the cultural and technical terms [Bol12, p. 480].

The duality of place is that a place is a sightseeing cultural attraction and a historical cultural heritage at the same time [Lee17, p. 711].

## 2.3 Using location-based Augmented Reality to explore cities

People all around the world have a smartphone and the number of owners is still increasing. At present, smartphones stand as the most favored electronic devices. The latest statistics on smartphone users reveal that they hold the highest popularity among all devices, being utilized by a staggering 96.6% of all internet users [Obe]. Augmented Reality (AR) combines the interactive real world with an interactive computer-generated world in such a way that they seamlessly blend together and it appears as one environment. It provides a “composite” view of the world and integrates content in the real surroundings [Sch16, p. 3]. For example, knowing the current location can be used to improve information retrieval and it has potential for a serendipitous exploration [Lø11, p. 187]. It can help tourists find the way and offer them information about a place combining the capability of a Global Positioning System (GPS) navigation, a guide book and a search engine in one small device by using a smartphone. “*Locative media make it possible to annotate the world with invisible notes attached to spaces, places, people and things*” [Lø11, p. 183]. Locative media benefits if it is primarily aural, because “*if the medium prevents the user from taking in the surroundings while experiencing the text, this feature is poorly exploited*” [Lø11, p. 188]. It can provide an arena for art in public space, a *spatial hypertext*, which is the representation of a real space or “... *create a textual universe that one can walk through, similar to the way one might ‘walk’ through the virtual world of a computer game ...*” [Lø11, p. 183]. For Løvlie [Lø11] the challenges to create annotative locative media can be summarized with three keywords: granularity, participation and serendipity. *Serendipity* is defined as the user experience that should be enabled using the locative media. This means, this is the potential for serendipitous exploration by “... *helping people to find things they didn’t know they were looking for*” [Lø11, p. 187]. *Granularity* describes the practical problem in achieving serendipity, for example, how far should an object be that triggers the augmentation? What is the shape of the location? Is it a point on the map, another geometrical object like a polygon? It is important to define the right granularity and to give the user the freedom to adjust some settings, so that the user can explore it serendipitously and this also means that *participation* describes the problem belonging to both categories [Lø11, p. 187]. Effecting the participation in a way, for example, if we define text about all the mundane of everyday spaces in the world, we need to open it up for user participation and make it cross-platform available for the devices. If we didn’t do this and consider only one platform, for example, Android, we would exclude all other users and this would be undemocratic [Lø11, p. 189]. In REXpoler [BKW08] they stated that tour guides are sometimes boring so that they developed a game concentrating for tourists in the age from 15-30 who grew up with playing video games at home and acclimate them to their surroundings and raise interest in the culture and history of the city. The game extends the visitor’s experience beyond the museums walls and the device acts like a paranormal activity detector that communicates with spirits by casting spells in the city center of Regensburg [BKW08, pp. 244-245]. The game is not designed as a real tour guide, it takes into account that Regensburg is a UNESCO world heritage site

with the best-preserved medieval city in Germany and the spell vocabulary, which enables the communication to the spiritual world consists of symbols inspired by a mysterious secret language from a historical artifact [BKW08, p. 246]. The gamer needs to make a gesture to awake the spirit and get more instructions. The different spirits are located on significant buildings and act like “cliff hangers” for important periods and events in the history [BKW08, p.246]. After the tour the user gets an e-mail with a URL to the souvenir travel blog with the customized show of their personal experience in the city. They can also take pictures during the visit and these photos are automatically connected to their personal blog and the location is marked in the map. The blog provides a summary of the experiences and the traveller can access the blog at home through a standard desktop web browser and share this with his or her family and friends [BKW08, p. 248]. For Ballagas et al. “*Travel blogging is an emerging trend*” [BKW08, p. 246]. Nisi et al. [NDBN] also use a gameification approach to broaden the experience of museums’ visitors into the neglected area of the neighbourhood by telling Yasmine’s adventures. Yasmine is a fictional school girl who lives in the neighborhood, starting her trip by escaping from a school nearby the museum, stopping in various places corresponding to the POIs and finally going back home.

In “Voices of Oakland” the application tries to bring the stories of the cemetery inhabitants to life. It is not a game with fictive characters, instead it tells the life about the cemetery inhabitants. It is an informative, entertaining and innovative walking tour which was designed to introduce the visitor to the history and architecture of Oaklands Cemetery, which is the oldest cemetery in Atlanta. A narrator guides the user from a grave to the other, the user could choose audio segments and get more information depending on their particular interests. It creates a dramatic narrative during walking in the cemetery [SMB<sup>+</sup>15].

In “History Unwired” [EV06] a researcher team developed a location-aware application for a walking tour so that visitors can investigate the lesser-traveled neighborhood, but still culturally-rich areas of Venice. They wanted to bring alternative cultural offerings of the city to the average visitor and deliver a solution for the problem of mass tourism, because most visitors stay about eight hours in the city and the tourist flow concentrate around the popular St. Mark’s square so that “... *the historic center of Venice has become a kind of Disneyland*” [EV06, p. 302] without having an intimate experience of Venetian life. The content was created over a series of walks with Venetian who were famous or had an attachment to the neighborhood. The tour was a combination of a treasure hunt and a multimedia documentary where user gets folkloric and personal stories of five locals.

In ArcheoGuide [VIK<sup>+</sup>02] user gets personalized information about an archaeological site and he or she can collect, exploit and update archaeological data on any given time. ArcheoGuide is short for Augmented Reality-based Cultural Heritage on-Site Guide and it is a well designed mobile system, kind of an electronic outdoor guide that helps users to explore the archaeological site and makes the most of their visit. The application tries to bridge the gap between education, scientific research and recreation [VIK<sup>+</sup>02, p. 52]. The



system delivers images, 3D models, audio, video clips and text about an archaeological site. The prototype was tested and evaluated during Greece's Olympic games in Athen and uses Differential Global Positioning System (DGPS), which has an accuracy less than 1 meter. The positioning and the data of the most important monuments were displayed on a map.

In the paper of Kallergis et al. [KCD<sup>+</sup>20] an application has provided a “virtual time leap” of a monument by extracting, processing pictures and showing how the monument looked in a given era. The application has also provided a routing to a specific monument based on different criteria like the user's available time, the distance of the monument or the historical era. So, the proposed monuments were not the most famous ones, but still important and the so-called “hidden” monuments in the neighborhoods of Athens [KCD<sup>+</sup>20, p. 157]. In this work we also want to bring the cultural heritage to the user and we want the user to discover the neighborhood, but we will not suggest any monuments, routes or places. We want the user to freely wander around the city and get the needed information.

## 2.4 Storytelling of the neighbourhood to emotionally connect to a city

Most of the information in location based apps is user generated content. Residents have a better association and sense of belonging to the city they live in if they knew more about the location. People are generally more involved and engaged in a community, when they are active participants in the dissemination of the culture [BB17, p. 293]. Locative storytelling may also help to strengthen attachment to a place and to develop *place commitment* which is the willingness of individuals to contribute to their local place.

It is hard to achieve the creation of locative stories and content [SNS17, p. 5]. One method can be the “Share Yourself Approach” which contains two parts: the preparation and the history sharing. For example, people were invited to think of a meaningful locations in their neighborhood and to write a story based on their personal memory, recent historical events or current facts about the place [SNS17, p. 7].

The shared history of a person can have an impact on other people to also wanting to share a meaningful story from their lives. The storyteller makes herself or himself *vulnerable* if he or she shares something personal from his or her history. The emotional accessibility also comes with the risk of a *shame trigger* if it is abused by participants or researchers. But being *vulnerable* can also be “*the birthplace of love, belonging, joy, courage, empathy and creativity*” [SNS17, p. 6] and increases connection, trust and engagement. Silva et al. [SNS17] focuses on motivating and training less advantaged communities to give them the knowledge to share history about themselves for them to be able to create content via the Internet. They focus on less developed communities as the access to the Internet is more challenging for poorer, less educated minority groups. Their first access to the

Internet is through a smartphone. In contrast users in more privileged areas access the Internet through a computer for the first time. Recent academic publications show that because of the increasing internet-enabled mobile devices, the division based on device access is no longer as significant as it once was and the greater challenge is having knowledge, skills and motivation to use location based services and a lack of awareness of the device's locative capabilities [SNS17].

This is more a *participation gap* than an *accessing gap* as Silva et al. states that “... *people may be enticed to adopt an artifact or practice if others they know and trust are already involved*” [SNS17, p. 3]. But producing locative media can lead to confidence and pride for the accomplishments, because this leaves behind something written for others as a heritage. The written stories are what will survive after a person's life is over [SNS17, p. 8].

Iverson [Ive11] explains how students leave traces in their neighborhoods by attaching different media to a space or place so that the urban landscape becomes a canvas of the visible and invisible aspects of a place. The projects invite public participation and encourage students to map a trail using a GPS device. Some of the students mapped the trail by uploading pictures or audio and annotating the path with the captured media. Another student annotated the map with the songs that she listened to on her way. This is a new way to visualize a personal geography and share the experience and understanding of personal urban mobility. We want to use the idea of sharing the personalized experience in urban spaces. So our work will be about the residents being able to tell the history of their own city.

Hudak [Hud19] states how important it is to have a place brand, which enables people to associate certain attributed values with an area so that residents create their own image of a place with their emotional and socio-cultural bond and with their interactions with local resources, infrastructure and landscape. Place brands encourage residents to take responsibility for the place brand. It also helps to fuse multiple voices and visions into a unique result. It has important residents, tourists, business owners, religious institutions, government and academic organizations. All of them add a more complex layer to how these places exist for the different stakeholders. It summarizes and characterizes a place with its reputation, quality of life, industry, offers for entertainment, place history and culture. It boosts tourism, attracts business, functions as a global contender and enhances the quality of life for the residents [Hud19, pp. 1-2]. The residents influence the brand more than any other stakeholders, as they live, occupy and embody the place brand every day. They are consumers and ambassadors at the same time and communicate unintended and intended messages about the place brand, therefore, residents need to participate in a branding process [Hud19].

### 2.5 Safety aspects on using technology

In considering mobile devices in traffic, we need to look at smartphone addiction and specifically the usage of smartphones in traffic. People with smartphone addiction are



more likely to have an accident, fall from heights or collide with objects. [CP18, p. 2].

Compared to adults, adolescence are at a greater risk, because they still need to develop self-control regarding smartphone usage [CP18, p. 2]. Pedestrians, cyclists and motorcyclists are the most vulnerable road users. They have little or no protection against speed and mass and, as a result, they often get seriously injured or killed in road accidents [MWZ21, p. 1]. People are chat, listen to music, play games, surf on the web, use social media or do other activities, which leads to a cognitive distraction, impact on the attention of the pedestrians and this results in dangerous situations while walking. [CP18, MWZ21] It is also notable that texting, for example, has a much higher impact on cognitive distraction than talking or listening on to music. People who were texting could not maintain their walking pace or stroll across the street in contrast to the other two groups [CP18, p. 2]. Those who were surfing the web, missed more opportunities to cross the street safely, looked away, checked for cars in both directions less frequently, waited longer at the intersection or almost had an accident with a vehicle [CP18, p. 2]. Others made risky street crossings like using a narrower traffic gap or crossing during red lights. Those playing games missed the most visual targets and exhibited the worst ability to walk and balance properly [CP18, p. 2]. This blindness due to inattention decreases awareness as the focus is not just divided but concentrated on a main task and unusual objects outside the focus go unnoticed. There is also an unintentional deafness. In the experiment the national hymn was played by a clown and some of the music listener did not hear this [CP18, p. 1]. This can be extremely dangerous in case an emergency vehicle with high speed and an alarm siren is approaching the intersection.

Barin et al. [BMF<sup>+</sup>18] state that 51% of the young adults are colliding with objects or other people due to distraction by the mobile device [BMF<sup>+</sup>18, p. 810]. During a phone call it is likely a speaker does not perceive everything, for example, participants in a study where distracted to the degree that 75% failed to notice a clown on a unicycle. They also displayed a dangerous street crossing behaviour. Painted sidewalk stencils as a reminder on pedestrian safety and technological distractions were used to make pedestrians aware of the problem and decreased the cell phone distractions for them. However, these installations only had a short-term improvement. After noticing them when they were first implemented, pedestrians started to ignore them as time went on. There is also a difference of effectiveness in the age groups. The interventions are more likely to work for adults than for children. This is due to the fact that adults are more likely to understand the risks of street-crossing behavior and they remember a time and their behaviour when cell phones did not exist [BMF<sup>+</sup>18, p. 814]. Additionally, people tend to see pedestrian crossings as a safe place for pedestrians. Statistics, on the other hand, provide a strikingly different reality as most accidents with pedestrians happen on pedestrian crossings [MWZ21, p. 2].

Another reason is the rapidly evolving smartphone technology over the last years as larger screens sizes and telecommunications technology was beneficial for streaming videos or gaming. Therefore, smartphone usage is more cognitively demanding that it was before smartphones became an integral part of our lives, regardless of age and gender [MWZ21,

p. 1][CP18, p. 3].

Using mostly sound during mobility allows moving safely in and through traffic. Not focusing on a small screen, which is vulnerable to lighting or weather conditions like sun, dark night, snow or rain, is also crucial [Lø11].

Both cold weather and snow have an impact on the willingness for people to explore by using a mobile device and inhibits the experience. For these situations, the user needs to use special gloves to operate the phone or a pocket or plastic bag to protect the mobile device from snow or rain [FTC<sup>+</sup>12, p. 756].

### 2.6 User-Centered Method

To create an application for users, it is crucial to understand the users' lives, environs and motivations[CRC07]. *User-centered design (UCD)* involves the end-users in the design process so that they have an influence on how a design takes shape which leads to a more effective, efficient, safer, accepted and successful product [AP04, p. 2]. For this it is crucial to carefully think about who is a user and how he or she will use the final product and how we can include him or her in the design process [AP04, p. 5]. To abstract something there is a concept called *model*, which is a useful abstraction representing complex phenomena and relationships for better understanding and visualization. "Models of users" are called *personas* and are a powerful tool for interaction design and describe how users behave, think, what they want to accomplish and why they want it. They are based upon observed behavior patterns and describe a user's goal in a specific context without using stereotypes and generalizations by taking into account that personas are archetypes that represent a broad cross-section of users with their social and physical environments, the product itself and the relationship with other users. Personas are based on research and represent a group of users in one individual person. Sometimes personas represent nonusers, where the person who purchases the product is not the user. For example, children's toys, enterprise software or medical products. Personas resolve the issues of the elastic user, the self-referential design and designing for edge cases. The elastic user results from the fact that everyone who makes product decisions has their own idea of who the user is and what he needs, so that the presuppositions results in bending and stretching the users needs so that it allows the product development team to build whatever they please, while still serving "the user". For example, if it is convenient for the development team that the same user is a "power user" for one task and an "unsophisticated first-time user" for another. The self-referential design is when developers or designers project their skills, motivations, goals and mental models onto the product's design. Designing for edge cases is also a syndrome that personas can help eliminate and provide a reality check. Edge cases must be designed and programmed but should never be the design focus. So personas have many strengths as a design tool. Personas build consensus and commitment to the design by using a common language and understanding. They measure the design's effectiveness and the design choices can be tested on a persona like it is a real user. Personas are determined so that they provide

the foundation and describe what a product should do and how it should behave and communicate with designers, developers and stakeholders in a common language. They also help to provide information and purpose across the organization like for marketing campaigns, sales plan and other strategic planning [CRC07].

## 2.7 Creating content aspects

Writing an article collaboratively is expensive because the coordination effort increases by adding multiple authors, but that does not automatically increase the quality of the article. It is important to use proper coordination techniques to properly harness “the wisdom of crowds” [KE08, p.37]. Wikipedia uses such techniques and the content is comparable to traditional encyclopedias. Editors can explicitly coordinate via an “article talk page”. This is a dedicated page for each article where editors can negotiate about coordinating changes, policies, procedures and the structure and scope of an article. There editors propose changes for the article page. This coordination via an “article talk page” is important as the number of contributors has grown over the years. *“More than half of all edits in the first week of an article are made to the talk page rather than to the content of the article”* [KE08, p. 39].

Communication is especially important, when the tasks are highly uncertain, unconstrained and when the subject has a lot of changes. Articles where contributors use the talk page and editors get advice from collaborators, improve more than articles where the contributors get no input [KE08, p. 44]. An implicit coordination means structuring the work, for example, by providing a table of contents and specifying the degree of managerial hierarchy [KE08, p. 39]. It is suggested that a small number of contributors set the direction, scope and structure of the new article by providing enough information for other editors to continue. These “leadership groups” are naturally and informally formed in Wikipedia based on the pre-existing interest, expertise, commitment and availability of the editor. *“... in other peer production environments it may be valuable to appoint leaders to positions of authority and control and to recognize their roles formally. This may be especially true for tasks where it is critical to get things right [KE08, p. 45].”* Authoritative management techniques are found in critical knowledge bases where researchers may propose new changes but expert curators are responsible for maintaining a cohesive structure and approve the changes [KE08, p.45]. When the article matures, the coordination effort drops and it is more effective to distribute to a larger group [KE08, p.45].

Chou et al. [CLY20] worked out that open collaboration is an important knowledge source, when different people with different abilities and knowledge work together. Each volunteer editor does a little bit of work and helps to grow in coverage and article size. However, there is a major concern when it comes to quality. They state that only around 0.6% of the articles are recognized as “Good Articles” (GA) or above like “A-class” and “Featured Article”. The “Featured Article” is the very best work and is characterized by professional standards of writing, sourcing and presentation. “GA requirements includes:

well written with no obvious mistakes and approaching the quality of a professional encyclopedia” [CLiy20, p. 30].

Also editors can be distinguished in quantitative scores by given scores to different characteristics as “content-shaping for creating article content; copy-editing that improves the writing; indexing that links articles to the Wikipedia category; reversion, which fights vandalism; vandalism, which damages articles; and link fixing which is the activity of fix link” [CLiy20, p. 30].

It is also important to consider the length of the stories. Information that is relatively long and forces a pedestrian to stop for a few minutes in one place is not desirable. The better solution is providing a summary and if desired the user can then have the option to request the long version [FTC<sup>+</sup>12, pp. 757-759].

Google also uses the data from the crowd which contributes to about 700,000 new places added every month in Google Maps. To collect this information Google uses Local Guides who are volunteers entering and editing data, uploading pictures of places, reviewing locations, tagging photos, adding roads, responding to QAs, rating businesses and so on [Dod22].

For each entry, the user gets points depending on the contribution and rises within levels. If a level is complete, the user starts with the next level and can earn points for the next contribution. In level four or higher the user gets a badge which is displayed next to the name when it appears in Google Maps. To become a *Local Guide* the user just needs to follow a simple sign-up process that is available to every Google Account [Sou22].

# Implementation

Our implemented solution is a user iterative design process. We did some user research and had a literature review to find out the important facts. After this process we defined our personas, did some wireframes, evaluated it with our users and worked the feedback into our mockup. After our mockup we conducted interviews again with our users and included the findings in the implementation process of our prototypical application. We evaluated the prototypical application with user tests, a questionnaire and a group discussion.

<i>PERSONA</i>	<i>Acknowledge</i>	<i>Profile URL</i>
EXPLORER	Photo by Harps Joseph on Unsplash	<a href="https://unsplash.com/de/fotos/7zcbtbI4E2o">https://unsplash.com/de/fotos/7zcbtbI4E2o</a>
EDITOR	Photo by <i>Jonathan Borba on Unsplash</i>	<a href="https://unsplash.com/de/fotos/5wgrPt1rnaA">https://unsplash.com/de/fotos/5wgrPt1rnaA</a>
REVIEWER	Photo by Harps Joseph on Unsplash	<a href="https://unsplash.com/de/fotos/tAvpDE7fXgY">https://unsplash.com/de/fotos/tAvpDE7fXgY</a>

Table 3.1: Appreciation images

## 3.1 Personas

From the literature review, we know that we have three main user roles. The “content creator”, the “reviewer” and the “explorer”. At first we started to define our personas and scenarios and we created two personas for each role, one male and one female. During the scenario defining we noticed that the “content creator” and the “reviewer” in our application need to have similar abilities like content editing. Only the approving and rating part is additional to the role of the reviewer. Due to the of the overwhelming work, we decided to define the “reviewer” role as our non-persona and cut down our

persona just to one example per role. We ended up with the “content creator” as our primary persona, the “explorer” as our secondary persona and the “reviewer” as our “non-persona”.

#### 3.1.1 Primary persona - Content editor

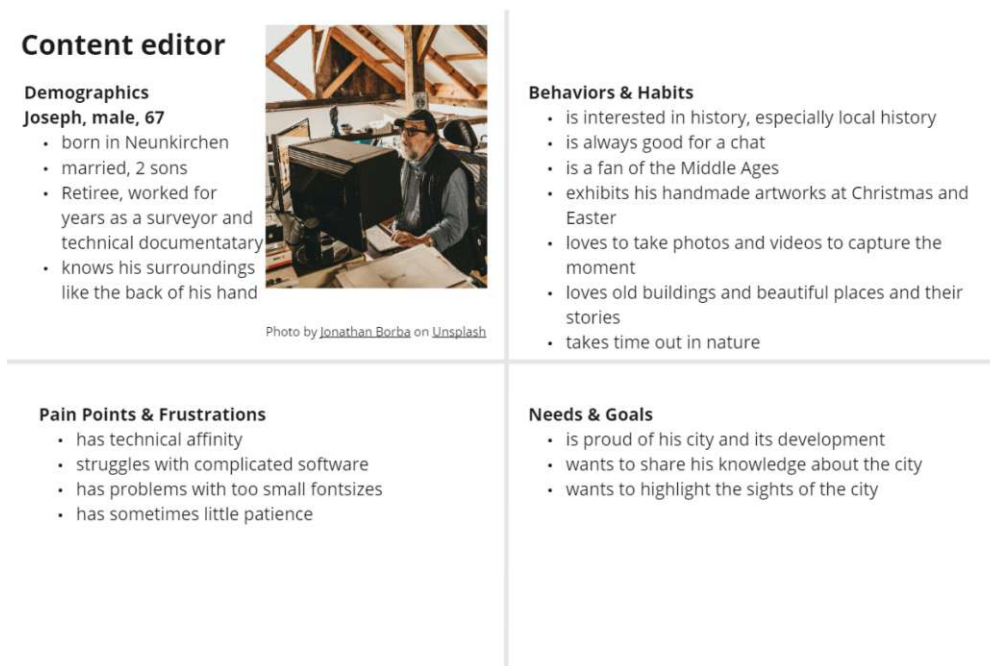


Figure 3.1: Primary persona - Content editor

#### Scenario description for the content editor

*Joseph* is a retired surveyor and technical writer, who knows his city very well. He was born in Neunkirchen, is 67 years old, married and has two sons. Every morning after he gets up, he puts on his shoes and walks around the neighborhood for about three quarters of an hour. Sometimes he sees interesting things that are easy to pass by, but since he takes the time to stop and look at them and take a picture, he can look them up on the internet and look up what they mean. Thus, he has already researched many interesting things about certain sculptures from the city park, paintings of buildings or even the stories of certain places. Sometimes on his walks he meets someone he knows and he chats with them about his lately discoveries but more often he comes home and shares it at breakfast at the kitchen table with his wife and his two sons. They are also very interested but sometimes he tells things more than once. From his work as a technical writer, he knows how to write documents, browse the web, and use different tools. Therefore, despite his age, he has no trouble to learn about new online-tools. He is very proud of the skill to keep up with modern technology, but sometimes he gets a little bit frustrated if the software is too complicated. He also struggles sometimes with small

font sizes or inappropriate contrast in applications. When this is the case, he is a little bit frustrated and he asks one of his sons for help. He is busy on weekends, working as a talented craftsman producing handmade bows and is very interested in history. You can find him on exhibitions where he presents his handmade work or where he gives training courses on how to build different tools which were used in the specific era. If he is not in an exhibition or training course, he likes to be outdoors and take photos and videos and explore the neighborhood and the nature. He wishes he could share his knowledge without having the feeling that he is smothering or boring his opposite with his knowledge during a conversation. He also wishes that he could capture the moment easier and start with a first draft when he is outdoors, because sometimes he forgets that he took a picture of a building or place and when he browses his phone gallery and accidentally sees the photo of his last discovery, then he remembers that he wanted to look it up back then.

### 3.1.2 Secondary persona - Explorer

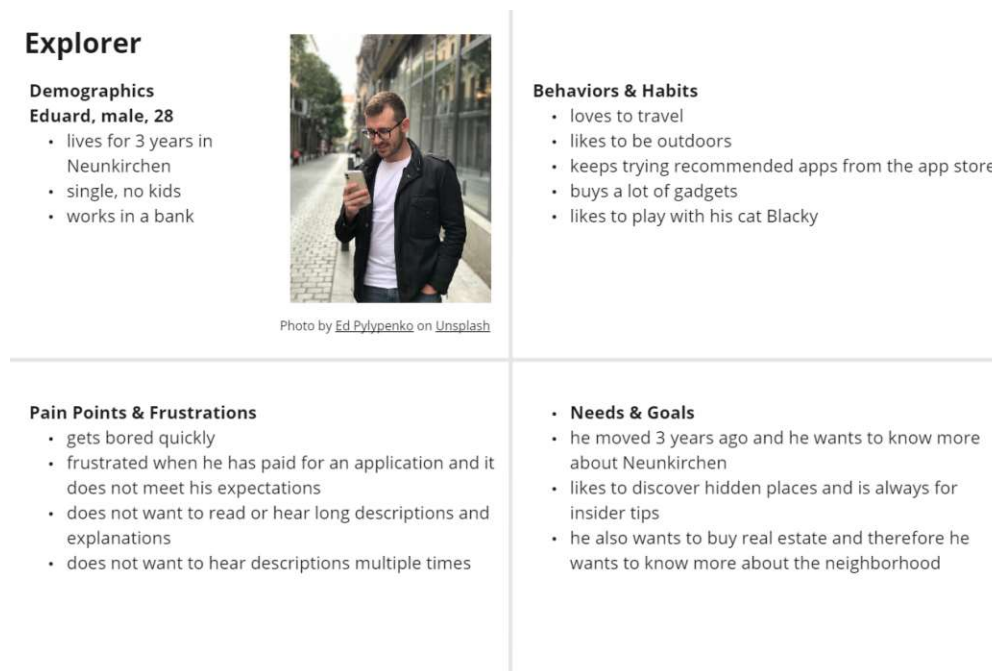


Figure 3.2: Secondary persona - Explorer

#### Scenario description for the explorer

*Eduard* is 28 years old man and lives in Neunkirchen. He is single, has no kids and moved there 3 years ago. He loves to travel, to be outdoors and to discover hidden places and insider tips. He works in the local bank, therefore, he also keeps an eye on his personal finances, thus, when he pays for an application and the application doesn't meet his expectations, he gets frustrated. If the application is for free, he is very tolerant with the



features and functionality. He always likes to try recommended applications, but he is a little bit impatient when the application has too long descriptions and explanations. He is always looking for the best gadget that supports his lifestyle. He has no car, and he walks to work. Sometimes after work, he takes different routes and detour just to wander around the city and to enjoy the different weather, people and locations. He is also interested in the local housing market, because he intends to buy real estate therefore he always likes to know the neighborhood and the history of the buildings. Sometimes his way home takes more than two hours, even though it is only two kilometers away.

### 3.1.3 Non-persona – Reviewer

#### Reviewer

##### Demographics

**Daniel, male, 35**

- born and lives in Neunkirchen
- married, no kids
- works in the museum, and runs the local library



Photo by Harps Joseph on Unsplash

##### Behaviors & Habits

- studied history
- is involved in the local politics
- makes various historical events and exhibitions
- lives his passion to the fullest
- has encouraged his wife to also participate in the exhibitions

##### Pain Points & Frustrations

- has basic technical knowledge, but does not want to deepen it further
- is sometimes too detailed and overwhelms the other person
- thinks it is a pity that there is so little public money for this area

##### Needs & Goals

- hopes that the city becomes more popular and the museum has more visitors
- wants to inspire the public, especially the youth for history and cultural heritage
- would like to acquire more public funds for this purpose

Figure 3.3: Non-persona - Reviewer

#### Scenario description for the reviewer

*Daniel* is a 35-year-old man who was born and raised in Neunkirchen and still lives there. He is married and has no kids. He works in the museum and runs the local library. He is very passionate about his work and likes to inspire the public, especially the youth, for history, books, museum exhibitions and cultural heritage. In the morning, when he wakes up, he starts his day reading the local newspaper. Then he goes to the library, where he works. For lunch he meets up local politicians and sometimes they also give him phone calls about specific topics and ask for his expertise. After lunch he goes to the museum, where he works as a custodian. He does various historical events and exhibitions and does all the marketing on his own, in order to acquire as much public money as possible to collect, save and store the cultural heritage for the next generation. He wishes that



politics would also recognize that small cities have a cultural heritage and that public funds are distributed more equitably. One of his greatest achievements is that he was able to convince the local politicians, that a museum is needed in a city, no matter the size it has and that cultural heritage is of paramount importance. He wishes that he could share this struggle with others and that other people would help to collect data and information about the city and the cultural heritage. If the data were to be available, he and his coworkers could just check it for correctness and approve the data. He also knows some people, who's profound knowledge he trusts and if he could give them access to enter data, without an approving process, it would be a tremendous relief in data collection.

## 3.2 Wireframes

From our personas and scenarios we were able to design our wireframes. The wireframes were created in *MIRO* and evaluated by 5 users with whom we conducted the interviews. The users were two woman and three men, all in the age between 27 and 37. Four of the interviews were conducted face to face and one of them was via Microsoft Teams. The interviews were between 30 minutes and 1.5 hours and were recorded, transcribed and relevant data was extracted. The wireframes contained the *exploration*, the *content creation* and the *reviewing part* and the interviewees could evaluate all three parts.

### 3.2.1 Wireframe for the exploration application

The aim of the exploration is for a user to wander around the city and get information akin to an outdoor audio guide for a specific building, place or monument with minimal distraction from the mobile phone. Therefore, we want the option for the user to put the cell phone in the pocket in order for him or her to be able to concentrate fully on the experience. The user will be located via GPS and the application will know where he or she actually wanders around. The user will control the application via voice commands, for example, to adjust settings or to navigate through the narrative. When the user starts his or her walk, he or she will get the information about a POI. Here, the explorer will get the short version first and only if he or she also wants to hear the long version afterwards, he or she will be able to control this via a voice command. Additionally it will be possible that the user can set an option in the settings that he or she should always hear the long- and the short description of a POI. If the explorer already passed a POI, he or she won't hear the already visited POI twice. Should the user want to look at additional media of a POI, he or she would have to get out his or her smartphone and start the media via voice command. Furthermore, adjustable settings will be controlled via voice commands as well. It will also be possible for the user to add an interesting POI right where he or she stands.

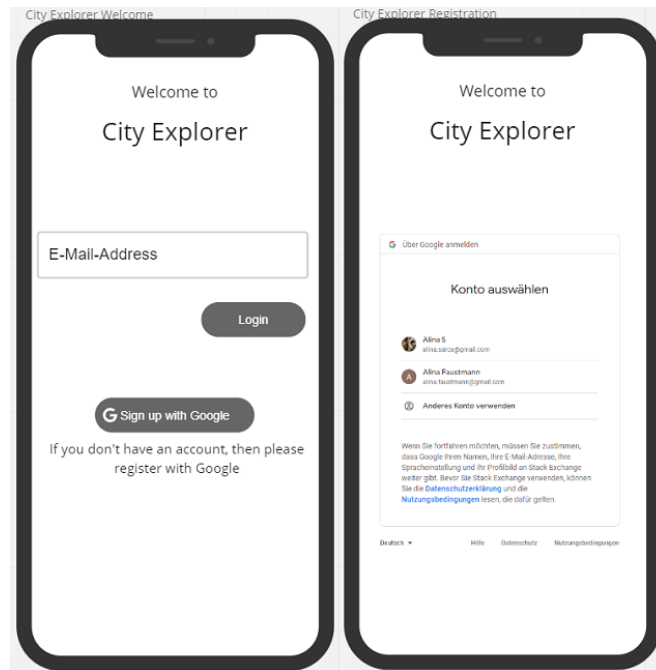


Figure 3.4: Wireframe for exploration - Login and Registration

In the Figures 3.4, 3.5 and 3.6 we see the screens from the wireframe for the exploration application. It contains a login and registration with a Google Account. Then the application starts in the home screen like in Figure 3.4.

The *Home* screen is an additional information to what is currently playing. In the home screen, the user can also handle the media files or navigate to another view, for example, the next view or the detail view where the explorer can see other POIs which are in the neighborhood. An indicator shows you, which POIs he or she already heard in a specific impact radius. These two screens are shown in the Figure 3.5.

It will also be possible that a user can quickly add a new POI. For example, he or she stands right in front of a church, takes a picture and adds the POI with the current GPS coordinates of the device. This information will be edited in the *content creating application*. The settings page will contain some common adjustable settings like the impact radius, which defines how far a POI can be so that the application starts reading the data. The speech speed will be selectable from a given drop down. The initial speech speed would be “1” and get faster by a factor, for example, with “2” the speech speed would be two times faster than normal. Also it should be possible to change the reading voice. These screens are shown in Figure 3.6.

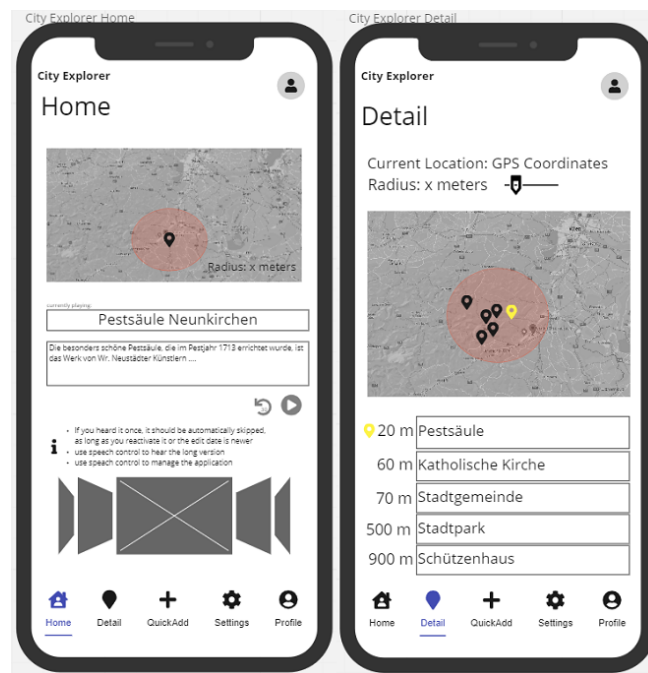


Figure 3.5: Wireframe for exploration - Home and Detail

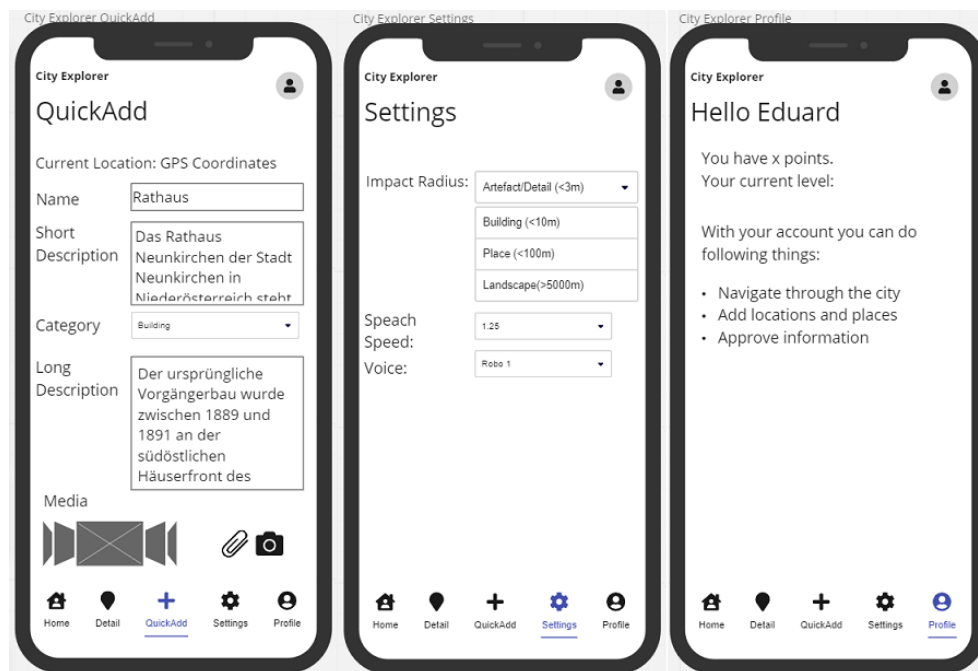


Figure 3.6: Wireframe for exploration - Quick Add, Settings and Profile

The application will also be controllable via voice commands. The voice commands will be indicated by a keyword, for example, “EXPLORER” and then the actual command. Examples for commands are in the Table 3.2.

<i>Command</i>	<i>Description</i>
EXPLORER SKIP	Skips the current POI
EXPLORER LONG VERSION	Long description of the current POI is played
EXPLORER LONG DESCRIPTION	Long description of the current POI is played
EXPLORER SHORT VERSION	Short description of the current POI is played
EXPLORER SHORT DESCRIPTION	Short description of the current POI is played
EXPLORER SHOW MEDIAS	Shows the media files the current POI
EXPLORER PLAY AUDIO FILES	Plays the audio files the current POI
EXPLORER ADD NEW POI name	Adds a new POI with a name
EXPLORER ADD SHORT DESCRIP-TION	Adds a short description to the currently new created POI
EXPLORER ADD LONG DESCRIP-TION	Adds a long description to the currently new created POI
EXPLORER SET RADIUS TO x ME-TERS	Sets impact radius to x meters
EXPLORER SET RADIUM TO ARTE-FACT   DETAIL   BUILDING   PLACE   LANDSCAPE	Sets the impact radius to one of the values
EXPLORER SET SPEECH SPEED TO 0.5   0.75   1   1.25   1.5   2	sets the speech speed to one of the values
EXPLORER SET VOICE to ROBO1   ROBO2   ...	Sets the voice to a predefined voice selection

Table 3.2: Voice commands for the exploration application

### Evaluation of the wireframe for the exploration application

All interviewees thought that the login with a Google Account is a good idea and no one wanted to have another authentication. However, after the login, one pointed out that there should be another screen, which has a collage or a feed of the new added POIs in the application. The current *Home* screen should be called *Exploration* and the *Detail* should be called *Neighbourhood*.

The *Home* view which should be called *Exploration* view, should have a map which is more zoomed in and the streets need to be visible. Also the current position should be marked by a specific icon. If the user approaches a POI and he or she does not want to hear it, then skipping should be possible. If he or she skipped the POI by accident, then it should be possible to revert the last skipping. One participant also thought that having a playlist connected to the application would be interesting and if the explorer comes across a POI, the music should fade out and the voice should start. After the announcements of the POI the music should automatically fade in again. No one else needed this function but another interviewee could imagine that others might use this if it would be connected with a Youtube (<https://www.youtube.com>) or

Spotify (<https://open.spotify.com>) playlist. Another interviewee pointed out that an acoustic indicator should be played before and after the voice of a POI. Another wanted to have a vibration before a POI. When approaching a POI all asked on how the media files get integrated and accepted the current idea of just accessing it in the application. But some of them said that it would be nice if the audio files could be played automatically after the text or each media gets a description, which is played after the POI description. One also wanted to integrate the media in the description. For example, “you are in front of a church, then the voice is saying something about the church and then the audio file of the church bell is playing and then the text says you can enter the church and in the church there is a audio with the church organ” one of the interviewee said.

It would also be nice if the user could add friends and see in the *Exploration* view if a specific POI was visited by one of his friends or if the friends liked the POI. It should also be possible to say if the user likes the POI by him- or herself with a thumb up/down. One interviewee thought of grading the content with stars and a comment area, but discarded this idea, because it would open up a door for vandalism and unjustified comments. Two interviewees also wanted to have a report function for unsuitable media files or content. Most of them did not want to know the author of a POI, but one of them asked specifically if it is possible to follow an author and his content, for example, by getting a newsletter.

The *Detail* view and in this case the new *Neighbourhood* view, should not only have an indicator of the already heard, but also an indicator if there were content changes in the already explored POIs. For example, if the content changed more than five words or a new media file has been uploaded. The application should highlight the changed POI. Also a voice command would be nice for resetting an already heard POI, but it is enough if the application would offer this in the view. Also some thought that it would be nice if there were a newsletter for new or edited POIs. For example, the user gets a newsletter once a month or adjustable in the settings.

All of the interviewees were very enthusiastic about the *QuickAdd* view. Some of them asked, if it should also be possible to add a private POI and a global POI. The private POI should contain, for example, private pictures like selfies (Interviewee 1, 08:26) and additional information which should not be visible for other users in the application and should be visible and downloadable in the “content creation application”.

The *Settings* page should add some settings like a selection if the user always wants to hear just the short description, just the long description or at first the short description and then the long description. It should also be possible for a user to change the newsletter settings so a user can choose what type of news he or she receives or even to turn off the newsletter as a whole. A setting for defining the user’s home position is needed, because if the user wishes for a different newsletter, for example, new POIs from his or her neighbourhood in the range of 20km, then the application needs to know what the current home position of the user is.

The “impact radius” should be the “broadcasting radius” [Lø11, p. 195] and a combination of a type/category and the impact radius in meters. Some thought of, for example, “*I want all buildings from a specific time within ten meters*” (Interviewee 5 , 45:30). This also needs to be considered in the content creating application. One also wanted to have a type with “personal narratives” from other people.

One interviewee asked if it would be possible to change the theme and font sizes. For example, that the application offers a bright and a dark mode and the possibility of bigger letters. Others asked if there will be a language selection for the application. For example, the application and the content is in German and there should be a default fallback language for example, English if the language does not exist in the application. Another asked if the displayed map could be the satellite imagery and not the standard map and if it could be switched between them in the settings.

Some of them asked if the application could offer a route planning function, but this is out of the applications scope and all understood that the applications focus lies within the serendipitous exploration and enjoying strolling through the neighborhood without focusing on a specific target.

The *Profile* view could also be expanded by some features. For example, with the newsletter-settings or information about *Terms of Service*, *Security* and *Privacy Information*. These should be accepted when the users registers and could always be looked up in this view or in a separate one. Some wanted to have an overall statistics about how many users visited your created POI or the information of the rating from the reviewing process. One pointed out that the “Profile icon” and access in the bottom navigation is not necessary if the application has a profile access in the right corner. Also, if there are more pages, then more than five icons would be kind of overwhelming.

#### 3.2.2 Wireframe for Content Collection

In the content collection application, it will be possible to login as seen in Figure 3.8a. The user should be able to register with an Google Account as shown in Figure 3.8b and then to add and edit data like in Figure 3.9a. The whole workflow of the content collection can be seen in Figure 3.7. The user can login or if he or she does not is registered yet, the user needs to sign up with the Google Account as displayed in Figure 3.8b. There he or she needs to accept the terms and conditions and afterwards he or she can login in the application.

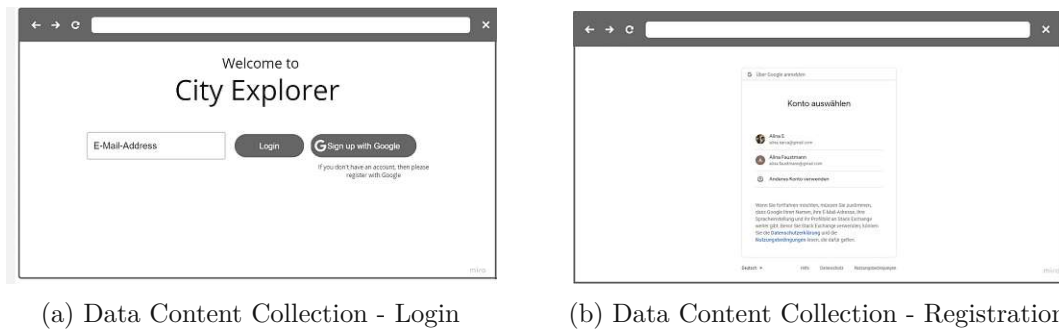


Figure 3.8: Data Collection

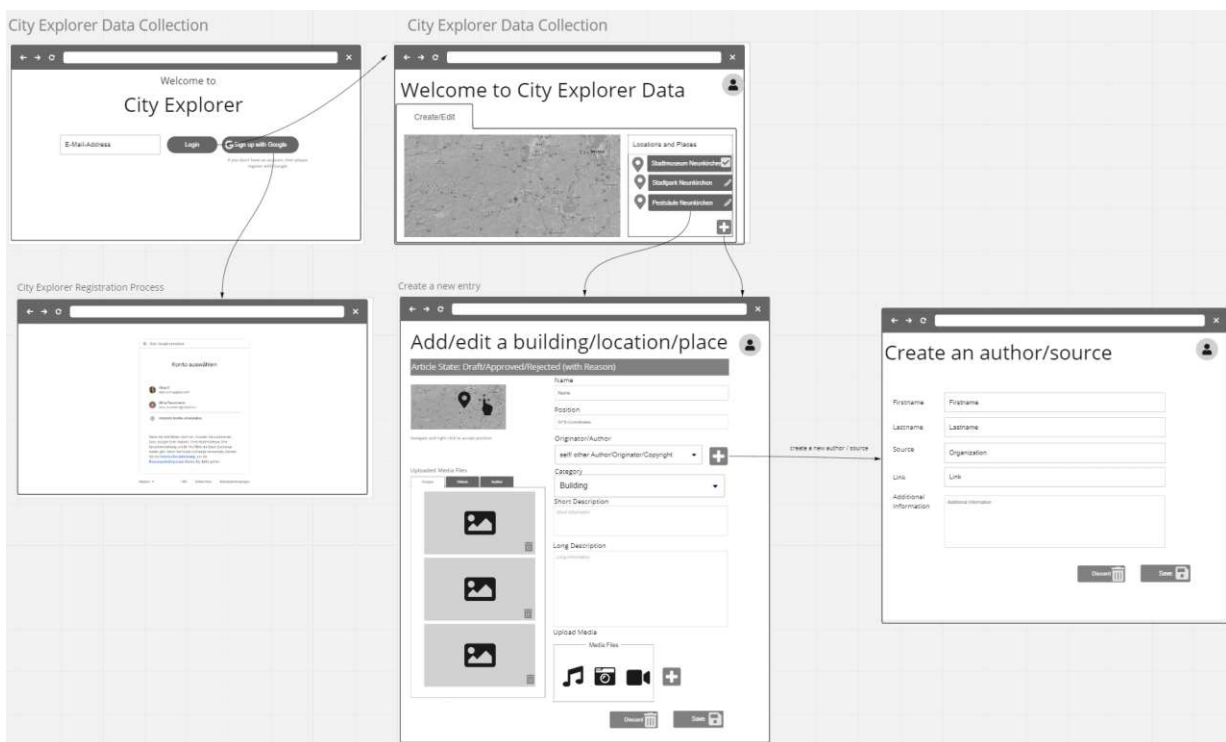


Figure 3.7: Content Collection Wireframe

After the *Login* screen as displayed in Figure 3.8a the user will get an overview of his or her personally created POIs and create a new entry. He or she will also be able to change data which he or she created in the “Content Collection” application or in the “Explorer Application”. For the entries, it will be possible to set and adjust the GPS coordinates, the name, a category, a long- and a short description and upload media files as seen in Figure 3.9b.

Also it will be possible to select or add a new author 3.10. After saving the POI, the data will be checked by a reviewer and if this process was successful, it will be displayed in the



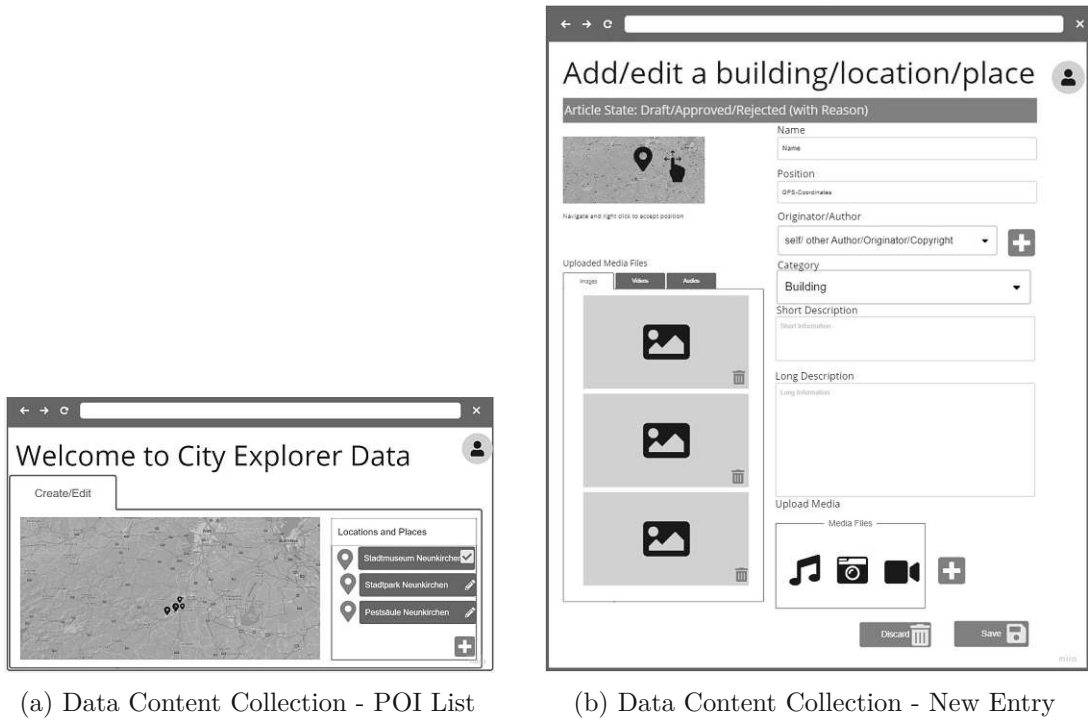


Figure 3.9: Data Content Collection

list with an approved-icon and the entry will be available in the “Explorer Application”. However, the approving-process is out of the scope of this diploma thesis. Nonetheless, we will mention it in Subsection 3.2.3 about Wireframe for Reviewing.

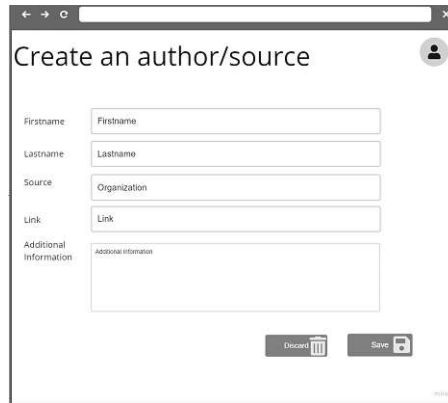


Figure 3.10: Data Content Collection - Author/Source

### Evaluation of the content collection application

The interviewees liked the fact that users could enter data, but they also wanted to add addition data and POIs which are just privately visible for them and not for others, to



use for selfies at the POIs. This data should be also visible in the “content collection application” and downloadable as a kind of “my journey”. They also wanted to see all existing POIs from others and to comment on the descriptions or upload new pictures to a POI, or to report a content or a media file. The reviewer would get the reported and commented data and could take further steps. Therefore, the author dropdown should be erased, because the entry author will always be the currently logged in user and a new reference list, which could be used in the description and the media files, should be inserted. Media files would then also have a reference and a description. The category dropdown should be a multi-select for specific categories like interesting epoch, interesting architecture, building, place, artefact or monument. For example, this is a “building” and a “medieval period”. The arrangements of the controls should be: position, category, name, short description, long description, references as a list and media files. One thought about a kind of advanced integration of the uploaded media files as a “timeline” in the description. For example, the user is in front of a church and the description is played and then the audio file for the bell is playing and also the additional description for the media file and then the description of the POI is played again and so on. Adding a category should be possible for the editor. Also a selection of the language and creating a new entry in another language was requested.

### 3.2.3 Wireframe for Reviewing

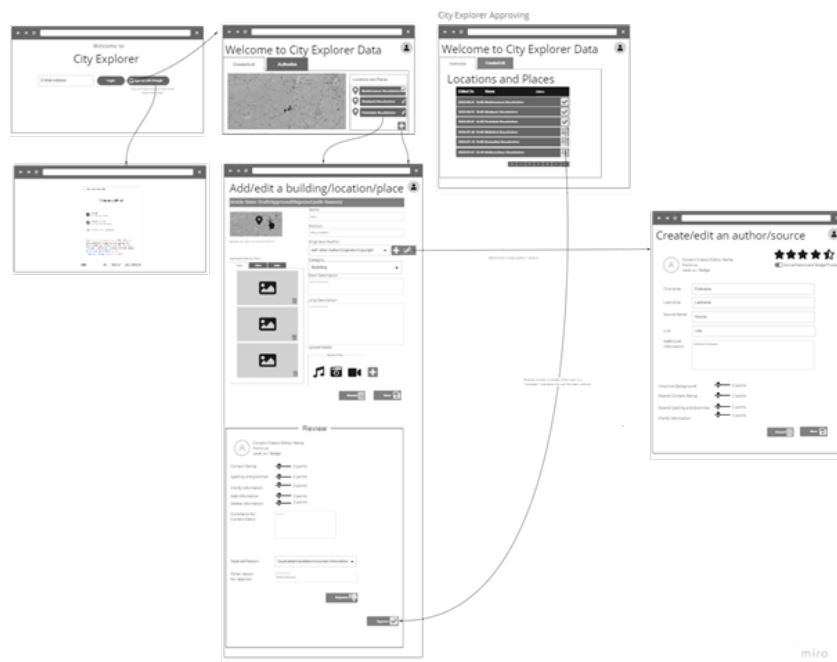


Figure 3.11: Content Reviewing

The design of the “Reviewing” application will contain the functionality of the “Content Collection” application but will also include an authoring tool where special users called

reviewers can review data from other user and approve it for the “Explorer” application.

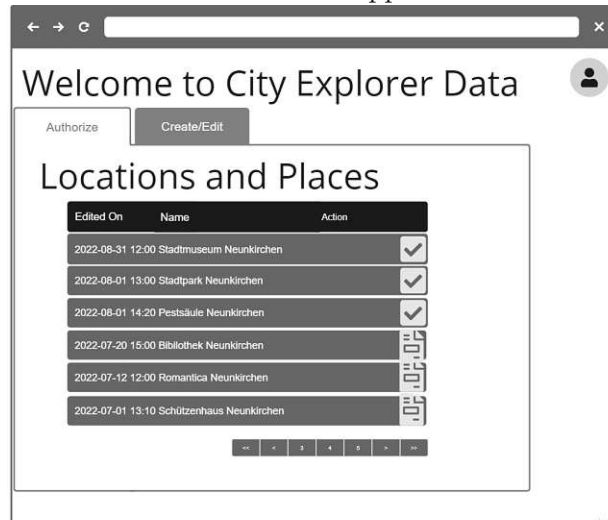


Figure 3.12: Content Reviewing

After a login with the Google Account it will be possible to add and edit new POIs but also to review data from other authors. The login and registration process is the same as for the content application and the views are shown in Figure 3.8a and Figure 3.8b.

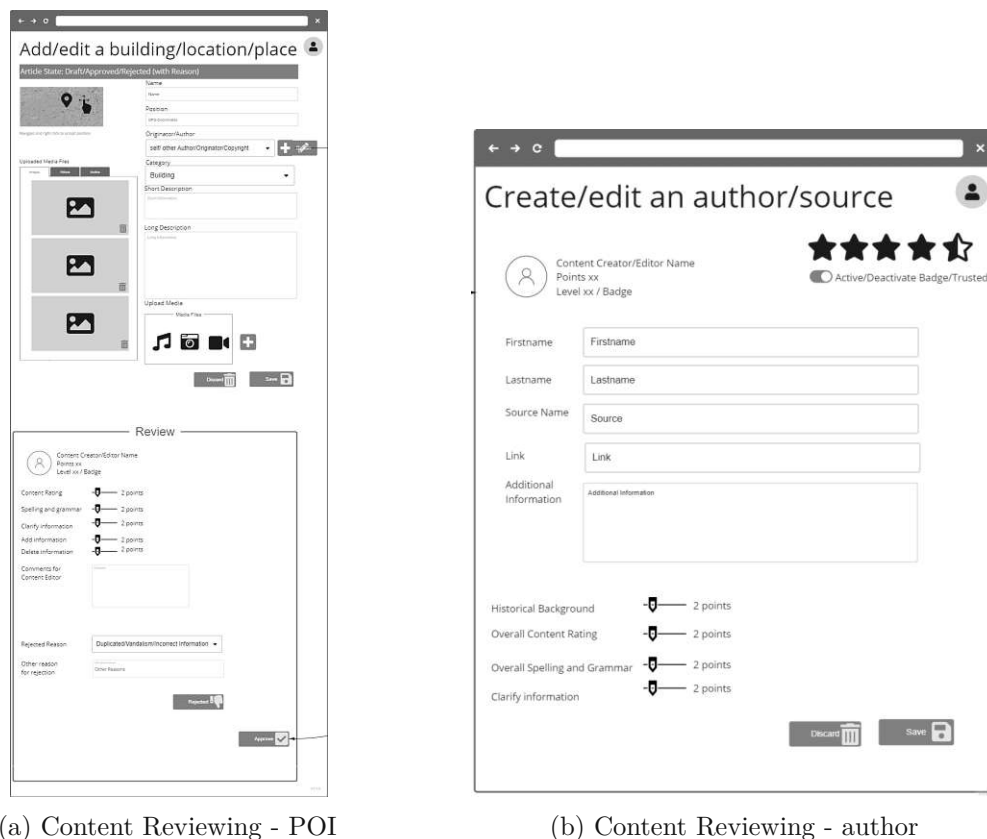
All open data for reviewing will be displayed in a list and already reviewed data gets another icon as seen in Figure 3.12.

The review will contain the rating of the content which can be seen in Figure 3.13a and the rating of an author which is shown in Figure 3.13b.

The review of the content will contain scoring, giving points from “1” to “10” in the following categories described in Table 3.3. The more points, the better the scoring. We use the categories that are mentioned by Chou et al. [CLIY20, p. 38] and adopt them for our needs.

The content will be approved or rejected with a reason and comments from the editor. The author will then get points and will rise within a level. If he has a specific level, he will get a badge and the reviewing process will not be necessary for his entries.

The reviewer will be able to remove the badge at any time if the user is no longer trusted. The rating for the author will be automatically calculated from his content rating points and displayed in the authors-view. The rating of the historical background of the editor will be set manually by a reviewer by assigning points, all other ratings will be calculated by summing up all the rating points an editor got for his content contribution. To create an author, it will be possible to add a first name, last name, a link and additional information to describe user characteristics. The source will also be added if the author is not the original source but got the information from another person, a book, an article, etc.



(a) Content Reviewing - POI

(b) Content Reviewing - author

Figure 3.13: Content Reviewing

<i>Rating category</i>	<i>Description</i>
Content Rating	How accurate and easy to read was the content
Spelling and grammar	How good was spelling and grammar (10 is no errors, 1 would indicate too many errors)
Clarify information	Was it necessary to clarify the information (10 no need for clarification, 1 too much work to clarify the information)
Add information	Information was missing and information needed to be added (10 no information needed to be added, 1 a lot of information is needed to be added)
Delete information	Was it necessary to delete information (10 no information was needed to be deleted, 1 too much unnecessary information is needed to be deleted)

Table 3.3: Content Rating Table

#### Evaluation of the reviewing application

There should be a distinction between authors and references. The author is always the logged in person, the so called “editor”. The POI content can have many references, therefore, there should also be a reference list, where the user can select from references. The references could also be books, websites with access time, academic articles, videos, etc. but a POI content can be submitted without a reference (Interviewee 2, 10:02-10:51). Therefore, from the findings of (Interviewee 2, 05:12-09:05), there should also be an authors/editors list, where, for example, the reviewer can remove or manually grant the badge or block an author/editor completely from the application. Furthermore, a reason why the badge was removed or why the author is blocked should be given. There should also be a contact form, where a author can claim his badge back or where a author can apply for unblocking.

The “Historical background” rating should be a multi-select or a free text. For example, if the user is a historian, librarian or a historical exhibitor. The information should cover the fact that the editor is a professional or specialist.

In the mockup feedback (Interviewee 1, 37:26) it was also stated that the region and the radius of an editor is important. For example, that one is just an expert for a city like Korneuburg, but not, for example, for Neunkirchen.

A POI can have many authors/editors, because an editor can always comment on the content of an existing POI and the reviewer then needs to accept the change or merge the data. However, adding new media or reporting media from other editor’s content still needs to be reviewed from the reviewer, even if the editor has a badge. The editor can just pass without reviewing if he or she created the POI entry, but not if he edits a content from other editors.

### 3.3 Mockups

For our wireframes, we redesigned the mockups based on our findings from the wireframes. The mockup was created with figma using the default style from figma basics. The icons were font-awesome free icons and the persona images were from [unsplash.com](https://unsplash.com) as shown in Table 3.1.

All other images in the mockup or used in the prototype depicting the city were taken with a personal mobile phone or taken from the book *Neunkirchen für unsere Gäste und Einheimische - Ein Kurzführer über die Geschichte und sonstiges Wissenswertes, verfasst von Wolfgang Haider-Berky* [HB20]. A great amount of historical content was also taken from this specific book or from different websites, for example, for *Bräuhaus Neunkirchen* [Bau], which is used in the wireframe and translated to English, we used the data from their chronic page [Bau]. This references will be considered in the content of the POI. Some test data is also from the points of interests itself as many had boards or plates on the monuments, artefacts, walls, stones or art figures. Some examples are presented in Figure 3.14.

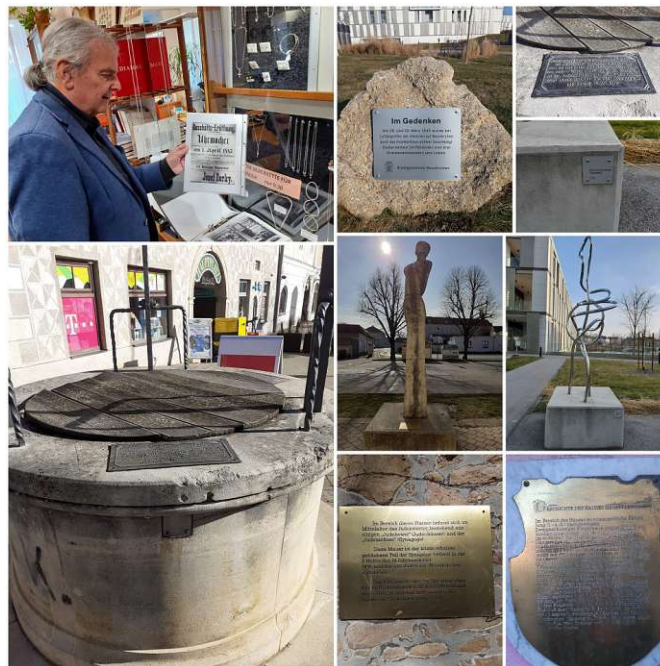


Figure 3.14: Different data sources and Wolfgang Haider-Berky in his office

We created two different mockups in figma. One for the “explorer” and one for the “content editor” role. The mockups for this two roles were described in the following sections.

### 3.3.1 City Explorer Content Mockup

Many projects use carefully composed media and users do not have the possibility to contribute their own content [Lø11, p. 193]. We want to change this and strive to focus on story telling of the inhabitants. You just need to sign up, register and can start to contribute content. It should be a website so that we are not limited to any mobile operation system, therefore, that we want to do this cross-platform, so that we contribute the ‘participation’ of the GPS-model and make it available to everyone’s devices [Lø11, p. 189].

The Content creation mockup contains the login and registration process including accepting the terms and conditions.

The login and registration process is shown in Figure 3.15.

### 3. IMPLEMENTATION

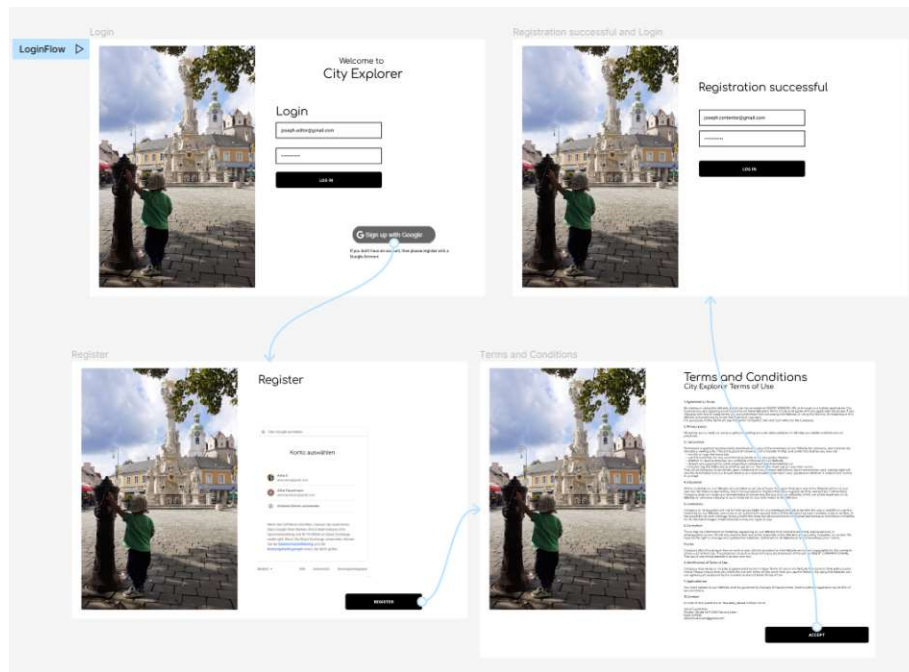


Figure 3.15: Process of login and registration

After the login there is a *Private Content* section and *Public Content* section. In this list in the right corner there is the profile icon and the user name. By clicking Figure 3.16 on the image the profile page appears. This can be seen in the Figure 3.21. The logout button is also in the right corner and redirects to the login-page.

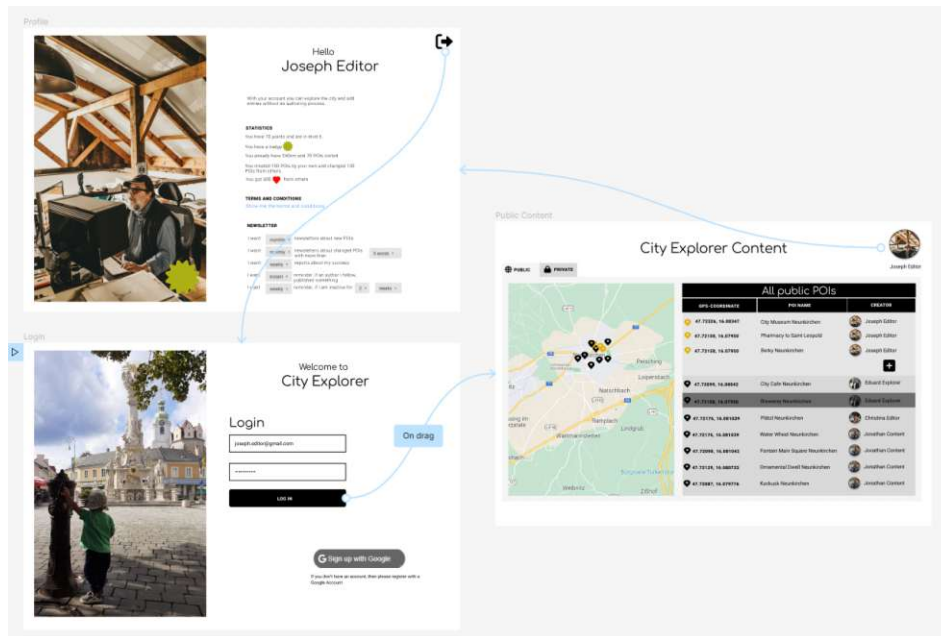


Figure 3.16: Profile-process



The “City Explorer Content” contains two main registers. The “Public POIs register” and the “Private POIs register”. The *Public POIs* contains all Points of Interests (POIs), which the user created on his own and the POIs which are created by other editors and marked as “public”. This means the POIs are visible for all users and available in the City Explorer. The “private” ones are just visible for the user who created the POI.

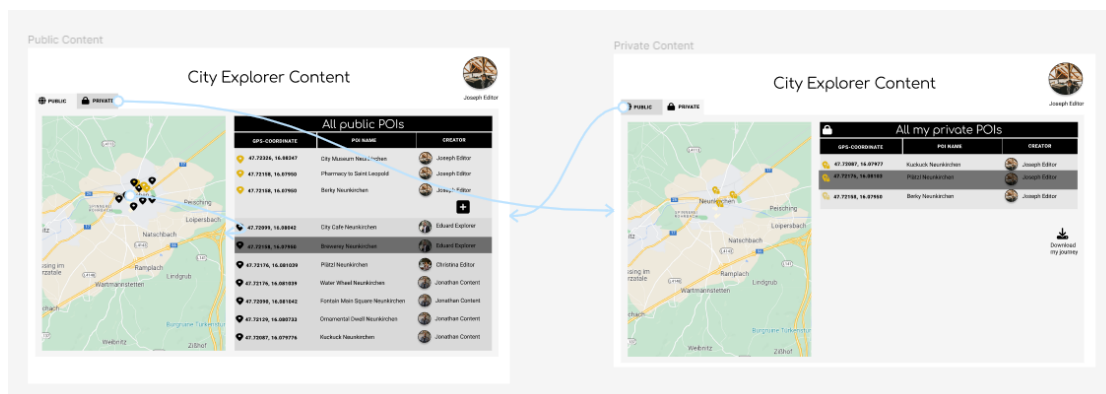


Figure 3.17: Public and private POIs register

The personal public POIs are shown in a map by a golden marker and the POIs of other editors are shown in black. This can be seen in Figure 3.18.

Personal POIs can be accessed by both registers. The own public POIs in the “public POI register” and the personal private POIs in the “private POI register”. After accessing a POI it is possible to change the position and adapt the information, which was created in the explorer application by the “QuickAdd”. It is also possible to create a POI in both registers.

POIs of other editors can just be annotated or, if needed, reported. The user can suggest a different text or upload a new image to a foreign POI in the annotation process. Additionally it is also possible to report a wrongly uploaded image or report the entire POI.

This feature can be seen in Figure 3.20. Private POIs are also displayed by a golden marker with a lock. This POI is just visible for the creator. Additionally, it should be possible to download all the private POIs as a summary in a HTML-file or a PDF-file, shown in Figure 3.19.

By clicking on the register tab it is possible to switch from the public to the private POI register, as shown in Figure 3.17.

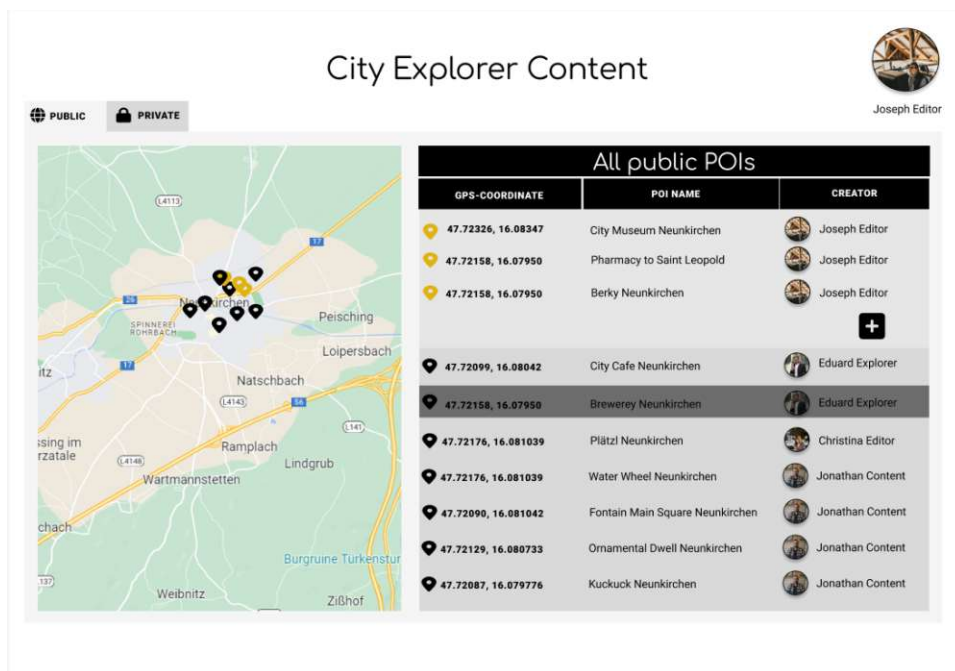


Figure 3.18: Public POIs register

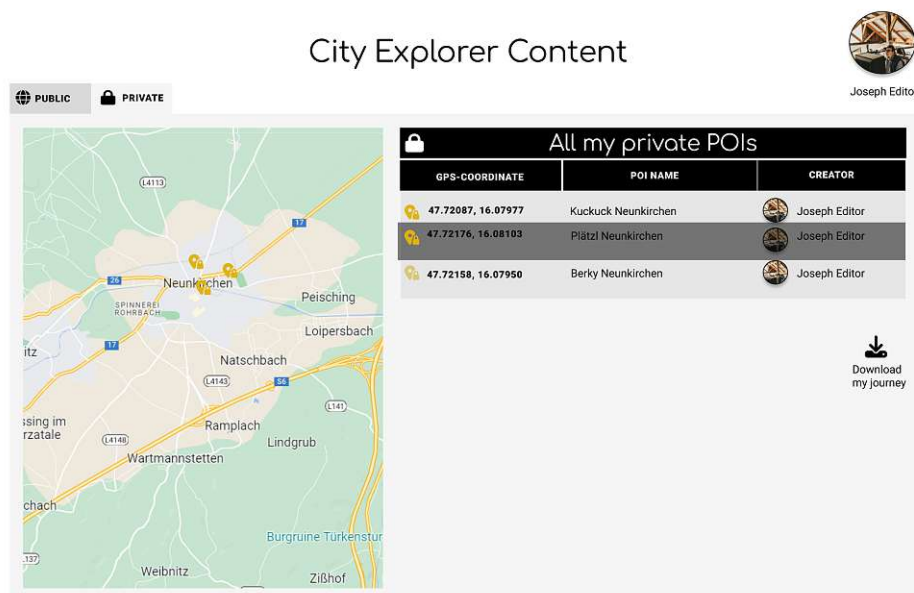


Figure 3.19: Private POIs register



City Explorer Content - Changing other POIs



### Brewery Neunkirchen



**Media Files**




report symbol on hover and click

Are you sure you want to report this media?

🗑️
✓

**Category**  
Building (<10m), Era before 1500

**Short Description**

The foundation walls probably date back to the late 14th century. For a long time it was assumed that the main square was built on the remains of a Roman settlement. Due to the lack of archaeological research possibilities, this issue could not be concluded yet.

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🗑️
✓

**Long Description**

In 1485 Neunkirchen was conquered by troops of the Hungarian king Matthias Corvinus. In 1529 and 1532 the market Neunkirchen was completely destroyed by the Turks. Around 1600 the market was rebuilt. The Renaissance burgher houses are built, also the Old Brewery House may have been a burgher house or tavern at that time. In the late 17th century the brewery was built. In 1683 the market was again burned down by Turkish hordes. After the reconstruction on February 18, 1694 first documentary mention as 'Brauhaus'.

1733 renovation of the house. During renovation work in 1926, the remains of a sundial from 1652 were discovered, which still adorns the east facade. One can see baroque depictions and the motto: 'Serius et citius mentiam prope inusad unam. Sera nimis, vilia est crastina -Vive hodie!' (Much too late is the life that is postponed to tomorrow - Live today!)

The beer production was stopped around 1880. After changing tenants and owners, the Old Brewery was acquired by the Schwechat Brewery and the front part continued as an inn.

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🗑️
✓

**References**

[1] <https://www.altes-brauhaus-neunkirchen.at/index.php/chronik>

[1] <https://www.altes-brauhaus-neunkirchen.at/index.php/chronik>

🗑️
✓

REPORT POI

DONE WITH COMMENTING

Figure 3.20: Annotate

The user profile contains the details of the person. It is displayed if the user has a “editor role” or just an “explorer role”. It is also displayed if the user has a badge, how many kilometers the user has walked with the app and how many other users liked the POIs he created. This is displayed by a heart icon. The user can read the terms and conditions and can set the preferences for the newsletters.

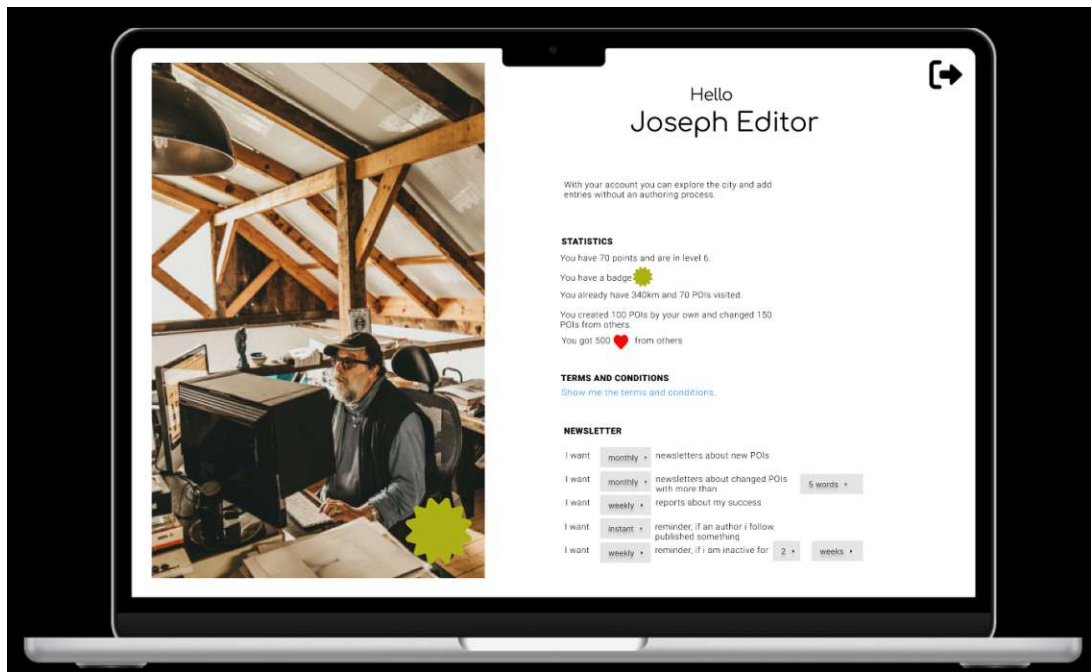


Figure 3.21: User Profile

The user can choose the following newsletters in different frequencies like “instant”, “daily”, “weekly”, “monthly” or “never”.

- newsletters about new POIs
- newsletters about changed POIs (for example, when 5 words changed)
- reports about the success (statistics about walked distance and visited POIs),
- reminders if an author he/she follows has published something new
- reminders if the user is inactive for a given time (for example, 2 weeks of inactivity)

### Add and edit own POIs

It should be possible to add new POIs and edit personal POIs. This process is shown in Figure 3.22. Coming from the City Explorer Content page, there is the first table with the personal public points of interest. These POIs are displayed as golden marker. If we press the [add]-button now the user with the “editor” role can enter new data. This data is shown in Figure 3.23 where the user can enter the POI data, upload images and create references.

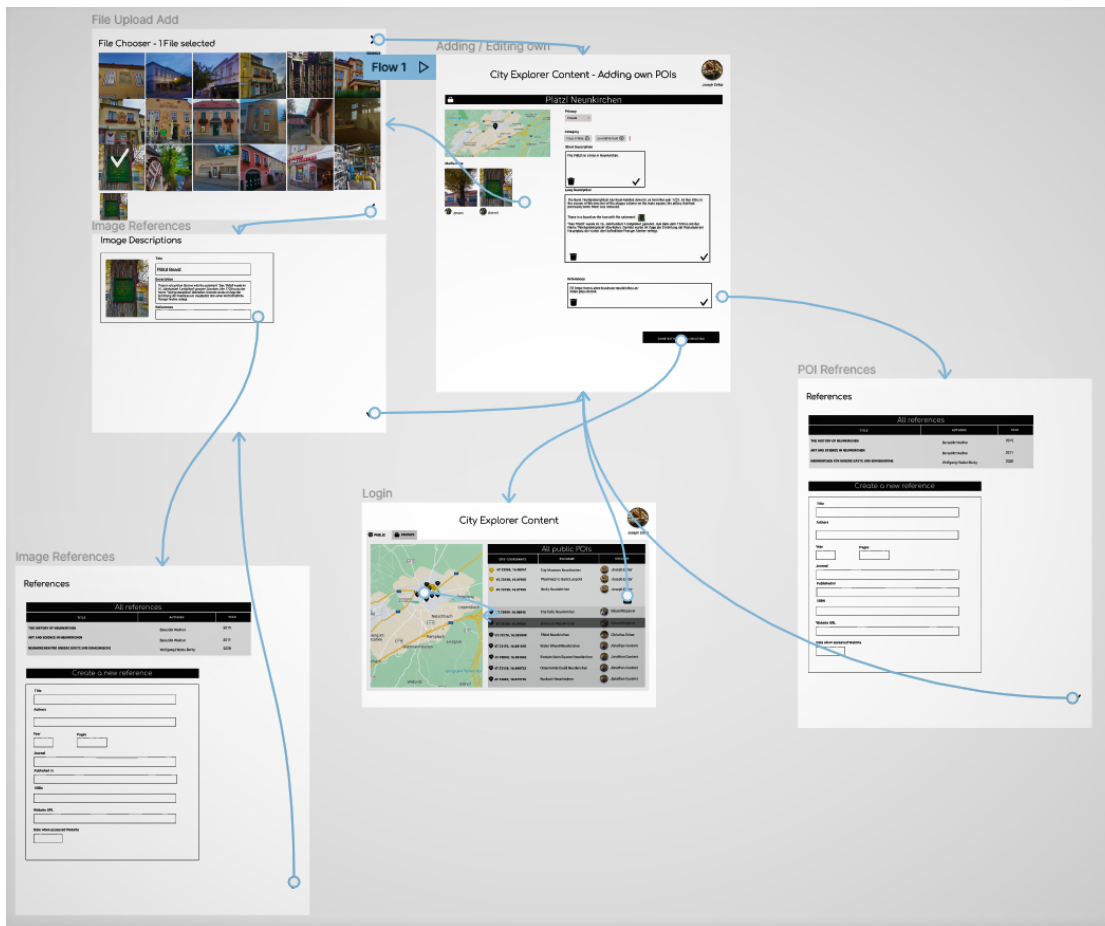


Figure 3.22: Add or edit own POIs

The user can define if the POI is a private or a public POI. The editor can position the new POI and define the category. The categories are predefined and are, for example, a “Monument”, “Artefact”, “Building”, “Landscape”. However, due to the fact that we figured out in our wireframe evaluations that multiple categories should be assigned, we also can have epoches like “Roman Antic”, “Romantic”, “Gothic”, “Renaissance”, “Barock”, “Classicism” or “Modern”. And some of the interviewees also wanted a category like “User Story”, which means a POI can have multiple categories.

The POI can also have a title, a short description and a long description. This information is given in the output of the text-to-speech. Additionally, it should be possible to add media files to a POI. This should be possible by clicking the paper clip icon. By doing this a file chooser should be possible where the media files can be selected. This is shown in Figure 3.23.

## City Explorer Content - Adding own POIs



Joseph Editor

🔒 **Plätzl Neunkirchen**



**Media Files**




 @geduard

 @geduard

**Privacy**

Private

**Category**

Place (<10m) | Era before 1500

**Short Description**

The Plätzl ist a tree in Neunkirchen.

🗑️
✓

**Long Description**

The Bane Teichgrabenplätzl has been handed down to us from the year 1723. At that time, in the course of the erection of the plague column on the main square, the pillory that had previously been there was removed.

There is a board on the tree with the statement: 

"Das 'Plätzl' wurde im 16. Jahrhundert 'Lindplätzl' genannt. Aus dem Jahr 1723 is uns der Name 'Teichgrabenplätzl' überliefert. Damals wurde im Zuge der Errichtung der Pestsäule am Hauptplatz der vorher dort befindliche Pranger hierher verlegt.

🗑️
✓

**References**

[1] <https://www.altes-brauhaus-neunkirchen.at/index.php/chronik>

🗑️
✓
+

DONE WITH EDITING/CREATING

Figure 3.23: Adding or changing own POIs

After the file chooser opens as seen in Figure 3.24, the user can select the media files, enter the media descriptions by giving title, description and reference. This screen is seen in Figure 3.25. For the references, the reference library should be opened and the user is enabled to select a respective reference from the reference library, shown in Figure 3.26. If a specific reference is not available, the editor should be capable to add a new references by defining the title of the reference, specify the authors, define if it is a journal or give an ISBN, specify the year, pages and where it is published or say if the information is from a website by giving the URL and specify when the data was accessed.

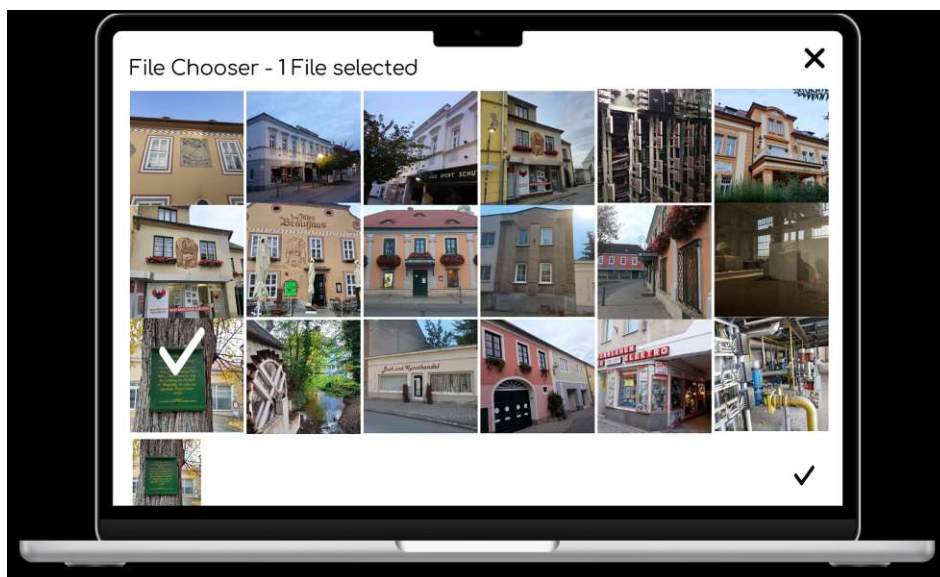


Figure 3.24: Adding images

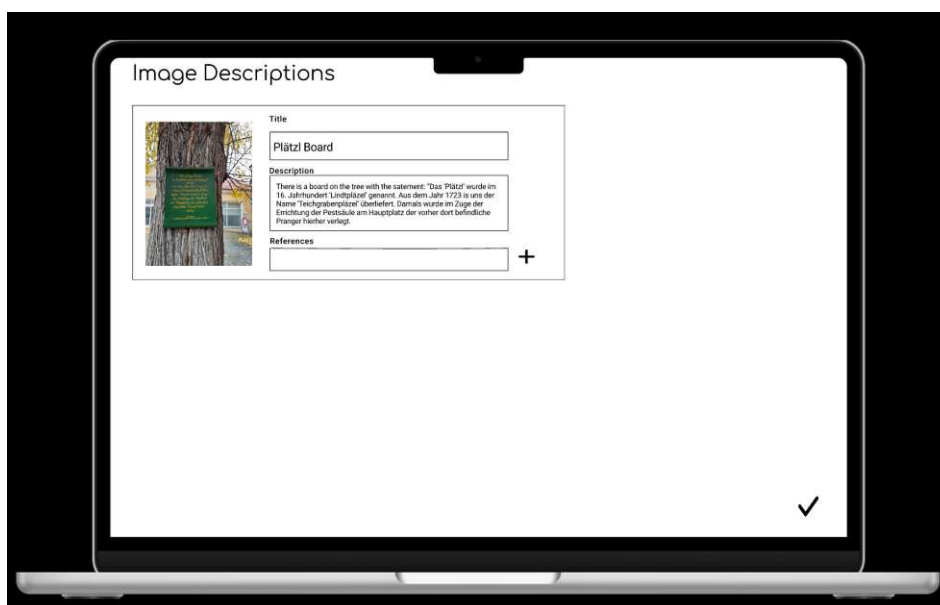


Figure 3.25: Adding images and image descriptions

## References

All references		
TITLE	AUTHORS	YEAR
THE HISTORY OF NEUNKIRCHEN	Benedikt Wallner	2015
ART AND SCIENCE IN NEUNKIRCHEN	Benedikt Wallner	2011
NEUNKIRCHEN FÜR UNSERE GÄSTE UND EINHEIMISCHE	Wolfgang Haider-Berky	2020

Create a new reference

**Title**

**Authors**

**Year**  **Pages**

**Journal**

**Published in**

**ISBN**

**Website URL**

**Date when accessed Website**

Figure 3.26: Adding image references

Changing other users POIs is only possible in cases of an annotation process and starts by selecting a foreign POI from the public list, as seen in Figure 3.27, then the editor can suggest other data. This means, the suggested data will be verified by a *reviewer role*. Due the fact that the reviewing process is excluded from this master thesis, we only discuss the annotation process from the authors perspective. The reviewer itself would have an approval list, where all the reported POIs will appear and the reviewer could release the POI. The annotation process for a POI contains suggesting another position by clicking on the map and suggesting another short- or long description or adding new



references or images. This process is shown in Figure 3.28 It is also possible to report false images images or report the entire POI by clicking on the buttons with the bug icon, once for images and once from the whole POI.

Other authors can also add media files to others POIs, this is shown in Figure 3.29.

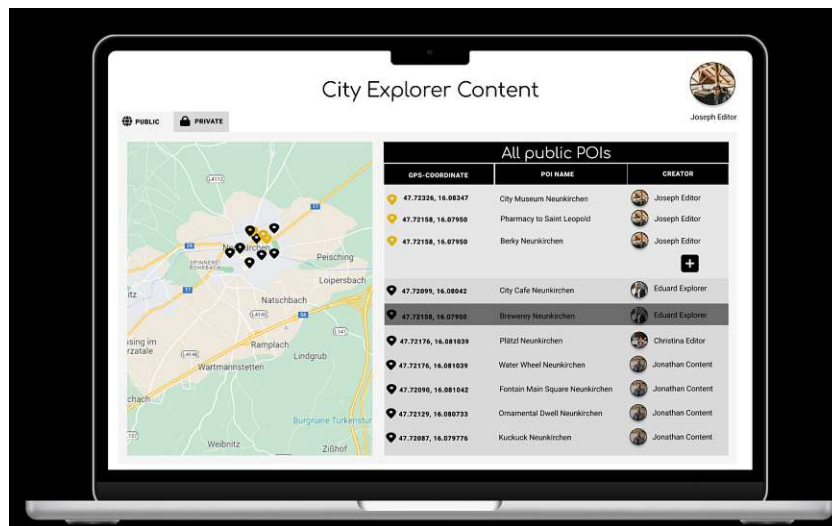


Figure 3.27: “Changing”/annotate other users POIs, selected from the public list

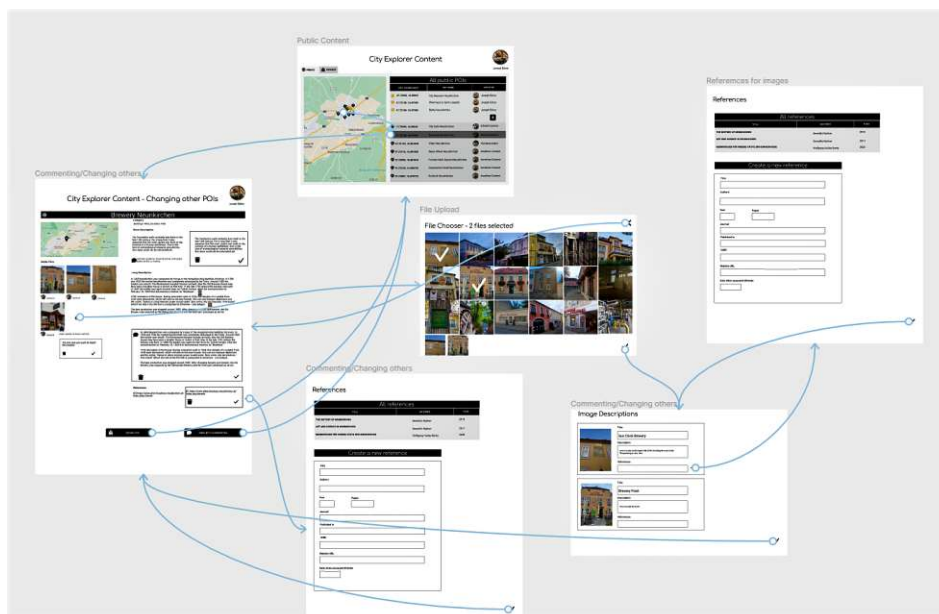



Figure 3.28: Annotation process


City Explorer Content - Changing other POIs



### Brewery Neunkirchen



**Media Files**



**Category**  
Building (-10m), Era before 1500

**Short Description**

The foundation walls probably date back to the late 14th century. For a long time it was assumed that the main square was built on the remains of a Roman settlement. Due to the lack of archaeological research possibilities, this issue could not be concluded yet.

**Long Description**

In 1485 Neunkirchen was conquered by troops of the Hungarian king Matthias Corvinus. In 1529 and 1532 the market Neunkirchen was completely destroyed by the Turks. Around 1600 the market was rebuilt. The Renaissance burgher houses are built, also the Old Brewery House may have been a burgher house or tavern at that time. In the late 17th century the Brewery was built. In 1683 the market was again burned down by Turkish hordes. After the reconstruction on February 18, 1694 first documentary mention as 'Brauhaus'.

1733 renovation of the house. During renovation work in 1926, the remains of a sundial from 1652 were discovered, which still adorns the east facade. One can see baroque depictions and the motto: 'Serius et citius mentam prope inusad unam. Sera nimis, vita est crastina - Vive hodie!' (Much too late is the life that is postponed to tomorrow - Live today!).

The beer production was stopped around 1880. After changing tenants and owners, the Old Brewery was acquired by the Schwechat Brewery and the front part continued as an inn.

**References**

[1] <https://www.altes-brauhaus-neunkirchen.at/index.php/chronik>

comment-symbol on hovering and on clicking box  
Additional box is showing

Are you sure you want to report this media?

The foundation walls probably date back to the late 14th century. For a long time it was assumed that the main square was built on the remains of a Roman settlement. Due to the lack of archaeological research possibilities, this issue could not be concluded yet.

report symbol on hover and click

Are you sure you want to report this media?

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[1] <https://www.altes-brauhaus-neunkirchen.at/index.php/chronik>

[1] <https://www.altes-brauhaus-neunkirchen.at/index.php/chronik>

REPORT POI

DONE WITH COMMENTING

Figure 3.29: Annotate other users POI

### 3.3.2 City Explorer Mockup

For the *City Explorer* application, we introduce the role “explorer”. This is the person, who strolls through the city and gets information about the sights, monuments and places. This locations we call *points of interest* or short POIs.

The application starts with the *Login* screen, which has two buttons: a login and a registration-button as seen in Figure 3.31.

The entire login and registration process is shown in Figure 3.30, where the user registers with his or her Google Account, then gets the *Terms and Conditions*, and if he or she accepts the terms and conditions, he or she will be redirected to a *Registration successful* page and is shown the *Introduction* page about the City Explorer. Then the user gets redirected to the *Home* view. If the user is already registered, he or she can press the [login] button and gets directly to the *Login* page. After a successful login, the explorer will be forwarded to the *Home* view.



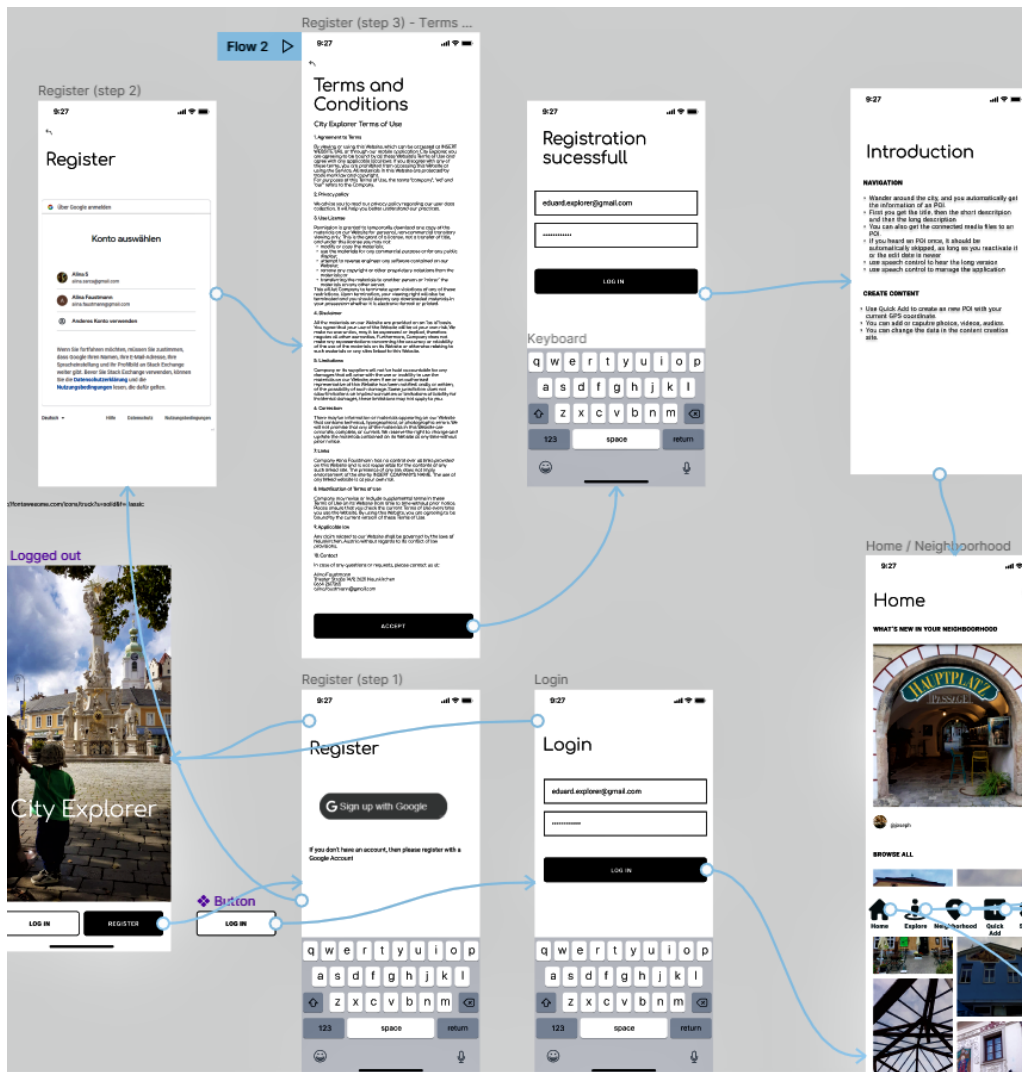


Figure 3.30: Login and registration process

In Figure 3.31 and Figure 3.32 the detailed view of this process is shown. After a successful registration, there is an introduction page and the user gets redirected to the home screen. If a user is already registered, then the user gets automatically redirected to the *Home* screen after the login as shown in Figure 3.32.

The home view should give a preview for new POIs so that the explorer gets encouraged to use the app from time to time. So the home view has two roles, displaying what is new in the neighbourhood and letting the user discover new places. So it suggests in the upper part new POIs in the neighbourhood and in the lower part new POIs from all around the world. It is also possible to get information about the user by clicking on the small user icon.

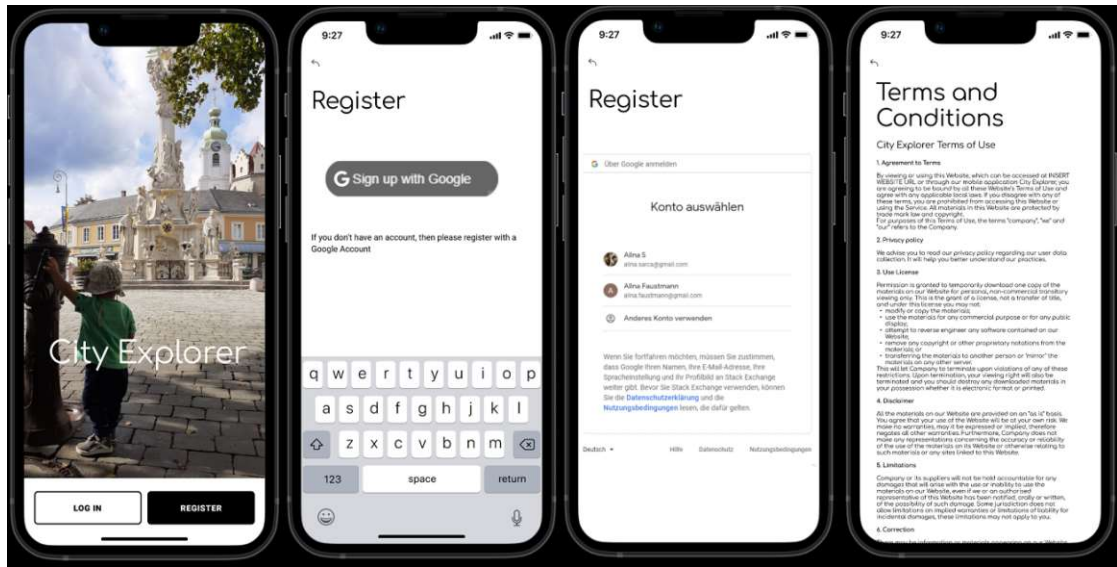


Figure 3.31: Login and registration screens

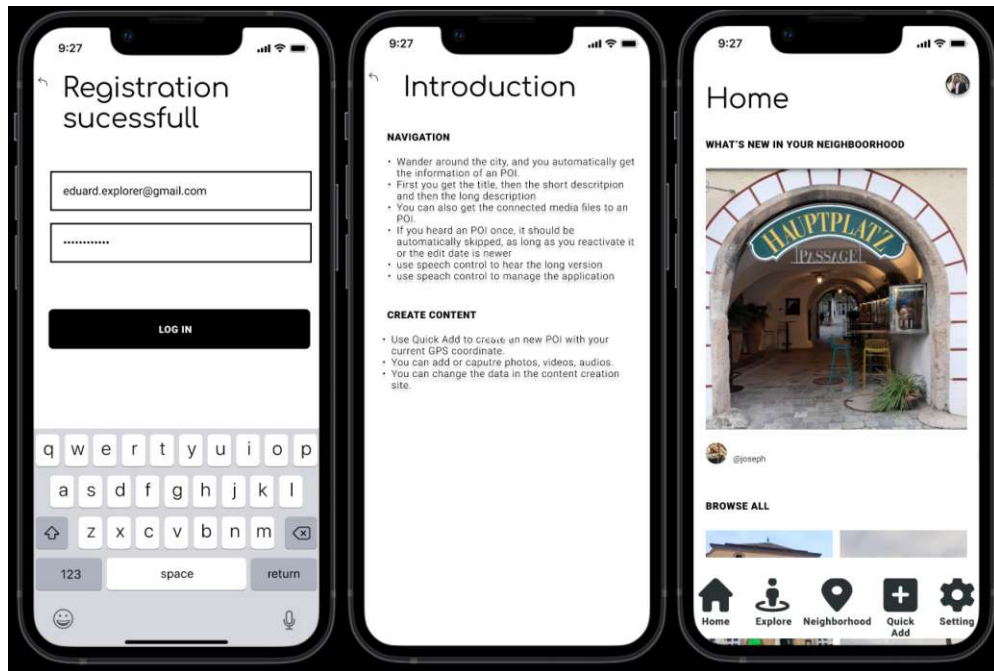


Figure 3.32: Login and registration screens

The upper part, called “*What’s new in your neighbourhood*”, can be navigated by sliding to the right. Then the newest POIs in the neighbourhood are shown. This is seen in Figure 3.34. By clicking on an image, a new overlay will appear with the bigger photo. The lower part, called *Browse All*, where all POIs around the world are shown, displays the POIs by just scrolling down.

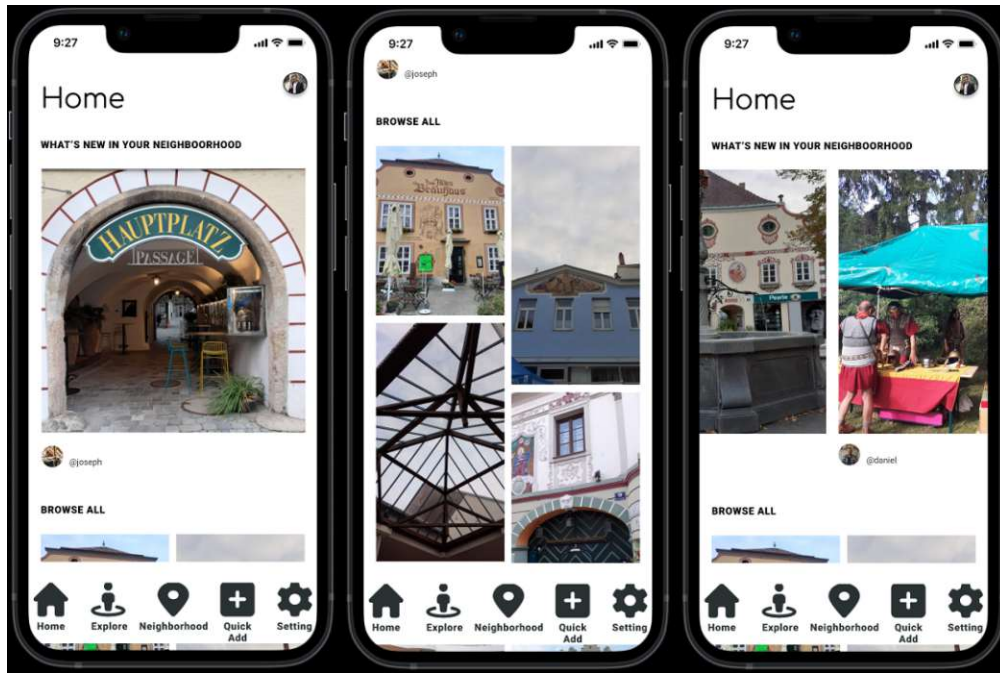


Figure 3.33: Home screens

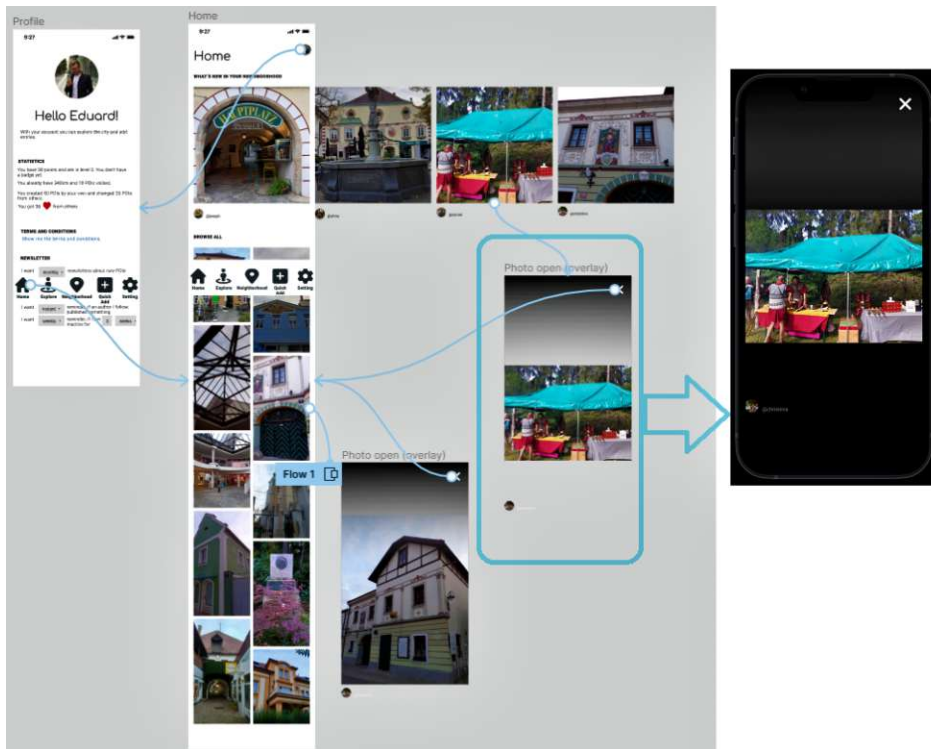


Figure 3.34: Home screen

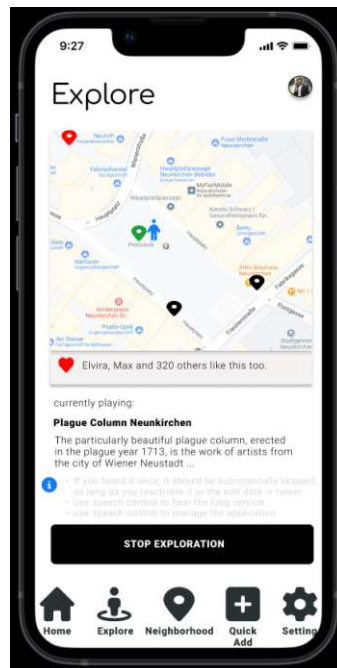


Figure 3.35: Explore

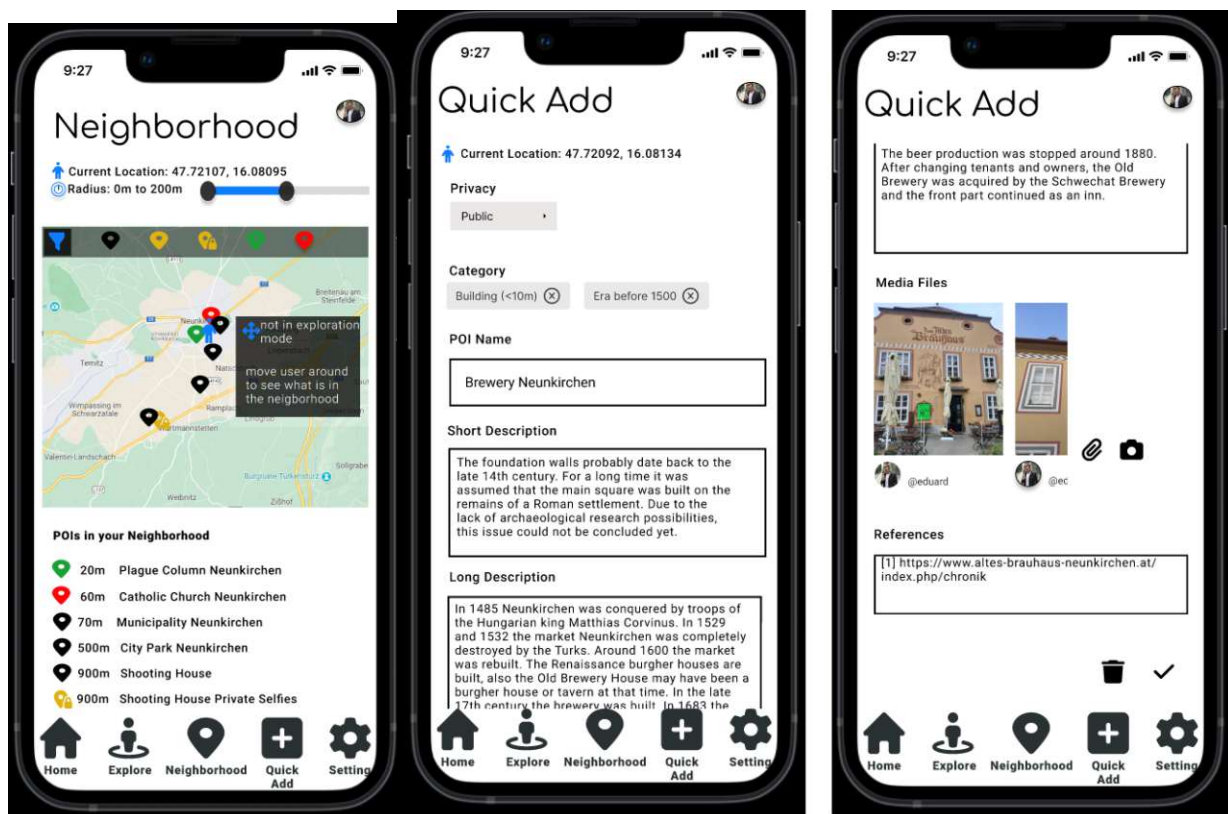
The *Explore* view is the main view of the app, which gives the exploration feeling. The user in his “explorer role” can start an exploration, and when he or she gets closer to a POI, the device will use speech synthesis and start to playback the name, short- and long description of the POI. The POIs filter are already set in the *Settings* page 3.39a. The voice will also announce if there are media files connected to the POI. The explorer is then able to standstill and look at the attached photos or videos. If there are audio files connected to a POI, this files could be played automatically. After all the information has been played, this POI would be marked as “already heard” and if the user will pass this POI again, then he will not get the information again.

The *Neighbourhood* view also has two different roles. The first is to show the next POIs, which are played, when the user is in the exploration mode. Therefore, the user already decided the criteria and the POIs will be shown on the map. The “current location”, which is displayed as a “blue male icon” will always be the physical location where the user actual is. This means the position is the actual GPS position of the device.

The second role is to let the user move around “current location”-marker freely, so he or she can see which POIs exist in a certain neighbourhood so he or she can decide whether it is worthwhile to explore this area or not. This POIs will also be displayed as a list under the map.

The user can also adjust the impact radius and can select and deselect the POIs by filters like showing just the public POIs (black), just the POIs, which the user created by himself (golden), the private POIs (golden with a lock), already heard POIs (red) or the currently playing POI (green). The filter-bar in the upper part of the map in





(a) Neighbourhood

(b) QuickAdd

Figure 3.36: Neighbourhood and QuickAdd

Figure 3.36a. The categories of the POIs like “Building” or “Place” are already set and can just be edited in the settings view seen in 3.39a.

In the *Quick Add* section the user is able to stand in front of a POI and can record it directly and save it in the database. The GPS position will be recognized and he or she can announce the name and the short and long description of the POI by voice recognition. It is also possible to take a photo as seen in 3.38b or select photos from the device 3.38a and connect it to the POI.

This two different possibilities are shown as a process in figure 3.37. The selected files can also have a name, description and references which are also used for the voice output.

By pressing the camera symbol in the *Quick Add* view 3.36b, a new view with all images on the devices gets visible. The user can then select one or more images and this images are then uploaded and connected to the actual POI.

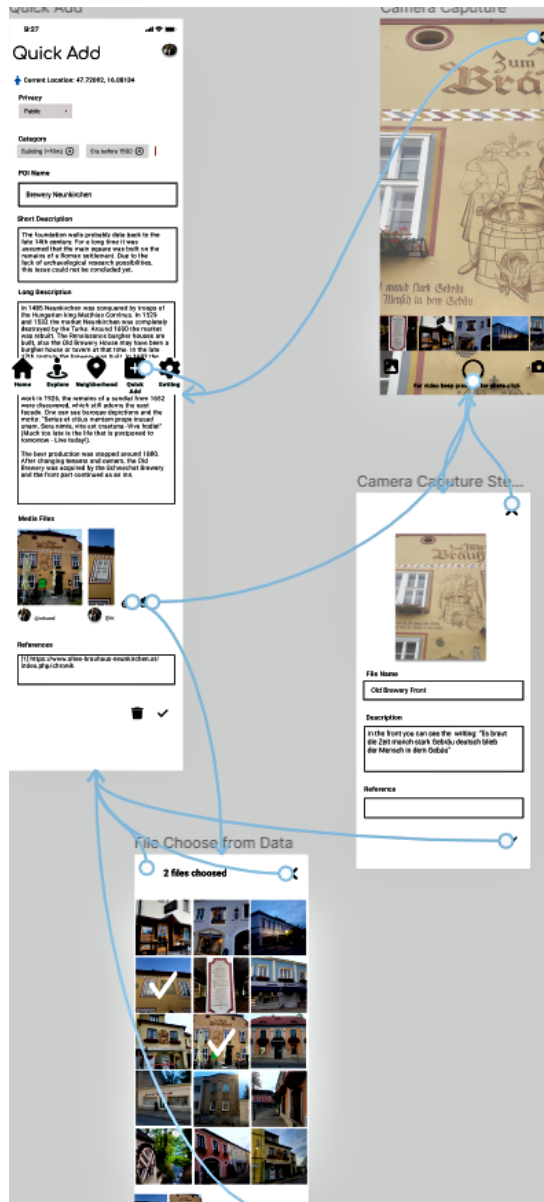


Figure 3.37: Taking photos or selecting photos from the device

The *Settings* page contains the home position of the user. This position is needed to define where the user lives. This has an impact on the suggested POIs he or she receives in the home screen 3.33 as “What’s new in your neighbourhood” and has also an impact on the newsletter 3.39a he or she gets about new or changed POIs. This position is also the fallback position if the device gets no GPS signal in the Neighborhood view 3.36a. The application should also support multiple languages and give the user the possibility to change the language. For this we introduce two different language settings. Once for the application itself. This means the localization for the app and the site itself, where



(a) Selecting photos from the device

(b) Taking photos with the device

Figure 3.38: Selection or capturing photos

the authors can enter the data and is described in the next chapter 3.3.1. Therefore, we distinguish between “application language” and “content language”.

The next setting is the definition of the “impact”. These are the different categories a POI can have and which are then used in the exploration and neighbourhood views. For example, a POI is a building that is from the fifteen century, then the POI will have two categories, which can be selected, and will be used in combination with the position as “impact”.

With the “speech speed” setting, the speed of the text to speech synthesizer is controllable. It indicates a factor of the normal speed. The value “1” means that it is at a normal speed. “2.0” means that it is twice as fast, and “0.5” means that the voice slower down and it is half as fast as normal.

The “voice” setting controls the voice itself. The voices are depending on the voice data, which are installed on the device. Some user prefer a female voice, some prefer a male voice. These voices need to be installed manually. But also the preferred language is important. Because we can’t use an English voice for German content, because the pronunciation is in English different then in German.

The “font size” dictates the height of the lettering of the content and application. For this purpose we introduce “small”, “normal” and “large”.

For the “theme” we assume that most people want a light and a dark mode.

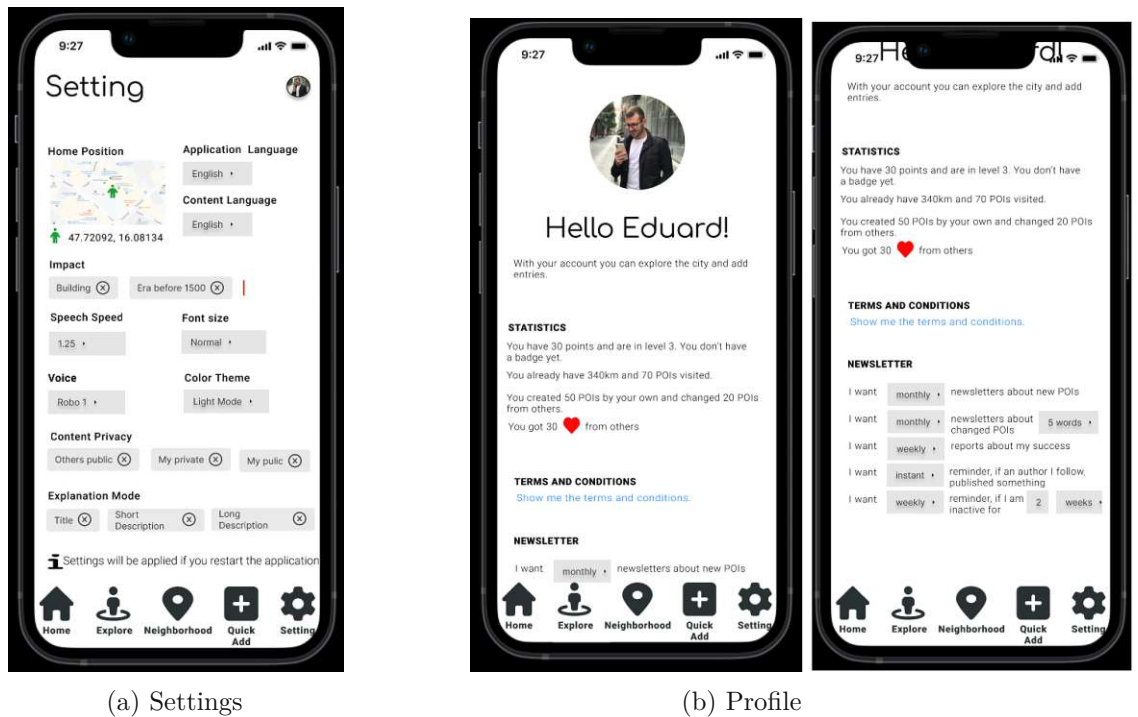


Figure 3.39: Settings and Profile

The “content privacy” is a setting for the content itself, which will be used in the application. It has an impact on the displayed POIs. All others, means that from other editors, which are marked as public will be used in the application. “My publics” are the POIs which the user created himself and he or she marked the POI as public and my private are the POIs, which are just for the creator himself. This setting will have an impact on the whole application.

The “explanation mode” indicates the default mode of the speech synthesis used in the exploration. The explanation mode is used when the content is read by the speech synthesizer. If the explorer reaches a point of interest, then the selection will be considered. If the user just want to hear the title, or the title and the short description or also the long description. In the right corner of the setting view, there is the profile image. Clicking on the profile icon, the user gets redirected to the profile view.

The *Profile* page gives an information about the user himself. It declares what the user can do if he or she is an author or an explorer. The application also displays if he or she has a badge, how many entries the user authored or corrected and how many kilometers he or she already walked in an exploration session while using the application. There is also an indication how many likes he or she got for the created content. The user can also access the terms and conditions and configure newsletter settings. For example, the user can decide if he or she can have monthly, weekly, daily or instant newsletters about specific POI states or the user don’t want any newsletter at all. This newsletter can be if



a POI is new, or if a POI was changed. Some people also want to have reports about their own success or reminder if they did not use the application for a longer period. It is also possible to follow an author, and then the user can decide if he or she will get a newsletter, when the followed author published a new POI. This follow/unfollow process is possible in the profile view of a specific user as seen in Figure 3.40 by clicking on the link.



Figure 3.40: Follow / unfollow an editor

### 3.3.3 Evaluation of the Mockups

For the mockups evaluation we did five interviewees, which were recorded and transcribed. For better overview, we break the findings down to specific feature and views.

#### Login and Profile aspects

All interviewee said that it is a good idea to use the Google login and not to build an own user management. Therefore the whole checking if the Google user is a real person, is delegated to Google. An information how long the login cookie is available, should be displayed in the application (Interview 4, 37:18).

The roles “explorer”, “editor” and “reviewer” were fully understandable and accepted by the interviewee.

Some wanted to have the possibility to link events to POIs and create special newsletters for this events and that the user who favorites the specific POI will get a special newsletter for the upcoming event. For example, someone favorites the “City Museum” and there

is an upcoming event in three weeks of the “Special exhibition of the Roman festival” an author could write a newsletter about the event and the user will get the specific newsletter (Interview 1, 00:14:45).

Another wanted that the favorite POIs should always be played, even if it was already heard (Interview 4, 17:10). Another wanted to have a list for the favorite POIs, so that he can walk through the list and remember that he wanted to visit the place (Interview 3, 46:58).

For one interviewee (Interview 5, 05:17) the newsletter settings are too complicated. He didn’t understand why it should be so granular. For example, the newsletter about changed POIs was stated in the mockup as: “I want to get monthly newsletters about changed POIs 5 words.”. The interviewee stated that it would be enough to get just newsletter if something changed, but then the problem is that if someone corrects a typo, this would be a changed POI, and the explorer will get a newsletter. Therefore we introduced a dropdown selection with the word counts. After some discussion we thought about that the approver could state if the change is a newsletter worthy change or not, like it is handled in confluence. But due to the fact that other interviewees liked the concept of the “five words threshold”, but had a problem with the wording (Interview 4, 02:08), we will use this idea in the application.

#### Content Management and content aspects

Some of the interviewees made it clear that the accuracy of the references is very important, and that even Digital Object Identifier will be needed (Interview 1, 23:00), and others stated that references will not make a very big impact on their usage, because they will use more the *QuickAdd* function, when they are staying in front of a POI. Therefore we will implement this just as a text field, where the POI will have the possibility to have multiple references as a text.

All interviewees (e.g. Interview 1, 31:54) found the idea great that media files could be connected in the short- or long description and so that a story can be created by the combination of the descriptions and the media files. Due to the fact that this is very complicated to implement and not a main future, it will be a discussion for feature work.

It was also stated that all tables in the content manager should have pagination (Interview 4, 38:45).

#### 3.3.4 Changing other editors content

The idea that the editor can just make notes on the descriptions and the changes will come to the reviewer were totally accepted. Also that an editor can upload for example, images on other POIs, but the editor is not capable of deleting an image. A other person can just report it and the reported image, will go to the reviewer. A interviewee had a problem with the report icon, because the icon is a “bug” symbol, and the meaning was not clear. After clarifying it, we discussed different symbols. Due to the fact that we

use the Font Awesome Free Icon Set we are quite limited for appropriate icons and we decided that the icon is fine.

## Reviewing

For all interviewees it was understandable that the “reviewer” part is just discussed theoretically and can be excluded from this work, and it was stated that the reviewer should always get the reported POIs (Interview 2, 14:20). It should also be possible to define the expertise of the reviewer and it must be clear for which area the reviewer is allowed to evaluate the content (Interview 1, 34:55). For example, that a reviewer has knowledge of a city, but not of the whole country (Interview 1, 7:26).

The reviewer should get a list where he can walk through all the new and reported entries and he or she can thus work through them. Therefore he or she will get different states like that the entry is reported, approved or waiting. For example, new entries will be in waiting for approving, and reported POIs will have the state reported with a description why the POI was reported (Interview 4, 27:32). Approved POIs are those, who the reviewer walked through and released. This POIs will be available as public POIs in the content management and in the explorer application.

If an image will be uploaded to a POI, then the POI itself is already approved, but the image will need an extra approval. Therefore there will be an indication in the list that the POI needs just component-wise approving. There will be an indication which component needs to be approved. For example, someone changed the short description, then there will be two different versions of the short description. In the application the old version will be displayed, as long the reviewer will release the new version of the short description. Another example is a new image. The image will not be shown until the reviewer has approved the image.

## Speech Recognition and Speech Control

For the speech recognition we discussed (Interview 3, 19:13) how to handle the speech speed, for example, by the command “Set speech speed to 2”, and the speech will be twice as fast. We figured out that setting the speech speed, is enough if it will be set global and not to be changeable for each exploration session.

## Navigation and Map

The colors of the markers were a big discussion. One interviewee wanted that the icons of the markers should be customizable. He wanted to select the color of the own POIs (golden) and the already visited POIs (Interview 3, 03:59 and 24:29). The interviewer would not make an optical distinction between skipped (grey) and already visited POIs (green), but he wanted to have the green for this states. A other interviewee (Interview 5, 11:05) also stated that the skipped and visited state should have the same color, but he would use the color grey. We made it clear that there will be a technical possibility to make the

icons custom able, but this would be out of scope for this thesis, because the main focus is the exploration during visiting a city. But it should be possible to reset a skipped POI, so that it will be played.

One interviewee also asked if it would be possible to show the weather condition on and the time (Interview 4, 30:33). Due to the fact that the application is used outdoors and the explorer already sees the weather and that the time is available on each mobile device, this idea was not taken into account. But the time is considered as a day and night mode for the map (Interview 4, 31:22).

One stated that the handling of the map (Interview 3, 08:06), should be like the handling on Google Maps. We will use Google Maps in the application. The map should also contain a scale (Interview 4, 15:14) and the map should also support different map types like a terrain map.

For already heard POIs, which have been updated, someone wanted to have an indicator like a star that there is new content available. (Interview 3, 26:19)

All interviewees (Interview 3, 47:16) asked about the possibility to define a route and get navigated by the app to the POIs, but this is explicitly excluded in this work. The main character of this thesis is to allow a serendipitous exploration, so that the user can explore POIs which he or she didn't expected to find.

#### Home View

For the *Whats new in your neighbourhood* we discussed that the section, should contain featured POIs, and that always the first image of a POI will be selected as preview if the POI will have more then one image. After clicking on the image, the detail screen as an overlay of the POI as seen in 3.34 will open and the image will appear in a higher resolution. The interviewee mentioned that the detail overlay should contain the name of the POI and at least the short description and the image itself (Interview 3, 46:18).

The interviewee also wanted to save the point of interest as a "remarkable POI", so that this POI will be displayed in a own list, where he could walk through his saved POIs, which he want's to explore later (Interview 3, 46:58).

*"Maybe you can make a list, for example, called 'Want to Explore', which contains the POIs you can to explore when you're bored."* (Interview 3, 46:58)

He also wanted to have a link, which would show the POI directly in the neighbourhood view or will show the POI on a map.

One interviewee (Interview 4, 32:37) also stated that there should be different sizes of images and asked if it would be possible to download the images. The app will have different resolutions of the images, but a download of the images will not be allowed in the app.

In the application, we will fake a download of a zip-file, where the user could download his private points in some kind of *My journey* (Interview 4, 28:30). This zip-file will

contain the private POIs as a HTML or a PDF and will also contain the private images, where, for example, people could make selfies with a monument. But no other images from other user or the own public images will be included in this zip-archive.

### Exploration View and aspects

One interviewee (Interview 3, 19:47) thought about combining the exploration view with the neighbourhood view, because the neighbourhood view has the list of the upcoming POIs in the area. But we discarded this idea, because the exploration view, has the speech synthesis and the detail of a POI, which is currently played. It makes more sense that there are two different views.

### Neighbourhood views and aspects

One interviewee had a problem that the indicator of the current position, also visible as the “blue male icon” in the map should not be move able by dragging around in the area, instead of this, the current location should be changed by clicking or tapping on the map. The dragging action will lead to confusion it with the standard behaviour of zoom-in and zoom-out of Google Maps.

Someone also mentioned that when the current location changes by repositioning the “blue male icon”, the header of the list should change from “POIs in your Neighbourhood” to “POIs in this Neighbourhood” (Interviewee 5, 37:22). Due to the fact that this is not a critical feature, we will ignore this in the application.

The filters of the neighbourhood view were a major discussion. The first thing is the impact radius. It is designed as a double-valued slider with a min and a max value, where a range can be set (Interview 3, 28:24). But after going through the possible scenarios with an interviewee of the slider and the combination with the POI category, we decided that the double slider should be changed to a normal slider with indicating the meters, because the POI category is now a multi select and the range can also be mapped to a category and this category can be assigned to one of the poi categories, so it is no longer necessary defining the impact radius by meters with a min and max value (Interview 5, 31:45).

The filter bar at the top in the neighbourhood view contains icons that indicate the state of the POIs. These icons can be clicked and the POIs in the map will be shown or hidden depending on the selected icons. These icons have no labels in the mockup and one interviewer (Interview 5, 08:13) requested a description of the icons, when the icons are pressed.

It was also requested if the user will get a preview of a POI if he or she will click on the marker icon, but this will make it obsolete to explore the area, therefore we will not add this feature.

#### QuickAdd

With the participant of (Interview 3, 12:10) we discussed the possible fields and decided that the name, category and privacy of a POI should be required. With another interviewee we figured out that besides the coordinates and the privacy setting, just the name should be required and he also stated that the indication like an icon of the required entries is missing (Interview 5, 26:02).

Also it should also be obvious which coordinate system is used (Interview 4, 19:13). Due to the fact that we use the Google Maps, the system is World Geodetic System 1984 (WGS84) [Sana] and we will state this information in the application.

We also discussed the different views as QuickAdd and in the content management as the Create/Edit-View. Due to the fact that this will be the same views the QuickAdd view will have all entries, which are also available for the content management (Interview 5, 34:36).

#### Settings

The settings page missed the description of the settings. So therefore we will include an information icon that the user can click and a short description of the setting will appear (Interview 5, 20:27).

### 3.4 Prototypical Application

For our prototypical application we want to build a location-based Augmented Reality application. From our literature research [Lø11, p. 188] we found out that we want to create a location-based, cross-platform application that tells the history of a place, building or monument.

The control of the narrative thread should be done by voice commands. This should make it possible that you can put the smartphone in your pocket and focus on the surrounding and traffic and it frees the user from looking on a small screen all the time [Lø11, p. 188].

The distance to a POI, the so called “*broadcasting radius*” [Lø11, p. 195] which takes the granularity of the system into account and is used to trigger the text, must be adjustable. This means that the user can adjust the system and define how close he or she can be to a location before the connected content is played.

We did not use markers, stickers or anything that you need to install on-site, because these objects have some disadvantages like dependence of lighting conditions, vulnerability against weathering like sunlight, rain, wind, snow and damage, some can be stolen [CMV11, p.716]. Also the fact that it is not necessary to install anything, means that we can use any place, even a private property or a public place without asking for permission to install a object that triggers the augmentation.

The entire application has a dark and light mode and the font size is adjustable.



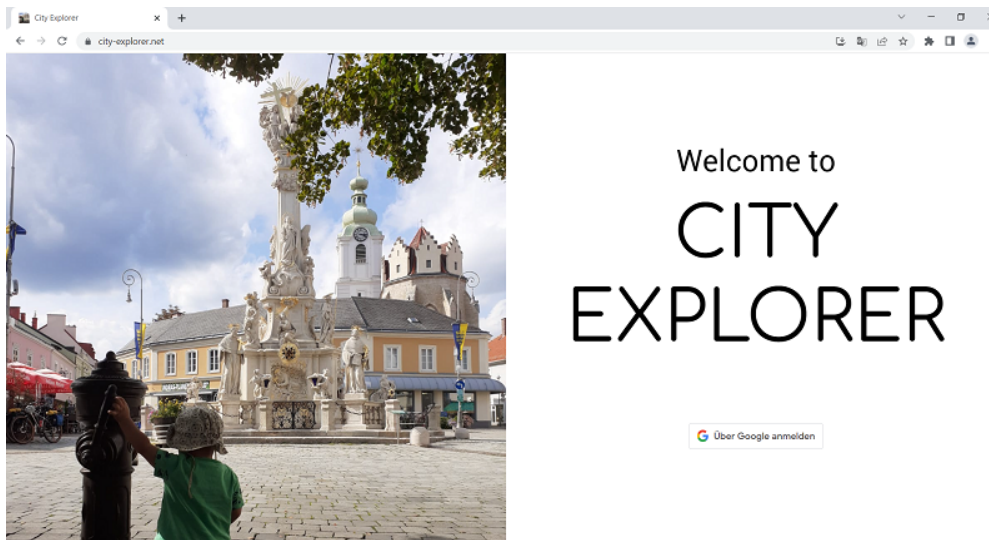


Figure 3.41: Login in the browser

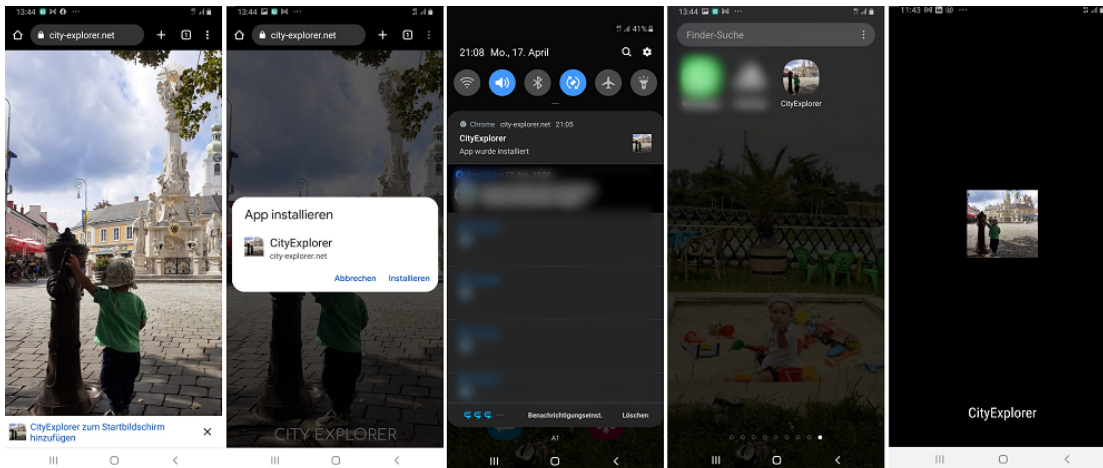


Figure 3.42: PWA installation

### 3.4.1 Implementation of the prototypical application

The project is an implementation of a Progressive Web App (PWA) in .Net 7 with Asp.Net Core using React as the front-end framework.

The data was stored in a SQLite database. To host the application the hoster smartasp.net was used, so that the application accessible via <https://city-explorer.net>.

To set everything up we installed VS Code, the latest nodejs version (18.13) and the .Net 7 SDK.



### 3.4.2 Database

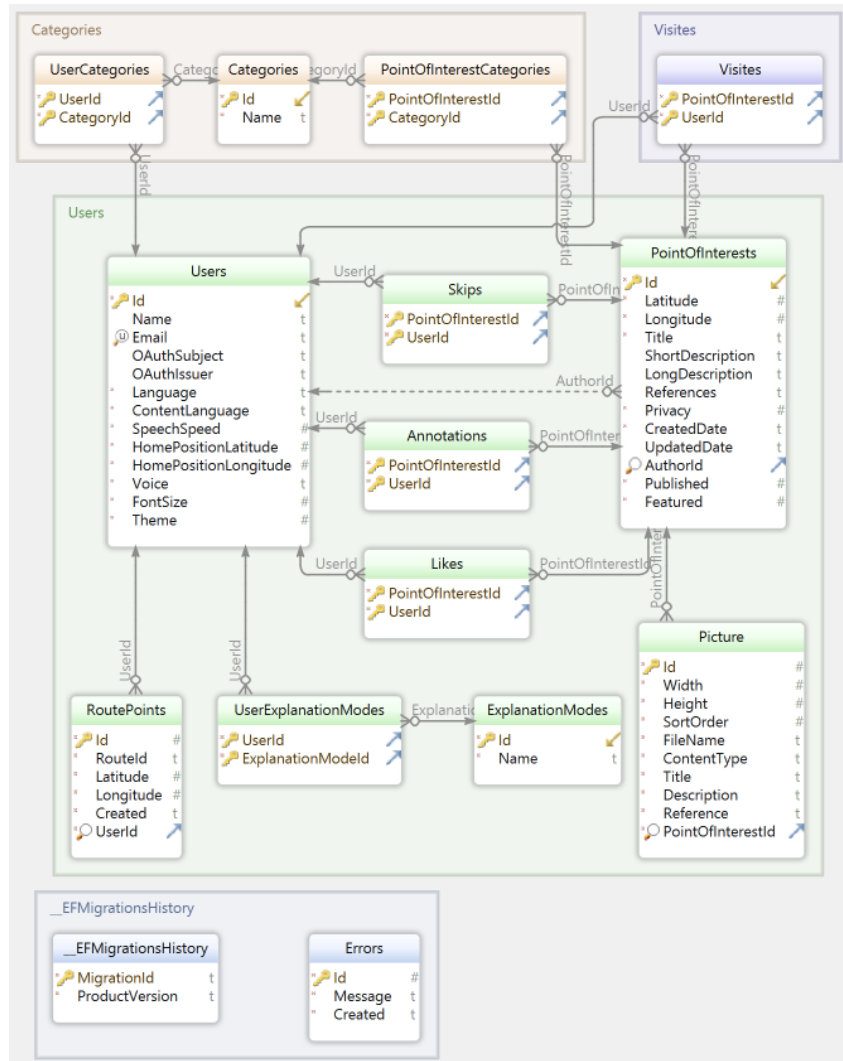


Figure 3.43: Entity relationship diagram

The data was stored in a SQLite database. The tables were created by using the ORM Entity Framework with a code first approach, where we defined the entities by creating classes and relationships by creating properties of these classes. The entity relationship diagram looks like in Figure 3.43.

The central entity is the `PointOfInterest`. The `PointOfInterest` can have multiple images connected and can have many `PointOfInterestCategories`.

One `PointOfInterest` has always an author, which references to the `Users`. The user can also select which POI categories he wants to hear when he explores the city. For example he or she just wants to hear about Roman buildings, then the user selects the categories "Roman Antic (up to 500)" and "Building". If he or she just wants to hear

stories created from local inhabitants, which could be not exactly historical adequate, then the user can select the category “User Stories”. This is represented in the table `UserCategories`.

A user can like multiple POIs and also a POI can be liked by many users, we need a `Likes` table. This is the same with the `Visits`, `Skips` and `Annotations`, because a user can visit or skip many POIs and the same POI can be visited or skipped by many users. The annotation is here just rudimentary designed, because we let the user to annotate or report a POI, and the user will get a message that this was successful, but it is not fully implemented, because it is out of scope for this thesis. It is just a counter for the annotation, so that we can have a visual feedback of the functionality in the explorer application. By starting an exploration session, the user generates new entries in the `RoutePoint` table, so that we can group points by a route and calculate the total walked distance over all routes for a user.

The last two tables `__EFMigrationsHistory` and `Errors` are meta tables for Entity Framework to control the creation of the tables and data.

### 3.4.3 Test data

The test data contained 89 POIs gathered together in an excel file. Most of the content is from *Neunkirchen für unsere Gäste und Einheimische - Ein Kurzführer über die Geschichte und sonstiges Wissenswertes* [HB20] which we have cited. Some of the text is from chronic pages looked up in the internet. Some POIs also had a description on a sign, which we just added as a short- or a long description. All images, except some from the mentioned book [HB20] are taken personally with a mobile device. Some of the images can be seen as a collage in Figure 3.44.

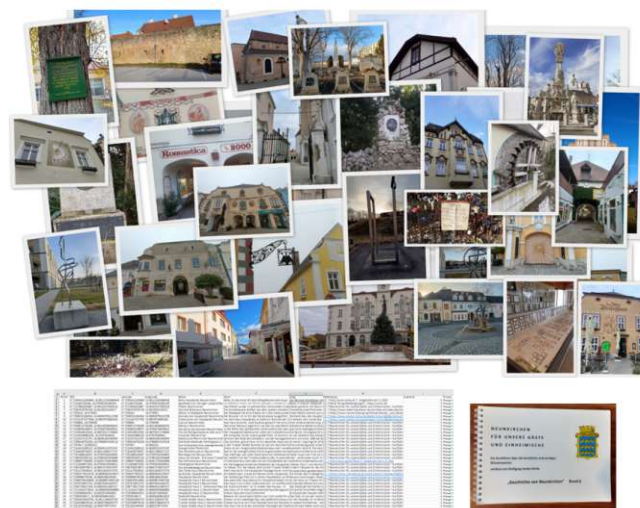


Figure 3.44: Data collection of the test data

The excel file has one sheet with the POIs and one sheet with the images. The code commands were directly generated in the excel file, utilizing formulas, and were just copied and pasted in the `CityExplorerContext.cs` which generates the initial data as seen in Listing 3.1. Also the default poi-categories, explanation modes, users and so on are directly initialized in the `CityExplorerContext.cs` file.

Listing 3.1: Example for a PointOfInterest

```
new PointOfInterest {
    Id=-1,
    Featured=true ,
    Published=true ,
    Privacy=Privacy.Public ,
    AuthorId=-1,
    Title="Berky Main Square Neunkirchen",
    ShortDescription="Berky is the first business building...",
    LongDescription="The owner Wolfgang Haider-Berky ..."
    References = "[1],
    "http://www.berky.at ", called at 2023-01-01",
    Latitude = 47.720944412949684,
    Longitude = 16.081213054869448,
    CreatedDate = new DateTime(2022, 11, 30)
}
```

And to attach an image to the POI, the excel generates a code like the following, which calls the `BuildPicture` function described in Listing 3.2 and Listing A.1.

Listing 3.2: Connects a picture to a POI

```
Picture.BuildPicture(-1, -1, 1,
    "Berky.jpeg",
    "image/jpeg",
    "Berky building",
    "This is the Berky store",
    "")
```

Then the image is uploaded in the data-folder of the project.

#### 3.4.4 Login and Authorizing with Google Maps

To use the Google Login in the application, we needed to create a Goggle OpenID Api Key via the Google Cloud Console as displayed in Figure 3.46.

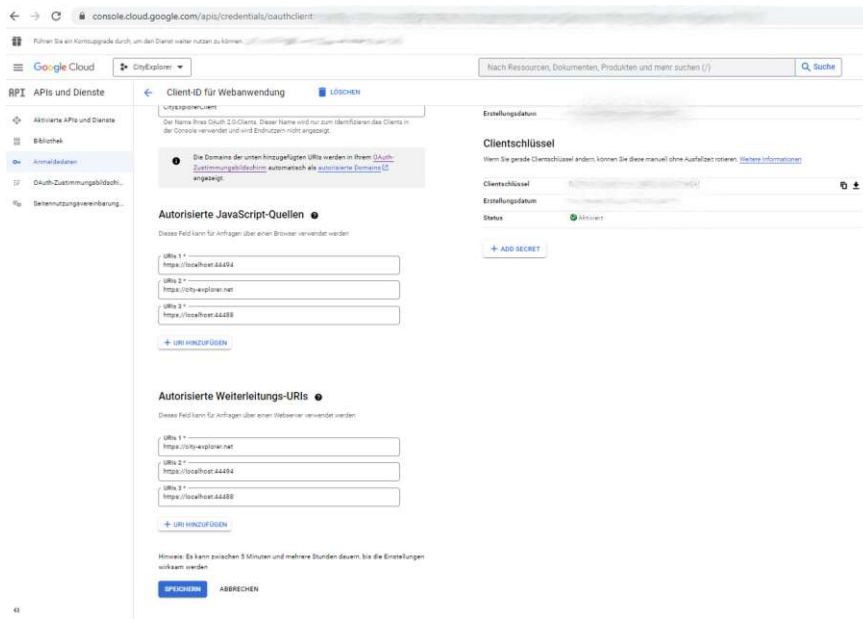


Figure 3.45: Google Cloud Console with Client Id and authorized URLs

There we created a new project with the name “CityExplorer” and we allowed OAuth registration and defined our test users 3.47. This also includes the registration to the Google API Services 3.46 by creating an OAuth client Id and requires also billing information to create a Google Maps API key as seen in Figure 3.45.

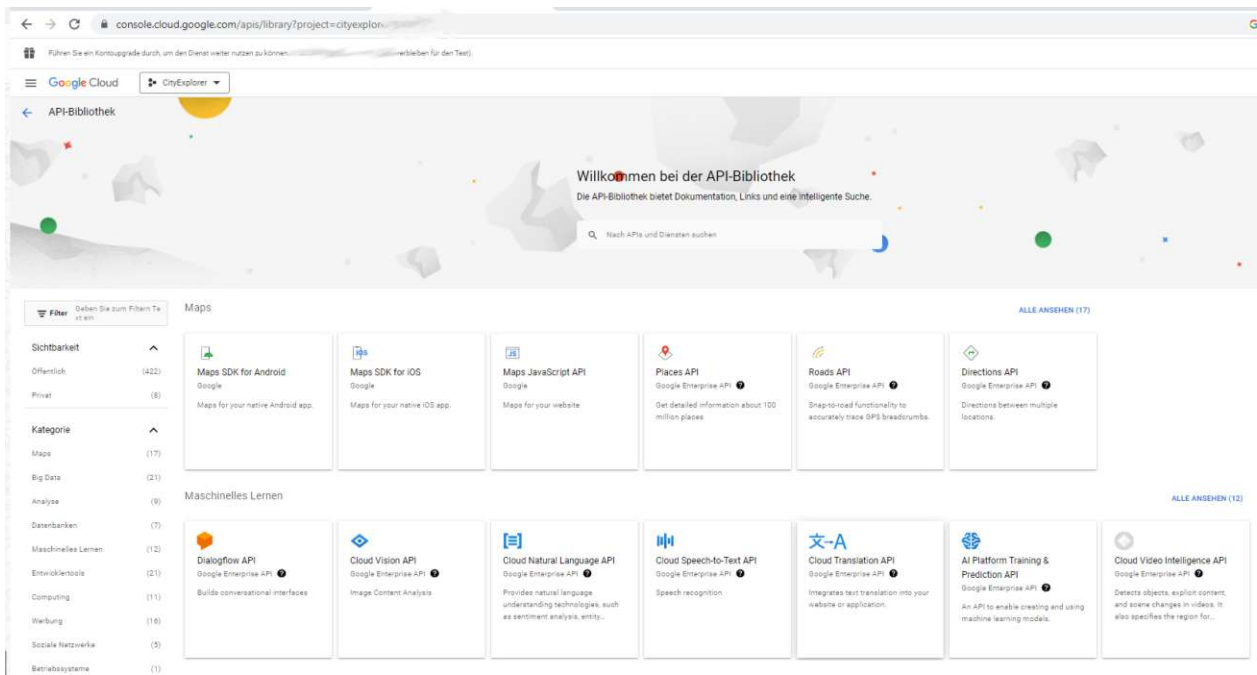
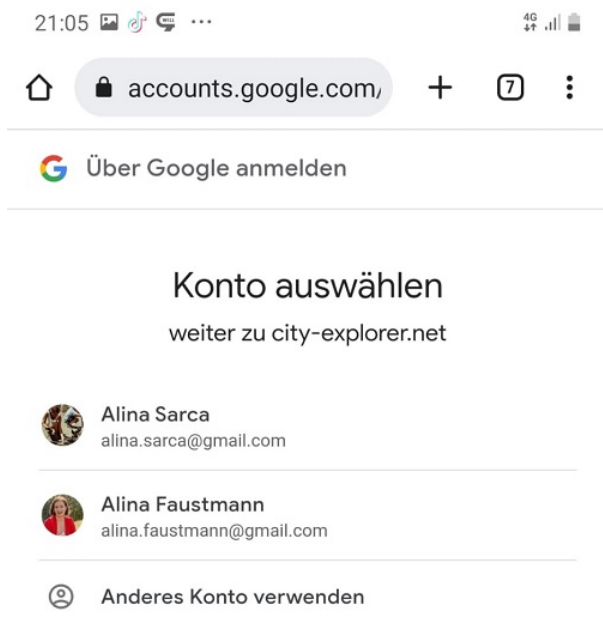


Figure 3.46: Google Maps API

### 3. IMPLEMENTATION



(a) Selection of the Google Account



(b) Login with the Google Account

Figure 3.48: Google Login with Google Accounts

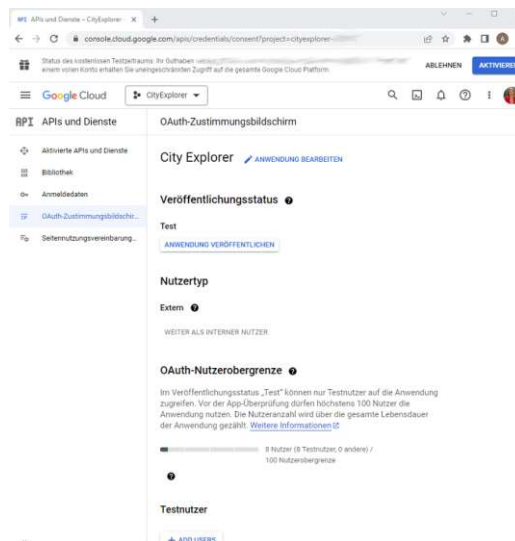


Figure 3.47: OAuth Consent Screen

We call the `ValidateAsync` method on the `GoogleJsonWebSignature` class and save the results into a variable called `payload` and this contains all the information about the google user. We need the e-mail address, profile image, name. This information

we use to check against our user own table and update the information if necessary. The google web token has an expiration time of 55 minutes. We create our own token and extend the expiration time 5 times of the google web token, because we assume that an exploring session is longer than one hour. In the future this token should get automatically renewed if a user interaction occurs in the application.

The `AuthController.cs` described in Listing A.3 contains code to handle the authentication. In the front end we used the `GoogleOAuthProvider` react component to handle the interaction with the Google OAuth API. For this we needed to install the node package via the command `npm install @react-oauth/google@latest` and we need to set the Google Auth API Key called `clientId` showed in Listing A.4.

In the `user-action.js` there is the `login` method which handles the user input and makes a HTTP POST to the API in the `AuthController.cs` as shown in Listing A.5.

### 3.4.5 Map with Google Maps

For Google Maps we needed to install a package with the command `npm install -save google-map-react`. We add the tag `GoogleMapReact` with attribute `bootstrapURLKeys` to set Google Map API Key.

This code sample in Listing A.25 will draw the Google Map and and user icon indicating the current position of the device. For the spatial data and so the coordinates from our POIs we will use the WGS84 which is the *World Geodetic System* and the spatial reference system of GPS satellites [GIS].

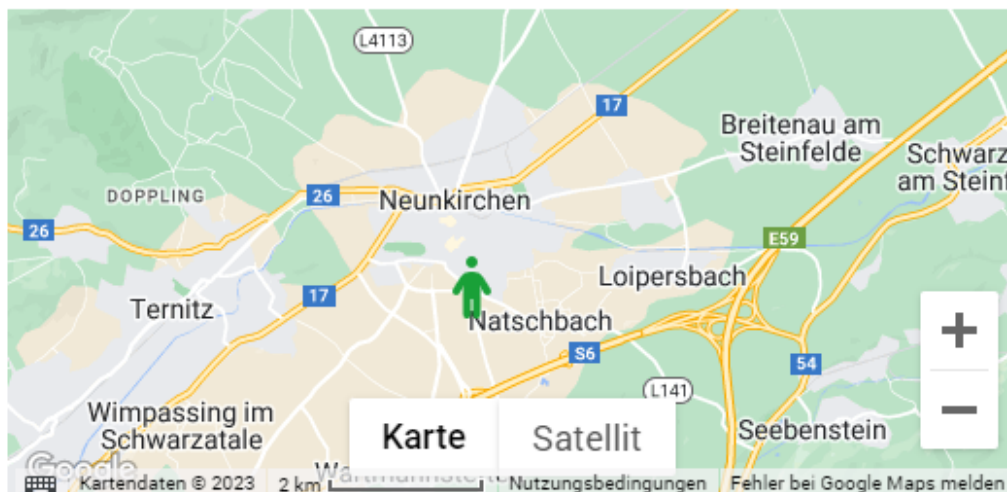


Figure 3.49: Rendered Google Map in the application



CityExplorer



EXPLORE



Short Introduction for voice commands

Lock screen Start listening

Start Exploring

Figure 3.50: Rendered Google Map in the application in the exploration view

### 3.4.6 Implementation of Location-based features

In the *Explore*, *Neighbourhood*, *QuickAdd*, *Settings* views we use the location feature to determine our position. The following code sample in Listing 3.3 checks if the device supports the feature and if available the location watcher gets started, and we get continuous new position data when we move with the device. Because we want the highest possible accuracy to detect artefacts, we set the option `enableHighAccuracy`



to `true`, and cache the position for a maximum of 1 second, and if we don't get any new position data, then the location watcher retries again after 10 seconds. The obtained coordinates we write in our `currentPosition` property.

Listing 3.3: Checking geolocation features

```
const startLocationWatch = () => {
  if ("geolocation" in navigator) {
    setLocationWatchId(navigator.geolocation.watchPosition(
      // function watchPosition(callback)
      position => {
        setCurrentPosition(position.coords);
      },
      error => {
        alert(error);
      },
      {
        enableHighAccuracy: true,
        maximumAge: 1000,
        timeout: 10000
      }
    ));
  } else {
    alert("No geolocation available");
  }
};
```

### 3.4.7 Implementation of Speech Synthesis

The speech synthesis is an API implemented by the browser manufacturer and standardized by W3C. This short example demonstrates the API.

```
let utterance = new SpeechSynthesisUtterance("This is a POI.");
speechSynthesis.speak(utterance);
```

In Listing A.6, there is an excerpt, where we can set the `speechSpeed`, a specific voice and we can see that the indicator sounds are played before and after the reading of the POI. In the application there is more code, which also handles all descriptions like short and long description, the image descriptions and the listening to the voice commands. But here we get an idea how the speech synthesis works and we also see in this example that the default text like “Es gibt eine Kurzbeschreibung” is in German. This is due to the fact that our test data is in German and we install a German speech synthesis language pack on the device. If we would use the English language pack, then the pronunciation of the data will be incorrect.

The code `speechSynthesis.getVoices()` returns all installed voices.

The `voice-utility.js` handles the mapping of the `voiceIds` and the names, so that we can get a voice with a specific id as shown in Listing A.7.

The available voices are depending on the device itself, the operating system, installed browser, installed voice language, and installed male or female language package. Therefore, we need to install the German language male or female voice data on each device if it was is available.

### 3.4.8 Implementation of the Speech Recognition and Voice Commands

The voice commands are handled in the file `voice-command-utility.js` and we installed the package via the command: `npm install -save react-speech-recognition`

```
SpeechRecognition.startListening({ continuous: true, language: "en-US" });
```

The speech recognition gets a spoken phrase which is written to the variable `transcript` and will be fuzzy matched with the command list with a minimum specific similarity configured by `fuzzyMatchingThreshold` as shown in Listing A.8 and Listing 3.4. If a command was found then the handler in `Explore.js` is called.

Listing 3.4: Different voice commands

```
voiceCommandUtility.addCommandHandlers([
  ...
  {
    command: voiceCommandUtility.COMMAND_INCREASE_SPEECH_SPEED,
    execute: () => { increaseSpeechSpeed(); }
  }, {
    command: voiceCommandUtility.COMMAND_DECREASE_SPEECH_SPEED,
    execute: () => { decreaseSpeechSpeed(); }
  } ...
])
```

The speech recognition quality is dependent on the language of the commands, so this must be taken into account when providing a multi-language application.

During implementation we redesigned some voice commands. For example we redefined the command “EXPLORER SET SPEECH SPEED TO some value” to “EXPLORER INCREASE SPEECH SPEED”. For example we would say “explorer set speech speed to two”, the application will not work correctly, due to the fact that ‘two’ and ‘to’ are pronounced similar for speech recognition was quite complicated, so we modified the command to “EXPLORER INCREASE SPEECH SPEED”. This command worked well, but it was very long to pronounce, so we introduced an alternative voice command like “EXPLORER FASTER”. In the following table there are the voice commands, which we thought we will use during the design process, and the actual implemented voice commands in the application. Some voice commands were newly introduced due to the

application handling and are listed in Table 3.4 and some were completely dropped. The dropped one are listed in Table 3.5. All commands have the keyword “EXPLORER” as an indicator to start listening.

COMMAND IN THE DESIGN PROCESS	IMPLEMENTED COMMAND	DESCRIPTION	REASON
	START EXPLORATION or START EXPLORING	Starts an exploration	
	STOP EXPLORATION or STOP EXPLORING	Stops an exploration	
	STOP	Stops the speech synthesis.	
SKIP	SKIP	Skipp the POI	
	UNSKIP or RESET POI	Unskips the POI	
	AGAIN or START	Resets the POI to unheard	
SET SPEECH SPEED TO 0.5   0.75   1   1.25   1.5   2	INCREASE SPEECH SPEED or FASTER	Increases the speech speed in the speech synthesis for the next POI	Command transformed to improve recognition performance
SET SPEECH SPEED TO 0.5   0.75   1   1.25   1.5   2	DECREASE SPEECH SPEED or SLOWER	Decreases the speech speed in the speech synthesis for the next POI	Transformed to improve recognition performance
	TITLE	Reads the title of the current POI	
SHORT VERSION or SHORT DESCRIPTION	SHORT or SHORT DESCRIPTION	Reads the short description of the current POI	
LONG VERSION or LONG DESCRIPTION	LONG or LONG DESCRIPTION	Reads the long description of the current POI	
SHOW MEDIAS	IMAGES	Reads the image titles, descriptions, references of the current POI and opens the gallery	

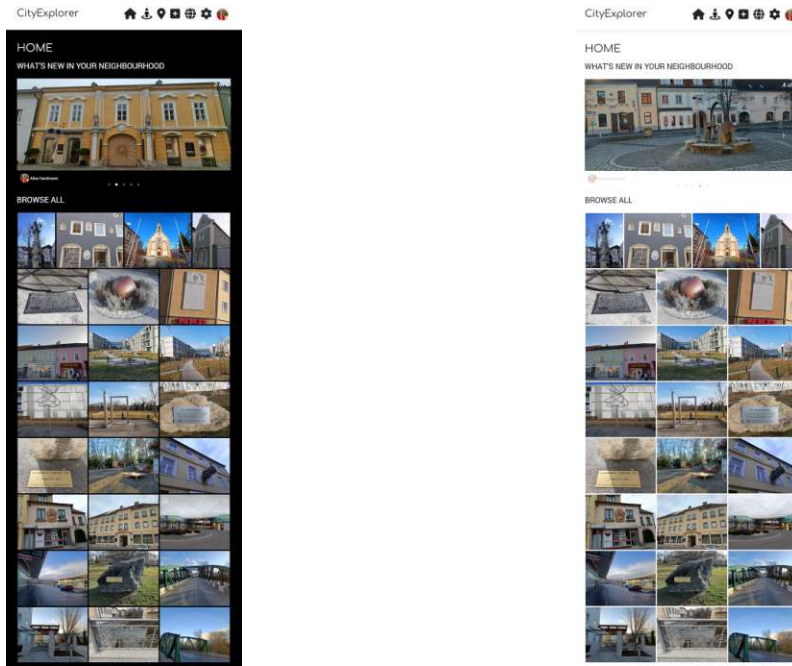
Table 3.4: Added or changed voice commands in the Explorer Application

COMMAND IN THE DESIGN PROCESS	DESCRIPTION	REASON
PLAY AUDIO FILES	Plays the audio files the current POI	We have just images as media files
ADD NEW POI name	Adds a new POI with a name	Makes no sense, due to the fact that we need to open the QuickAdd
ADD SHORT DESCRIPTION	Adds a short description to the currently new created POI	Makes no sense, due to the fact that we need to open the QuickAdd
ADD LONG DESCRIPTION	Adds a long description to the currently new created POI	Makes no sense, due to the fact that we need to open the QuickAdd
SET RADIUS TO x METERS	Sets impact radius to x meters	No settings handling via voice command, because it should not be changed frequently
SET RADIUS TO ARTEFACT   DETAIL   BUILDING   PLACE   LANDSCAPE	Sets the impact radius to one of the values	No settings handling via voice command, because it should not be changed frequently
SET VOICE to ROBO1   ROBO2   ...	Sets the voice to a predefined voice selection	No settings handling via voice command, because it should not be changed frequently

Table 3.5: Dropped voice commands during the implementation

### 3.4.9 Home

The *Home* view contains two sections with images. In the first section just 5 POIs are selected, which are published, have the “featured” attribute set and have at least one image. This POIs are shown in a carousel. The second sections contains the last 25 created POIs which were published. The code sample in Listing A.9 shows the call for loading the images of the two sections.



(a) Home view in dark mode (b) Home view in light mode

Figure 3.51: Home view in dark and light mode

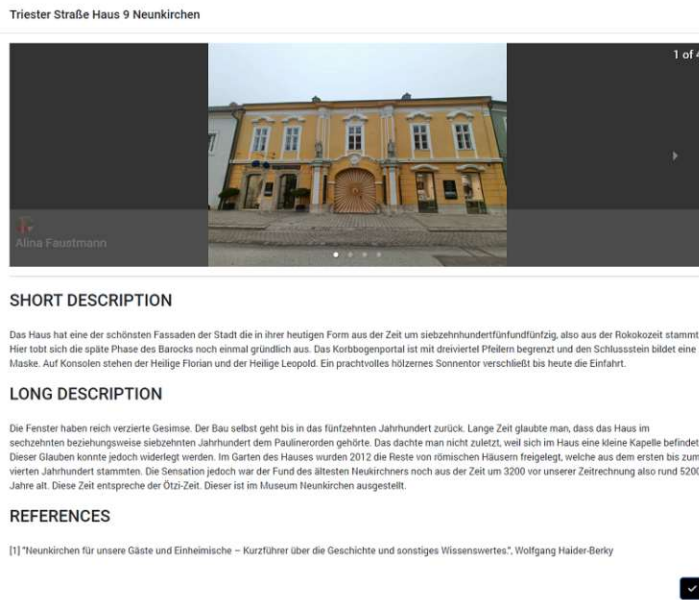


Figure 3.52: POI detail with image gallery

Afterwards the *Home* screen is populated with the first image for each POI in the list as

seen in Figure 3.51. By clicking this image, the POI detail with a gallery of the other POI images gets displayed. The details are opened in the `PointOfInterestModal`. This code sample is shown in Listing A.10.

### 3.4.10 Explore

The *Explore* view contains a map with all the published POIs which have the privacy attribute set to “public“ or the POIs which are created by the user itself and have the privacy attribute set to “private”. In the *Explore* view we can start an exploration session (Section 3.4.10) when we stroll around the city and the voice recognition (Subsection 3.4.8) and speech synthesis (Subsection 3.4.7) gets started.

The *Explore* view has different buttons depending on the exploration state. Before starting an exploration session, the button [Start Exploring] is visible but also the [Start listening] button as seen in Figure 3.53. Currently the listening state is not active and no voice commands are recognized by the voice recognition.

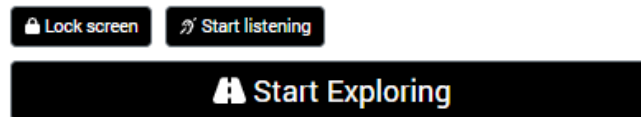


Figure 3.53: Explorer buttons - Start Exploring, Lock screen and Start listening

By pressing the [Start listening ...] button the voice recognition starts. Also if the user starts an exploration session the listening gets activated and the [Currently listening ...] button changes the state. Then also the exploration button switches to the state [Stop Exploring] so that the user can stop the exploration as seen in Figure 3.54.

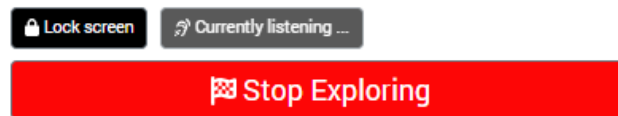


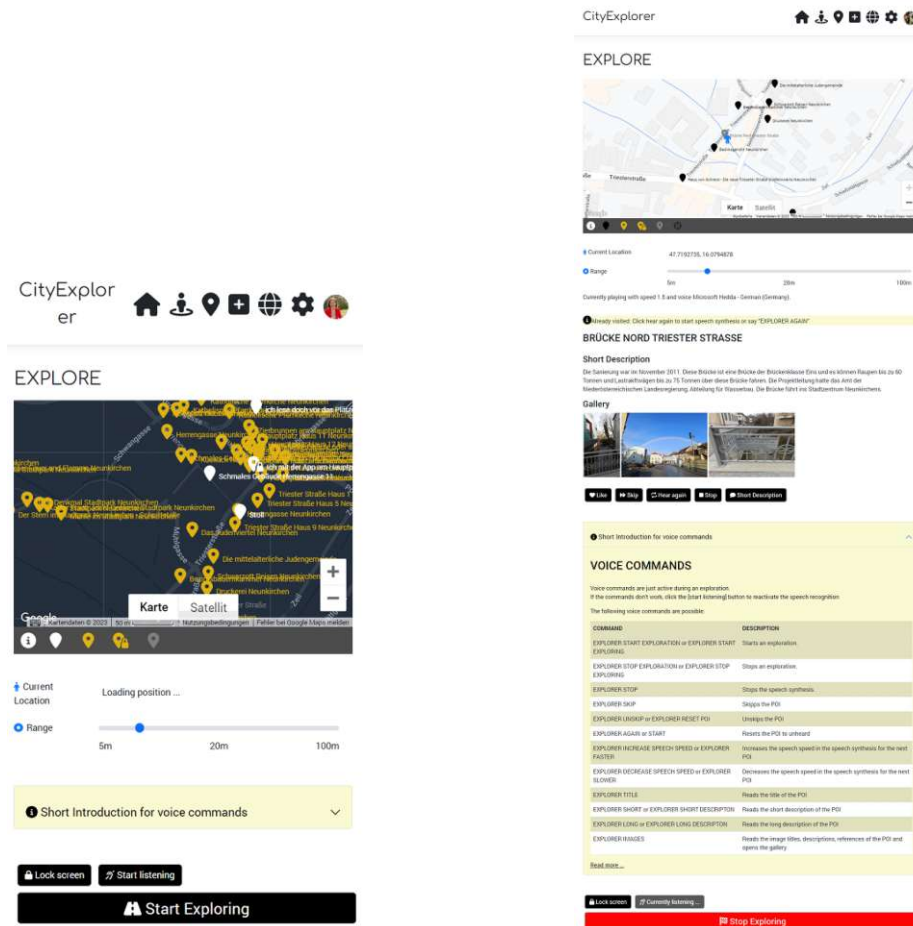
Figure 3.54: Explorer buttons - Stop Exploring, Lock and listening

During an exploration session, the user gets information about a POI if he or she approaches it and the application will mark the POI as visited and the marker will turn grey. The detailed functionality is described in Section 3.4.10.



Figure 3.55: Explorer buttons

The user can hear it again if he or she already heard the POI. To show appreciation the user can award a “like”. He or she can also unskip a POI if he or she skipped it



(a) The user wants to explore the city during night time (b) Exploration during daytime, opened voice command information

Figure 3.57: Explore view before exploration and during an exploration

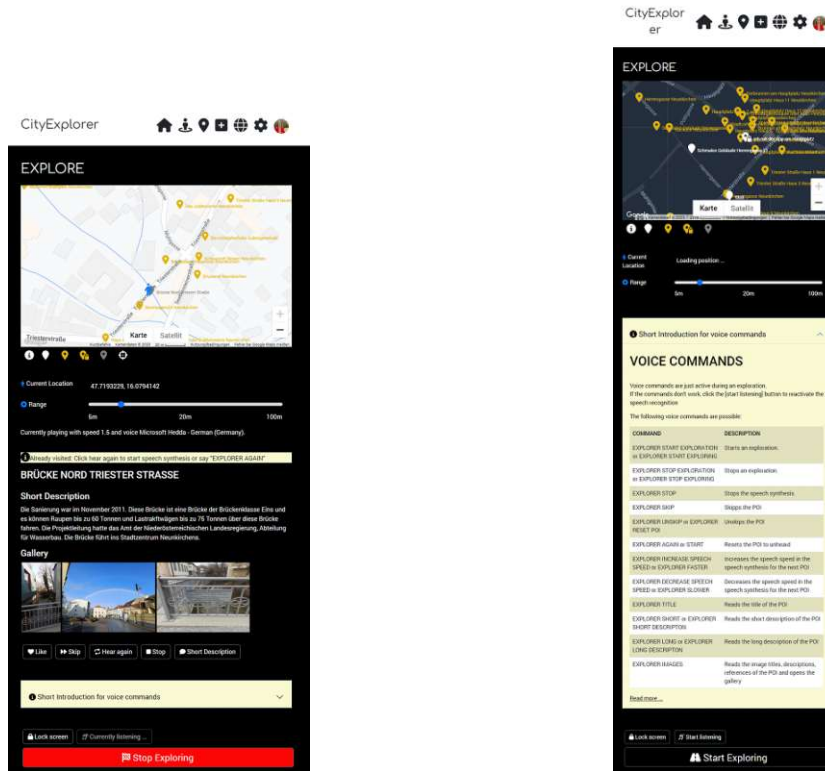
previously. This is buttons are seen in Figure 3.55 or the user can use the voice command as described in Subsection 3.4.8.



Figure 3.56: Explorer buttons

The user can also hear just the short- or long description of the current POI by using the buttons or the correspond voice command. He or she can also “unlike” the POI or skip it if he or she doesn’t want to hear it as shown in Figure 3.56.





(a) Exploration during night time

(b) Before start exploring, opened voice command information

Figure 3.58: Explore view in dark mode

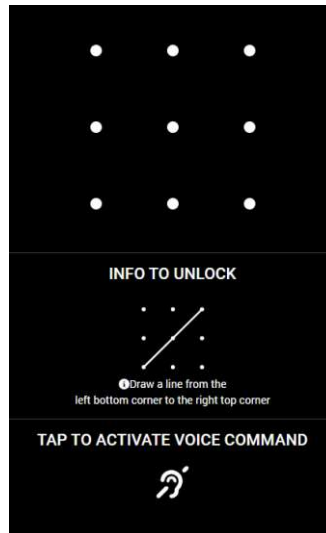


Figure 3.59: Lock screen to prevent taps on the screen

This view also has a dark mode as seen in `fig:app-explore-night`. The functionality of the [Lock screen] button is to prevent accidental taps on the screen if the phone is in the users pocket. This is described in Section 3.4.10 and in Listing A.11.

In this view, displayed in Figure 3.59, the user can accidentally press something and no interaction takes place. A tap just activates the speech recognition.

The information about the possible voice commands is also available in the applications information panel which can be expanded. This is shown in Figure 4.2. We redefined the voice commands due to better recognition as stated in Subsection 3.4.8 and because of the decision that we will not manage the application settings via the voice commands. The reason is that they are often changed only once. We have focused on the commands that enhances up the exploration experience and added for example “EXPLORER IMAGES” to open the current POI image gallery and reads the image descriptions.

The voice command information is extracted in an own file, so that the element `VoiceCommandHelp` can be included in any arbitrary page. The following Listing A.12 has an excerpt of the `VoiceCommandHelp.js` file.

COMMAND	DESCRIPTION
EXPLORER START EXPLORATION or EXPLORER START EXPLORING	Starts an exploration.
EXPLORER STOP EXPLORATION or EXPLORER STOP EXPLORING	Stops an exploration.
EXPLORER STOP	Stops the speech synthesis.
EXPLORER SKIP	Skips the POI
EXPLORER UNSKIP or EXPLORER RESET POI	Unskips the POI
EXPLORER AGAIN or START	Resets the POI to unheard
EXPLORER INCREASE SPEECH SPEED or EXPLORER FASTER	Increases the speech speed in the speech synthesis for the next POI
EXPLORER DECREASE SPEECH SPEED or EXPLORER SLOWER	Decreases the speech speed in the speech synthesis for the next POI
EXPLORER TITLE	Reads the title of the POI
EXPLORER SHORT or EXPLORER SHORT DESCRIPTION	Reads the short description of the POI
EXPLORER LONG or EXPLORER LONG DESCRIPTION	Reads the long description of the POI
EXPLORER IMAGES	Reads the image titles, descriptions, references of the POI and opens the gallery

Figure 3.60: Voice commands

It is also possible to access the introduction page as described in the Subsection 3.4.16. We will now explain the different functionalities in the following sections.

## Start Exploration

When the user explores the city and he or she approaches a POI that he or she never visited, then the speech synthesis will start automatically. If the user already heard this POI an indicator sound will notify the user that there is an already heard POI.

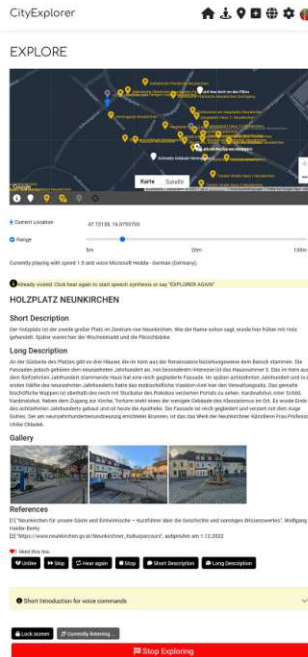


Figure 3.61: Exploration by night, all buttons visible, collapsed voice command information panel at the bottom

In Figure 3.61 we see that the map is in night mode and that there are many golden POI marker displayed. These are the public POIs which were created from other editors. The POI has a short description, a long description and an image gallery. The speech synthesis of the title, short-, long description and the gallery description can be activated via a voice command. There are also buttons to set the POI as a favorite POI, skip or unskip the POI or to hear it again. If the POI has a short- or a long description then there is also a button to hear each of the descriptions available.

When the user starts an exploration, then the location watcher starts to detect the surrounding POIs and the speech synthesis begins. This is shown in Listing A.13. The speech recognition is activated if we press the “start listening” button. Some devices also support continuous listening, but in our tests only Google Chrome for Desktop supported this features. This means the application is allowed to have a constantly active microphone so that a continuous listening for voice commands is possible. Android does not allow this function due to privacy concerns so we worked around this behaviour with the pattern lock, when we put the device in the pocket. This feature hinders the device from getting into the energy saving mode during an exploration session and will be discussed in Section 3.4.10. Furthermore, the features of detecting nearest POI, described in Section 3.4.10 and wakelock also get activated when we start an exploration session which we will explain in the Section 3.4.10 and Section 3.4.10.

During an exploration session, the user gets information about a POI if he or she approaches it and the application will mark the POI as visited and the marker will

turn grey. The approach distance, also called “broadcast radius”, where the speech synthesis gets triggered, can be set via a range slider as seen in Figure 3.58. If the user already heard this POI, then he or she will get an indicator sound that he or she already visited the POI. In the following Listing A.14 we see the three indicator sounds and what happens if the `currentPointOfInterest` gets updated, because then the application checks if the POI was not already visited, and activates the speech synthesis for the POI data.

### Detecting nearest POI

We get the `currentPosition` from our location watcher and we check if the distance to the previous position is more than 1m. This is to remove position jumps when standing still. If this is the case, then we will use this data as our new last position and call the `handlePositionChanged` function. This function shown in Listing A.15 calculates the distance from all POIs to our current position and sort it by distance. We always take the first from the list and so we get the nearest POI. If this distance is within a specific value, called our `searchRange` we set this POI as our `currentPointOfInterest`. We check if the application is currently not reading another POI, otherwise we can set the approached one as our new current POI, which will be read to the user.

### Wakelock

After a certain time, the screen of most devices turns black to save energy. We want to prevent this during an exploration session, because this also disables the positioning feature and the background positioning feature is not available in a PWA. For this we use the wakelock feature of the device. Not every device supports this feature so we detect support using the following command in the `Explore.js` discussed in Listing A.16.

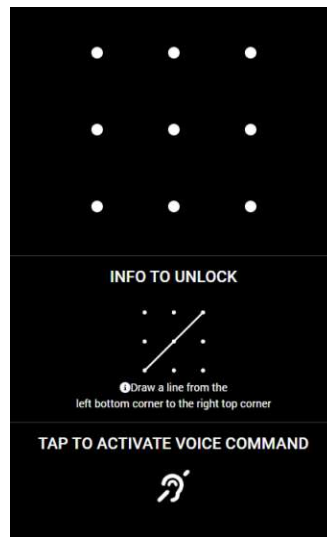
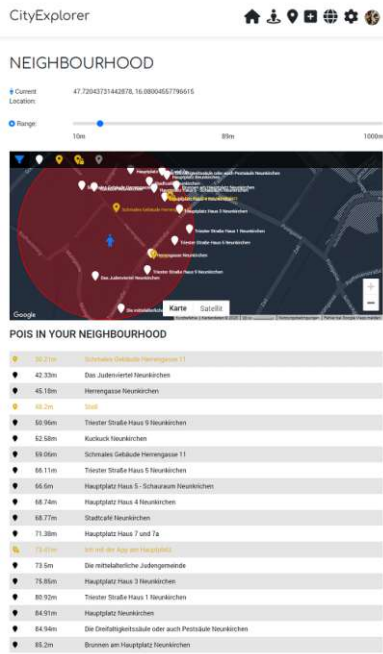
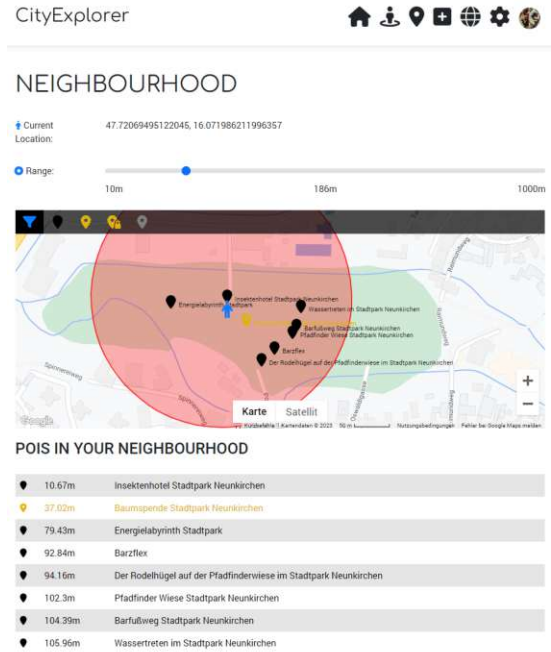


Figure 3.62: Pattern lock



Neighbourhood during night time



(a) Neighbourhood during daytime and changed current position

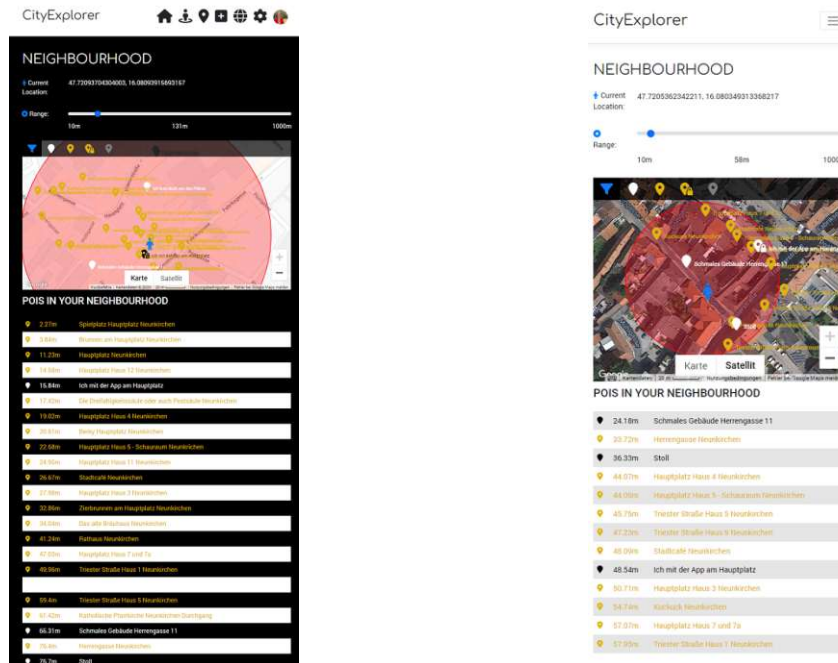
Figure 3.63: Neighbourhood views

### Pattern Lock

Since we want to prevent our screen from going into energy saving during an exploration session, but we don't want the user to press something unintentionally when he or she puts the phone in his pocket, we have included the pattern lock screen, which when tapped, activates only the voice recognition. To leave this screen the user has to enter a predefined pattern described in Listing A.17 and seen in Figure 3.62.

### 3.4.11 Neighbourhood

The *Neighbourhood* views shows the POIs with certain criteria in a defined radius. This is visualized by a drawn circle on the map as seen in Figure 3.64b. It also allows the user to view POIs of any neighborhood by changing the current position as seen in Figure 3.63a. The user can change the current position by clicking anywhere on the map. The radius can be changed by a slider and the POIs can be filtered by the different properties like: already visited, other users public POIs, own public POIs and private POIs as displayed in Figure 3.63a. These functions are described in Listing A.18.



(a) Neighbourhood black mode

(b) figure

Neighbourhood view in satellite

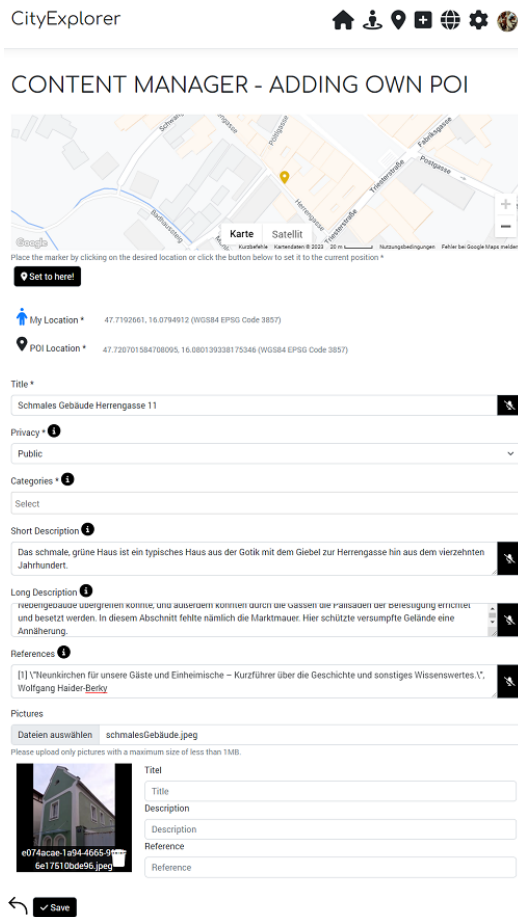
Figure 3.64: Neighbourhood views

### 3.4.12 QuickAdd

The *QuickAdd* view is actually a part of the content management, but since it is also used by the explorer role on the mobile phone when the user is strolling through the city, it has been extracted as a separate menu item.

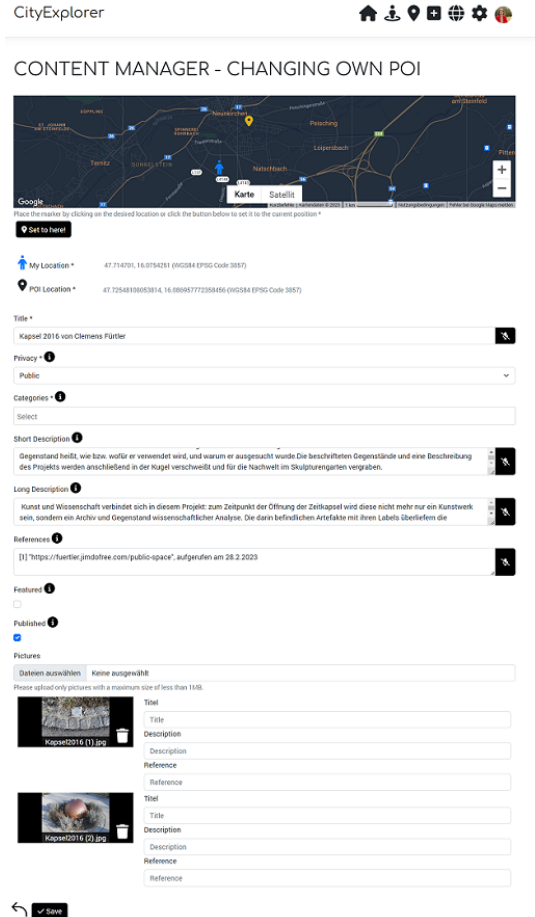
The *QuickAdd* view depends on the current user and the query-string parameters when the view was accessed by the user. If the URL has a `poi-id`, then we know that the user called the link to edit a POI as seen in Figure 3.65b. If there is no parameter, a new POI will be created. This is displayed in Figure 3.65a. The implementation is shown in Listing A.19. With the *QuickAdd* view the user can quickly take out his mobile device when standing in front of a POI and create a new POI in the application and record information. For this the coordinates of his current position are taken from the device and the “My location” and “POI location” will be initialized with these coordinates. The “POI location” will be shown on the map and the user can choose a different position. With the button [Set to here] the “POI location” will be set again on the devices coordinate which is the “My location” position.

The user can enter the data manually or he or she can use the voice recognition for the title, short description, long description or the POI references. This is described in



(a) figure

QuickAdd in light mode with data



(b) figure

QuickAdd changing own POI

Figure 3.65: QuickAdd views



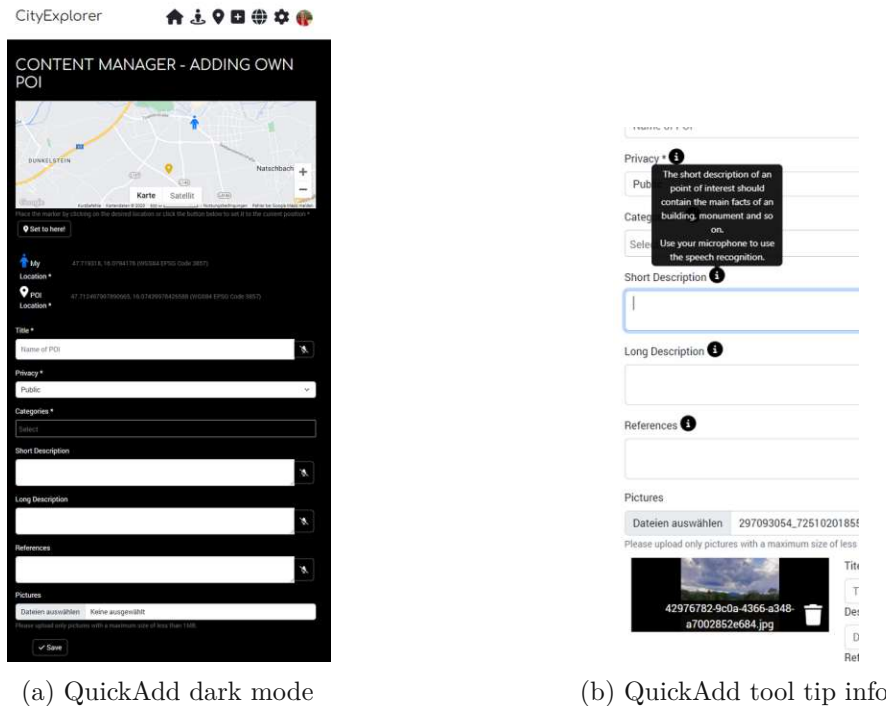


Figure 3.66: QuickAdd with info

the Section 3.4.12. The information about the specific field is shown in a tooltip as seen in Figure 3.66b. The categories of a POI can be set as well as the privacy. This means if a POI should be visible for all users or just for oneself. The user can also decide if the POI should be a featured POI, so that it will be visible in the home screen gallery of "What's new in my neighbourhood". In the edit mode it is also possible that the POI can be set to unpublished, so that it is just accessible in the content manager. This prevents that an unfinished POI is already seen in exploration.

The user is also empowered to quickly take a new photo using his devices camera or select one or more existing photos from his mobile device and upload it. This is also possible in the edit mode. The handling of the image upload feature is described in the Section 3.4.12. Also the annotation and reporting is handled by this view and implemented in the `QuickAdd.js` file. This will be described in the Section 3.4.12.

### Speech Recognition

By clicking the microphone icon next to the respective input field the speech recognition gets started. The browser indicates this activation as a record symbol in the tab header as seen in Figure 3.68. If the user is in the browser, he or she will get a notification that the microphone needs permissions to be accessed. The popup is seen in Figure 3.67. If the user installed the application on the device, he or she will need to give the application

permission.

Listing 3.5: Start transcript for the short description

```
<Button onClick={() => startTranscript("shortDescription")}>
  {listening && currentPropertyTranscript === "shortDescription "
    ? <FontAwesomeIcon icon={faMicrophone} />
    : <FontAwesomeIcon icon={faMicrophoneSlash} />
  }
</Button>
```

After listening this text is written in the property of the respective input field as described in Listing A.20 and Listing 3.5.

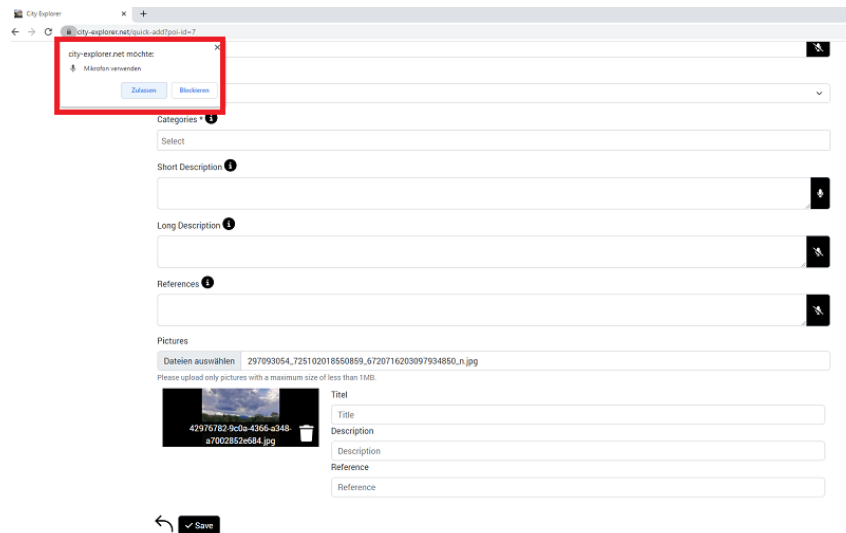


Figure 3.67: Popup for microphone permissions

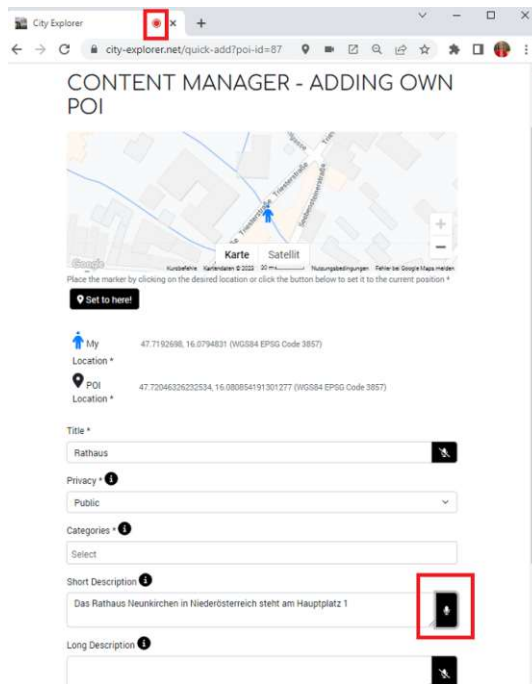


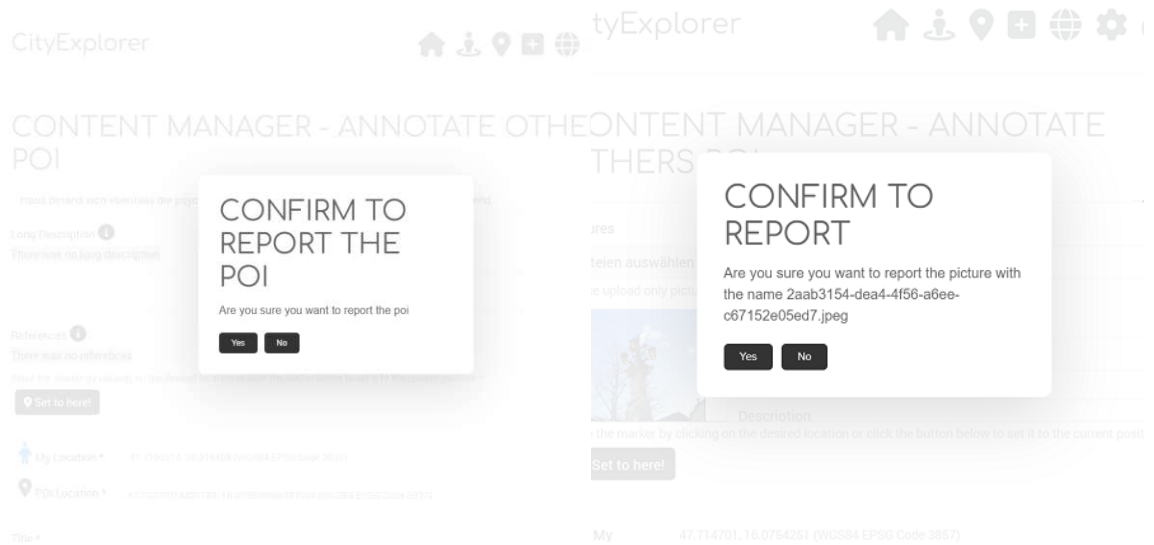
Figure 3.68: Speech Recognition for an input field

### Upload images

To add pictures we use the HTML input element and call the `handleFileSelected` function when the user takes a photo or selected some from storage. The POI data is in a Form tag and each attribute is a FormGroup. The code sample in A.21 shows the picture FormGroup tag. The `handleFileSelected` goes through all selected files and calls the method `add-picture-to-point-of-interest`, so that each picture gets uploaded and connected to the current POI.

### Delete images

The user is also allowed to delete images of own POIs. He or she will get a confirm dialog if he or she is sure to want to do this, and if the user accepts it, then the image will be disconnected from the POI and the picture list will be updated without the deleted one. This feature is shown in Listing A.22.



(a) figure  
Report POI

(b) figure  
Report image

Figure 3.70: Report POI and image

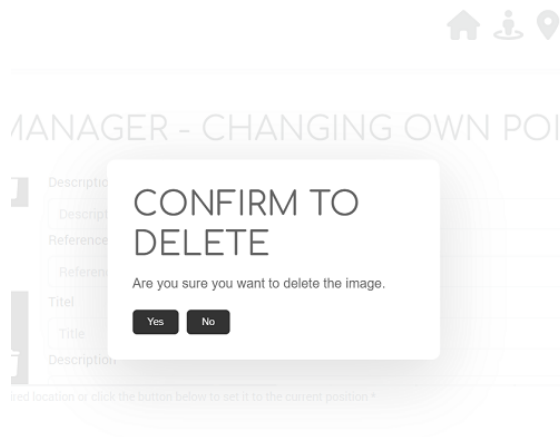


Figure 3.69: Delete image from own POI

### Annotate and Report

Depending on if the user is the creator of the POI or not, the HTML elements for the annotation and reporting will be shown in Listing A.23. The user can report the whole POI 3.70a, make suggestions like changes or additional text in the title, short description, long description or references as shown in Figure 3.71a.

It is also possible to report just a picture if it is wrongly connected to the POI. Reporting

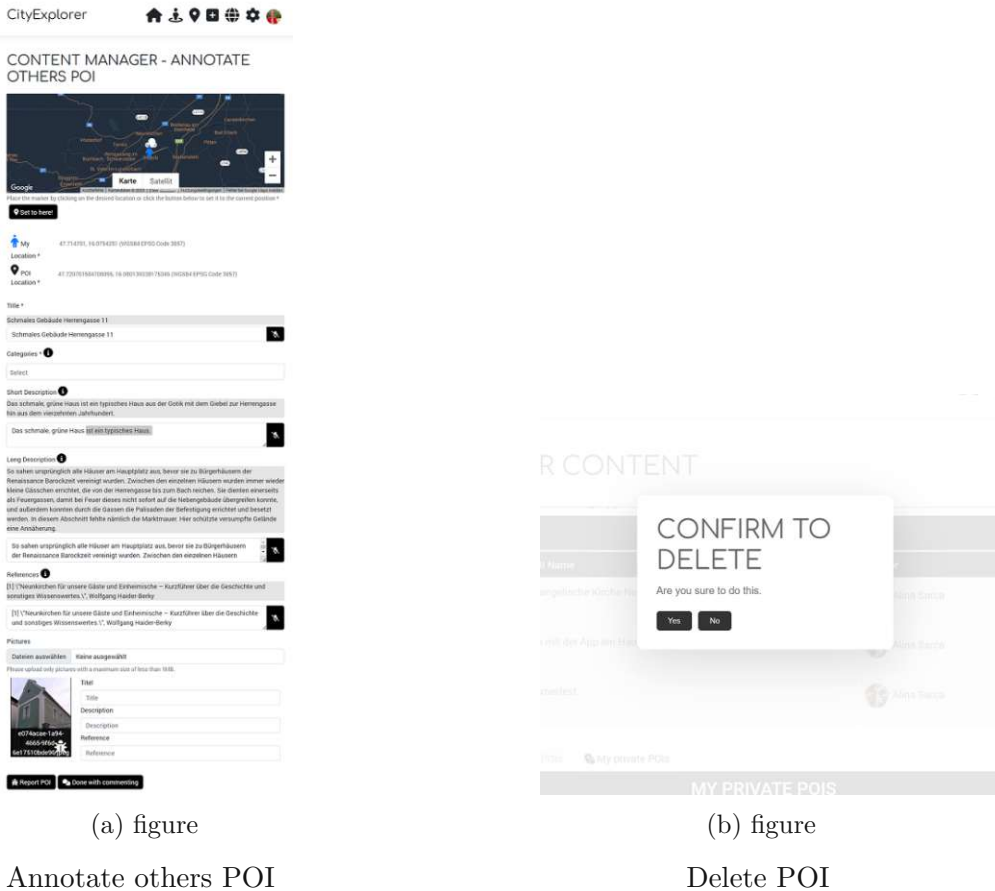


Figure 3.71: Annotate and Delete POI

just an image is also possible if there are people on the picture, who do not want to be on it or the picture does not represent appropriate content. This is displayed in Figure 3.70b.

For the annotation we load the previous version of a POI and the current version of a POI. If the owner of the POI differs from the current user then we determine that this is an annotation process as described in Listing A.24.

This annotation and reporting process is just covered up by the fields, buttons and the user will get different message boxes if he or she reports the POI like seen in Figure 3.70a or Figure 3.70b, but it is not fully implemented. Just a counter will be incremented, so that the application can use for statistics. After annotating the app will redirect the user to the *Content Manager*.

### 3.4.13 Content Management

The *Content Management* contains the list of all editable POIs and also the possibility to add and change own content. Adding and changing content is done in the QuickAdd view

by changing fields depending on the user permissions. This is described in the section 3.4.12. The content, which is used in the exploration are displayed in three tables which contains the public POIs 3.4.13, which are authored by other users, the public content, which is written by the user itself 3.4.13 and the private content of the user 3.4.13. These tables are all located in one file called `ContentManager.js` which loads the data and sets the corresponding visibility of the HTML elements. Therefore, a navigation gets rendered, where the tabs are activated, when the navigation is active.

The data will be rendered in Google Maps, therefore, a map is needed as shown in Listing A.25

Depending on the selected tabular the adequate Tab-Pane gets opened and the data is loaded as seen in Listing A.26 .

The functions to load the data are: `handleLoadedMyPublic`, `handleLoadedOtherPublic` and `handleLoadedPrivate`. Each function is a callback of a `fetchDataUrl` and sets the POIs for the map and the table.

#### Delete POI

When the user wants to delete a POI a confirmation dialogue opens as shown in Listing A.27. If the user enforces the delete process, then the POI will be deleted in the database. For the future work there should be a delete flag and not a physical deletion in the database.

#### Others public POIs

The “Others public POIs” table contains all the POIs that are created by other users. The Listing A.28 shows the function call. For each POI the GPS coordinates, the name and the creator is shown. This points are also displayed in the map by a black icon during daytime. In the night time the POI marker are displayed in white and the map has a grey-blue color. The current user gets a detail of the POI if he or she clicks on the buttons in the right. In the detail view he or she can annotate or report a specific POI like described in the Subsection 3.4.12 *QuickAdd* and in the Section 3.4.12 or he or she can add additional images to the POI as shown in Figure 3.24.

The super user, which is in our application a static user, but should be in future an own role can also delete the foreign POIs. There is also a pagination and navigation for the entries with a page size of ten.

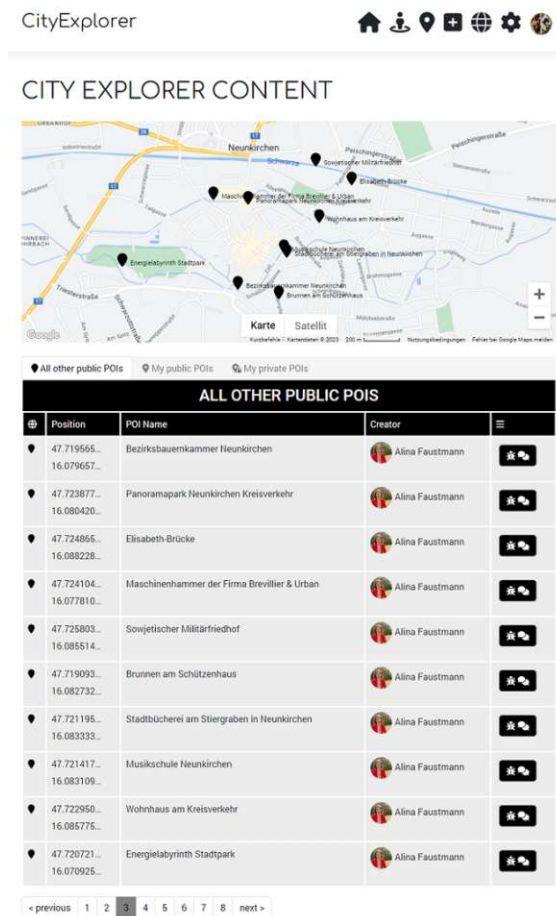


Figure 3.72: Others public POI

### My public POIs

The “My public POIs” are all the points created by the current user. This points are displayed by a golden color on the map. The overview contains like all content management tables the coordinates of the POI, the title and the creator. In the last column there are the action commands depending on the permission. Due to the fact that this table contains just the POIs that the user created, he or she has all permissions to edit or delete a POI. The delete button is accessed in the table directly. The data changes of the POI is accessed by clicking the edit button which opens the QuickAdd view with “edit” permissions. This table also has a pagination if the user created more than ten entries. The code sample is shown in Listing A.29.



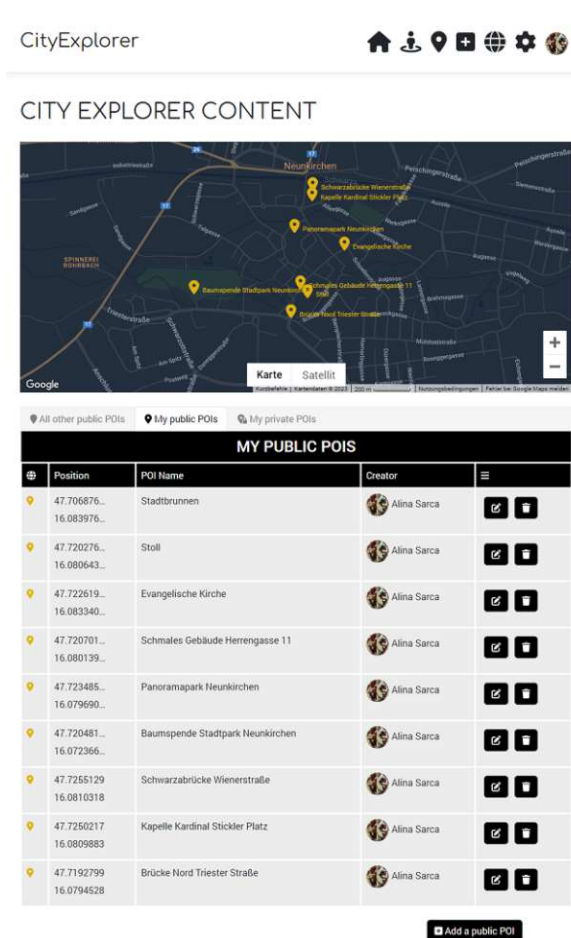


Figure 3.73: My public POIs at night

### Private POIs

The private POIs are only visible for the creator itself. This are displayed by a golden marker icon with a lock. With private POIs the user can document his journey by a photo session so that he or she can also make selfies of himself/herself and of others with the sights. No other user has access to this POIs, so the explorer or editor is freely to manipulate this POIs. This data should then be available to the user as a download as a PDF or as an archive file. There should be a summary of the POIs with the images, title, descriptions, references and so on.

The Listing A.30 shows that by calling the [Download my journey] button just a confirmation dialogue opens. We mocked this functionality up just to make the feature clear, but in the future there should be a real download.

The “edit” and “delete” feature is implemented and the private POIs can be edited. This data will be loaded in the *QuickAdd* view as seen in Figure 3.65b in edit mode. The

delete button is accessed directly in the table. This table also has a pagination if more than ten entries are available.

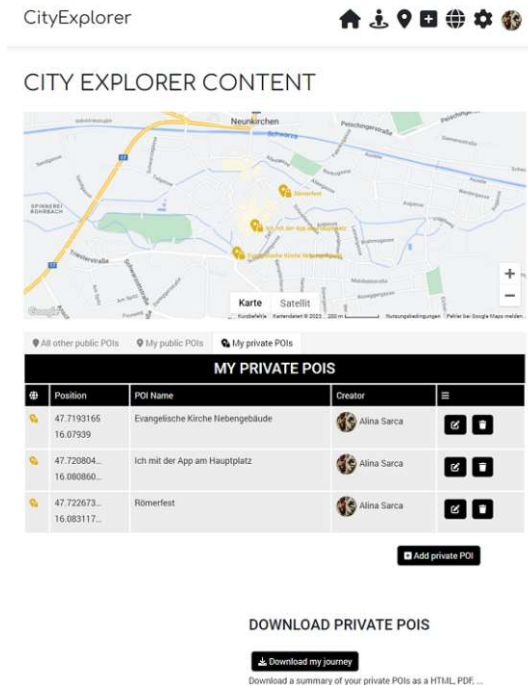


Figure 3.74: My private POI

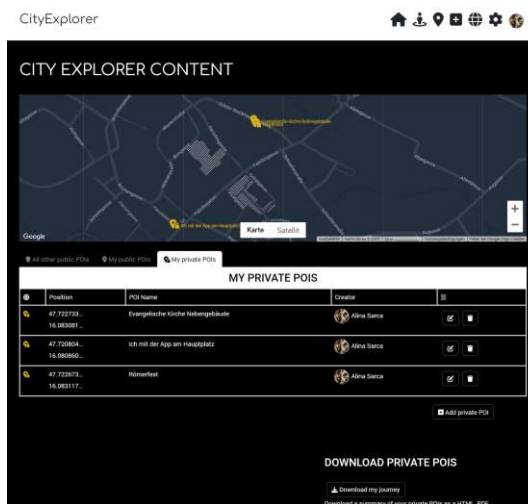
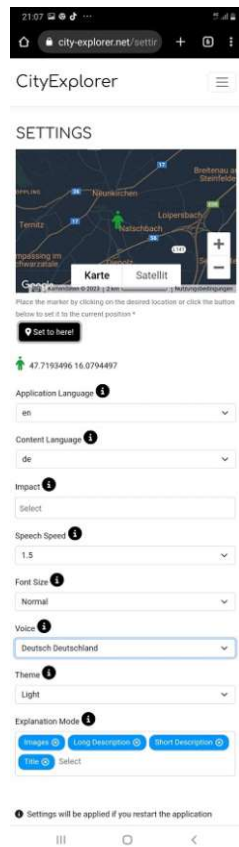
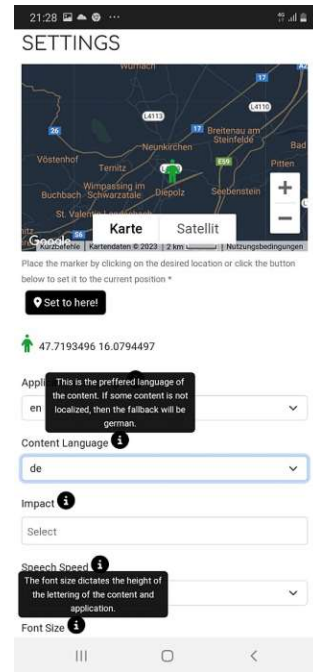


Figure 3.75: My private POI in black mode

There is also a dark mode for all of the tables. This is an example of the private points but, all the tables have the same behaviour. The dark mode is shown in Figure 3.75.



(a) Application Settings



(b) Tooltips

Figure 3.76: Settings

### 3.4.14 Settings

The *Settings* page allows the user to configure the application. Therefore, the configured settings of the current logged in user are read out in a `Form` element in the `Settings.js` file and be displayed in adequate HTML elements within a `FormGroup`. Each setting has a description which the user can display by clicking on an information icon. This is implemented as a `UncontrolledTooltip` or in case of the map for the first setting, the “home position” as a `FormText`.

When the user changes the specific setting value will be changed in the users object and the entire object will be submitted to the database by calling an API method from the `AuthController.cs` as described in Listing A.31. After refreshing the page or restarting the application the new value will have an impact on the application.

## Home Position

The user can change the home position. For this a Google Map will be rendered, where the home position is shown. For this we need to use the `GoogleMapReact` component and insert our API Key in the property `key`. The data for the map is in the following Listing A.32.

Clicking on the map will set the latitude and longitude of the home position variable by calling the function `setMarkerPosition`.

An additional button called `Set to here!` can always set the home position to the current GPS location. This is the `Button` with the `setMarkerPositionHere` action, which will execute this function. The *home position* will also have an impact on what POIs will contain sending the newsletters. The newsletters are not implemented.

## Content Language and Application Language

The next two settings are the language settings of the application. It is possible to save two different language settings for the user, the application- and content language setting. The *application language* is the preferred language of the application buttons and labels on the mobile device or in the browser. If something is not localized, then English will be used as fallback.

The *content language* is the preferred language of the content. If some content is not localized, then the fallback will be German. These two features are saved, but will not have any impact, as we did not implement the localization for the application or for the content. Our test data is in German and our application is English. The localization of the data and application is out of the scope of this thesis. Doing this, would mean that there will be several tables necessary to be multi-language capable. The Listing A.33 shows the functionality.

## Impact

The impact refers to the desired categories of the POIs. It is a multi select of the POI categories. These categories and the distance of the range slider will be considered in the exploration and neighbourhood view as the so called “broadcast radius” as discussed in Listing A.34.

## Speech Speed

The speech speed is the reading speed of the synthesizer. The user can select a factor of the normal reading speed. Is the factor less than 1, then the voice is slower than the normal speed. If it is more than 1 then it is faster as usual. For example 2.0 means that the voice synthesizer is twice faster as normal described in Listing A.35.

#### Voice

The voice is used to read the content of the application. The voices are the default system voices from the browser, mobile device or the installed ones as seen in Figure 3.77. When we change the voice, the new data will be set to the current logged in user.

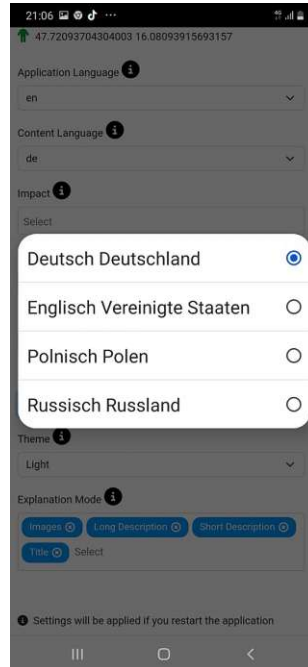


Figure 3.77: Available voices on the mobile device

The implementation of the speech synthesis is in Subsection 3.4.7 described. The Listing A.36 shows the implementation of the voice setting.

#### Font Size

The *font size* dictates the height of the lettering of the content and application. The possible values are “small”, “large” and the default value is “normal”. By changing the value the changes the current user data, which will be written in the database.

After restarting the application the `App.js` handles the user setting and sets the `CSS-class` for the specific font size as described in Listing A.37. The new class will also be set if we just refresh the browser page as seen in Figure 3.78. This method of changing the `CSS-class` also happens when the user selects another theme like the dark or light mode as seen in Section 3.4.14 and the following example in Listing 3.6 shows the switch of the body class. The handling for the font size is described in Listing A.37.



(a) figure

Settings with font size large



(b) figure

Settings with font size small

Figure 3.78: Settings with different font sizes

Listing 3.6: Setting current user's theme

```

let currentUser = userActions.currentUser();
if (currentUser) {
  window.document.body.classList.add(
    "font-size-" + currentUser.fontSize
  );
  window.document.body.classList.add(
    "theme-" + currentUser.theme
  );
}

```

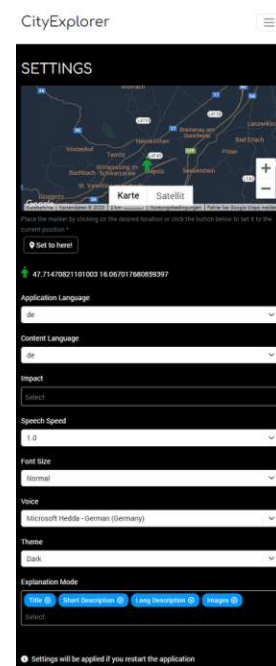
## Theme

The *theme* setting supports a “dark”, a “light” and a “default” mode. The “default” mode is the light mode. When we change the value of the drop down and save it to the logged in user in the database. After refreshing the page or restarting the application the theme changes. This is shown in Figure 3.79 and in Listing A.38.



(a) figure

Settings in light mode at night



(b) figure

Settings in dark mode at night

Figure 3.79: Settings in light and dark mode

### Explanation Mode

The *explanation mode* is used when the content is read by the speech synthesizer. If the user reaches a point of interest, then the selection will be considered if he or she just wants to hear the title, or the title and the short description or everything else from a POI or just a subset of the values. The explanation mode also allows multi select of the values. The possible values are: title, short description, long description or images. This functionality is shown in Listing A.39.

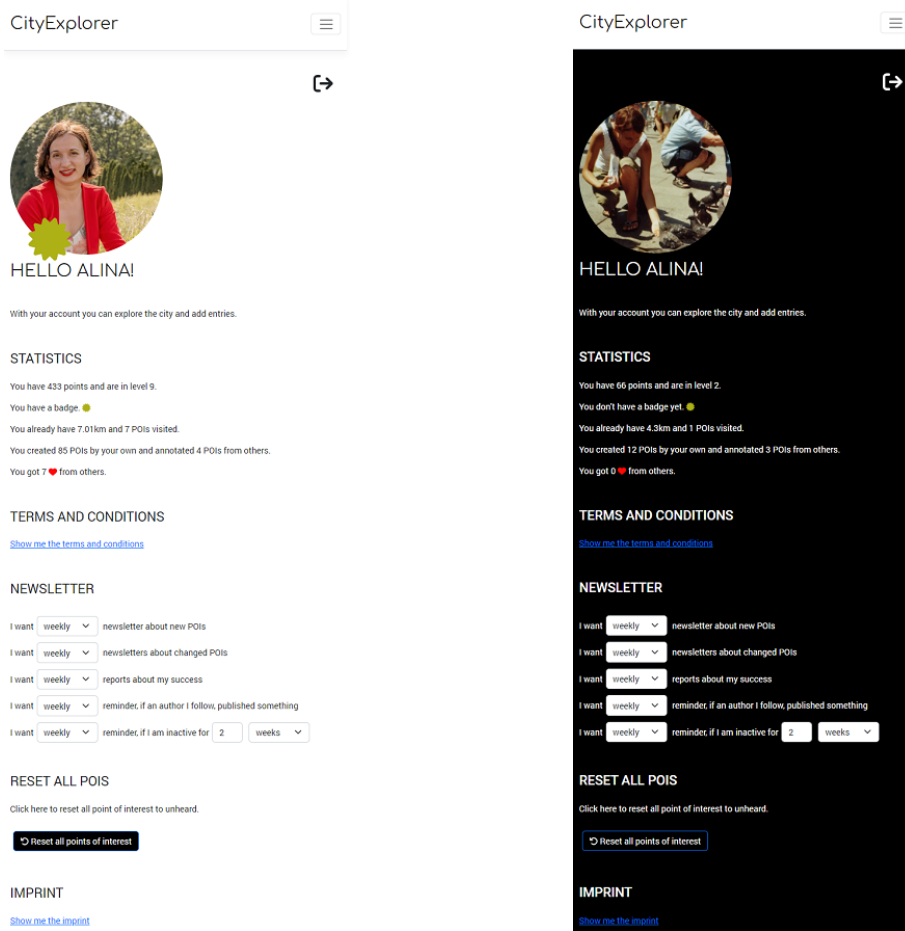
#### 3.4.15 Profile

The profile page contains the information about the logged in user as seen in Figure 3.80 and described in Listing A.40. The name and the image is taken from the Google Account and this information gets updated after every login.

#### Statistics

This view contains some statistics about the walked distance and the number of the POIs that the user visited in the exploration sessions. It also shows how many entries the user has created and how many likes he or she got from other users on his entries. It is also





(a) figure

(b) figure

Profile page in light mode - User has a badge

Profile page in dark mode - User without a badge

Figure 3.80: Profile in light and dark mode

displayed how many POIs from other users, he or she annotated and if the user has a badge or not. The calculation of the badge depends on the number of created entries or annotation progress for other users entries as shown in Listing A.41.

For each created POI the user gets 5 points. For each annotated POI, he or she gets 2 points. The user starts with level 1 and every 50 points he or she rises one level.

In level 4, he or she gets a badge. With the badge a user should be theoretically able to review other users POIs. Due to the fact that we did not implemented the reviewing process as it is out of scope for this thesis, we just handle this on the explorer site and show this on the profile page.

#### References to other pages

The user can also access the *Terms and Condition* page in Subsection 3.4.17 and the *Imprint* in Subsection 3.4.18 from the *Profile* view, so he or she can look up the needed information.

#### Newsletter

The newsletter options are also displayed but not implemented, as it is out of scope of the thesis. This is described in Chapter 6 *Summary and Future Work*.

#### Reset visited and skipped POIs

The button [Reset all points of interest] resets the visited and skipped state of all POIs for the user, so that he or she will get all the POIs in the speech synthesis again.

The following code is in the `Profile.js` where we can see the rendered button and the API call for the `PointOfInterestController.cs`.

The `PointOfInterestController.cs` handles the API call and delegates it to the corresponding provider so that the skips and visits are cleared for the user. This is shown in Listing A.42.

So this means that after pressing the button the statistic for the user changes. The distance walked is still remaining, but the visited POIs count is resetted to 0.

#### 3.4.16 Introduction

The introduction page contains a brief information about how to use the app. It also lists the information about the possible voice commands which can be used in the exploration view, which is the same element and is imported by the command `VoiceCommandHelp` element as shown in Listing A.43.

#### 3.4.17 Terms and Conditions

In the application it is always possible to read the *Terms and Conditions*. These were accepted once when registering. This is just a static HTML Code. An excerpt is in Listing A.44.

#### 3.4.18 Imprint

The *Imprint* view contains information about the City Explorer and the used sound effects. It is a JSX code with static HTML data and a back button. Because this is a short file, the Listing A.45 will contain the entire data of the `Imprint.js` file.



(a) Introduction light mode

(b) Introduction dark mode

Figure 3.81: Introduction to CityExplorer



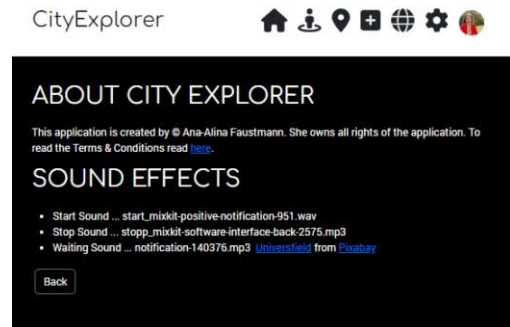
(a) Terms and Conditions in light mode

(b) Terms and Conditions in dark mode

Figure 3.82: Terms and Conditions



(a) Light mode



(b) Dark mode

Figure 3.83: Imprint in dark and light mode

# Evaluation

## 4.1 Evaluation of the City Exploration with a location-based Augmented Reality application

To evaluate our application against the AR experience we leaned our characteristics described of a serious game called *H-treasure Hunt* [KAKW15], modified and added additional questions. *H-treasure Hunt* [KAKW15] is a location and object-based serious game for cultural heritage to learn a historic site. It is also location based using GPS but because of the fact that artefacts are often located close to each other on a historic site, and so to pinpoint them, they also used object-based sensors. We don't need object-based sensors, because we don't need the accuracy of less than a few meters.

So we elaborated our questions and evaluated the Augmented Reality application against usability and emotional experience with the following questions by assigning values from 0 to 10 which can be translated on a scale from *strongly disagree* to *strongly agree*. We also covered some safety aspects and content collaboration thoughts with some questions.

The questions to determine the usability are:

- Application is easy to use
- Features were satisfying
- Voice recognition was accurate
- Voice interface was easy to use
- GPS was accurate
- Text to speech was accurate

- Settings for text-to-speech were easy to handle
- Adjustments options were satisfying

and for the emotional experience:

- Application offers a new experience
- Application offers stimulation to explore the city
- Application gave me a connection to a specific POI
- Application gave me a connection to the city
- Application makes me learn more about the city
- Application makes me think about the cultural heritage

Also some safety aspects were determined. The user had to think about following things:

- Did the application disturbed me from traffic?
- Did the application disturbed me from the surroundings like other people?
- Did the weather have an impact on the application usage and give thoughts about it

Excluded from the exploration itself and only discussed in the focus group, the participants should think about following aspects:

- Creating and editing content
- Thoughts about the content annotation
- Thoughts about reviewing

These questions are addressed in a questionnaire, answered individually by the users, after they have tried the application in the city and discussed it in the focus group. The last section about the “content collaboration thoughts” we discussed it without a rating.

The participants could assign to all other questions points and this points were normalized on a scale from zero to ten. After this the results were collected and analyzed. The results from the exploration in the field, the questionnaire and the group discussion are described in the following sections.

The prototypical application was tested during the implementation phase. Based on findings during those tests the GPS positions, images and descriptions were adapted, so

that after two major walk-throughs, and some minor ones, it was presented to the focus group. The final test data contained 89 POI and is also part of the project folder.

The focus group started with the instruction phase for the participants, then a short introduction on how to use the application when exploring the city and then a discussion with all participants where they also had to answer some questions on their own and discuss them in the group. This process is described in Subsection 4.1.3.

### 4.1.1 Prerequisites

Days before the focus group and exploration in the field, a WhatsApp group was created and the participants were instructed to use an Android device and to download the German voice language data for the speech synthesis. Therefore, there was a short instruction video created and distributed in the group. The participants should also access the site in chrome and allow chrome to download the application as a PWA as seen in Figure 3.42. Then they should give the chrome application the required permissions like GPS, microphone and camera. They were also instructed to take earphones and a powerbank with them, because in the test phase we noticed that the application needs quite lot of energy. Some additional backup hardware, was also prepared.

The participants also needed to send their GMail-addresses, so that they could be added as test users.

### 4.1.2 Preparation for Exploration

On the exploration day, there were 5 participants in the group: 3 males and 2 females. Two of them, one male and one female were not included in the rounds before for the evaluation of the wire frames and mockups, so this two participants were completely unfamiliar with the app and therefor had a fresh view on the application.

The participants also used their own smartphones and downloaded the application.

One participant needed to use a different device. She already mentioned this before, so she got a test device. But due to the fact that she let her own phone at home, she couldn't authorize with her own Google Account, so she used my second personal Google Account.

Before starting, all participants met at a place and we checked if all devices had installed the German voice language package and all had the correct permissions set so that the application could access the location data, camera and microphone.



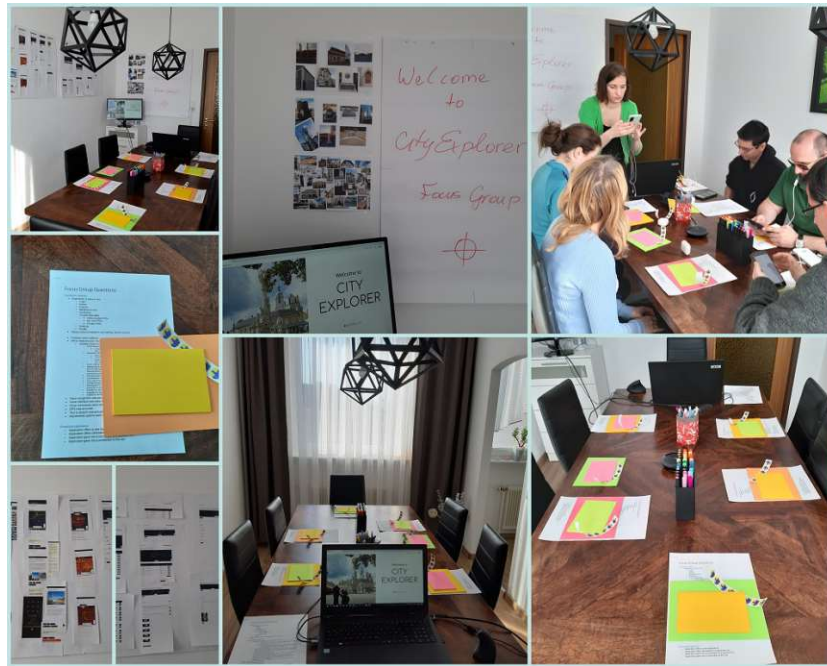


Figure 4.1: Focus group preparation

Then the participants got an introduction and briefly walk through the application how to use the exploration and content management features of the application.

Short introduction for voice commands

### VOICE COMMANDS

Voice commands are just active during an exploration.  
If the commands don't work, click the [start listening] button to reactivate the speech recognition

The following voice commands are possible:

COMMAND	DESCRIPTION
EXPLORER START EXPLORATION or EXPLORER START EXPLORING	Starts an exploration.
EXPLORER STOP EXPLORATION or EXPLORER STOP EXPLORING	Stops an exploration.
EXPLORER STOP	Stops the speech synthesis.
EXPLORER SKIP	Skippes the POI
EXPLORER UNSKIP or EXPLORER RESET POI	Unskips the POI
EXPLORER AGAIN or START	Resets the POI to unheard
EXPLORER INCREASE SPEECH SPEED or EXPLORER FASTER	Increases the speech speed in the speech synthesis for the next POI
EXPLORER DECREASE SPEECH SPEED or EXPLORER SLOWER	Decreases the speech speed in the speech synthesis for the next POI
EXPLORER TITLE	Reads the title of the POI
EXPLORER SHORT or EXPLORER SHORT DESCRIPTION	Reads the short description of the POI
EXPLORER LONG or EXPLORER LONG DESCRIPTION	Reads the long description of the POI
EXPLORER IMAGES	Reads the image titles, descriptions, references of the POI and opens the gallery

[Read more...](#)

Figure 4.2: Voice Commands

#### 4.1. Evaluation of the City Exploration with a location-based Augmented Reality application

A note with the voice commands, as seen in Figure 4.2 was distributed, which is also available in the application and we started our journey. The group was always together but they were free to move around and explore the specific area.

We started from the “Bezirksbauernkammer Neunkirchen” and after approximately one hour and a walked distance of 1.5 km the exploration was stopped. The route was also tracked via runtastic so that we have approximate values of distance walked for comparison. Due to the fact that the participants could move around freely but did not wander far from the group but remained at sight distance, the walked distance could differ, but should be approximately be the same.

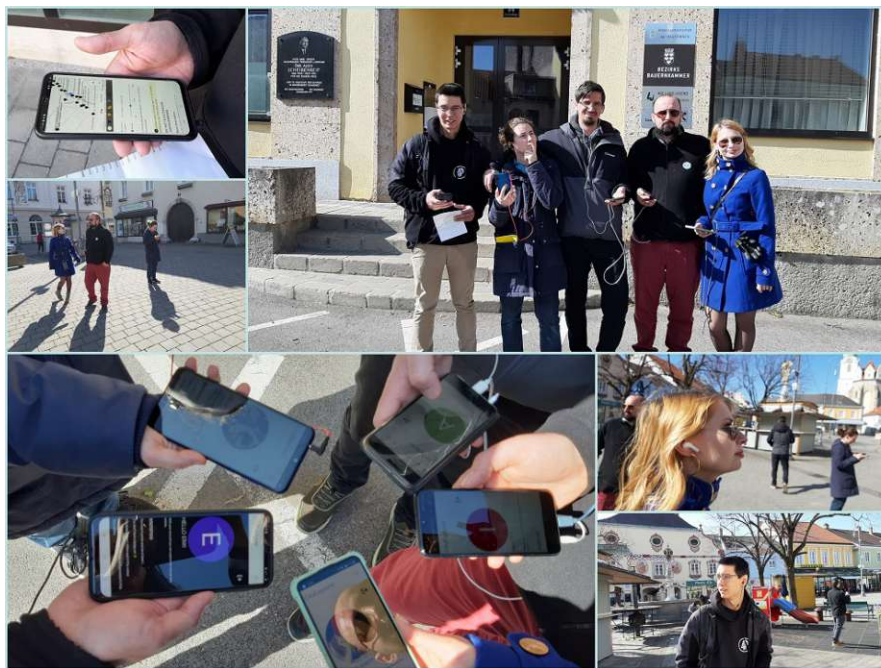


Figure 4.3: Focus group start exploration

##### 4.1.3 Evaluation of the Focus Group Discussion

After our exploration session we met again at the starting point and went into a group discussion. Everyone had to fill out a questionnaire and wrote down their thoughts on a post-it notes. These were collected and then attached to the separate features of the application, which were distributed on two posters. One for the exploration application, one for the content management application, displayed in Figure 4.4 and one for the content application, sen in Figure 4.5. There was also another poster which covered the motivational, emotions, safety aspects and general comments, as shown in Figure 4.15.

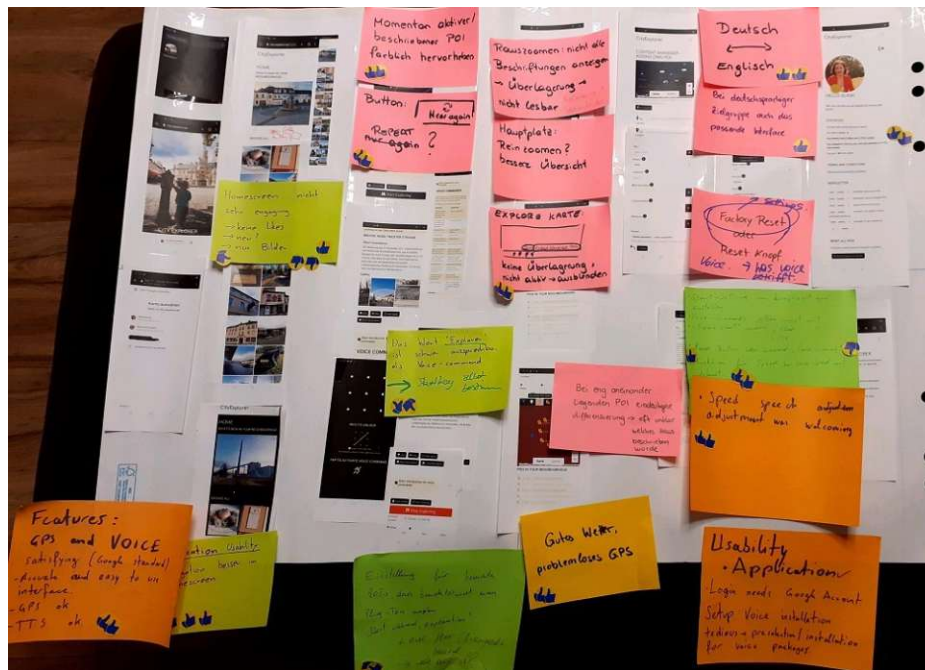


Figure 4.4: Exploration application poster

These notes were then discussed in the group and stickers with “thumb up” and “thumb down” were assigned to each note. If every participant agreed to the thought, then two “thumbs up”-stickers were attached if everyone disagreed then “two thumbs down” were given. In the case of disagreement, one ‘thumbs up’ and one “thumb down” were taped on the note. We recorded this discussion and transcribed and evaluated it.

In the following sections we explain the results of the focus group by evaluating the questionnaires and the group discussion.

We will start with the evaluation of the GPS and the speech synthesis and recognition and the possible performance issues and then we will discuss the evaluation of the features, the usability aspects of the exploration application and the content application. We will also cover the thoughts about motivations, emotions and safety aspects when using the application.

## 4.2 Evaluation of content aspects assuring a given content quality

We want to collect the data from the residents therefor it has to be easy to add and edit content with the support of the application. But we also need to ensure content quality, meaning that the data has to be correct, valid and up to date.

So we came to the conclusion that it will take a reviewer role to assure the content quality. Therefore, there should be a list with reviewers and a list with authors/editors. The

reviewer should be manageable by a super user with elevated permissions. The editor can be rated by giving points and raising in levels was an acceptable feature. Also the badge implementation was fully accepted and that a reviewer should have the possibility to grant or remove a badge from the author.

In the future there should be an indication which region the author is allowed to automatically bypass the review. The editors should be rated by the criteria that we discussed in the Table 3.3.

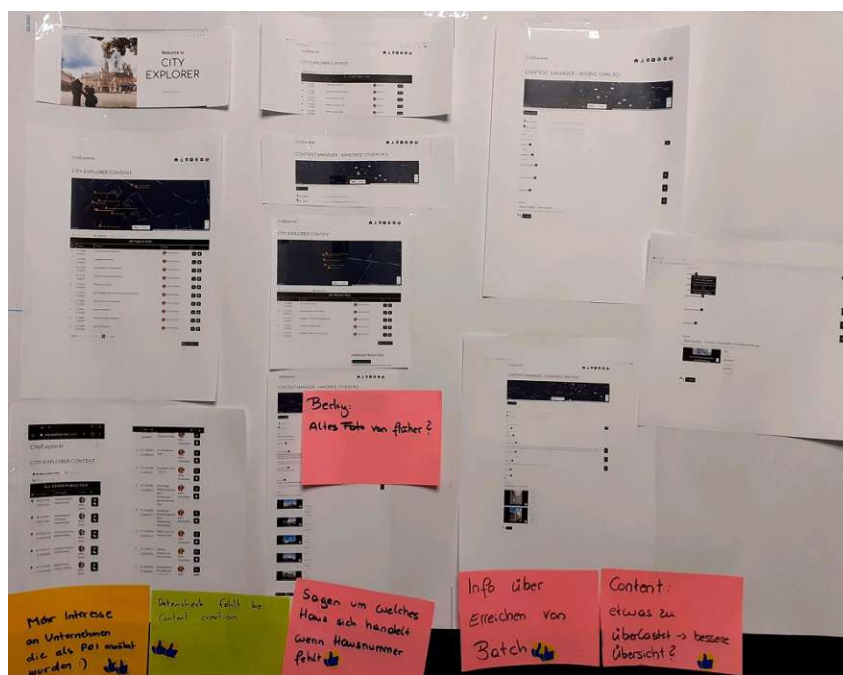


Figure 4.5: Content application poster

Concerns arised about uploaded image that there is no illegal material or to see images of people who do not want to be recorded and the responsibility of published images and content (Focus-group-interview, 00:06:29).

We covered these concerns in the “Terms and Conditions” page by a paragraph and mocked the “Report image” and “Report POI” functionality in the content management. We also discussed in the wire frames the functionality of the authoring tool and which characteristics it would take for the editors and reviewers to make sure that the content is valid and legal.

### 4.2.1 Evaluation methods for editor rating / evaluating editors

The editors should have an information about their historical background, and also a region indication for how far their geographical knowledge reaches. The reviewer badge should be also be revokable if the editor violates the the terms and conditions. But also for the editor it should be possible to have some kind of a contact form to claim the



badge back. We also detected other content aspects that are important and we gained the information during creating the content, implementing the application or using the application in an exploration session. We will discuss this finding in the following sections.

### 4.2.2 Yearly figures and numbers

During tests it became clear that text that contained a date expressed only as the year could cause problems when read. Each speech synthesizer emphasizes the year differently, so for example, 1918 does not get the output as “nineteen hundred and eighteen”, but “one thousand and eighteen”. Therefore, we needed to adapt the test data and write out the year numbers. This was also mentioned in the group discussion (Focus-group-interview, 00:16:33) that this will need an adaptation of the content or the application should cover this by an automatic replacement and conversion of the yearly figures to a written out number.

Also the numbers like 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> need to be written out, because each speech synthesizer handles it differently.

### 4.2.3 Indication of a POI

It is necessary for the explorer to know when a POI is coming up and played with the speech synthesis and which exact building or artifact is referred to in the real world. The test data was visually well prepared for this purpose, since almost all POIs had linked images and it was, therefore, easily possible to orient oneself quickly. However, a explorer who put the mobile phone in the pocket, because this is what they were instructed to do, and if there were also many POIs next to each other, it was more difficult to understand which POI was currently playing. This could happen at the main square or on narrow streets, which had many points of interest. Also during the exploration the participants felt like they want to take out the phone and look at the image if they are looking at the right POI, when there was not a house number, which was explained in the content description.(Focus-group-interview, 00:39:00).

So in the focus group discussions, some stated that the content needs adaptation if the explorer just puts the phone in the pocket, then the first sentences of the POI should contain a short description of the POI, itself for how the building looks like for example by mentioning the color of the building (Focus-group-interview, 00:15:44).

*“So, depending on how good the GPS data is, look up to your left, to your right. Just like every guide does. Now to your left you see the building with the large archways.”*(Focus-group-interview, 00:39:48)

Also the orientation in the space, for example on the left side or right side from the users perspective was mentioned (Focus-group-interview, 00:39:48).

Also reference points like other already known POIs will help to orientate themselves, for example that there should be a guidance in the content that the user should look at the building facing from the city hall (Focus-group-interview, 00:40:26).

This leads us to the different indication sounds of a POI, when a new POI is ready to be read by the speech synthesizer, we play different indication sounds.

We also have learned that the indicator sounds are very useful. This was accepted by all participants. The sound indicating the end of the POI was also accepted by all participants. However, there is one more sound and that is if the POI has already been heard. That allows the user to revisit the POI and he or she has the possibility to listen to the already visited POI again if the user is still interested in the new content. This sound was accepted by almost everyone, only one user found the sound annoying and would like to have an option to turn this sound off. He can imagine that this sound makes sense for or already visited POIs, which also have new content. But he still would appreciate it if the notification of the already visited POIs could be turned off. He can also think about a new sound for just the changed POIs, which aren't already visited. However, for this sound he also wants the option to be turned off (Focus-group-interview, 00:18:49). As a future work there could also be a vibration alarm as an additional indicator (Focus-group-interview, 00:17:15).

### 4.2.4 Large places

Based on our literature research, we were aware that circles are not always sufficient for representing places, and polygon shapes are much more suitable for depicting areas [Lø11, p. 192]. During the self tests, we also noticed that large places or long streets are quite a problem, because only points trigger the speech synthesizer, but for large areas it is not immediately clear where the trigger point should be placed. Therefore, we created multiple POIs and just one POI had the description of the place, the other POIs were indicators to go the main POI. The following is the example of the “Herrengasse”, which is a long street with two instruction points.

*“Herrengasse is the back side of the main square houses 3 to 7 and Kirchengasse. The economic parts of the large bourgeois houses were located in this alley. Walk through the alley to learn more about the buildings.” [HB20].*

Another POI with the name “Herrengasse Neunkirchen” and the coordinates 47.72028,16.08060 had also the same instruction. This problem could also be seen in Figure 4.6.

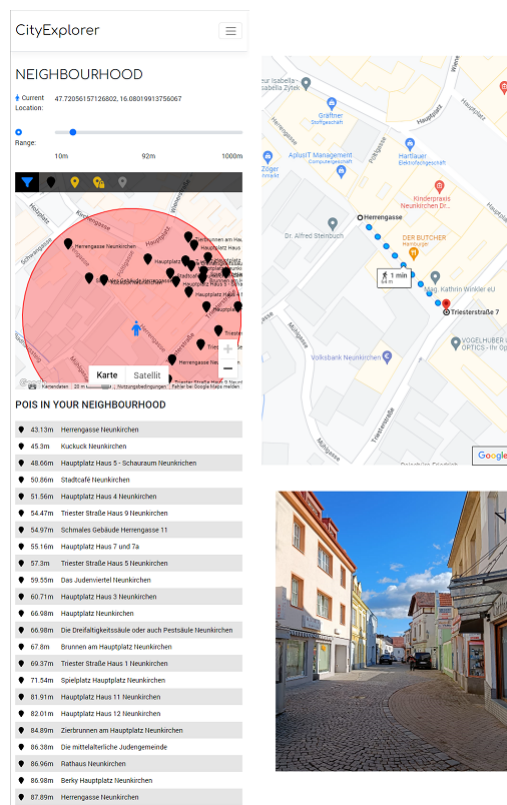


Figure 4.6: Herrengasse with multiple POIs

This also happened with large places like the mall, where there were multiple entry points and also a parking lot as seen in Figure 4.7.

For example there was a POI created called “Panorama Park Neunkirchen Roundabout” with the coordinates 47.72387, 16.08042.

*“The Panorama Park was built near the city center. Go from the traffic circle into the Panorama Park to the mall and listen to the stories about the Panorama Park.”*

And the story itself was in the POI called “Panoramapark Neunkirchen” with the coordinates 47.72348, 16.07969.

*“Panoramapark Neunkirchen Neunkirchen owes the Panoramapark to Heinz Seiser, who developed the idea from the Hauptplatzpassage. The shopping center is a success story and achieved the best rating of all Austrian shopping centers in 2014. This consists of a variety of commercial buildings that invite you to shop and linger. Thus, the Panormapark is also an important point to leave the money of Neunkirchen residents in Neunkirchen and to revitalize the city center.”* [Sanb]



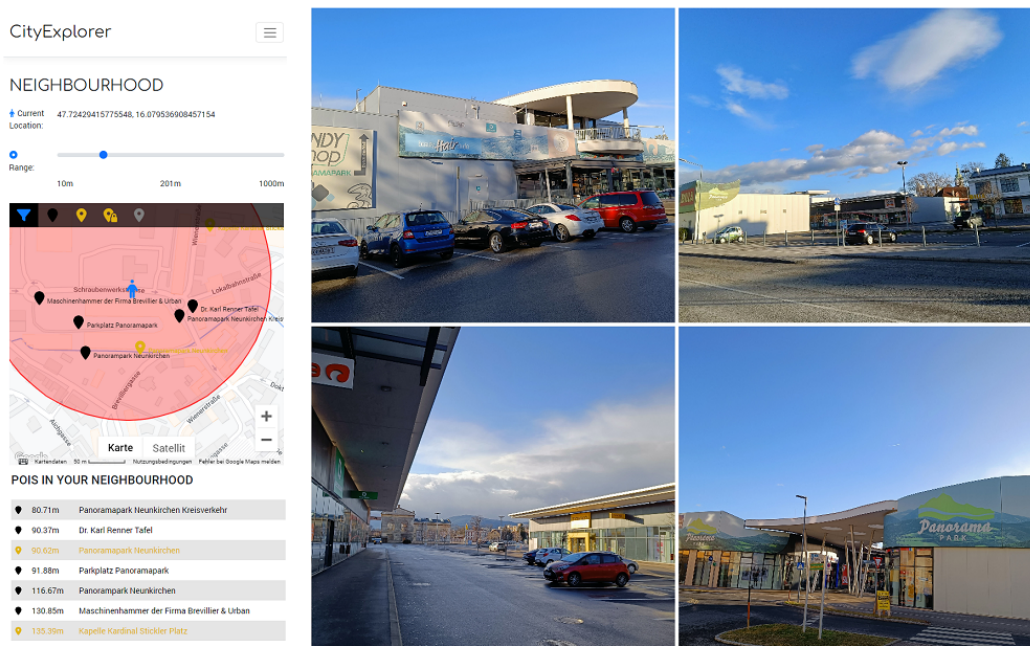


Figure 4.7: Panoramapark with multiple POIs

#### 4.2.5 Evaluation of emotional factors for content creation

An interviewee said that he would add or complement the POI content if he would hear new interesting facts about it and would also update the information of a given POI is not correct and would suggest corrections.

*“So if there is a function and I’ve been to some place, for example, and I’ve been to a coffee house and I’ve heard this and that, then I quickly pull out the app and add that to the POI.” (Focus-group-interview, 00:52:53)*

That would be a concern for him that the data is up to date and that he would also change it if he came across outdated or incorrect information.

*“Sure, I would use it. The function that you give additional information or at least say this information is not correct, please change in the review process.” (Focus-group-interview, 00:54:39)*

Another one would appreciate it if there were some kind of Mini Game, which animates to create content (Focus-group-interview, 00:47:53). Also to know how many points he needs to get to the next level and when he gets a badge (Focus-group-interview, 00:56:53) Also, everything that creates some kind of challenge is welcomed. For example a newsletter or information page about the “Content writer of the month”, who wrote the most articles or the most liked articles (Wireframe-interview 4, 01:03:51). Summaries of personal success, notifications and summaries about other editors which the user follows or information

about the best authors in specific areas like “trending authors” (Wireframe-interview 4, 01:03:51).

### 4.3 Evaluation of the city exploration

In the following section we evaluate if our location-based Augmented Reality application gave the participants an immersive experience to explore the city and the cultural value of the POIs, facilitating text-to-speech synthesis and speech recognition, as seen in Figure 4.8. We also will evaluate the gained experience, knowledge and look at safety aspects for the users. Additionally we evaluate the application by the usability and feature satisfaction.

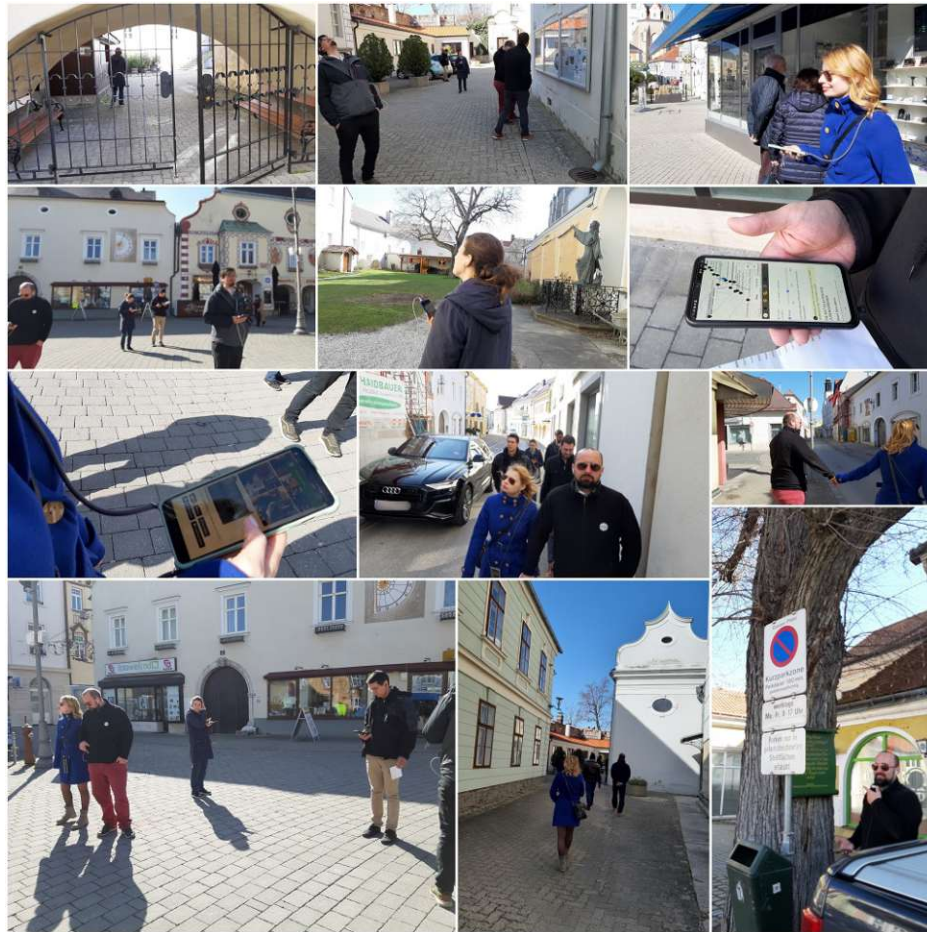


Figure 4.8: City exploration impressions

### 4.3.1 Evaluation of GPS accuracy

The content was very accurate about the GPS position and it worked very well so that all participants gave a 10/10 as seen in the Table 4.1 and Figure 4.9. The participants also stated this in the focus group discussion.

*“We had nice, sunny weather, so the devices had the best prerequisite for getting a good GPS signal.”* (Focus-group-interview,00:24:36)

Questions	P1	P2	P3	P4	P5	AVG	Median
GPS was accurate	10	10	10	10	10	10	10

Table 4.1: GPS accuracy

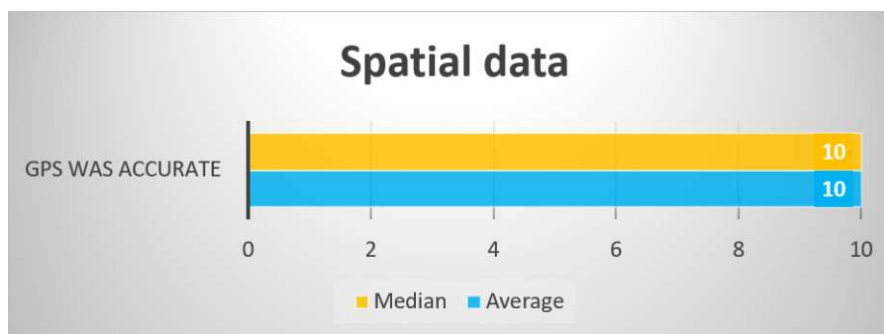


Figure 4.9: GPS accuracy

But after looking at the statistics in the profile view we still noticed that the GPS of some devices was quite jumpy, so the walked distance for example was 1.79km for participant P2 and for participant P4 it was 4.26km. For comparison, Runtastic recorded a walked distance of approximately 1.37km as seen in Table 4.2. Now we know that not all participants visited exactly the same POIs and had the same route, but now we know that P3 and P5 walked quite together, because they are a couple and we can also see that P3 had 27 POIs visited and P5 had 29 POIs visited. So they didn't walk the same route, but quite the same and P5 had just 2.73km. So we can say that the GPS accuracy can differ greatly across different mobile devices as seen in Figure 4.11.

In Figure 4.10 we see the profile page of each participant with the statistics. One had to use a backup device and needed to login with my personal account, therefore, one is called “Alina” as already mentioned in Subsection 4.1.2.

## 4. EVALUATION

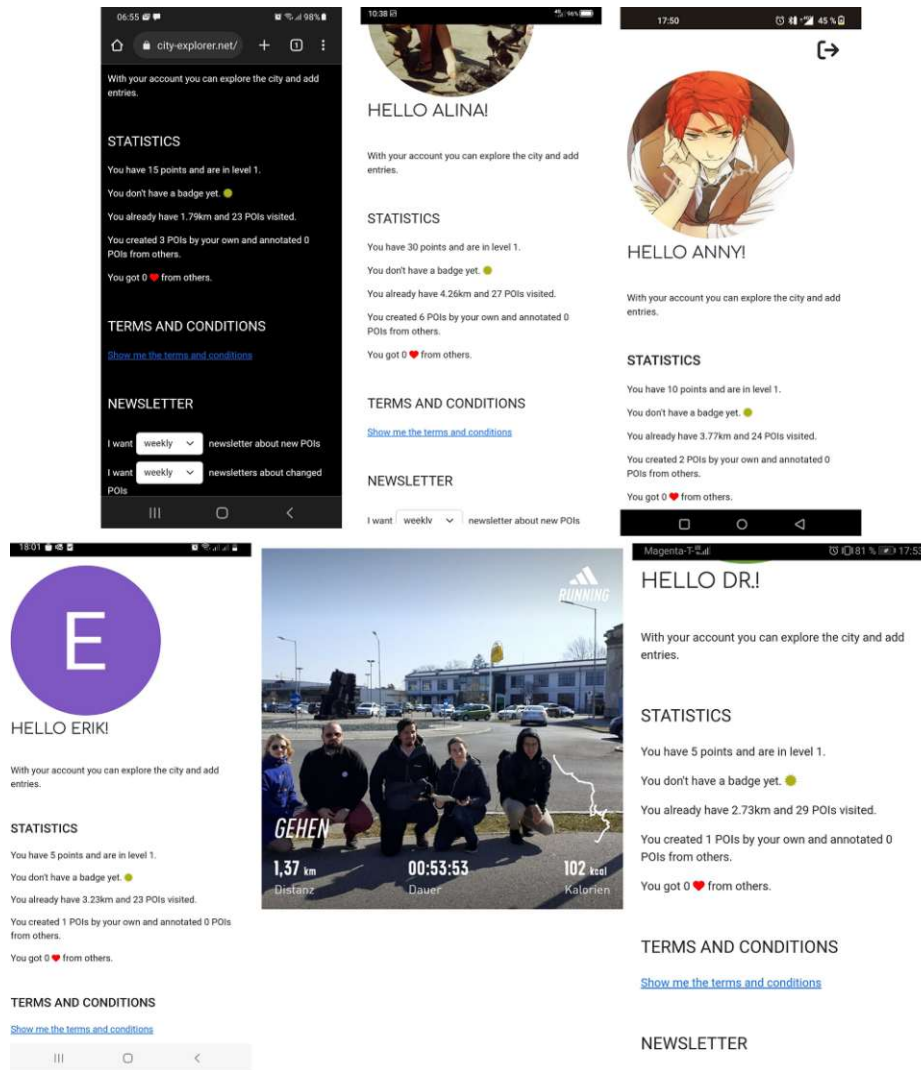


Figure 4.10: Statistics displayed on the profile page

PARTICIPANT	POIs visited	KM
P1	24	3,77
P2	23	1,79
P3	27	4,26
P4	23	3,23
P5	29	2,73
Runtastic		1,37

Table 4.2: Visited POIs and walked distance



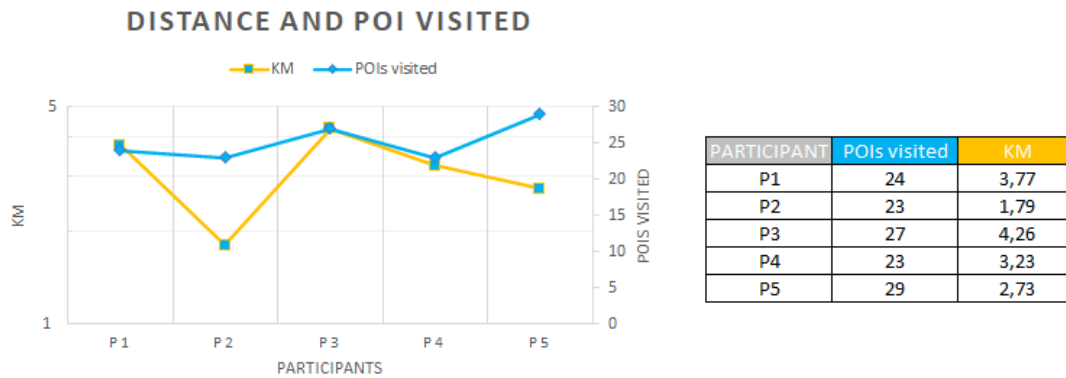


Figure 4.11: Visited POIs and walked distance

The route contains many points and if one of the points gets a false GPS coordinate, then the distance increases due to this point. This inaccuracy does not impact the functioning of the app, because, by moving around, the device eventually will get a new position and the POI will hit the “broadcasting-radius” [Lø11], but the wrong point is still in the route and the distance will be calculated a sum over all route points and so the different walked distances are explainable. So for correct calculations of the distance, extreme outliers need to be purged.

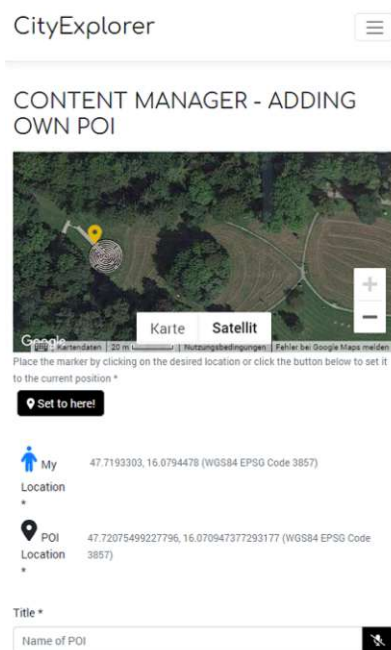


Figure 4.12: Satellite view in QuickAdd

One participant stated that the GPS signal quality does decrease in buildings, so we thought about having an indication like a signal strength bar indicating how good the GPS signal actual is (Focus-group-interview, 00:03:15).

The GPS signal jumps have an effect on the content creation too, for example when we want to create a POI in the city park, it can happen that the signal jumps in the second, when the POI is created and the position is now pointing somewhere different and not to the desired location. Therefore, we also added different map overlays like satellite imagery and topographic layers, where we get a better overview of the landscape as seen in Figure 4.12 and we can always change the position of the POI in the content management (Focus-group-interview, 00:46:22).

#### 4.3.2 Evaluation of voice commands and speech synthesis

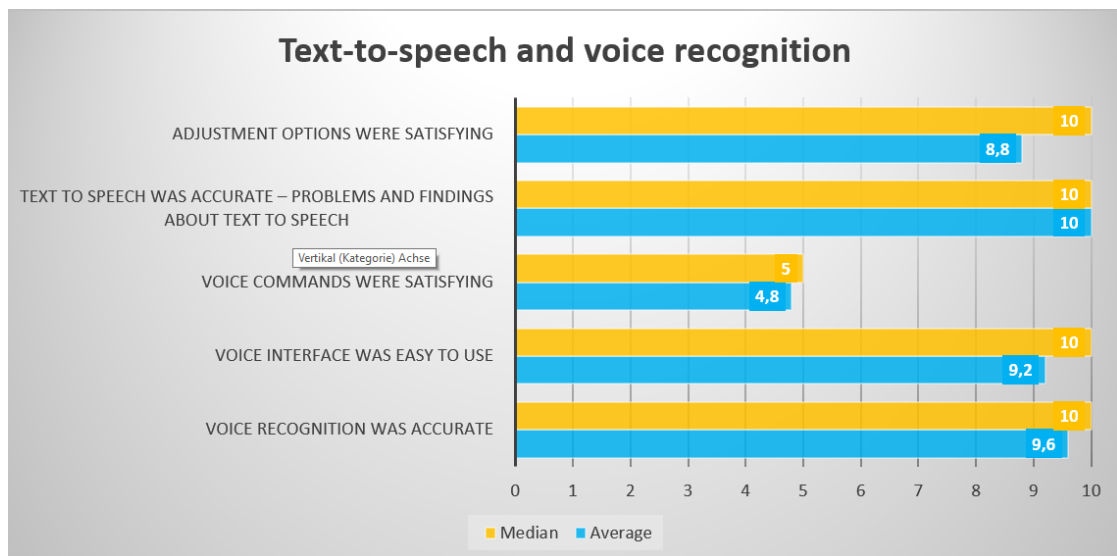


Figure 4.13: Usability of text-to-speech and GPS

The speech synthesizer generally worked very well. All participants were amazed about the combination of the location-based feature and the Text-to-Speech output as seen in the Table 4.3. One participant said:

*“So, in principle, it worked very well, because you clicked on ‘Start Exploration’ and you went through the city and you heard every POI, depending on what GPS strength you had or what settings you made. And it went exactly as it should have.”* (Focus-group-interview, 00:19:33)

Also the speech recognition itself was satisfying. The average points were 9.6/10 and the median was 10/10.

*“The playback of text-to-speech was great and also the accuracy of the speech recognition was amazing.”* (Focus-group-interview, 00:19:56)

Also the speech adjustments were satisfying, for example that they could slow down or speed up the voice output (Focus-group-interview, 00:27:17). The participants evaluated as a median score 10/10. But they still had some ideas for improvement, so that the average score is 8.8/10. This fact we can also see in the Figure 4.13.

They also liked to have a reset feature for the speech speed to set a specific “default value” like a factory reset just for the speech features, for example with a command like ‘Explorer Set Speed to Default’(Focus-group-interview, 00:28:39).

But they don’t want that a voice command applies the factory reset. There should be a button in the settings (Focus-group-interview, 00:31:21).

And most of the participants wanted to have a pause and resume button, so they could start an exploration, hear a POI and then pause it and after a while continue the exploration and that the current reading would continue at the text where the speech synthesizer was stopped (Focus-group-interview, 00:27:22). Also a visual highlighting of the currently read text would be pleasing, but this would need a completely different implementation of the text-to-speech feature. A way to implement this feature could be segmenting the content into sections with keywords, and that the speech synthesis reads the each section after one another, instead of the whole text. (Focus-group-interview, 00:29:13).

Questions	P1	P2	P3	P4	P5	AVG	Median
Voice recognition was accurate	10	10	10	8	10	9,6	10
Voice interface was easy to use	8	10	10	8	10	9,2	10
Voice commands were satisfying	5	5	5	4	5	4,8	5
Text to speech was accurate	10	10	10	10	10	10	10
Adjustment options were satisfying	5	10	10	9	10	8,8	10

Table 4.3: Results of speech recognition and speech synthesizer

The speech recognition was rated as good. The participants assigned a 9.6/10 as an average score, but they were not as satisfied with the voice commands as they gave a 5/10 for the median score and a 4.8 for the average rating. The participants wanted to change some voice commands. For example they wanted to have following adjustments to the commands:

- RESTART instead of RESET POI
- REPEAT instead of AGAIN

They also wanted to change the start keyword “EXPLORER”, which is the trigger word to recognize a voice command to something different for example the word “GUIDE” or “TOUR”. We discussed that it would be nice to allow the user to customize the trigger word as a “setting value” in the *Settings* or *Profile* view (Focus-group-interview, 00:15:23).

“The word ‘explorer’ is to difficult to pronounce in the voice command.” (Focus-group-interview, 00:14:51)



### 4.3.3 Evaluation of performance

The performance of the prototypical application was good, but since the used database does not support querying spatial data and all POI distance calculations have to be done by the application itself, we can imagine that this will lead to scaling problems when the database will contain much more data and exploration sessions. We already noticed after much more exploration sessions that the profile pages takes noticeable longer to load then before, because the total distance of a user needs to be summed up over all routes and for all routes the distance between all points needs to be calculated. With a database that supports spatial data, this could be achieved in a query. Alternatively, we could cache the calculated distance of each route in the database.

### 4.3.4 Evaluation of emotional and motivational factors for exploration

The quality of the content and the offered features have a huge impact on city exploration. The prototypical application offered the users a new experience, with an average and median score of 10/10 and stimulated the user to explore the city with an average score of 9.6/10 and a median result of 10/10.

The “motivation to explore by provided features” were rated with an average score of 8.8/10 and a median result of 10/10. So the features lead the participants to engage longer with the application as seen in Figure 4.14.

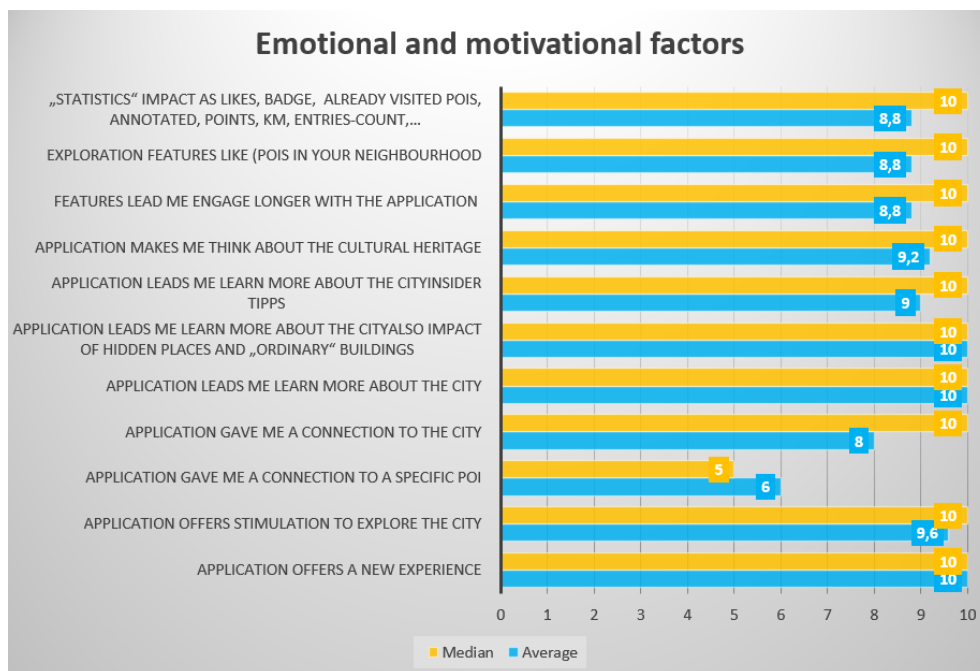


Figure 4.14: Emotional factors

Now we realize that our prototypical application was rated very good over all emotional and motivational factors with an average and median scores of 8.9/10.

Concerning the provided content, all participants stated that the application content was very interesting and that they liked it a lot and it motivated them to explore the city (Focus-group-interview, 00:34:55). They were addressed to give some examples and explained as follows:

*“I have a lot of examples, so even though I didn’t find the Neunkirchner Ötzi that exciting. I found it interesting to know how old it is in general, because it is well known that Neunkirchen is old. But it wasn’t just the general info that can be looked up online, it was the trivia, the little stories about the buildings and places. They all were there too. One of the fascinating stories was how often the pharmacy was sold and at what interval. I find this quite funny, because the city trivia, where you can also start a conversations in a guesthouse with a local inhabitants and not just the information about the 5200 year old Ötzi, which doesn’t interest me.”* (Focus-group-interview, 00:35:03)

They all liked local stories about the people. They didn’t want to hear stories for example about the church, which could be looked up on the internet. They wanted to have person centered stories like banter and anecdotes from peoples who lived in the buildings, and also city whispers are very interesting (Focus-group-interview, 36:02). Another participant said that the jeweler in fourth generation or the travel office and their buying busse stories caught her interest (Focus-group-interview, 00:35:30).

The all stated that they had a new experience and were encouraged to explore the city, as seen in Figure 4.15. One said that he was always thrilled to visit the next POI, because he liked the stories he heard before, so knowing about the city also encourages to explore the city (Focus-group-interview, 00:36:40). This is also covered by the question if the application leads the users to learn more about the city. All participants rated this with 10/10.

They all felt more connected to the city (average 8/10), which encouraged to learn more about the city (10/10) and increased interest in historical and cultural heritage of the city (average 9.2/10). They also said that they discovered hidden places, but also places that they didn’t even know, had a relevant story, like the one with the tree that was once a pillory.

*“Yes, it was very interesting to know at the place with the tree where you pass 100 times has cultural value and was once a pillory.”* (Focus-group-interview, 00:37:25)



Figure 4.15: Emotions and motivations

This is represented in our data from the questionnaire with average and median scores of 10/10 for the “hidden places” and “insider tips”. This evaluation can be seen in Figure 4.14.

An interviewee, who also lived here, but just moved in as an adult, found it interesting that the trinity / plaque column is made out of sandstone and, therefore, it needs to be restored regularly. All other participants also went here in the elementary school and they already knew the story, because it is one of the main attractions in the city, but for moved-in residents this is new information (Focus-group-interview,00:38:28).

Someone also wanted to have old photos of the POIs matching to the description, because it also raises the interest if the participants knew the story and historical transition in time of a building to the current date and also has the old images attached to it. She stated that first it raises the interest in the building, and then also in the company which is now located in the building (Focus-group-interview, 00:55:19).

*“And I find the interest in the company is more stimulated when you know the story behind it. So, knowing the building itself gets more interesting, but then in the course also the company which is now inside, is also very interesting, because you know what was there before and after some time it was something different, and now it is for example the pharmacy inside. I personally find that very interesting.”* (Focus-group-interview, 00:55:21)

Someone also said that a timeline represented by images would also be a nice feature (Focus-group-interview, 00:55:44).

Questions	P1	P2	P3	P4	P5	AVG	Median
Application offers a new experience	10	10	10	10	10	10	10
Application offers stimulation to explore the city	8	10	10	10	10	9,6	10
Application gave me a connection to a specific POI	0	5	5	10	10	6	5
Application gave me a connection to the city	0	10	10	10	10	8	10
Application leads me learn more about the city	10	10	10	10	10	10	10
Application leads me learn more about the city - Also impact of hidden places and “ordinary” buildings	10	10	10	10	10	10	10
Application leads me learn more about the city - Insider tips	10	10	5	10	10	9	10
Application makes me think about the cultural heritage	8	10	8	10	10	9,2	10
Features lead me engage longer with the application	10	10	10	4	10	8,8	10
Longer engaging - Exploration features like (POIs in your neighbourhood)	10	10	10	4	10	8,8	10
Longer engaging - Statistics impact as likes, badge, visited POIs, annotated, points, km, entries-count ...	10	10	10	4	10	8,8	10
	<b>7,8</b>	<b>9,5</b>	<b>8,9</b>	<b>8,4</b>	<b>10,0</b>	<b>8,9</b>	<b>8,9</b>

Table 4.4: Results for emotional aspects

They also stated that the application could be very powerful in the educational sector. For example the students could do a geography, biology, history exploration with different POIs.

*“So in principle, for every school in Neunkirchen it would be a matter of interest. For the higher schools that they make their own POIs with descriptions. For the lower schools that they just listen and fill out worksheets or work assignments ... so you can really work a lot with it, not only in history and political education. You could also say that in geography you can take a closer look at the city park. In biology, you go to the city park and look at exactly which trees there are. So there’s also really, really a lot.”*

(Focus-group-interview, 00:043:23)

This request of the participant could be implemented easily by our POI categories. The POI can have multiple categories assigned, so it will be no problem to add categories like 'educational', 'biology', 'geography', 'sports' and so on. But this thesis covers cultural heritage and, therefore, we will add this to the outlook.

Also the fact that the "Hear again" feature that we will now call "Repeat" for rehearing an already visited POI was a welcoming feature. Because the participants could also rehear a POI if they were distracted or looked in the wrong direction or they missed part of the read content.

*"A problem with many city guides is, you hear it and ... not only that you forget it, but you may not understand it correctly the first time, what he means, because maybe you look at the wrong building or he talks too fast or with a Spanish accent, everything I already experienced. I think it's good that you can just stand there and listen to it again. In this regard the app is even better."* (Focus-group-interview, 00:38:20)

Also if they put the phone in the pocket and they wanted to take it out to orientate themselves this function was highly welcomed, because they could look at the image and restart the text-to-speech synthesis. So the exploration experience with the mobile phone in the hand was very good, but when they put the phone in the pocket, they sometimes felt that the content needs a little bit of adaptations in some ways (Focus-group-interviews, 00:39:00). This result we cover in the Section 4.2.

Also as already discussed in the evaluation for the *Home* view 4.3.6 some participants are motivated to explore a POI if other users have already visited it and gave a like for the POI (Focus-group-interview, 00:10:38).

This can be also seen in our Table 4.4 that currently the attachment to a specific POI has just an average count of 6/10, even though some participants were highly connected to the POI, as mentioned the stories about the jeweler and his office, but still it is not covered enough, because this question was the only question that didn't get a 10/10 for the median score. So including this aspect could be a future work.

### 4.3.5 Evaluation of usability aspects

The usability of the application had a very good rating. All participants were happy with the application itself, but the setup of the speech synthesizer was horrible, so we got 0/0 as a median result for this. Due to the fact that this had also an impact on our *Settings* page that we needed to select the voice, we got bad grades here too. This is also represented in our results of an average score of 7.7/10 and 8.3/10 as a median score. We will discuss now all views one by one. The feature satisfaction was higher. There we obtained an average score of 9.2/10 with a median score of 10/10. This can be seen in Figure 4.16.

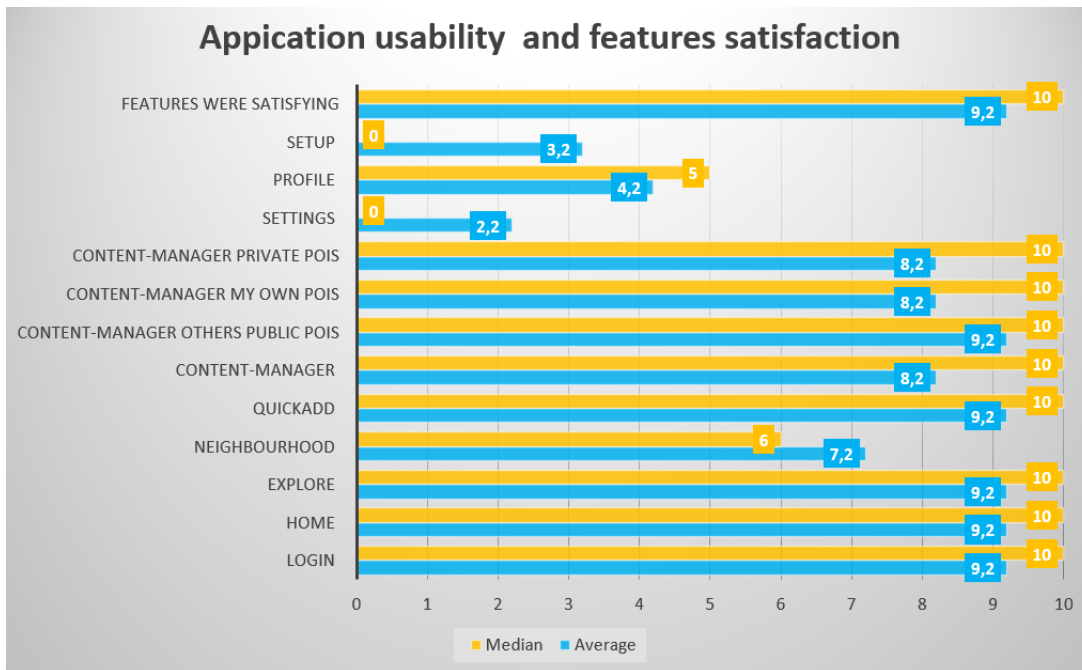
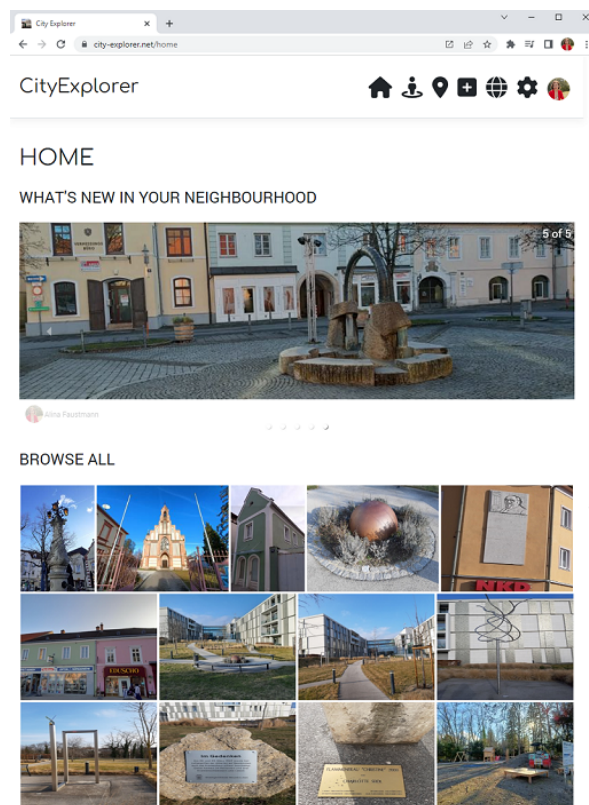


Figure 4.16: Usability of the application usage

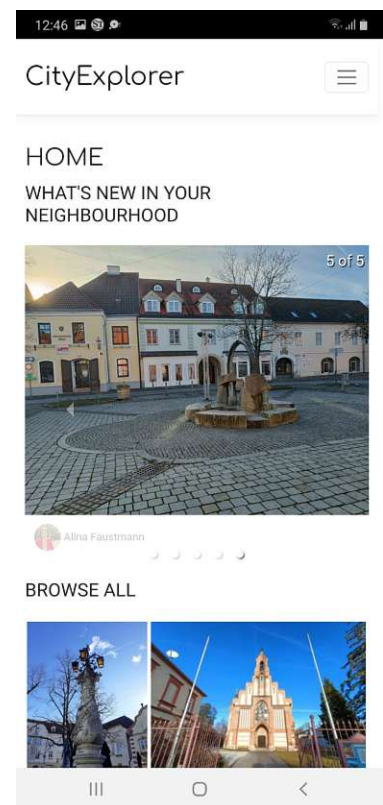
Features and Questions	P1	P2	P3	P4	P5	AVG	Md
Login	10	10	10	6	10	9,2	10
Home	10	10	10	6	10	9,2	10
Explore	10	10	10	6	10	9,2	10
Neighbourhood	10	5	5	6	10	7,2	6
QuickAdd	10	10	10	6	10	9,2	10
Content-Manager	10	10	5	6	10	8,2	10
Content-Manager Others public POIs	10	10	10	6	10	9,2	10
Content-Manager My own POIs	10	10	5	6	10	8,2	10
Content-Manager Private POIs	10	10	5	6	10	8,2	10
Settings	0	0	0	6	5	2,2	0
Profile	0	5	5	6	5	4,2	5
<b>Application is easy to use</b>	<b>8,2</b>	<b>8,2</b>	<b>6,8</b>	<b>6,0</b>	<b>9,1</b>	<b>7,7</b>	<b>8,3</b>
<b>Setup</b>	<b>10</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>0</b>	<b>3,2</b>	<b>0</b>
<b>Features were satisfying</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>6</b>	<b>10</b>	<b>9,2</b>	<b>10</b>

Table 4.5: Results application usage and features





(a) Home view with menu in browser



(b) Home view with menu on mobile

Figure 4.17: Home view with navigation

### 4.3.6 Menu and Navigation

The application was created for both roles, “explorer” and “editor” so it covers all features for content management and supporting the exploration features itself. Therefore, it is implemented as a PWA with a responsive design to allow an optimized viewing experience on desktop and mobile devices. The menu bar is in the right top corner, and for the mobile device the menu is collapsed as seen in Figure 4.17. In the wireframe and mockup the navigation was designed as buttons on the bottom as seen for example in the mockup for the home screen in Figure 3.33 (Focus-group-interview, 00:10:54).

### Login

The authentication with the Google Account worked well for our testing purposes (Focus-group-interview, 03:35), and installation and accessing the PWA from a shortcut placed on the home screen of the mobile devices functioned as planned. But during the focus



group discussion one of the participants, who was not present in the previous design process of wireframes and mockups, said that he didn't like the idea of just providing a login with a Google Account, because not everyone has a google account or want to use it for the application, so he gave a 6/10 and we have an average score of 9/10 and a median result of 10/10.

*"... why do I need one for this? I have the GPS data. Why do I need a Google Account if I don't think I want to participate in this weird Google system, when all I want to do is walk around the city?"* (Focus-group-interview, 00:25:53)

This criticism is valid and it would be no problem to implement different ways to login, but to reduce the scope of the implementation we decided to use the Google OAuth Api. Using this API takes care of many features needed for an application of this nature. For example the validation if a user is real or a bot, password resetting, the whole registering process including sending confirmation emails, changing passwords and profile information (Focus-group-interview, 00:25:53).

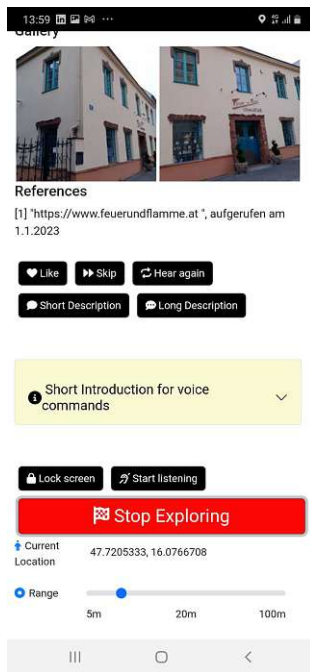
### Home

For the *Home* view we got a 9.2/10 as an average rating and a median of 10/10. But a participant gave a 6/10, he wanted to have more "likes" displayed on the home view and more information in the gallery about the POI, for example the creation date (Focus-group-interview, 00:05:48).

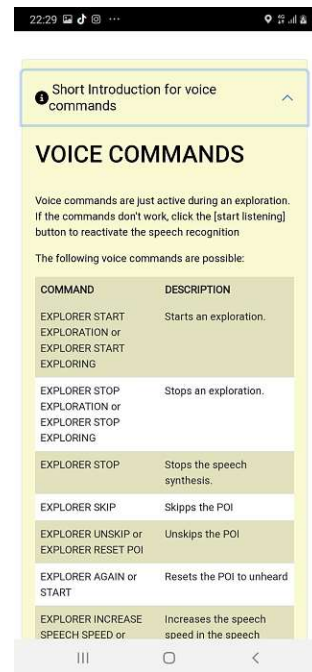
We discussed showing likes for images on the home view and additionally the filtering and sorting of the shown POIs. There is a gallery with featured images for the "What's new in the neighbourhood" section and the "Browse all" section where the POIs are sorted by the created date. Someone wanted to display the like counts for images. We thought about putting this information in the detail view, which opens, when a user clicks on a POI on the home screen. Someone also wanted to have this information on the home screen and that the POIs are sorted by the amount of received likes. We thought about it and discarded it at first, because then the probability to get also hidden POIs on the home view, which don't have many likes decreases (Focus-group-interview, 00:07:39).

*"The featured ones are already the ones where someone said that 'they are highly interesting'."* (Focus-group-interview, 00:10:21)

On the other hand the POIs marked as "featured" were marked by a reviewer or content editor as "featured". Rewarding a POI with likes, many explorers deem this POI interesting, so we agreed to allow users to filter the POIs on the screen by multiple characteristics such as the like count, created date or distance to the home position (Focus-group-interview, 00:10:38).



(a) Button [Hear again]



(b) Voice command 'EXPLORER AGAIN'

Figure 4.18: Difference between voice commands and button description

## Explore

The exploration feature is the main focus of the application, there we get an average score of 9.2/10 and a median result of 10 out of 10. The participants wanted to have other colors and that the current POI should be highlighted.

This was also a discussion during the mockup interviews and the mockup was created with a specific color for the currently playing POI. The color for the current playing POI was green as seen in Figure 3.35, but not all interviewees liked that, so we did not implement this feature. Now after the exploration session all participants wanted to have an own indicator of the currently playing and also an indicator that the POI has new content and to select the colors of the POI states freely, so that a customization of the colors is possible. Changing or setting colors is no problem, due to the fact that we have all data and states, so an implementation should not be a major problem (Focus-group-interview, 00:11:54).

The buttons and the voice commands should have the same wording. For example the voice command to repeat a POI was “EXPLORER again” but the button had the label “hear again” as seen in Figure 4.18. We decided that the button should have the label “repeat” and the voice command should be activated by saying “EXPLORER repeat” (Focus-group-interview, 00:13:57).

## Neighbourhood

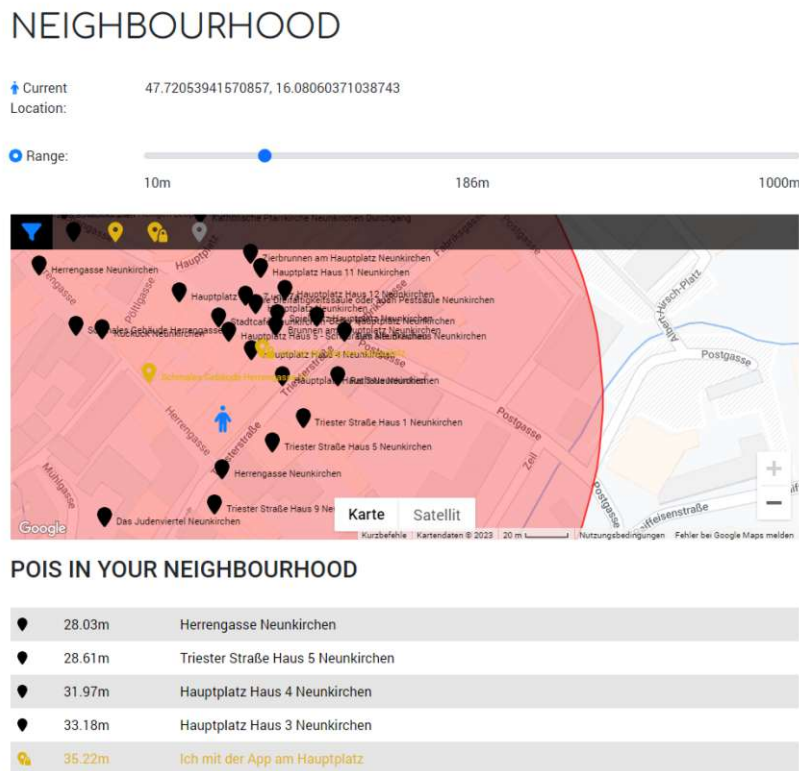


Figure 4.19: Some overlapping POI titles in the neighbourhood with a zoomed-in map

For some participants, who weren't part of the design process before, found the distinction between *Explore* and *Neighbourhood* not clear, because we used the application while we explored the city. So the idea that you can look at another neighborhood to see if it would be interesting to visit, did not come across clearly during the exploration session. After explaining the functionality and intention of the view during the focus group discussion, all the participants understood the feature and tested it.

After testing it, they detected some visual issues. We had many POIs that were very near each other, therefore, we had a lot of POI titles overlapping on the map, as seen in Figure 4.19 and Figure 4.20. This issue is also represented in our results by evaluating the questionnaire and justifies the average result of 7.2/10 and a median score of 6/10.

In the mockup we designed the map icons without the POI titles, but for testing purpose and the focus group exploration session, we decided to also show the titles (Focus-group-interview, 00:20:30). This led to visual unappealing representation of the POI markers. The participants stated that it would be nice if the title will be shown depending on the selected zoom-factor of the map and the relevance of the POI. If the map is totally zoomed in, all POIs can be shown (Focus-group-interview, 00:20:54). The idea that the title should be just shown, when the user clicks on the POI that was not accepted.

*“If you can filter it that way with the zoom function, then that’s perfectly sufficient. But the fact that it’s a jumble of points and texts is too much. Nobody really knows what POIs there are.”* (Focus-group-interview, 00:20:54)

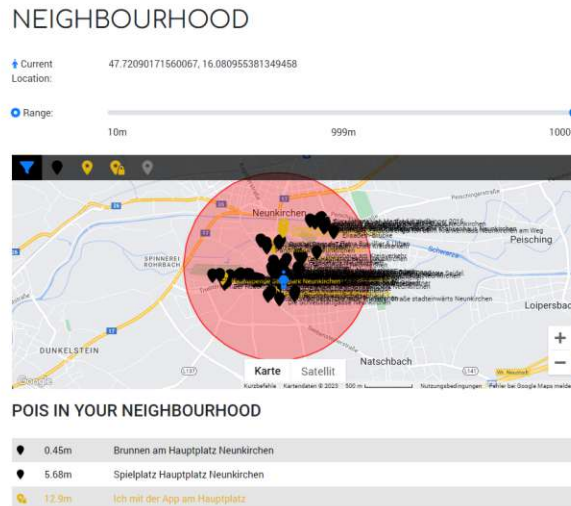


Figure 4.20: All overlapping POI titles in the neighbourhood with zoomed-out map and range slider set to maximum

The next problem was the descriptions of the filter. They should automatically fade out after some seconds. Now they still are visible if the user activates them and the user has to manually deselect the descriptions (Focus-group-interview, 00:23:58).

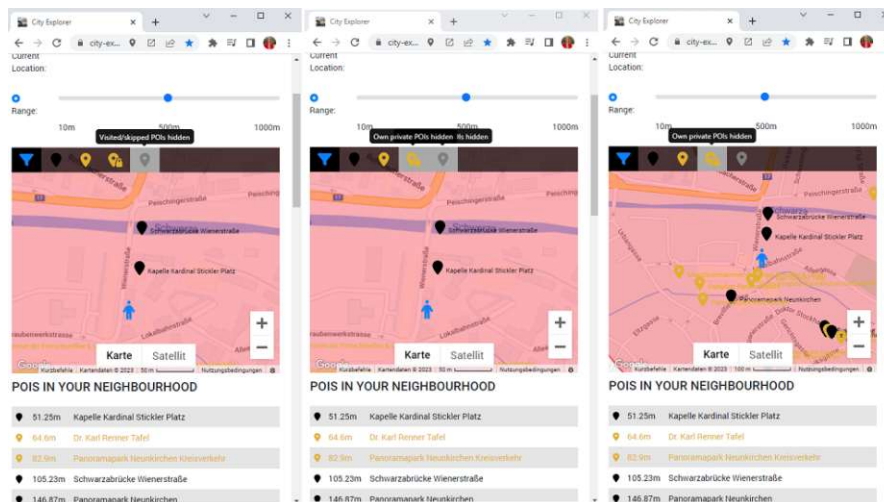


Figure 4.21: Overlapping filter descriptions

### QuickAdd

The content creation worked fine for most participants, but there were validation checks missing, so that it was possible to create empty data. So we got an average rating of 9.2/10 and a median score of 10/10.

The speech recognition to automatically fill out the title and short- and long description fields was deemed effective.

The participants did not notice any GPS problems while creating data. But we know from the test runs that obstacles such as trees in the city park, can cause that the GPS to jump when a new POI is created and then the POI has wrongly assigned coordinates. We already described this problem in Subsection 4.3.1 and handled it also by implementing the different map types, like the “satellite” and button which can request the new GPS coordinates from the device. Also manually setting the GPS position by clicking on the map is possible.

### Content Manager

The content management was implemented as far as that it could be used in the city exploration application and that the participants could understand all features regarding annotation and reviewing process. But it is just the first step and it is highly extendable. For example it should give the possibility to sort and filter data and that data entry checks are implemented (Focus-group-interview,00:59:40).

Participants also stated that they would like to have also video and audio support too (Focus-group-interview, 00:04:45).

But we still got good scores for the content manager. We had an 8.2/10 as an average rating and 10/10 for the median score. Someone also liked the “Others public view” more than the “My public view” because he thought it is interesting that it is possible to see all the other POIs created in the content management.

### Profile

In the *Profile* page, there should be an information which action rewards how many points. Also how many points are missing to reach the next level or badge.

It would be nice if the travelled routes were visible and that the user can have the option to share them on platforms like Facebook or let other users like them in the application (Focus-group-interview, 00:49:34).

Some participants wanted to be able to follow the other users routes.

*“For example, I’m new in Neunkirchen, I don’t know my way around and I only have two hours now. I can’t go to explore the entire neighbourhood. I will look at a tour with the most likes, then I know, okay, there you have the best experience.”* (Focus-group-interview, 00:50:39)

But this is not the approach of the thesis. The approach is a serendipitous exploration, without any given routes, traces and intentions. If the user will be stick to a route, he or she will just explore the highlights, but the user should be able to just go outside, explore the neighbourhood to give her or him the possibility to find new places, monuments and artefacts and their cultural heritage for what he or she didn't looked for.

So we got a 4.2/10 for the average score and a 5/10 as a median result.

### Settings, Setup

For each android device we need to install the language data for the speech synthesis. Therefore, the setup was rated with a median of 0 points and in average 3.2., because even with video and text instructions shared in the WhatsApp group, the participants had problems to set it up correctly. We needed to walk through this together in the preparation phase of the focus group and it was also mentioned in the discussion (Focus-group-interview, 00:01:34). Also selecting the correct voice in the setup page and setting the home position correctly was too difficult and overwhelming for the participants.

In the app there should be an automatic detection that the speech language package is missing and the application should download it and display it in the setting view (Focus-group-interview, 00:27:17). So we got for the settings page a lower grade of 2.2/10 in average and 0/10 as a median score, because the participants couldn't really distinguish these to parts and said that the configuring of the device should be automatically done via the application settings.

They would also like to have a factory reset button, where the settings should be restored to a default configuration (Focus-group-interview, 00:31:17).

The application language should be consistent with the content language was topic of discussion (Focus-group-interview, 00:33:20). We already excluded the languages from this thesis and mocked the settings. This will be matter for future work to provide different languages for the application and content.

### 4.3.7 Evaluation of safety aspects

The results regarding the safety aspects in Figure 4.22 show that the participants were not distracted from the surroundings or traffic by the application. The median for both questions were zero. This can be seen in the Table 4.6.

So we asked the participant the following question:

*“Did the application distracted me from the traffic?”*

One participant was highly distracted with a score of 8 out of 10. She stated that the headphones had also an additional impact.



“I deliberately stopped so that I do not put myself in danger and listen to the application.” (Focus-group-interview, 00:41:19)

She had to stop so that she could listen to the points without putting herself in danger. Another participant, gave a score of 4/10, but on the note he wrote with 60%. The participant stated that he used the application for the first time and if he would use it more often, then the rating would probably drop, but for this time he was busy handling the application. He changed his points to a scoring 4 out of 10 during the discussion. Two of them said that they were not particularly distracted and rated this question with zero points. They were not distracted by the headphones, and mentioned that it was just a matter of volume and the others should lower the volume to better hear the traffic (Focus-group-interview, 00:41:20). Now we also know from our literature research that there is always a distraction, even from listening to music [CP18, MWZ21]. We mentioned this fact in our group discussion, therefore, a score of 6/10 for the first time usage of the application itself, is not a real problem. It is a new application that the participants have to get used to. Our results are still very satisfying, because the average score is a 2.8/10 and the median score is 2/10. So the users weren't extremely distracted by the application that they couldn't notice the traffic.

Questions	P1	P2	P3	P4	P5	AVG	MD
Application distracted me from the traffic?	0	2	8	4	0	2,8	2
Application distracted me from the surrounding like people?	0	0	8	4	0	2,4	0
Application use in different weather conditions + thoughts about it?	5	7	7	4	7	6	7

Table 4.6: Results safety aspects

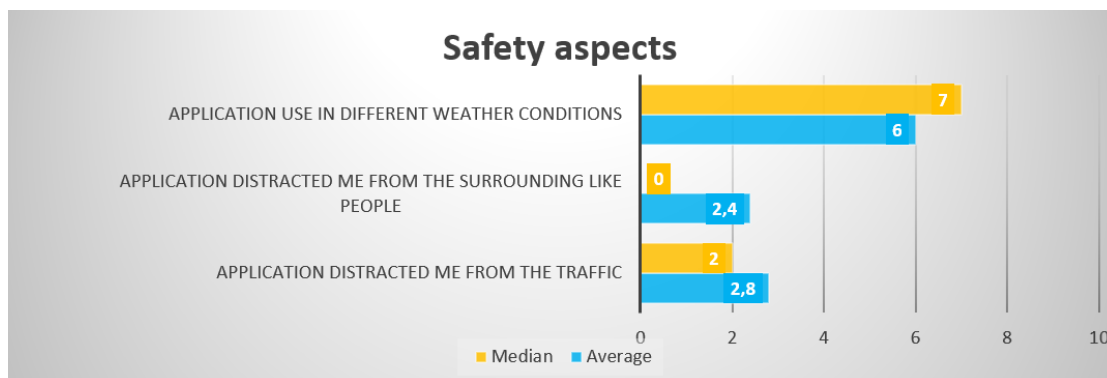


Figure 4.22: Safety



Then we asked the participants following question:

*“Did the application distracted me from the surrounding like people?”*

Regarding the distraction of the application we had one person which rated an 4/10 and one with an 8/10. All other rated 0/10, so we have an average of 2.4/10 that the application distracted the interviewee from the surrounding. We can assume that the interviewee had an immersive exploration experience and that the application enhanced their experience without being greatly distracted by the technology usage, because the median score is 0/10.

At least we looked at the weather conditions concerning the application. We asked the participants following question:

*“Would I use the application under different lightning and weather conditions then daylight and a day without rain, snow, strong wind and so on?”*

During our minor and two major test runs we used the application in all weather and lightning conditions and also during day and night time as seen in Figure 4.23.

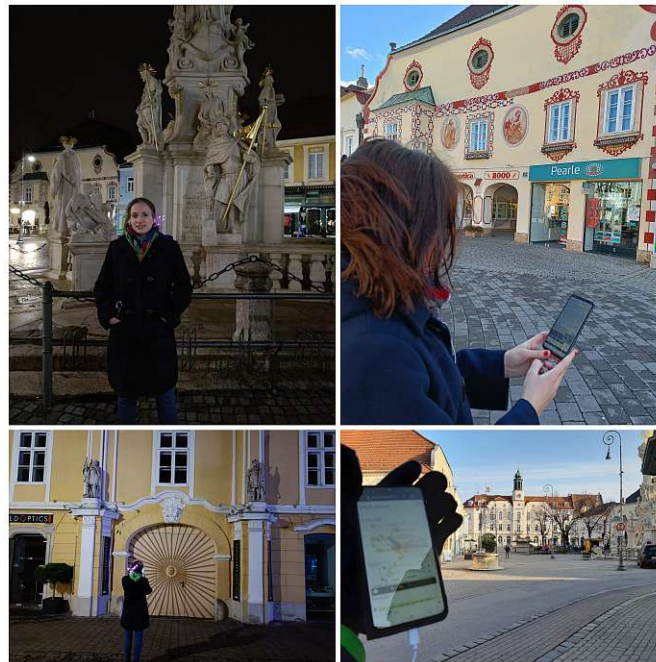


Figure 4.23: Application usage in different lightning and weather conditions (rain, night, cold, wind)

In the winter we wore gloves on and it was no issue to put the device in the pocket and take it out as seen in Figure 4.23. On the day of our focus group run we had clear weather conditions. The participants had a sunny day and so some of them could not

imagine that they would use the application during night time, when it snows or when it rains because they would not explore any city by this weather or lighting conditions.

*“I wouldn’t stay in front of a church for ten minutes in the rain or snow.”* (Focus-group-interview, 00:47:07)

Some of them could probably think about it and also standing 10 minutes in front of a church during rain if they would use the lock function and put it in the pocket, but they had still concerns about the device getting wet. One also stated that she would not use it during night time (Focus-group-interview, 00:47:32).

Even though there is a night mode for the application, which gets activated after a specific time. So the overall score for using the application under different weather conditions, at daylight without rain or snow is about 6/10 in average and as the median score a 7/10 as seen in Table 4.6.



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The approved original version of this thesis is available in print at TU Wien Bibliothek.

## Results and Critical reflection

The significance of cultural heritage cannot be overstated. It is of paramount importance as it encompasses the preservation of past generations' lifestyles, ethnic cultures, and the aesthetic value of structures, monuments, gardens, landscapes and more [Lee17, p. 707]. Places and venues play a vital role in transporting public knowledge, ensuring the continuity and appreciation of our rich cultural legacy [KCD<sup>+</sup>20]. Hudak [Hud19] emphasized an exceeding importance to have a place brand in order for residents to create their own image and bond with a place. Furthermore, it encourages them to take responsibility for the place, resources, infrastructure and landscape. We discussed this in our literature review in Chapter 2 and ascertained that residents should be able to tell the history of their own city. Chou et al. discovered that open collaboration serves as a crucial wellspring of knowledge and that by pooling together diverse abilities and knowledge of the “wisdom of crowds” creates knowledge itself [CLiy20, p. 30]. Silva et al. [SNS17] states that engaging in the creation of locative media can instill a sense of confidence and pride as it leaves a lasting legacy for others to inherit. These written narratives serve as a testament to one's accomplishments and continue to endure even after the individual's lifetime [SNS17, pp. 7-9]. Based on the literature review in Chapter 2 we identified open collaboration as an important knowledge source and we defined our first research question:

*“How can we collect data from the residents, what is relevant data and how can we assure a given content quality”.*

We also gained an understanding of what relevant content means and defined the criteria which assure a given contents' quality. We also elaborated criteria, to identify some residents as content creators/editors and looked at how reviewing, ranking and rewarding helped us to define a good content creator. This led to the realization that two groups are necessary concerning the content creation process. A content creator/editor who enters data and a reviewer, who validates and approves the information. According to the two different roles we created in Section 3.1 our personas which helped us to understand the

users' needs, motivations and handling of the application [CRC07]. In Subsection 3.2.2 we created the wireframes for these two personas. We evaluated the wireframes with five different interviewees and we got insights about the content creation and validation process. We identified our buildings, places, monuments and artefacts as our points of interest and learned that we will need different granularity of the description of a point of interest in form of a short- and long description. This granularity was proposed by Fitzgerald et al [FTC<sup>+</sup>12, pp. 757-759] and also requested by our interviewees. The content validation process ended with this step, because we had enough information to theoretically describe what is needed to assure a given contents' quality. After this step we focused on the content creation and collection process. Therefore, we created mockups and evaluated them again with our interviewees. We also collected data from a local who wrote a city guide and transcribed it. Additionally, we gathered information about the POIs through web search or from the POIs themselves by applied boards and signs installed on them or nearby, and collect them for our test data into a database. During this process we also took images of the POIs and connected the images to the POIs. This process is described in Section 3.3 and Subsection 3.4.3.

In Section 3.4 we created our prototypical application so that the users were enabled to swiftly add a new POI while exploring the city. Whenever they came across an intriguing POI, they had the option to take a picture and attach it to the POI along with the current GPS coordinates from their device and dictate the title and descriptions of the POI as mentioned in Subsection 3.4.12. Subsequently, this information could be further managed and adapted using the *Content Management* described in Subsection 3.4.13.

We also looked at criteria for creating or annotating content in order for the content to not only describe just a POI but also that the explorer, based on our secondary persona Figure 3.2, can orientate himself or herself quickly by getting the information of which POI is currently being played, for example, by mentioning special visual features of buildings as indicator sentences.

We contributed this requirement by testing our prototypical content creation application in the field with five different users and evaluating it in a focus group discussion in Section 4.2. We also discovered motivational factors for content contribution in form of appreciations and challenges considering likes, points, badges, mini-games and newsletters, in order for the editors to be motivated and animated to contribute content. This is described in Subsection 4.2.5.

Nisi et al. state that the process of creating these stories not only allowed the users to learn but also made them more aware of their neighbourhood [SNS17, p. 7]. We also found out that people are not just more aware of the place they live in [p. 7] but also more motivated to update data (Focus-group-interview, 00:52:53) and even share meaningful stories from their personal lives, despite the vulnerability that comes with divulging details from their own history [p. 6].

People are more motivated and triggered to explore a city when the story is told by a local person because then they feel emotionally more connected to the city and they will

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also learn about hidden places that would not be listed in a city guide [Lø11, p. 187]. The focus was therefore not just on the biggest and most famous spots but also on the overlooked and hidden places with a deep cultural heritage. In Subsection 4.1.3 we conducted a focus group to verify these statements and all participants confirmed in Subsection 4.3.4 that they were more connected and interested in the city, its buildings, monuments and in the people or business who are located there, after the trial. One participant expressed this with the following statement:

*“Yes, it was very interesting to know that the place with the tree, you pass 100 times, has a cultural value and was once a pillory”* (Focus-group-interview, 00:37:25)

Another participant emphasized the scope of interacting with other people by putting a strong emphasis on fostering social engagement. He stated:

*“I found it interesting to not just get informed how old this place is, because it is well known that the city is old, but also the trivia about the place. The content also included the little stories and narratives of the people. One of the fascinating ones was how often the pharmacy changed owners and at what interval. This I find quite funny, because with this city trivia you can also start conversations with other inhabitants for example in an inn with guests from a different table.”*(Focus-group-interview, 00:35:03)

People, particularly tourists, make efforts to transcend the sensation of isolation as they yearn for meaningful social interactions [Lee17, p. 707]. In Subsection 2.2.1 we learned about the duality of place postulated by Lee that a place is not solely a sightseeing cultural attraction but a historical cultural heritage at the same time [Lee17, p. 711].

Our focus was on providing the ultimate experience for delving into a city’s history. Our objective was to enable pedestrians to explore freely, stay in the narrative flow, and move safely throughout the city and, as discussed in Section 2.3, serendipitous exploration, the ability to stumble upon things you weren’t even searching for, was the driving objective. In Subsection 2.2.1 we learned that Audio Guides cultural heritage sites serve the purpose of conveniently providing visitors with cultural information, depending on their information needs, mobility and personal preferences [Lee17, p. 706]. The literature review Section 2.3 has revealed that locative media gains significant advantages when it emphasizes an aural experience [Lø11, p. 188].

To pick up on this information, we have formulated our second question, which is from a city exploration point of view:

*“How can we maximize the exploration of a city, but take urban traffic, lighting conditions and the distraction of the mobile device into account? How can an Augmented Reality application support this?”*

In Section 3.4 we implemented a location-based Augmented Reality application that tells the history of a place, building or monument. Therefore, we used the physical location of the device by detecting the GPS position in Subsection 3.4.6, connected the corresponding information of our test data from Subsection 3.4.3 and used the speech synthesizes described in Subsection 3.4.7 to retell the stories of a POI in the

application so that the pedestrian, called explorer in Subsection 3.1.2, can freely stroll through the city and put the device in a pocket. The reason for this was we did not want to use any applied marker due to their reduced suitability for outdoor Augmented Reality applications as suggested in [ZCS12, p.134]. Such installations would be more vulnerable [Lø11, p.193] because markers like papers, signpost, plates and so on can be vandalised, no longer readable due to weathering or mounted in such a way that makes them challenging to locate [Lø09, pp.1258]. Applying markers at any POI is also not possible due to reasons like building proprietorship, which restricts access and usage for such purposes. Furthermore, physical signs would require the user to point their mobile device at the marker resulting in other pedestrians feeling like they are being watched, and the user themselves may feel uncomfortable in such a situation as well [NDBN, p. 95].

So we considered this from the beginning, and the wireframes in Subsection 3.2.1 were already designed for a marker-less solution and by creating the mockup in Section 3.3 and evaluating them, all participants liked the text-to-speech approach and the possibility to control the application via voice commands. The prototypical application was developed with these features and during the focus group sessions, participants expressed their amazement at the accuracy of the GPS and speech synthesis, as documented in Subsection 4.3.2.

They also liked the fact that we considered the granularity of the information in order for the participants to be able to listen to their preferred complexity of the content as suggested by Fitzgerald et al. [FTC<sup>+</sup>12, pp. 757-759] and Lee [Lee17, pp. 710-711]. We implemented this by separating short- and long descriptions of a POI, to provide the explorer with the option to stop in one place for a few minutes or a longer period of time. The user could request the long version or set the default settings so that short- and long description is always played. Additionally, we provided image descriptions, which are an option for the default settings or by requesting it via a button action or voice command. This was implemented as the user could thus experience the story telling while the device was in the pocket. A great source of distraction was therefore eliminated and makes moving safely through the city, by minimizing the safety issues that rise from looking down at screens while navigating through cities, possible [MB11, p. 1256].

This has led us to our safety aspects. We also looked at how the application usage has an impact on the users' behaviours. This was approached from three different perspectives. Firstly, if the application has an impact on the behaviour in traffic. Secondly, how substantial the distraction of the application is regarding the surrounding and people. Thirdly, how different weather impacts the applications usage. From our literature review in Section 2.5 we attained that the usage of mobile devices while being in traffic has always an impact on a person's behaviour [CP18, p. 2]. Especially pedestrians are a vulnerable group [MWZ21, p. 1]. Furthermore, listening to music also leads to a cognitive distraction which can have an impact on the attention of the pedestrians and this results in dangerous situations while walking [CP18, MWZ21]. However, it is notable that texting, for example, has a much higher impact on cognitive distraction than talking or listening to music [CP18, p. 2], therefore, we created an application that focuses on



---

text-to-speech. This behaviour was also present during our testing of the prototypical application with our focus group in Subsection 4.3.7 where one participant was highly distracted from the application, even when the participant put the device in the pocket. Other participants stated that they weren't distracted at all and it was just a matter of volume if they could focus on the story telling and also on the traffic and the surrounding like other peoples. Another stated that after some usage, it probably wouldn't distract him a lot but during the first time usage, he was quite distracted by the application. These insights were gained through the review of the focus group by a group discussion and a questionnaire in Subsection 4.1.3.

The weather conditions also had an impact. Although the participants could put the mobile phone into a pocket, some of them couldn't imagine using the application during rain or snow because they wouldn't even explore the city in uncomfortable weather conditions. These results and usage of the application by night are described in Subsection 4.3.7.



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## CHAPTER 6

# Summary and future work

In this thesis we demonstrated how it is possible to use location-based Augmented Reality to explore the city and their cultural heritage. We wanted to achieve a high immersion into the surroundings for the user so he or she could experience the monument's significance surrounded by people and in the place itself [KCD<sup>+</sup>20, p. 157]. We wanted to investigate if the residents have a better sense of connection to the city and get motivated to be more involved, when he or she knew more about the city [BB17, p.293]. For this, we wanted to use the geographical position of a device and provide the adequate information about a monument for the explorer. Therefore, we implemented a prototypical application by using the GPS coordinates, speech synthesis and for managing an exploration session, voice commands by implementing voice recognition. We proved the functionality via evaluation of our prototypical application in the field, where five participants used the application for an exploration session for approximately one hour. The data was collected from a local inhabitant, via web researches about the POIs and through signs mounted on the POIs itself. This information was stored in a SQLite database and the application offered content management features, enabling users to quickly add data during a city exploration, but they also could enter the content management and edit their own or other users content afterwards.

We conducted a literature research and had a user-centered design approach by defining personas, scenarios and scenario descriptions, designing our wireframes and mockups and evaluating them in interviews. Through our design process, we collected a lot of data and feature requests, thus we already needed to narrow down the scope of our application. Finally, we implemented the application and presented it to a focus-group, which tested it in the city and we had a discussion with them afterwards. After an evaluation, we gained more insights and possible directions for future work. We will discuss these aspects in the following sections.

## 6.1 Performance

We used a SQLite database, due to hosting and cost reasons, but this database did not support spatial data, so we needed to calculate all distances between points and routes with an algorithm [ove]. This calculation can take a long time and issues on the profile pages are visible after multiple exploring sessions. Due to this reason, we skipped the idea of showing the upcoming POIs in the exploration session as it would drain the devices battery even faster. For this reason, we will change the *SQLite* database to a database which supports spatial data in the future, for example, *SQLServer* or *PostgreSQL* database. Also the handling of large places as described in Subsection 4.2.4 will get easier if the database provides spatial area handling features and we will use different data structures to represent large places or long streets.

## 6.2 Maps and Navigation

During an exploration the users wanted to get visual feedback of the currently listened POI and an indicator for already heard or skipped POIs that had new content. These indicators should be customizable. There should also be a list of POIs the user is approaching, when the application is in exploration mode. Therefore, a list should be in the “Explore” view of these POIs, which should be customizable by the user. In our prototypical application we had a similar feature implemented in the “Neighbourhood” view, but here the calculation is not done frequently like in the exploration view where the current position changes often.

The users wanted to have a visual representation of the route they went and that it could be shared and liked. For this feature and the calculations of the total distance, position outliers need to be removed. This happens when the devices don’t get an accurate GPS signal and the points are far from the actual route.

## 6.3 Voice recognition

The voice recognition commands are currently all in English, even though the content is in German. If we implement different application and content languages, the voice commands should consider the configured language. Therefore, we will need to adapt our commands. For example “EXPLORER slower” would then be “EXPLORER langsamer” in German.

Some voice commands should be changed to match the button descriptions or to represent the feature better. For example “Explorer again” should be “Explorer repeat”. Participants expressed the desire that the keyword “Explorer” should be customizable as it is difficult to pronounce for a native German speaker.

The handling of complex voice commands is not implemented. For example, we used “EXPLORER slower” instead of a command like “EXPLORER SET SPEECH SPEED TO 1.5”. The recognition of values in commands will be a discussion for future work.

## 6.4 Speech Synthesis - Text-to-Speech

The installation process of the voice data was too difficult for the participants, even with instructions. Depending on the device language, the application should automatically download a default voice data package for a device and install it. This should then be pre-selected in the applications settings.

Changing settings regarding the speech synthesizer have no immediate impact on the currently read POI, because the entire text content is already transmitted. This means that if we change, for example, the speech speed, this will only have an impact on the next POI or on restarting the same POI. There was also the wish to have a pause button for the speech synthesis. For example, if a user is halfway through the long description of a POI and he or she wants to pause and start from this point on later. This could be implemented as a new feature. Also a visual highlight of the currently spoken sentence in the user interface could be a new feature.

## 6.5 Content aspects

The content should be available in multiple languages, so that the user is able to select his native language for entries and editing.

Another future aspect could be, that deleted content is only marked as deleted, but not physically deleted, so that the content data can be restored later, if the user deletes it unintentionally.

The users wanted to have the option to upload different media files other than images, like video and audio files. These files should also be references in the short- or the long description, so that it could create a “storyline” within the POI descriptions. For example the voice output would say: “You are entering the church. Now the bell is playing” and then the media file for the bell starts and then the synthesizer will continue with the description.

The descriptions of POIs need to be adapted, so that the synthesizer can read yearly figures and digits correctly. This should be done by the application itself. The content editors and reviewers need to assure that the descriptions of the POIs have an indication of the appearance of the POI, so that a user in exploration mode can orientate themselves quickly which POI he or she is currently listening to. For example, the editor will get an introduction or information how he or she can write content correctly, so that he or she can include street numbers, descriptions of the buildings like colors, major features like for example a big gate, or reference points like other bigger POIs and so on.

Also validation checks for the entered data should be implemented, so that the required field input and correctness of the data is given. The content management should offer the possibility to review and approve new or edited content as described in Section 6.9.

### 6.6 References management

The points of interest and media-file management should be connected to a central reference-table. In our prototypical application the references of a POI or an image are implemented as unstructured text including all the reference data. This should be replaced by an additional table where the data is managed. Therefore, we need a reference management view.

### 6.7 User management

The user management should support multiple roles. In our prototypical application we assumed that every logged in user has automatically the “explorer” and “editor” role. The outline is that we need a “reviewer” role.

There will be lists of authors and reviewers, which also can be managed by another role like a super-user or a “city-manager” who is responsible to assign reviewers for a specific region.

This role can define the “impact-radius for reviewers“, which defines the scope and knowledge of a reviewer. For example, a reviewer has just knowledge about Neunkirchen, but no expertise to review data about Vienna or other parts of Austria, so he or she should only review POIs in Neunkirchen.

### 6.8 Customization of the displayed content

The different views should have the option to display different data customized by the user or sort it differently.

In the home view there was the desire that the list can be sorted by different criteria such as number of likes for a POI, created date, distance of the POI to the home position. The POI markers and titles on the maps should be visible by respecting the selected zoom-level or the importance of a POI by like count, so that not all titles are displayed on the map at once to prevent overlapping text.

The labels for the different filters on the map or on the forms should automatically fade out after some time. The different tables in the content management should have the option to be filtered and sorted by different criteria. For example by the reviewing-state, created date, title, category and others.

### 6.9 Reviewing

The reviewing process should guarantee the correctness and actuality of the content. However, a reviewer should also check if the data is interesting, motivating to explore the city and has the correct indications of features of a POI so that the explorer can easily orientate himself even when he puts the device in the pocket.

For the reviewing management we would need more views and tables to cover the user roles and assure the handling of content editing, reviewing and gratification of the editors. Also contact forms between reviewer and editors should be implemented to enable better coordination.

## 6.10 Customization of the app

The users wanted to have more customization options. Beginning from selecting different colors for the POIs in their different states and additional vibration and sound indicators. Vibrations and sound should be configured in the user settings. The start keyword “Explorer” for the voice commands should be adjustable.

The application should offer different restore points. One for the speech and voice settings, which should be also be controllable by a voice command and one for restoring the entire application with all the user settings like selected colors, languages, POI categories. These settings should just be accessed via the application interface and not by a voice command.

## 6.11 Newsletters, statistics and other engagement

There should be various other statistics and gratifications included in the application. A gamification approach, so that the editors are motivated to enter or annotate data, was requested. The information, how points are calculated and how many points a user needs to rise to the next level or how many points are missing for a badge, should be displayed in the *Profile* page.

The newsletters should be implemented with different options and by using a SMTP Server to send them. This includes newsletters, reminders and summaries about the user’s success, usage and followed authors. Additionally, there could be “event-newsletters” for a specific POI. For example, in the museum is an exhibition on a certain date and the user, who liked the POI gets a newsletter for the event. Therefore, we will need a newsletter and POI-event-management to handle event specific newsletters.

The integration of music in the application during an exploration session was discussed. Some wanted to integrate a spotify or youtube-playlist and the feature for the music to fade out when there is a POI ready to be read and fade in again if the POI stops.

Another wish was to have different login options other than using a Google Account.





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## Code samples

### A.1 Test Data

Listing A.1: BuildPicture

```
public static Picture BuildPicture(int id, int pointOfInterestId,
    int sortOrder, string fileName,
    string contentType, string title = "",
    string description = "", string reference = "")
{
    var filePath = Path.Combine("Data", fileName);

    if (File.Exists(filePath))
    {
        using var image = Image.Load(filePath);

        return new Picture()
        {
            Id = id,
            SortOrder = sortOrder,
            Width = image.Width,
            Height = image.Height,
            PointOfInterestId = pointOfInterestId,
            FileName = fileName,
            ContentType = contentType,
            Title = title,
            Description = description,
            Reference = reference
        }
    }
}
```

```

    };
  }
  else
  {
    throw new FileNotFoundException(filePath);
  }
}

```

## A.2 Map with Google Maps

Listing A.2: GoogleMapReact

```

<GoogleMapReact
  bootstrapURLKeys={{ key: "map-api-key" }}
  defaultCenter={{
    lat: initialPosition?.latitude,
    lng: initialPosition?.longitude
  }}
  options={mapUtility.getMapOptions}
  defaultZoom={17}
  yeastIWantToUseGoogleMapApiInternals={true}
  onGoogleApiLoaded={({ map, maps }) => handleApiLoaded(map, maps)}
>
  {pointsOfInterest.map(pointOfInterest =>
    <PoiMarker
      key={pointOfInterest.id}
      lat={pointOfInterest.latitude}
      lng={pointOfInterest.longitude}
      text={pointOfInterest.title}
      nightMode={nightMode}
      poiId={pointOfInterest.id}
      own={pointOfInterest.author?.id === currentUser?.id}
      visited={pointOfInterest.visited}
      skipped={pointOfInterest.skipped}
      privacy={pointOfInterest.privacy}
    />
  )}

  {currentPosition && <UserMarker
    key="homePositionMarker"
    lat={currentPosition.latitude}
    lng={currentPosition.longitude} />
  }

```

```
</GoogleMapReact>
```

## A.3 Implementation of Google Login

### A.3.1 Google Login Response

Listing A.3: Google Login Response

```
[AllowAnonymous]
[HttpPost("google")]
public async Task<LoginResponse> Google([FromBody] UserView userView)
{
    ...
    var payload = await GoogleJsonWebSignature.ValidateAsync(
        userView.Token,
        new GoogleJsonWebSignature
            .ValidationSettings());
    ...
    var user = _userRepository.FindUserByEmail(payload.Email);
    UpdateOrCreateUser(payload);
    DownloadUserImage(payload);

    // Create a new claims array for our
    // Own jwt (e-mail, user id, token identifier)
    var claims = new []
    {
        new Claim(JwtRegisteredClaimNames.Sub,
            _securityService.Encrypt(
                _authConfiguration.JwtEmailEncryption,
                user.Email)),
        new Claim(
            JwtRegisteredClaimNames.Jti,
            Guid.NewGuid().ToString()
        ),
        // just for debugging, we create our own claim
        new Claim("UserId", user.Id.ToString()),
    };

    // Create a key, so that the token holder can be authenticated.
    // JwtSecret ist our generated Key.
    // Symmetric key for encrypt- and decrypt.
    var key = new SymmetricSecurityKey(
```

```
        Encoding.ASCII.GetBytes(
            _authConfiguration.JwtSecret));

// Creds with key and algorithmus, which will be passed
// to the user.
var creds = new SigningCredentials(
    key,
    SecurityAlgorithms.HmacSha256);

// Jwt token expires after 55 minutes,
// Expiration time google is 1h;
// We extend the expiration time for our local jwt to 5x
var expires = DateTime.Now.AddSeconds(55 * 60 * 5);
var token = new JwtSecurityToken(String.Empty,
    String.Empty,
    claims,
    expires: expires,
    signingCredentials: creds);

// Serialize the token
var serializedJwt = new JwtSecurityTokenHandler().
    WriteToken(token);

// Give the token with the user-data back
return new LoginResponse() {
    Token = serializedJwt, User = user
};
}
```

### A.3.2 AuthProvider and Login

Listing A.4: GoogleOAuthProvider

```
<div className={'login-panel ${loading ? "loading" : ""}'}>
  <GoogleOAuthProvider
    clientId="AUTH-KEY.apps.googleusercontent.com">
    <GoogleLogin
      className="login-button"
      buttonText="Login"
      onSuccess={(credentialResponse) => {
        setLoading(true);

        userActions.login(credentialResponse).then(
          // Login was successful
```

```

        () => {
            window.location.href = "/home";

            setLoading(false);
        },
        // Login failed
        () => {
            setError('An unknown error happened. ' +
                'Please try again.');
```

```

            setLoading(false);

            // hide error message after 3 seconds
            setTimeout(() => {
                setError(null);
            }, 3000);
        });
    }
    onError={() => {
        setError('Could not login user. Please try again.');
```

```

        setTimeout(() => {
            setError(null);
        }, 3000);
    }
}
/>
</GoogleOAuthProvider>

{error &&
  <div className='login-error'>
    {error}
  </div>
}
{loading &&
  <div className='login-loading'>
    <Spinner animation="grow" variant="dark" /> Loading ...
  </div>
}
</div>

```

Listing A.5: LoginUser

```
async function login(credentialResponse) {
  // CredentialResponse: data with username + password
  const tokenBlob = new Blob(
    [JSON.stringify(
      {token: credentialResponse.credential},
      null, 2)
    ],
    { type: 'application/json' }
  );
  const requestOptions = {
    method: 'POST',
    body: tokenBlob,
    cache: 'default'
  };

  // Controller call
  const response = await fetch("/auth/google", requestOptions);

  const loginResponse = await response.json();

  // Data from our AuthController (serialized token)
  const token = loginResponse.token;
  const user = loginResponse.user;

  // Saves the authToken for the user in the local storage.
  localStorage.setItem("authToken", token);

  // Save token also in global state (whole react app – recoil)
  setAuthToken(token);

  // Saves the user in local storage (chrome).
  //eg. name, picture url, e-mail
  updateUser(user);
}
```

## A.4 Implementation of Speech Synthesis

Listing A.6: Speech Synthesis gets started

```
const startSpeaking = async (pointOfInterest,
                             overrideExplanationMode) => {
  ...
  await startIndicatorSound.play();
}
```



```

...
let text = "";
if (addTitle) {
    text += pointOfInterest.title + "\n";
}
if (addShortDescription) {
    text += pointOfInterest.shortDescription + "\n";
}
else if (!addShortDescription &&
    pointOfInterest.shortDescription?.length > 0) {
    text += "Es gibt eine Kurzbeschreibung. " + "\n";
}
...

// Set the text for the speech synthesis
let utterance = new SpeechSynthesisUtterance(text);

...
if (voice) {
    utterance.voice = voice;
}

// Set speech speed
if (0.1 <= currentUser.speechSpeed &&
    currentUser.speechSpeed <= 10) {
    utterance.rate = currentUser.speechSpeed;
} else {
    utterance.rate = 1;
}

// Define event for onend before starting speak
utterance.onend = async () => {
    // State for gui button
    setSpeaking(false);

    await stopIndicatorSound.play();

    setTimeout(() => {
        startListenToSingleCommand();
    }, 1000);
};
// speechSynthesis exits from the browser.
speechSynthesis.speak(utterance);

```

```
    ...  
  }
```

Listing A.7: Handles the mapping of the voiceIds and the names

```
async function getVoiceById(voiceId) {  
  const voices = await getVoices();  
  const matchedVoices = voices.filter(voice =>  
    voice.voiceId === voiceId);  
  if (matchedVoices && matchedVoices.length >= 1) {  
    return matchedVoices[0];  
  }  
  // no match found, return first  
  else if (voices && voices.length > 0) {  
    return voices[0];  
  } else {  
    return null;  
  }  
}
```

## A.5 Implementation of the Speech Recognition and Voice Commands

Listing A.8: Spoken phrase gets fuzzy matched with a command list

```
[  
  {  
    command: [  
      COMMAND_INCREASE_SPEECH_SPEED,  
      COMMAND_DECREASE_SPEECH_SPEED  
    ],  
    callback: (command,  
              spokenPhrase,  
              similarityRatio,  
              { resetTranscript }) => {  
      findAndExecuteCommandHandler(command);  
  
      NotificationManager.success(command);  
      // Clear for next command  
      resetTranscript();  
    },  
    isFuzzyMatch: true,  
    fuzzyMatchingThreshold: 0.8,  
  },  
]
```

```

    bestMatchOnly: true
  }
]

const {
  transcript,
  listening,
  browserSupportsSpeechRecognition,
  browserSupportsContinuousListening
} = useSpeechRecognition({ commands })

```

## A.6 Implementation of Home

Listing A.9: Different loadImages calls for the two sections

```

await loadImages(
  "/pointofinterest/point-of-interests-for-home/5/true",
  images => setCarouselImages(images));
await loadImages(
  "/pointofinterest/point-of-interests-for-home/25/false",
  images => setGalleryImages(images));

```

Listing A.10: Loads images for carousel and gallery

```

await loadImages(
  "/pointofinterest/point-of-interests-for-home/5/true",
  images => setCarouselImages(images));
await loadImages(
  "/pointofinterest/point-of-interests-for-home/25/false",
  images => setGalleryImages(images));

...

<div>
  <h1>Home</h1>

  <div>
    <h3>What's new in your neighbourhood</h3>

    {carouselImages && carouselImages.length > 0 &&
      <Carousel showThumbs={false} onClickItem={(itemIndex, _) =>
        selectPoi(carouselImages[itemIndex].pointOfInterest)}>
      {carouselImages.map((image, index) => <div key={index}>

```

```

<img
  style={{ height: "300px" }}
  src={image.highResolutionSrc}
  alt={image.caption} />
{image.author ?
  <p className="legend customized">

    <img src=
      {'/picture/profile-picture/${image.author.id}/default '}
      alt={image.author.name}
      style={{ borderRadius: '50%', width: '30px' }} />
    &nbsp;
    {image.author.name}
  </p> :
  <p className="legend customized">
    System
  </p>
  }
</div>)}
</Carousel>
}

{galleryImages && galleryImages.length > 0 &&
  <
    <h3>Browse all</h3>
    <Gallery images={galleryImages} onSelect={{(index) =>
      selectPoi(galleryImages[index].pointOfInterest)} />
  </>
  }
</div>

<PointOfInterestModal
  isOpen={isModalOpen}
  pointOfInterest = {selectedPoi}
  selectedPictureIndex={0}
  onClose={() => { setIsModalOpen(false); }}>
</PointOfInterestModal>
</div>

```

## A.7 Implementation of Explore

Listing A.11: Pattern Lock

```

const [lockPattern, setLockPattern] = useState([]);

const handleFinish = () => {
  setLastPatternLockFinished(new Date().getTime());

  // Differs from mobile device number -1
  if (lockPattern.join("-") === "6-4-2") {
    closeOverlay();
    setLockPattern([]);
  } else {
    setLockPattern([]);
  }
};

```

### A.7.1 Voice Command Help

Listing A.12: Voice Commands

```

import { Table } from 'reactstrap'
function VoiceCommandHelp() {
  VoiceCommandHelp.displayName = VoiceCommandHelp.name;
  return (
    <div>
      <h2>Voice Commands</h2>
      <p>
        Voice commands are just active during
        an exploration.<br />
        If the commands don't work, click the
        [start listening] button to reactivate
        the speech recognition
      </p>
      <p>The following voice commands are possible: </p>
      <Table>
        <thead>
          <tr><th>COMMAND</th><th>DESCRIPTION</th></tr>
        </thead>
        <tbody>
          <tr>
            <td>
              EXPLORER START EXPLORATION or
              EXPLORER START EXPLORING
            </td>
            <td>Starts an exploration.</td>
          </tr>
        </tbody>
      </Table>
    </div>
  );
}

```

```
        </tr>
        <tr>
            <td>
                EXPLORER STOP EXPLORATION or
                EXPLORER STOP EXPLORING
            </td>
            <td>Stops an exploration.</td>
        </tr>
        <tr>
            <td>EXPLORER STOP </td>
            <td> Stops the speech synthesis.</td>
        </tr>
        ...
    </tbody>
</Table>
</div>
);
}
export default VoiceCommandHelp;
```

### A.7.2 Start Exploration

Listing A.13: Start Exploring

```
const startExploring = () => {
    setExploring(true);
    enableWakeLock();

    if (voiceCommandUtility) {

        const continuousListeningEnabled = voiceCommandUtility
            .start(true, {
                callback: (isListening) => {
                    setListening(isListening);
                }
            });

        if (!continuousListeningEnabled) {
            NotificationManager.warning(
                "Continuous listening is not supported on this device."
            );
        }
    }
}
```

```

    startLocationWatch ();
};

```

### A.7.3 Indicator Sounds and Start Speaking

Listing A.14: Indicator Sounds and Start Speaking

```

import startIndicator from '../assets/start_indicator.mp3';
import stopIndicator from '../assets/stop_indicator.wav';
import alreadyVisitedIndicator from
    '../assets/already_visited_indicator.mp3';

useEffect(() => {
  // Start speaking
  if (currentPointOfInterest) {
    if (!currentPointOfInterest.visited) {
      visit(currentPointOfInterest);

      startSpeaking(currentPointOfInterest);
    } else if ((currentPointOfInterest.visitedDate &&
      (new Date().getTime() - currentPointOfInterest
        .visitedDate) > 1000) ||
      !currentPointOfInterest.visitedDate) {
      startAlreadyVisited(currentPointOfInterest);

      startListenToSingleCommand();
    }
    console.log(
      'Already visited "${currentPointOfInterest.title}"'
    );
  }
}, [currentPointOfInterest]);

const visit = async (pointOfInterest) => {
  if (pointOfInterest) {
    await authenticatedFetchApi.post(
      'pointofinterest/visit',
      { pointOfInterestId: pointOfInterest.id });

    const updatedCurrentPointOfInterest = { ...pointOfInterest,
      visited: true,

```



```

        visitedDate: new Date().getTime() };

        setCurrentPointOfInterest(updatedCurrentPointOfInterest);
        updatePointsOfInterest(updatedCurrentPointOfInterest);
    }
};

```

#### A.7.4 Detecting nearest POI

Listing A.15: Detect nearest POI

```

useEffect(() => {
  if (previousPosition) {
    const distanceToPreviousPosition = calculateLength(
      previousPosition.latitude,
      previousPosition.longitude,
      currentPosition.latitude,
      currentPosition.longitude);
    // We ignore little position changes to improve performance
    if (distanceToPreviousPosition >= 1) {
      setPreviousPosition(currentPosition);
      handlePositionChanged();
    }
  } else {
    setPreviousPosition(currentPosition);
    handlePositionChanged();
  }
}, [currentPosition]);

const handlePositionChanged = () => {
  if (currentPosition) {
    ...
    // Update distance between POIs and current position
    for (const pointOfInterest of pointsOfInterest) {
      const distance = calculateLength(
        pointOfInterest.latitude,
        pointOfInterest.longitude,
        currentPosition.latitude,
        currentPosition.longitude);
      pointOfInterest.currentDistance = distance;
    }
    // Get all points within 20m
    const pointsOfInterestWithDistance = pointsOfInterest.filter(

```

```

        pointOfInterest => pointOfInterest
            .currentDistance < searchRange);
    if (pointsOfInterestWithDistance.length > 0) {
        // Sort the points by their distance asc
        const sortedPointsOfInterestByDistance =
            pointsOfInterestWithDistance.sort(
                function (a, b) {
                    return a.currentDistance -
                        b.currentDistance;
                });
        // Always take the nearest
        approachedPointOfInterest(
            sortedPointsOfInterestByDistance[0]);
    }
};
const approachedPointOfInterest = (pointOfInterest) => {
    // Nearest point, but not my current which I am hearing
    if (currentPointOfInterest?.id !== pointOfInterest?.id
        && !speaking && currentUser)
    {
        setCurrentPointOfInterest(pointOfInterest);
    }
};

```

### A.7.5 WakeLock

Listing A.16: WakeLock

```

const enableWakeLock = async () => {
    if ('wakeLock' in navigator) {
        setWakeLockSupported(true);

        try {
            setWakeLock(await navigator.wakeLock.request('screen'));

            NotificationManager.success(
                "Wakelock is active. " +
                "Your screen will now stay on.");
        } catch (err) {
            NotificationManager.error(
                "Could not activate wakelock. " +
                "Exploration will stop if the display turns off.");
        }
    }
};

```

```
    } else {  
      setWakeLockSupported( false );  
    }  
  }  
}
```

### A.7.6 Pattern Lock

Listing A.17: Pattern Lock

```
const handleFinish = () => {  
  setLastPatternLockFinished(new Date().getTime());  
  // Differs from mobile device number -1  
  if (lockPattern.join("-") === "6-4-2") {  
    closeOverlay();  
    setLockPattern([]);  
  } else {  
    setLockPattern([]);  
  }  
};
```

```
<PatternLock  
  width={300}  
  pointSize={15}  
  size={3}  
  path={lockPattern}  
  onChange={setPattern}  
  onFinish={handleFinish}  
>
```

## A.8 Implementation of Neighbourhood

Listing A.18: Draws a circle in Google Maps

```
const handleApiLoaded = (map, maps) => {  
  // Draws the radius circle in google maps  
  // map = map is the instance of the google react map  
  // maps = container with all drawables like streetmaps,  
  // polygons, rectangle, points, ...  
  setCircle(new maps.Circle({  
    strokeColor: '#FF0000',  
    strokeOpacity: 0.8,  
    strokeWeight: 2,  
    fillColor: '#FF0000',
```

```

        fillOpacity: 0.3,
        map,
        center: { lat: neighbourhoodPosition.lat,
                  lng: neighbourhoodPosition.lng
                },
        radius: searchRange,
    }));
}

```

```

// changes the current position by clicking anywhere on the map.
const setMarkerPosition = (event) => {
    setNeighbourhoodPosition({ lat: event.lat, lng: event.lng });
    circle.setCenter({ lat: event.lat, lng: event.lng });
}

```

//The radius can be changed by a slider and the POIs can be filtered by the diff already visited, other users public POIs, own public POIs and private POIs.

```

const handleSearchRangeChange = (event) => {
    const radius = parseInt(event.target.value);
    const searchRangeMin = parseInt(event.target.min);
    const searchRangeMax = parseInt(event.target.max);

    setVisibleSearchRange(radius);
    setSearchRangeMin(searchRangeMin);
    setSearchRangeMax(searchRangeMax);

    circle.setRadius(radius);

    handleDebouncedSearchRangeChange(radius)
}

```

## A.9 Implementation of QuickAdd

Listing A.19: Create or edit a POI

```

useEffect(() => {
    const loadPointOfInterest = async () => {

        let poiId = searchParams.get("poi-id");

        if (poiId) {

```

```
setMode("edit");
QuickAdd.displayName = QuickAdd.name;

let pointOfInterestToEdit = await authenticatedFetchApi.get(
  '/pointofinterest/get?pointOfInterestId=${poiId}');

setPointOfInterest(pointOfInterestToEdit);
setPreviousVersionPointOfInterest({ ...pointOfInterestToEdit });
} else {
let newPointOfInterest = await authenticatedFetchApi.post(
  "/pointofinterest/create-point-of-interest");

setPointOfInterest(newPointOfInterest);
setSearchParams({ "poi-id": newPointOfInterest.id });

}
};

loadPointOfInterest();
}, []);
```

### A.9.1 Speech Recognition

Listing A.20: Start Transcript to current property

```
const startTranscript = (property) => {
  setCurrentPropertyTranscript(property);

  voiceCommandUtility.startTranscript(
    {
      callback: (transcript) => {
        const copy = { ...pointOfInterest };

        if (!copy[property]) {
          copy[property] = transcript;
        } else {
          copy[property] += transcript;
        }

        setPointOfInterest(copy);
      }
    },
    {}
  );
};
```

```

        callback: (isListening) => {
            setListening(isListening);
        }
    }
);
};

```

## A.9.2 Upload images

Listing A.21: Upload images container

```

<Form>
...
<FormGroup>
  <Label for="poiPictures">Pictures </Label>
  <Input
    id="poiPictures"  onChange={handleFileSelected}
    multiple  name="file"  type="file"
    accept=".jpg, .png, .jpeg, .gif"
  />
  <FormText>
    Please upload only pictures with a maximum
    size of less than 1MB.
  </FormText>
  {
    pointOfInterest && pointOfInterest.pictures &&
    pointOfInterest.pictures.length > 0 &&
    <Container className='upload-images-container'>
      {pointOfInterest
        .pictures.map((picture, index) =>
          <Row key={picture.id}>
            <Col md="3">
              <div className='upload-image-container'>
                <img src={`/${picture}/${picture.id}/300`}
                  width="300px"/>
              <div className='upload-image-attributes'>
                {pointOfInterest.author?.id===currentUser?.id
                  ? <FontAwesomeIcon
                      className="bug-button
                        delete-button"
                      icon={faTrash}
                      onClick={() => deletePicture(
                        pointOfInterest.id,
                        picture.id)} />
                }
              }
            }
          }
        }
      }
    }
  }
}

```

```
        : <FontAwesomeIcon
          className="bug-button "
          icon={faBug}
          onClick={() => reportPicture(
            pointOfInterest.id ,
            picture)} />
      }
    <div>{picture.fileName}</div>
  </div>
</div>
</Col>
<Col md="9">
  <div>
    <div>
      <Label for="pictureTitle">Titel</Label>
      <Input
        id="pictureTitle "
        name="pictureTitle "
        placeholder="Title "
        value={picture.title }
        onChange={e => handlePictureTitleChange(
          e, index)}
        type="text "
      />
    </div>
    <div>
      <Label for="pictureDescription">
        Description
      </Label>
      <Input
        id="pictureDescription "
        name="pictureDescription "
        placeholder="Description "
        value={picture.description }
        onChange={e =>
          handlePictureDescriptionChange(
            e, index)}
        type="text "
      />
    </div>
    <div>
      <Label for="pictureReference">Reference</Label>
      <Input
```



```

        id="pictureReference "
        name="pictureReference "
        placeholder="Reference "
        value={picture . reference }
        onChange={e => handlePictureReferenceChange (
            e, index)}
        type="text "
    />
</div>
</div>
</Col>
</Row>
}
</Container>
}
</FormGroup>
...
</Form>

```

```

const handleFileSelected = async (event) => {
    const files = Array.from(event.target.files);

    for (const file of files) {
        const data = new FormData();

        data.append("pointOfInterestId", pointOfInterest.id);
        data.append("picture", file, file.name);

        fetch("/pointofinterest/add-picture-to-point-of-interest", {
            method: 'post',
            headers: {
                Authorization: `Bearer ${authToken}`
            },
            body: data,
        }).then(response => {
            response.json().then(updatedPointOfInterest => {
                if (updatedPointOfInterest) {
                    setPointOfInterest(
                        { ...pointOfInterest,
                          pictures: updatedPointOfInterest.pictures
                        }
                    );
                }
            });
        });
    }
}

```

```
    );

    NotificationManager.success(
        'Picture ${file.name} added.'
    );
} else {
    NotificationManager.error(
        'Could not add picture ${file.name}.'
    );
}
});
}, () => {
    NotificationManager.error(
        'Could not add picture ${file.name}.'
    );
});
}
};
```

### A.9.3 Delete images

Listing A.22: Delete images of a POI

```
const deletePicture = (pointOfInterestId, pictureId) => {
    showAlert({
        title: 'Confirm to delete',
        message: 'Are you sure you want to delete the image.',
        buttons: [
            {
                label: 'Yes',
                onClick: async () => {
                    let deleteResponse = await authenticatedFetchApi.post(
                        "pointofinterest/deletePicture",
                        {
                            "pointOfInterestId": pointOfInterestId,
                            "pictureId": pictureId
                        }
                    );
                }
            }
        ]
    });

    if (deleteResponse.success) {
        // get all pictures without the currently deleted
        setPointOfInterest({
            ...pointOfInterest,
            pictures: pointOfInterest.pictures.filter(
```

```

        (picture, _)
        => picture.id !== pictureId
    )
    });

    NotificationManager.success(
        'Image deleted ' + pictureId
    );
} else {
    NotificationManager.error(
        'Could not delete picture.'
    );
}
}
},
{
    label: 'No',
    onClick: () => {
        NotificationManager.info('Aborted');
    }
}
]
});
};

```

#### A.9.4 Report POIs and images

Listing A.23: Report POI and report image

```

const reportPoi = () => {

    confirmAlert({
        title: 'Confirm to report the POI',
        message: 'Are you sure you want to report the poi',
        buttons: [
            {
                label: 'Yes',
                onClick: async () => {
                    NotificationManager.success(
                        'POI ' +
                        previousVersionPointOfInterest?.title + ' reported '
                    );
                }
            }
        ],
    });
};

```

```
        {
          label: 'No',
          onClick: () => {
            NotificationManager.info('Report aborted');
          }
        }
      ]
    });
  }
}
```

```
<div className='upload-image-container'>
  <img src={'/picture/${picture.id}/300'} width="300px" />
```

```
<div className='upload-image-attributes'>
```

```
  {pointOfInterest.author?.id === currentUser?.id
    ? <FontAwesomeIcon
      className="bug-button delete-button"
      icon={faTrash}
      onClick={() =>
        deletePicture(
          pointOfInterest.id,
          picture.id)} />
    : <FontAwesomeIcon
      className="bug-button"
      icon={faBug}
      onClick={() =>
        reportPicture(
          pointOfInterest.id,
          picture)} />
  }
```

```
<div>
  {picture.fileName}
</div>
</div>
</div>
```

```
const reportPicture = (pointOfInterestId, picture) => {
  confirmAlert({
    title: 'Confirm to report',
    message: 'Are you sure you want to report '+
```

```

        'the picture with the name ' + picture.fileName,
    buttons: [
        {
            label: 'Yes',
            onClick: async () => {
                NotificationManager.success('Picture reported. ');
            }
        },
        {
            label: 'No',
            onClick: () => {
                NotificationManager.info('Aborted ');
            }
        }
    ]
    });
};

```

### A.9.5 Annotate POIs

Listing A.24: Annotate POIs

```

...
{
    previousVersionPointOfInterest &&
    previousVersionPointOfInterest.author?.id !== currentUser?.id &&
    <h1>Content Manager – Annotate others POI</h1>
}
...
<FormGroup>
    <Label for="poiTitle">
        Title *
    </Label>

    {
        previousVersionPointOfInterest &&
        previousVersionPointOfInterest.author?.id !== currentUser?.id
        &&
        <div className='quick-add-owner-data'>
            {previousVersionPointOfInterest?.title}
        </div>
    }
}

```

```
    }

    <InputGroup>
      <Input
        id="poiTitle "
        name="title "
        placeholder="Name of POI"
        value={pointOfInterest?.title || ""}
        onChange={handleTitleChange}
        type="text "
      />
      <Button onClick={() => startTranscript("title")}>
        {listening && currentPropertyTranscript === "title "
          ? <FontAwesomeIcon icon={faMicrophone} />
          : <FontAwesomeIcon icon={faMicrophoneSlash} />
        }
      </Button>
    </InputGroup>
  </FormGroup>

  ...
  const annotatePoi = async () => {
    if (previousVersionPointOfInterest) {
      await authenticatedFetchApi.post(
        'pointofinterest/annotate',
        { pointOfInterestId: previousVersionPointOfInterest.id }
      );
      NotificationManager.info('Annotation successfull ');

      navigate("/content-manager");
    }
  }
}
```

## A.10 Implementation of Content Management

### A.10.1 Google Map

Listing A.25: GoogleMapReact

```
<GoogleMapReact
  bootstrapURLKeys={{ key: "api-key" }}
  defaultCenter={{
    lat: mapCenter?.lat ,
```

```

    lng: mapCenter?.lng
  }}
  options={mapUtility.getMapOptions}
  defaultZoom={16}
>
  {
    pointsOfInterest.map(pointOfInterest =>

      <PoiMarker
        key={pointOfInterest.id}
        lat={pointOfInterest.latitude}
        lng={pointOfInterest.longitude}
        text={pointOfInterest.title}
        nightMode={nightMode}
        poiId={pointOfInterest.id}
        own={pointOfInterest.authorId === currentUser.id}
        visited={pointOfInterest.visited}
        skipped={pointOfInterest.skipped}
        privacy={pointOfInterest.privacy}
      />
    )
  }
</GoogleMapReact>

```

## A.10.2 Content Management Tabs

Listing A.26: Content Management Tabs

```

<Nav tabs className='content-manager-nav'>
  <NavItem>
    <NavLink className={activeTab === '1' ? 'active' : ''}
      onClick={() => selectedTab('1')}>
      <FontAwesomeIcon icon={faLocationPin} /> All other public POIs
    </NavLink>
  </NavItem>
  <NavItem>
    <NavLink className={activeTab === '2' ? 'active' : ''}
      onClick={() => selectedTab('2')}>
      <FontAwesomeIcon icon={faLocationDot} /> My public POIs
    </NavLink>
  </NavItem>
  <NavItem>
    <NavLink className={activeTab === '3' ? 'active' : ''}

```



```
                onClick={() => selectedTab('3')}>
                <FontAwesomeIcon icon={faLocationPinLock} /> My private POIs
            </NavLink>
        </NavItem>
    </Nav>
    const handleLoadedMyPublic = (pois) => {
        if (currentPosition !== null) {
            setMapCenter(
                {
                    lat: currentPosition.latitude,
                    lng: currentPosition.longitude
                }
            );
        }
        setPointsOfInterest(pois);
    };

    const handleLoadedOtherPublic = (pois) => {

        if (currentPosition !== null) {
            setMapCenter(
                {
                    lat: currentPosition.latitude,
                    lng: currentPosition.longitude
                }
            );
        }
        setPointsOfInterest(pois);
    };

    const handleLoadedPrivate = (pois) => {
        if (currentPosition !== null) {
            setMapCenter(
                {
                    lat: currentPosition.latitude,
                    lng: currentPosition.longitude
                }
            );
        }
        setPointsOfInterest(pois);
    };

    const selectedTab = (tabId) => {
```

```

    setPointsOfInterest ( [] );
    setActiveTab ( tabId );
  }

```

### A.10.3 Delete POI

Listing A.27: Delete POI

```

const deletePointOfInterest = async ( pointOfInterestId ) => {
  showAlert ( {
    title: 'Confirm to delete ',
    message: 'Are you sure to do this.',
    buttons: [
      {
        label: 'Yes',
        onClick: async () => {
          let deleteResponse = await authenticatedFetchApi
            .post (
              "pointofinterest/delete",
              { "pointOfInterestId":
                pointOfInterestId
              }
            );

          if ( deleteResponse.success ) {
            loadPois ();
            NotificationManager.success (
              'POI deleted ' + pointOfInterestId );
          } else {
            NotificationManager.error (
              'Could not delete POI.' );
          }
        }
      },
      {
        label: 'No',
        onClick: () => {
          NotificationManager.info ( 'Aborted ' );
        }
      }
    ]
  } );
}

```

### A.10.4 Others public POIs

Listing A.28: Show others public POIs

```
<TabPane tabId="1">
  {activeTab == "1" &&
    <div>
      <div className='poi-table-title '>
        <h3 >All other public POIs</h3>
      </div>
      <PoiTable
        fetchDataUrl=
          "/pointofinterest/find-other-public-points-of-interest "
        loadedCallback={handleLoadedOtherPublic}>
      </PoiTable>
    </div>
  }
</TabPane>
```

### A.10.5 My public POIs

Listing A.29: My public POIs

```
<TabPane tabId="2">
  {activeTab == "2" &&
    <div>
      <div className='poi-table-title '>
        <h3 >My public POIs</h3>
      </div>
      <PoiTable
        fetchDataUrl=
          "/pointofinterest/find-my-public-points-of-interest "
        loadedCallback={handleLoadedMyPublic}>
      </PoiTable>

      <div className='content-manager-add-button '>
        <button
          className='btn btn-secondary '
          onClick={() => navigate("/quick-add")}>
          <FontAwesomeIcon icon={faPlusSquare} />
          Add a public POI
        </button>
      </div>
    </div>
  }
</TabPane>
```

&lt;/TabPane&gt;

### A.10.6 My private POIs

Listing A.30: My private POIs

```

const downloadPrivatePointsOfInterests = () => {

  confirmAlert({
    title: 'Confirm to download priavate POIs',
    message: 'Are you sure you want to '+
      'download all private points?',
    buttons: [
      {
        label: 'Yes',
        onClick: async () => {

          if (pointsOfInterest != null &&
            pointsOfInterest.length > 0)
          {
            NotificationManager.success(
              'You will get a pdf with the detail of ' +
                pointsOfInterest.length + ' POIs'
            );
          }
          else
          {
            NotificationManager.error(
              'You have no private POIs that could be downloaded.'
            );
          }
        },
      },
      {
        label: 'No',
        onClick: () => {
          NotificationManager.info('Report aborted');
        }
      }
    ]
  });
}

```

```
<TabPane tabId="3">
  {activeTab == "3" &&
    <div>
      <div className='poi-table-title '>
        <h3>My private POIs</h3>
      </div>
      <PoiTable
        fetchDataUrl=
          "/pointofinterest/find-my-private-points-of-interest "
        loadedCallback={handleLoadedPrivate}>
      </PoiTable>
      <div className="content-manager-add-button">
        <button className='btn btn-secondary '
          onClick={() => navigate("/quick-add")}>
          <FontAwesomeIcon icon={faPlusSquare} /> Add private POI
        </button>
      </div>
      <br /><br /><br />
      <div className="content-manager-add-button">
        <div>
          <h3>Download private POIs</h3>
          <button className='btn btn-secondary '
            onClick={downloadPrivatePointsOfInterests}>
            <FontAwesomeIcon icon={faDownload} /> Download my journey
          </button>
          <br />
          <span>
            Download a summary of your
            private POIs as a HTML, PDF, ...
          </span>
        </div>
      </div>
    </div>
  }
</TabPane>
```

## A.11 Implementation of Settings

Listing A.31: UserSettings

```

const currentUser = userActions.currentUser();

// Save Settings if somethings changes
useEffect(() => {
  if (!loading) {
    saveSettings();
  }
},
[
  language,
  contentLanguage,
  speechSpeed,
  fontSize,
  homePosition,
  voice,
  theme,
  selectedExplanationModes,
  selectedCategories
]);

const saveSettings = () => {
  const userSettings = {
    "language": language,
    "contentLanguage": contentLanguage,
    "speechSpeed": speechSpeed,
    "fontSize": fontSize,
    "voice": voice,
    "theme": theme,
    "explanationModes": selectedExplanationModes,
    "categories": selectedCategories,
    "homePositionLatitude": homePosition.latitude,
    "homePositionLongitude": homePosition.longitude
  };

  authenticatedFetchApi.post("/auth/update-settings",
    userSettings).then(updatedUser => {
    userActions.updateUser(updatedUser);

    NotificationManager.success('Saved');
  }, () => {
    NotificationManager.error('Could not save settings.');
```

```
    });  
  }
```

### A.11.1 Home Position

Listing A.32: User Map Settings

```
const mapUtility = useMapUtility();  
const map = renderMap(currentPosition, homePosition);  
  
useEffect(() => {  
  const initialize = async () => {  
    // Center map to current position  
    setCurrentPosition(await mapUtility.getCurrentPosition());  
  }  
  
  setLoading(false);  
  
  initialize();  
}, []);  
  
const renderMap = (currentPosition, marker) => {  
  return (<div style={{ height: '250px', width: '100%' }}>  
    {currentPosition &&  
      <GoogleMapReact  
        onClick={setMarkerPosition}  
        bootstrapURLKeys={{ key: "ourAPIKey" }}  
        center={{  
          lat: currentPosition?.latitude,  
          lng: currentPosition?.longitude  
        }}  
        options={mapUtility.getMapOptions}  
        defaultZoom={11}  
      >  
        {marker && <UserMarker  
          key="homePositionMarker"  
          lat={marker.latitude}  
          lng={marker.longitude} />}  
      </GoogleMapReact>  
    }  
  </div >);
```



```

}

const setMarkerPosition = (event) => {
  // Actual clicked position
  setHomePosition({
    latitude: event.lat,
    longitude: event.lng });
}

```

```

<FormGroup>
  {map}
  <Label className='margin-top-class' for="settingHomePosition">
    <FormText>
      Place the marker by clicking on the desired location or
      click the button below to set it to the current position *
    </FormText>
    <br />
    <Button onClick={setMarkerPositionHere}>
      <FontAwesomeIcon icon={faLocationDot} /> Set to here!
    </Button>
    <br /><br />
    <HomePositionMarker></HomePositionMarker>
    {homePosition.latitude} {homePosition.longitude}
  </Label>
</FormGroup>

```

```

const setMarkerPositionHere = async () => {
  const position = await mapUtility.getCurrentPosition();

  setHomePosition({
    latitude: position.latitude,
    longitude: position.longitude });
};

```

## A.11.2 Content Language and Application Language

Listing A.33: Content Language and Application Language

```

const handleLanguageChange = (event) => {
  setLanguage(event.target.value);
}

```

```
const handleContentLanguageChange = (event) => {
  setContentLanguage(event.target.value);
}

<FormGroup>
  <Label for="settingLanguage">
    Application Language
    <span id="infoApplicationLanguage">
      <FontAwesomeIcon
        icon={faCircleInfo}
        className="infoIcon" />
    </span>
    <UncontrolledTooltip
      placement="top"
      target="infoApplicationLanguage"
      trigger="click">This is the preferred language of
        the application on the mobile device
        or in the browser.
        If something is not localized,
        then the fallback will be english.
    </UncontrolledTooltip>
  </Label>

  <Input
    id="settingLanguage"
    name="select"
    type="select"
    value={language}
    onChange={handleLanguageChange}>
    <option>de</option>
    <option>en</option>
  </Input>
</FormGroup>
<FormGroup>
  <Label for="settingContentLanguage">
    Content Language
    <span id="infoContentLanguage">
      <FontAwesomeIcon
        icon={faCircleInfo}
        className="infoIcon" />
    </span>
    <UncontrolledTooltip
```

```

    placement="top "
    target="infoContentLanguage "
    trigger="click">
        This is the preferred language of the content.
        If some content is not localized , then
        the fallback will be German.
    </UncontrolledTooltip>
</Label>

<Input
    id="settingContentLanguage "
    name="select "
    type="select "
    value={contentLanguage }
    onChange={handleContentLanguageChange}>
    <option>de</option>
    <option>en</option>
</Input>
</FormGroup>

```

### A.11.3 Impact

Listing A.34: Settig Imapct

```

const onSelectCategory = (selectedList , _) => {
    setSelectedCategories (selectedList)
};

const onRemoveCategory = (selectedList , _) => {
    setSelectedCategories (selectedList);
};

<FormGroup>
  <Label for="settingImpact">
    Impact
    <span id="infoImpact">
      <FontAwesomeIcon
        icon={faCircleInfo }
        className="infoIcon " />
    </span>
    <UncontrolledTooltip
      placement="top "
      target="infoImpact "
      trigger="click">

```

```
        This are the desired categories of the POIs.
    </UncontrolledTooltip>
</Label>
<Multiselect
  options={categories}
  selectedValues={selectedCategories}
  onSelect={onSelectCategory}
  onRemove={onRemoveCategory}
  displayValue="name"
/>
</FormGroup>
```

#### A.11.4 Speech Speed

Listing A.35: Setting Speech Speed

```
const handleSpeechSpeedChange = (event) => {
  setSpeechSpeed(parseFloat(event.target.value));
}

<FormGroup>
  <Label for="settingSpeechSpeed">
    Speech Speed
    <span id="infoSpeechSpeed">
      <FontAwesomeIcon
        icon={faCircleInfo}
        className="infoIcon" />
    </span>
    <UncontrolledTooltip
      placement="top"
      target="infoSpeechSpeed"
      trigger="click">This is the speed of the
        speech speed of the synthesizer.
        <br />For example:
        <br />* normal speed is 1.0
        <br />* double speed is 2.0 <br />
    </UncontrolledTooltip>
  </Label>

  <Input
    id="settingSpeechSpeed"
    name="select"
    type="select"
    value={speechSpeed}
```

```

      onChange={handleSpeechSpeedChange}>
    <option value="0.1">.1</option>
    <option value="0.25">.25</option>
    <option value="0.5">.5</option>
    <option value="0.75">.75</option>
    <option value="1">1.0</option>
    <option value="1.25">1.25</option>
    <option value="1.5">1.5</option>
    <option value="1.75">1.75</option>
    <option value="2">2.0</option>
    <option value="3">3.0</option>
    <option value="4">4.0</option>
    <option value="5">5.0</option>
    <option value="7">7.0</option>
    <option value="10">10.0</option>
  </Input>
</FormGroup>

```

### A.11.5 Voice

Listing A.36: Setting Voice

```

const [voice, setVoice] = useState(currentUser.voice);

const handleVoiceChange = (event) => {
  setVoice(event.target.value);
}

<FormGroup>
  <Label for="settingVoice">
    Voice
    <span id="infoVoice">
      <FontAwesomeIcon
        icon={faCircleInfo}
        className="infoIcon" />
    </span>
    <UncontrolledTooltip
      placement="top"
      target="infoVoice"
      trigger="click">
      The voice is used to read the content of the application.
      The voices are the default system voices
      from your browser or moile device.
    </UncontrolledTooltip>
  </Label>

```

```
<Input
  id="settingVoice "
  name="select "
  type="select "
  value={voice}
  onChange={handleVoiceChange}>
  {systemVoices && systemVoices.map(systemVoice =>
    <option
      key={systemVoice.voiceId}
      value={systemVoice.voiceId}>
      {systemVoice.voiceName}
    </option>
  )}
</Input>
</FormGroup>
```

### A.11.6 Font Size

Listing A.37: Setting Font Size

```
const handleFontSizeChange = (event) => {
  setFontSize(parseInt(event.target.value));
}

<FormGroup>
  <Label for="settingFontSize">
    Font Size
    <span id="infoFontSize">
      <FontAwesomeIcon
        icon={faCircleInfo}
        className="infoIcon " />
      </span>
      <UncontrolledTooltip
        placement="top "
        target="infoFontSize "
        trigger="click">The font size dictates the
          height of the lettering of the content
          and application. <br />
      </UncontrolledTooltip>
    </Label>

    <Input id="settingFontSize "
      name="select " type="select "
```

```

        value={fontSize}
        onChange={handleFontSizeChange}>
    <option value="0">Small</option>
    <option value="1">Normal</option>
    <option value="2">Large</option>
  </Input>
</FormGroup>

```

### A.11.7 Theme

Listing A.38: Setting Theme

```

<FormGroup>
  <Label for="settingTheme">
    Theme <span id="infoTheme">
      <FontAwesomeIcon
        icon={faCircleInfo}
        className="infoIcon" />
      </span>
      <UncontrolledTooltip
        placement="top"
        target="infoTheme"
        trigger="click">
        The theme supports a dark and a light mode. <br />
        Default is the light mode.
      </UncontrolledTooltip>
    </Label>

    <Input id="settingTheme"
      name="select"
      type="select"
      value={theme}
      onChange={handleThemeChange}>
      <option value="0">Light</option>
      <option value="1">Default</option>
      <option value="2">Dark</option>
    </Input>
  </FormGroup>

  const handleThemeChange = (event) => {
    setTheme(parseInt(event.target.value));
  }

```

### A.11.8 Explanation Mode

Listing A.39: Setting Explanation Mode

```

const onSelectCategory = (selectedList , _) => {
  setSelectedCategories(selectedList)
};

const onRemoveCategory = (selectedList , _) => {
  setSelectedCategories(selectedList);
};

<FormGroup>
<Label for="settingExplanationMode">
  Explanation Mode
  <span id="infoExplanationMode">
    <FontAwesomeIcon
      icon={faCircleInfo}
      className="infoIcon" />
  </span>
  <UncontrolledTooltip
    placement="top"
    target="infoExplanationMode"
    trigger="click">
    The explanation mode is used when the content is read by the
    speech synthesizer. If you reach a point of interest , then
    your selection will be considered. Do you want to hear
    just the title , or the title and the short description
    or everything. This means, title , short- and long
    description of a POI.
  </UncontrolledTooltip>
</Label>
<Multiselect
  options={explanationModes}
  selectedValues={selectedExplanationModes}
  onSelect={onSelectExplanationMode}
  onRemove={onRemoveExplanationMode}
  displayValue="name"
/>
</FormGroup>

```

### A.12 Implementation of Profile

Listing A.40: Profile view



```

<div className='profile-header'>
  <div>
    <div className='profile-button-container'>
      <Button color="" onClick={logout} disabled={busy}>
        <FontAwesomeIcon icon={faArrowRightFromBracket} />
      </Button>
    </div>
    <div className="profile-image-container">
      <img
        src={
          '/picture/profile-picture/${currentProfile.user.id}/big '
        }
        alt="Avatar "
        style={{ borderRadius: '50%', width: '250px' }} />
      {currentProfile.badge &&
        <FontAwesomeIcon
          icon={faCertificate}
          className="color-badge profile-badge" />
      }
    </div>
  </div>
  <h1>Hello {currentProfile.user.name.substring(
    0,
    currentProfile.user.name.indexOf(" ")
  )}!
</h1>
</div>
<p>
  With your account you can explore the city and add entries.
</p>

```

### A.12.1 Statistics

Listing A.41: Statistics

```

Points = _userProvider.GetPoiCreatedCount(_user.Id) * 5 +
         _userProvider.GetPoiAnnotationsCount(_user.Id) * 2;

public int Level => Points switch {
  >=450 =>10,
  >=400 =>9,
  >= 350 => 8,
  >= 300 => 7,
  >= 250 => 6,

```

```
>= 200 => 5,
>= 150 => 4,
>= 100 => 3,
>= 50 => 2,
_=> 1
};

public bool Badge => Level switch {
    >= 4 => true,
    _=> false
};

<div>
  <h3>Statistics </h3>
  <p>
    You have {currentProfile.points} points and are in level
    {currentProfile.level}.
  </p>
  {currentProfile.badge ?
    <p>You have a badge.
      <FontAwesomeIcon
        icon={faCertificate}
        className="color-badge" />
      </p>
    :
    <p>
      You don't have a badge yet.
      <FontAwesomeIcon
        icon={faCertificate}
        className="color-badge" />
      </p>
    }
  <p>
    You already have {currentProfile.distanceWalked}km and
    {currentProfile.poiVisitCount} POIs visited.
  </p>
  <p>
    You created {currentProfile.poiCreatedCount} POIs
    by your own and annotated
    {currentProfile.poiAnnotationsCount} POIs from others.
  </p>
  <p>
```

```

    You got {currentProfile.likesGot}
    <FontAwesomeIcon icon={faHeart}
      className="color-heart" />
      from others.
  </p>
</div>

```

### A.12.2 Reset visited and skipped POIs

Listing A.42: Reset visited and skipped POIs

```

<h3>Reset all POIs</h3>
<div>
  <p>
    Click here to reset all point of interest to unheard.
  <br /> <br />
  <Button
    className='profile-reset-all-pois'
    color="primary"
    onClick={resetAllPointsOfInterest}
    disabled={busy}>
    <FontAwesomeIcon icon={faArrowRotateLeft} />
    Reset all points of interest
  </Button>
</p>
</div>

const resetAllPointsOfInterest = async () => {
  try {
    setBusy(true);
    await authenticatedFetchApi.post(
      "/pointofinterest/reset-all-points-of-interest");

    setBusy(false);
    NotificationManager.success('Saved');
  } catch (error) {
    NotificationManager.error(error);
  }
}

var visits = _context
  .Visites.Where(visit => visit.UserId == userId);
var skips = _context

```

```
        .Skips.Where(skip => skip.UserId == userId);

foreach (var visit in visits)
{
    _context.Remove(visit);
}

foreach (var skip in skips)
{
    _context.Remove(skip);
}
_context.SaveChanges();
```

## A.13 Implementation of Introduction

Listing A.43: Introduction

```
<div className="info-page">
  <a href="javascript:;" onClick={back}>
    <img src={backIcon}></img>
  </a>
  <div>
    <h1>Introduction</h1>
    <h2>Navigation</h2>
    <ul>
      <li>
        Wander around the city, and you automatically
        get the information of a POI.
      </li>
      <li>
        First you get the title, then the short description
        and then the long description
      </li>
      <li>You can also get the connected media files to a POI.</li>
      <li>
        If you heard a POI once, it should be automatically
        skipped, as long as you reactivate it or
        the edit date is newer
      </li>
      <li>Use speech control to hear the long version </li>
      <li>Use speech control to manage the application </li>
    </ul>
```

```

<h2>Create Content</h2>

<ul>
  <li>
    Use Quick Add to create a new POI with your
    current GPS coordinate. </li>
  <li>You can add or capture photos from your device.</li>
  <li>You can change the data in the content creation site.</li>
</ul>

<VoiceCommandHelp></VoiceCommandHelp>
</div>
</div>

```

## A.14 Implementation of Terms and Conditions

Listing A.44: Terms and Conditions

```

<div class="info -page">

  <a href="javascript:;" onClick={back}>
    <img src={backIcon}></img>
  </a>

  <div>
    <h1>City Explorer Terms of Use</h1>

    <h2>1. Agreement to Terms</h2>

    By viewing or using this Website, which can be accessed at
    https://city-explorer.net or through our mobile application
    City Explorer, you are agreeing to be bound by all
    these Website's Terms of Use and agree with any
    applicable local laws. If you disagree with
    any of these terms, you are prohibited from accessing this
    Website or using the Service. All materials in this Website
    are protected by trade mark law and copyright.
    For purposes of this Terms of Use, the terms
    ‘‘company’’, ‘‘we’’ and ‘‘our’’ refers to the Company.

    <h2>2. Privacy policy</h2>

    We advise you to read our privacy policy regarding our

```

```
        user data collection. It will help you better
        understand our practices.
        ...
    </div>
    ...
</div>
```

## A.15 Implementation of Imprint

Listing A.45: Imprint

```
import React, { useState, useEffect } from 'react';
import { Button } from 'reactstrap';
import './Imprint.css';
import backIcon from '../assets/back.svg';

function Imprint() {
  Imprint.displayName = Imprint.name;

  const back = () => {
    window.history.back();
  };

  return (
    <div>
      <div>
        <h1>About City Explorer</h1>
        <p>
          This application is created by copy; Ana-Alina
          Faustmann. She owns all rights of the application.
          To read the Terms & Conditions read
          <a href="/terms-and-conditions">here</a>.
        </p>
        <h1>Sound Effects</h1>
        <ul>
          <li>
            Start Sound ...
            start_mixkit-positive-notification-951.wav
          </li>
          <li>
            Stop Sound ...
          </li>
        </ul>
      </div>
    </div>
  );
}
```

```

        stopp_mixkit-software-interface-back-2575.mp3
    </li>
    <li>
        Waiting Sound ...
        notification-140376.mp3 &nbsp;
        <a href="https://pixabay.com/de/users/
            universfield-28281460/
            ?utm_source=link-attribution&
            utm_medium=referral&
            utm_campaign=music&
            tm_content=140376">
            Universfield
        </a>
        from
        <a href="https://pixabay.com//?utm_source=link-
            attribution&utm_medium=
            referral&utm_campaign=
            music&utm_content=140376">
            Pixabay
        </a>
    </li>
</ul>
</div>
<div>
    <Button onClick={back}>
        Back
    </Button>
</div>
</div>
);
};
export default Imprint;

```



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# List of Algorithms



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# Acronyms

- AR** Augmented Reality. 9, 99
- DGPS** Differential Global Positioning System. 11
- GPS** Global Positioning System. 9, 99
- POIs** Points of Interests. 35, 37, 38, 134
- PWA** Progressive Web App. 59, 101, 122
- UCD** User-centered design. 14
- WGS84** World Geodetic System 1984. 58, 65



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The approved original version of this thesis is available in print at TU Wien Bibliothek.

# Bibliography

- [AAH<sup>+</sup>97] Gregory Abowd, Christopher Atkeson, Jason Hong, Sue Long, Rob Kooper, and Michael Pinkerton. *Cyberguide: A Mobile Context-Aware Tour Guide*. Wireless Networks, Volume 3(5), 1997.
- [AP04] Maloney-Krichmar Chadia Abras, Chadia and Jenny Preece. *User-centered design*. In Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications. (in press), 2004.
- [Bau] Johann Bauer. *Altes Bräuhaus Neunkirchen*. <https://www.altes-brauhaus-neunkirchen.at/index.php/chronik>. [Online; accessed 01-September-2022].
- [BB17] Letizia Bollini and Daniele Begotti. *The Time Machine. Cultural Heritage and the Geo-Referenced Storytelling of Urban Historical Metamorphose*. Computational Science and Its Applications – ICCSA 2017 10406 (2017): p.239-51, 2017.
- [BKW08] Rafael Ballagas, André Kuntze, and Steffen P Walz. *Gaming Tourism: Lessons from Evaluating REXplorer, a Pervasive Game for Tourists*. Pervasive Computing, 2008, Vol.5013, p.244-261, 2008.
- [BMF<sup>+</sup>18] Erica N Barin, Cory M McLaughlin, Mina W Farag, Aaron R Jensen, Jeffrey S Upperman, and Helen Arbogast. *Heads Up, Phones Down: A Pedestrian Safety Intervention on Distracted Crosswalk Behavior*. Springer US, Journal of community health, Vol.43, p.810-815, 2018.
- [Bol12] Letiziaj Bollini. *MilanoAttraverso: Telling the Story of Social Inclusion of Milan Through Digitised Archives Linked to Historical Cartography*. Cham: Springer International, Computational Science and Its Applications – ICCSA 202, Vol.12953, 2012.
- [CLiy20] Huichen Chou, Donghui Lin, Toru Ishida, and Naomi Yamashita. *Understanding Open Collaboration of Wikipedia Good Articles*. Cham: Springer International Publishing, Social Computing and Social Media. Participation, User Experience, Consumer Experience, and Applications of Social Computing, 2020-07-10, p.29-43, 2020.

- [CMV11] Ioannis Chatzigiannakis, Georgios Mylonas, and Andrea Vitaletti. *The final TimeWarp: using form and content to support player experience and presence when designing location-aware mobile augmented reality games*. Elsevier Inc, Computer science review, 2011, Vol.5 (1), p.103-118, 2011.
- [CP18] Ping-Ling Chen and Chih-Wei Pai. *Pedestrian smartphone overuse and inattentive blindness: an observational study in Taipei, Taiwan*. BioMed Central Ltd, BMC public health, Vol.18, p.1342-1342, 2018.
- [CRC07] Alan Cooper, Robert Reimann, and Dave Cronin. *About Face 3: The Essentials of Interaction Design*. Springer, Wiley Pub., 3rd ed., ISBN 1280855711, 2007.
- [Dod22] Cassie Dodd. *6 Ways Google Local Guides Generated Success with Geolocation*. <https://www.geopointe.com/2017/12/05/google-local-guides-geolocation>, 2022. [Online; accessed 26-July-2022].
- [EV06] Michael Epstein and Silvia Vergani. *History Unwired: mobile narrative in historic cities*. ACM, Proceedings of the working conference on advanced visual interfaces, Vol.2006, p.302-305, 2006.
- [FTC<sup>+</sup>12] Elizabeth FitzGerald, Claire Taylor, Michael Craven, Reza Rawassizadeh, Reza Rawassizadeh, Martin Tomitsch, Martin Tomitsch, Katarzyna Wac, and Katarzyna Wac. *To the Castle! A comparison of two audio guides to enable public discovery of historical events*. London: Springer-Verlag, Personal and ubiquitous computing, Vol.17 (4), p.749-760, 2012.
- [GIS] GISGeography. *World Geodetic System (WGS84)*. <https://gisgeography.com/wgs84-world-geodetic-system/>. [Online; accessed 22-April-2023].
- [GJBF15] Raynel Mendoza Garrido, Danilo Vargas Jiménez, Silvia Baldiris, and Ramon Fabregat. *Augmented and Virtual Reality - "Social Heritage" Augmented Reality Application to Heritage Education*. Springer International Publishing Switzerland 2015, Lecture Notes in Computer Science, Vol.9254, p.17-24, ISSN 0302-9743, ISBN 3319228870, 2015.
- [HB20] Wolfgang Haider-Berkey. *Neunkirchen für unsere Gäste und Einheimische - Ein Kurzführer über die Geschichte und sonstiges Wissenswertes*. Geschichte von Neunkirchen, Band6, 2020.
- [Hud19] Kasey Clawson Hudak. *Resident stories and digital storytelling for participatory place branding*. Place branding and public diplomacy, 2019-02-09, Vol.15 (2), p.97-108, 2019.
- [Ive11] Hana Iverson. *NEIGHBORHOOD NARRATIVES*. University Park: Pennsylvania State University Press, Transformations (Wayne, N.J.), 2011-04-01, Vol.22 (1), p.93, 2011.

- [KAKW15] Hayun Kim, Sungeun An, Sangeun Keum, and Wontack Woo. *H-Treasure Hunt: A Location and Object-Based Serious Game for Cultural Heritage Learning at a Historic Site*. Cham: Springer International Publishing, Learning and Collaboration Technologies. Vol.9192. Cham: Springer International, 2015. 561-72. Lecture Notes in Computer Science, 2015.
- [KCD<sup>+</sup>20] Georgios Kallergis, Marios Christoulakis, Aimilios Diakakis, Marios Ioannidis, Iasonas Paterakis, Nefeli Manoudaki, Marianthi Liapi, and Konstantinos-Alketas Oungrinis. *Open City Museum: Unveiling the Cultural Heritage of Athens Through an - Augmented Reality Based- Time Leap*. Culture and Computing, 2020-07-10, Vol.12215, p.156-171, 2020.
- [KE08] Aniket Kittur and Kraut Robert E. *Harnessing the Wisdom of Crowds in Wikipedia: Quality Through Coordination*. Cham: Springer International Publishing, Conference: Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work, CSCW 2008, San Diego, p.37-46, 2008.
- [KJK<sup>+</sup>18] Efstathia Kostopoulou, Ana Javornik, Petros Koutsolampros, Simon Julier, and Ava Fatah gen. Schieck. *Mediated Spatial Narratives: Experiencing Archival Material and Shared Memories in Urban Space*. Proceedings of the 4th Media Architecture Biennale Conference, 2018-11-13, p.118-127, 2018.
- [Lee17] Seung Jae Lee. *A review of audio guides in the era of smart tourism*. Information Systems Frontiers, p.705-71, 2017.
- [Lø09] Anders Sundes Løvlie. *Textopia: designing a locative literary reader*. Journal of Location Based Services, 3:4, p.249-276, 2009.
- [Lø11] Anders Sundnes Løvlie. *Annotative Locative Media and GPS: Granularity, Participation, and Serendipity*. Computers and Composition 28(3), p.246-254, 2011.
- [MB11] Joe Marshall and Steve Benford. *Using fast interaction to create intense experiences*. Proceedings of the SIGCHI Conference on human factors in computing systems, 2011-05-07, p.1255-1264, 2011.
- [MWZ21] Miroslava Mikusova, Joanna Wachnicka, and Joanna Zukowska. *Research on the Use of Mobile Devices and Headphones on Pedestrian Crossings—Pilot Case Study from Slovakia*. MDPI AG, Safety (Basel), Vol.7, p.17, 2021.
- [NDBN] Valentina Nisi, Mara Dionisio, Mary Barreto, and Nuno Nunes. *A Mixed Reality Neighborhood Tour: Understanding Visitor Experience and Perceptions*. OXFORD: Elsevier B.V Entertainment, Computing 27 p.89-100.
- [Obe] Oberlo. *How many people have smartphones in 2023?*  
<https://www.oberlo.com/statistics/how-many-people-have-smartphones>.  
[Online; accessed 22-July-2023].

- [OPP13] Mohd Othman, Helen Petrie, and Christopher Power. *Measuring the Usability of a Smartphone Delivered Museum Guide*. *Procedia - Social and Behavioral Sciences*, Vol.97, p.628-637, DOI 10.1016/j.sbspro.2013.10.282, 11 2013.
- [ove] Steiger Stefan overflow, stack. *Calculate distance between two latitude-longitude points? (Haversine formula)*. <https://stackoverflow.com/questions/27928/calculate-distance-between-two-latitude-longitude-points-haversine-formula>. [Online; accessed 01-January-2023].
- [Sana] Thomas Santrucek. *Karten- und Kachelkoordinaten*. <https://developers.google.com/maps/documentation/javascript/coordinates?hl=de>. [Online; accessed 15-April-2023].
- [Sanb] Thomas Santrucek. *Panoramapark will zusätzliche 10.000 m<sup>2</sup>, 30. März 2014, 00:03 Uhr*. [https://www.meinbezirk.at/neunkirchen/c-wirtschaft/panoramapark-will-zusaetzliche-10000-m\\_a887843](https://www.meinbezirk.at/neunkirchen/c-wirtschaft/panoramapark-will-zusaetzliche-10000-m_a887843). [Online; accessed 25 – February – 2023].
- [Sch16] Van der Heide Edwin Schraffenberger, Hanna. *Multimodal Augmented Reality - The Norm Rather Than the Exception*. ACM, Conference: the 2016 workshop, DOI 10.1145/3001959.3001960, 2016.
- [SMB<sup>+</sup>15] Gheric Speiginer, Blair Macintyre, Jay Bolter, Hafez Rouzati, Amy Lambeth, Laura Levy, Laurie Baird, Maribeth Gandy, Matt Sanders, Brian Davidson, Maria Engberg, Russ Clark, and Elizabeth Mynatt. *The Evolution of the Argon Web Framework Through Its Use Creating Cultural Heritage and Community-Based Augmented Reality Applications*. *Proceedings*, p.112-124, 2015.
- [SNS17] Cláudia Silva, Valentina Nisi, and Joseph Straubhaar. *Share yourself first: exploring strategies for the creation of locative content for and by low-literacy communities*. ACM, Proceedings of the 8th International Conference on communities and technologies, 2017-06-26, Vol.128532, p.236-245, 2017.
- [Sou22] Matt G. Southern. *Google Local Guides Program: How To Earn Points Badges*. <https://www.searchenginejournal.com/google-local-guides-program-adds-new-levels-new-perks/202294/>, 2022. [Online; accessed 26-August-2022].
- [VIK<sup>+</sup>02] V Vlahakis, M Ioannidis, J Karigiannis, M Tsotros, M Gounaris, D Stricker, T Gleue, P Daehne, and L Almeida. *Archeoguide: an augmented reality guide for archaeological sites*. LOS ALAMITOS: IEEE, IEEE computer graphics and applications, 2002-09, Vol.22 (5), p.52-60, 2002.
- [ZCS12] Stefan Zander, Chris Chiu, and Gerhard Sageder. *A computational model for the integration of linked data in mobile augmented reality applications*.

Proceedings of the 8th International Conference on semantic systems, 2012-09-05, p.133-140, 2012.