



André Filipe Reis Ferreira

Bachelor in Computer Science and Engineering

Extending the Auditory Atlas of the City of Évora

Dissertation submitted in partial fulfillment
of the requirements for the degree of

Master of Science in
Computer Science and Engineering

Adviser: Maria Armanda Simenta Rodrigues Grueau, Associate
Professor, NOVA University of Lisbon

Co-adviser: Nuno Manuel Robalo Correia, Full Professor, NOVA Uni-
versity of Lisbon

Examination Committee

Chair: Professor João Lourenço, Universidade NOVA de Lisboa
Rapporteur: Professor Teresa Chambel, Universidade de Lisboa
Member: Professor Armanda Rodrigues, Universidade NOVA de Lisboa



FACULDADE DE
CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

February, 2021

Extending the Auditory Atlas of the City of Évora

Copyright © André Filipe Reis Ferreira, Faculty of Sciences and Technology, NOVA University Lisbon.

The Faculty of Sciences and Technology and the NOVA University Lisbon have the right, perpetual and without geographical boundaries, to file and publish this dissertation through printed copies reproduced on paper or on digital form, or by any other means known or that may be invented, and to disseminate through scientific repositories and admit its copying and distribution for non-commercial, educational or research purposes, as long as credit is given to the author and editor.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank the NOVA School of Science and Technology for being my home during this journey and enabling me to grow both academically and as a person. Moreover, I want to thank PASEV for this challenging project and their assistance. A special thanks to my advisers professor Armanda Rodrigues and professor Nuno Correia for their guidance and support during this important final stage.

Furthermore, I would also like to thank my family, specially my parents who have always supported me no matter what and did everything they could to provide me and my brother with opportunities they did not have.

I would also like to thank all the friends I met before, during and after this journey started, for the good times and for standing by my side in the harsher times.

I'm also extremely grateful to Camila Wohlmuth, who helped me out during this thesis and played such an important part in it.

Finally, I wish to thank Milton Raimundo not only for encouraging me, but also because my life would not have been the same had I not met him.

ABSTRACT

The technological advancements have been transforming the world and the way people interact with it. Technology is increasingly more present in the daily life of people, from mobile devices (e.g. smartphones) to ubiquitous computing (e.g. smart homes). These tools have had and continue to have a major impact in people's lives, giving them access to information and other services that did not exist before. This trend led to service innovation, with some examples based on the user's location, growing in popularity. Solutions with the goal of promoting tourism and the cultural heritage of a given location can easily benefit from this approach when aided by an interactive map. Furthermore, the spatiotemporal context can also benefit from sound and music, both part of the mentioned cultural heritage. It becomes possible to create an immersive experience in touristic environments.

PASEV is an interdisciplinary project with the goal of exploring the cultural manifestations of the city of Évora and patrimonialise its soundscape during the period between 1540 to 1910. The city's History has a strong musical component from which the soundscapes benefit. The project thus aims to promote cultural tourism in the city. One of the main steps to achieve these goals is the creation of a digital platform that gathers the information and details about certain locations and events and allow the creation of itineraries. As the result of a previous academic work, a prototype of this web platform already existed. The main goal was to expand and improve it, mostly regarding the multimedia content and design. The solution includes the caption and display of 360-degree images and videos and spatial audio, as well as crowdsourced material, new management functionalities and insight regarding storytelling and gamification.

Keywords: Soundscape, Musical Heritage, Mobile Tourism, Spatial Audio

RESUMO

O avanço tecnológico tem transformado o mundo e a maneira como as pessoas interagem com ele. A tecnologia está cada vez mais presente no quotidiano do cidadão comum, desde plataformas móveis (e.g. *smartphones*) a computação ubíqua (e.g. *smart homes*). Estas ferramentas tiveram e continuam a ter um grande impacto na vida das pessoas, facilitando o seu acesso a informação e outros serviços e experiências anteriormente indisponíveis. Esta tendência levou à inovação de serviços, com alguns exemplos baseados na localização do utilizador, a crescer em popularidade. Aplicações com o objetivo de promover o turismo e a herança cultural de uma localização específica podem facilmente usufruir desta abordagem com o auxílio de um mapa interativo. Para além disso, a contextualização espaciotemporal pode ainda beneficiar do som e da música, ambos conteúdo da herança cultural. Assim, torna-se possível criar uma experiência imersiva em ambientes turísticos.

O PASEV é um projeto interdisciplinar com o objetivo de explorar as manifestações culturais da cidade de Évora e patrimonializar a paisagem sonora da mesma no período de 1540 a 1910. A História da cidade tem uma forte vertente musical da qual as paisagens sonoras beneficiam. O projeto pretende assim promover o turismo cultural na cidade. Um dos principais passos para alcançar estes objetivos é a construção duma plataforma digital que reúna a informação e detalhes sobre localizações e eventos e a criação de roteiros. Já existia um protótipo desta plataforma web, resultado de uma tese anteriormente realizada, o qual se pretendia expandir e melhorar, maioritariamente, em termos de conteúdo multimédia. A solução visou a captação e implementação de imagens e vídeo 360° e som espacial, bem como material *crowdsourced*, novas funcionalidades de gestão da plataforma e a análise de implementações de *storytelling* e *gamification*.

Palavras-chave: Paisagem Sonora, Herança Musical, Turismo Móvel, Áudio Espacial

CONTENTS

List of Figures	xv
List of Tables	xvii
Acronyms	xix
1 Introduction	1
1.1 Motivation	1
1.2 Context	3
1.3 Objectives	4
1.4 Contributions	5
1.5 Document Structure	5
2 Background	7
2.1 Soundscape	7
2.2 Sound	8
2.2.1 Monaural	9
2.2.2 Stereophonic	9
2.2.3 Spatial Audio	10
2.3 Image	13
2.3.1 360-degree experience	13
2.3.2 Virtual Reality	14
2.4 Timeline	15
2.5 Gamification and Storytelling	15
2.6 Conclusions	18
3 Related Work	21
3.1 Soundscapes	21
3.1.1 PASEV's Platform	21
3.1.2 Historical Soundscapes	23
3.1.3 Radio Aporee	23
3.1.4 Sonic Babylon	25
3.1.5 MoSART	25

3.1.6	Hush City	26
3.2	WONDER 360	27
3.3	TravelPlot Porto	27
3.4	Conclusions	28
4	Solution Design	31
4.1	Prototype	31
4.2	Technology	37
4.3	Data Compilation	41
4.3.1	Sound capture hardware	41
4.3.2	360 cameras	42
4.3.3	Field Work	43
4.4	Requirements	45
4.4.1	Functional	45
4.4.2	Data	46
4.4.3	Design	46
4.5	Conclusions	47
5	Implementation	49
5.1	Interface Design	49
5.2	Database	51
5.3	Web platform	53
5.3.1	First time user screen	54
5.3.2	Overlay map	55
5.3.3	Footer	56
5.3.4	Navigation bar	58
5.3.5	Timeline	60
5.3.6	Back-office	62
5.3.7	QR code scanning	64
5.4	Conclusions	65
6	Evaluation and Redesign	67
6.1	Evaluation	67
6.1.1	Task time	69
6.1.2	Questionnaire data processing	70
6.1.3	Expert evaluation	83
6.2	Redesign	83
6.3	Conclusions	91
7	Conclusions and Future Work	93
7.1	Conclusion	93
7.2	Future Work	94

Bibliography	97
Appendices	103
A Usability Test Tasks - Users (Portuguese)	103
B Usability Test Tasks - Users (English)	107
C Questionnaire (Portuguese)	111
D Questionnaire (English)	127
E Questionnaire graphs - Users (Portuguese)	141
F Questionnaire graphs - Users (English)	157
G Expert Evaluation	177
H Usability Test Tasks - Administrators (Portuguese)	179
I Usability Test Tasks - Administrators (English)	183
J Questionnaire - Administrators (Portuguese)	187
K Questionnaire - Administrators (English)	205
L Questionnaire graphs - Administrators (Portuguese)	221
M Questionnaire graphs - Administrators (English)	239
N Expert Evaluation on Newest Version	261

LIST OF FIGURES

2.1	Mono and stereo sound as perceived by a listener.	9
2.2	The Neumann KU 100 binaural microphone.	11
2.3	Comparison between stereo and spatial audio.	12
2.4	Implementation phase of a gamification design guideline.	18
3.1	PASEV's platform centred in "Praça do Giraldo".	22
3.2	Granada's section in the Historical Soundscapes website.	23
3.3	Recording display in Radio Aporee's website.	24
3.4	Example question asked during the evaluation process.	26
4.1	Prototype's main page in desktops/laptops.	32
4.2	Prototype's main page in mobile devices.	32
4.3	Prototype's timeline with the 19th century filter on.	33
4.4	Giraldo Square location's content and its respective tabs.	34
4.5	Prototype's search tab.	35
4.6	Active itinerary in the prototype.	35
4.7	Prototype's back-office with its respective tabs.	36
4.8	The system's architecture.	36
4.9	Prototype's database schema.	38
4.10	Recording setup.	44
5.1	The platform's main colour palette.	49
5.2	Customised navigation bar.	50
5.3	Navigation bar on a smaller screen.	50
5.4	Latest version of the database's schema.	52
5.5	Évora's city plan.	56
5.6	Footer cards with featured content.	57
5.7	Expanded footer card with featured content.	57
5.8	Platform's initial state and after clicking the scroll button.	58
5.9	Display of a selected itinerary, in a mobile device.	60
5.10	Timeline's first sub-component.	61
5.11	Timeline component as displayed in a large screen.	62
5.12	Login page for administrators.	63

5.13	Back-office tab to handle submitted pending content.	64
5.14	QR code creation tab after successfully submitting new information.	65
6.1	Answers to 'Career Field'.	71
6.2	Answers to 'How would you rate your experience with computers?'.	71
6.3	Answers to 'How would you rate your experience with smartphones/tablets?'.	72
6.4	Answers to 'On which browser did the test take place?' from users in laptop/desktop devices.	72
6.5	Answers to 'On which browser did the test take place?' from users in mobile devices.	73
6.6	Answers to 'How would you rate your experience with computers?' from the administrators.	73
6.7	Answers to 'How would you rate your experience with smartphones/tablets?' from the administrators.	73
6.8	SUS scoring graph for 15 users in desktops/laptops.	76
6.9	SUS scoring graph for 15 users in mobile devices.	77
6.10	SUS scoring graph for the administrators in desktop/laptops.	78
6.11	Answers to 'I find the options for different base maps interesting'.	79
6.12	Answers to 'It is easy to submit audio'.	79
6.13	Answers to 'The timeline is helpful'.	80
6.14	Answers to 'The timeline is easy to use'.	81
6.15	Answers to 'I understood how the timeline works'.	81
6.16	Answers to '(...) What happens when the 19th and 20th centuries are being filtered?'.	81
6.17	Not recording and recording states before the usability test.	84
6.18	Recording state after the usability test.	84
6.19	Interaction menu with an itinerary, before the usability test.	85
6.20	Interaction menu with selected and activated itinerary, after the usability test.	85
6.21	Old and new icon presentation when an itinerary is active.	86
6.22	Different options for the map settings, before the usability test.	87
6.23	Different options for the map settings, after the usability test.	88
6.24	Locations with 4 different categories.	89
6.25	Timeline component, after the usability test.	89
6.26	New filter and timeline layout.	89
6.27	New filter and timeline layout in English.	90
6.28	New filter and timeline layout in English in smaller screens.	91

LIST OF TABLES

6.1	Average time and standard deviation per task in desktops/laptops.	69
6.2	Average time and standard deviation per task in mobile devices.	70
6.3	Age groups of all participants.	70
6.4	Grading scale according to SUS Score.	75
6.5	SUS scoring for users in desktops/laptops.	76
6.6	SUS scoring for users in mobile devices.	77
6.7	SUS scoring for administrators in desktops/laptops.	78
6.8	Key-value pair example used in the JSON files.	90

ACRONYMS

API	Application Programming Interface
AR	Augmented Reality
BaaS	Backend as a Service
BLOB	Binary Large Object
CSS	Cascading Style Sheet
DBMS	Database Management System
GIS	Geographic Information System
GPS	Global Positioning System
HRTF	Head-Related Transfer Function
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
JDBC	Java Database Connectivity
JSON	JavaScript Object Notation
JSX	JavaScript Extensible Markup Language
MVC	Model-View-Controller
PASEV	Patrimonialisation of Évora's Soundscape
POI	Point Of Interest
QR	Quick Response
RDBMS	Relational Database Management System

ACRONYMS

REST	Representational State Transfer
SPA	Single-Page Application
SQL	Structured Query Language
SUS	System Usability Scale
TIFF	Tagged Image File Format
UI	User Interface
UNESCO	United Nations Educational, Scientific and Cultural Organization
URL	Uniform Resource Locator
VR	Virtual Reality

INTRODUCTION

Sound, along a landscape's many other attributes, is a powerful resource that can be used to better map different points of interest (POI) or activities, while also providing a learning experience. To be more exact, the **auditory atlas** of a city can be used for documentation and other purposes, such as to promote tourism, preservation of cultural heritage or even to play a role in environment ecology [3]. Soundscapes, which can be defined as a collection of sounds that emanate from a particular landscape [43], enable people to connect with their surroundings, while walking through certain areas or interacting with certain scenes. Music can even be inserted in the soundscape of a location, enhancing the experience. This is something to take into account when sharing the musical heritage of a city. As the concept of soundscapes develop further and become an increasingly promising approach for tourism, it is important for platforms to keep up with its progress.

1.1 Motivation

Évora is a Portuguese city with a strong history and vast cultural heritage, which has been built over centuries, shaped by many different factors relevant to the different eras. In fact, the city is considered a World Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO) since 1986 [55]. This heritage can be seen as the legacy of historical and artistic values from past generations. It is not limited to physical instances, such as sites and monuments, since it also includes non-physical examples, such as music and language. That said, an important part of that cultural heritage for this dissertation is the musical heritage.

In order to preserve and promote said heritage, digital platforms and applications that make use of heritage related content to explore cities are increasingly becoming

a solution. Smartphones became a common and powerful tool that people use on a daily basis. They grant access to information on the go and communication with many different services, such as the Internet. Their computational and processing power have been increasing, and so have their functionalities. Mobile devices now support complex applications that allow better interactions with the user's environment, ranging from taking high definition photographs to Augmented Reality (AR). Besides mobile platforms, ubiquitous computing is also on the rise. Both work towards providing the user with relevant information based on, for example, his location. This way, the user enjoys a more knowledgeable and interesting experience.

As previously mentioned, soundscapes are a concept that is growing and being explored [3] in various forms. It is used in a way that allows city officials to give out correct, specific information instead of generic descriptions to visitors, and has shown positive results [1, 3] in both user engagement and learning. Thus, they have a cultural significance and huge impact that can not be ignored and should be conserved and managed properly [18].

Sound and music have been used for some time in similar contexts, such as audio-guides and other interfaces in museums. However, the idea of this project is to break free from schedules and availability of borrowed hardware, which is, for example, the common procedure for the mentioned audio-guides. Through smartphones, people gain access to an array of other tools that they also use regularly. One example is the Global Positioning System (GPS). This is a system that has the purpose of providing the user with its geolocation, which in turn can be used in services based on location. The camera and microphone are other tools that often go ignored. Both of them, although not always accurately, can save and share what the person is experiencing. Images and videos are usually limited by their quality and ability of capturing all the details at the same time, and the same could be said for sound. Nonetheless, they stimulate the senses and can be used to better explain the environment.

Many digital solutions already use some combination of the mentioned elements, for many different reasons, even tourism. The application of modern and digital technologies in a way that it enhances the tourist experience is what **digital tourism** is about. The mass production of smartphones and introduction of Virtual Reality (VR) and AR [5] is what is causing this to develop so much and so fast, with promising results. The use of this type of resources allows the user to find POI and participate directly in the experience that was created to improve the learning experience. Image and sound are not only attractive, but can complement a map in a way that displays the city's history. Ultimately, users can even interact with each other through uploading their own pictures or recordings.

1.2 Context

PASEV¹ is a project set to contribute to an effective patrimonialisation of Évora's soundscape in the chronological period between 1540 and 1910, while exploring new perspectives on the cultural manifestations of the city. The institutions involved in the development of this project are the following: University of Évora (UE), NOVA School of Science and Technology (FCT NOVA), NOVA School of Social Sciences and Humanities (FCSH NOVA) and NOVA.ID.FCT - *Associação para a Inovação e Desenvolvimento da FCT*. While the research units are: NOVA Laboratory for Computer Science and Informatics (NOVA LINCS), *Centro de História d'Aquém e d'Além-Mar* (CHAM) and *Centro de Estudos de Sociologia e Estética Musical* (CESEM). The starting year of the aforementioned period is when the Archdiocese of Évora was established and the ending year is when the current Portuguese Republic was established. In terms of soundscaping, this period of time is very rich, with high musical activity from events, churches and theatres, among others. Consequently, it becomes possible to map relevant itineraries based on the documentation available.

As mentioned previously, NOVA LINCS is part of this project and is responsible for two main tasks. One is the development of the interactive platform for the auditory atlas of the city of Évora and the other is the domain analysis and geographic context, which includes identifying and defining all the concepts and relevant information for the city's soundscape domain. It is important to note that this platform and the database it uses, both of which were worked on during this dissertation, are part of the PASEV architecture. This architecture also includes a mobile AR application and a game, which are being researched and developed in parallel.

Prior to this dissertation, an initial prototype of the digital platform had already been created [47]. The prototype enabled users to explore Évora's soundscape in several devices. More specifically, it allowed the user to explore multimedia resources that are connected to the city's rich soundscape, through space and time. It was possible to explore locations based on their musical and cultural relevance through different eras, by the displayed georeferenced data, which made for an easier interaction between the user and the system.

The prototype allowed soundscape specialists to add locations and events with their respective details to a database. The created map has relevant locations linked to visual and auditory representations (e.g photographs, videos, sounds, music, among others), focusing mostly on musical elements, which are presented as audio files or music sheets. These locations, stored in the database, are displayed as markers over a map, and their visibility can be filtered based on options from a timeline. These markers can be clicked on and reveal additional information about that location. A search feature is available to find a specific location or event, providing details if it is an event and centring the map on the result if it is a location. These are some of the features that were implemented in the prior thesis, along the proper research and concepts.

¹<https://pasev.hcommons.org/>

1.3 Objectives

The focus of this dissertation was on extending the digital platform with new functionalities, in order to improve its interactivity, as well as gather new resources. Although the functional prototype was publicly available², it was since updated.

One of the expected functionalities was to include 360-degree images and videos and spatial audio, in order to display them. This new type of content would be optional and separate from the already existing galleries. It was also part of this task to gather the spatial multimedia content, in the city of Évora, using proper techniques and hardware that provide results to be used successfully in immersive experiences. This feature should allow the user to interact with the images and videos in order to see different portions of the panorama, while having access to audio that is more realistic and, in this context, accurate than stereo sound.

It was also expected to investigate possible interactions with the itineraries, which are essentially paths between multiple locations in a specific order. One of the possibilities was to include some form of storytelling or gamification in the platform. In the prototype, itineraries do not provide special information nor accompany the user, but do feature the locations and can be created associated with an event. The user's geo-localisation was an important aspect to explore.

Another goal was to support crowdsourcing of multimedia resources. Although the initial prototype allowed non-administrator users to upload audio files, it was a simple and counter-intuitive feature that was not scalable. The expected result was to improve it and extend it by including images, videos and the previously mentioned additional resources. This is an important aspect that includes the user in the step of complementing locations with their own content and experiences, even without having to create accounts.

One final goal, besides evaluation and adjustments, was to overhaul the interface design. The prototype's design not only revealed issues [47], but it also did not fit the city's ambience. In combination with the implementation of new features, the interface was updated to be more intuitive and give the platform identity.

It is worth noting that *PASEV* has the goal of implementing gamification mechanisms. Gamification is a broad concept that requires much analysis and planning. Despite it not being an objective for this dissertation, Quick Response (QR) code scanning was partially implemented and left available only for the developers to use. This feature was suggested in the previous dissertation [47], which contributes to the overall gamification environment. The augmented-reality approach would have users visiting and learning about locations, but also explore them further in order to obtain some type of reward.

With that in mind, the aim was to explore the different ways of implementing these features, how they could be improved and what limitations existed, with special attention to detail in order to guarantee user engagement.

²<https://pasev.di.fct.unl.pt/>

1.4 Contributions

As a result of the work done in this thesis, the contributions were the following:

- **Database restructure** - The database was restructured in order to reflect the new features and requirements;
- **New design** - Implementation of a new design, supported by a designer involved with the project, regarding previous usability tests and new content;
- **Crowdsourcing** - Support for users to submit images, videos or audios and for the gallery to display approved content;
- **Library of spatial multimedia content** - Small repository of new interactive content, recorded in the city;
- **System evaluation** - Usability evaluation of the platform by average users, usability experts and PASEV's soundscape specialists;
- **Sustainable platform management** - Back-office features new methods for adding, editing and deleting content and resources from the database;
- **"Sonoridades Eborenses" Colloquium presentation** - A presentation and discussion regarding the platform, with plans for an article to be included in the colloquium's journal.

1.5 Document Structure

This document is divided into the 6 following chapters:

- **Chapter 1** - This chapter is the introduction to the dissertation, composed by its motivation, context, problem to solve, contributions and the document structure itself.
- **Chapter 2** - In this chapter a background of relevant topics is presented, in order to provide a better understanding to aid the development of the dissertation. Useful concepts regarding image, sound and gamification are introduced, related to how they can be used with a soundscaping platform.
- **Chapter 3** - In this chapter there are some categorised examples that use one or more of the elements to add or improve in the project, along a brief analysis of the similar features.
- **Chapter 4** - This chapter describes the initial prototype and its architecture, the various requirements for the solution and the technology used to achieve those requirements.

- **Chapter 5** - This chapter describes the implementation process, including how the compilation of the spatial multimedia content was done and the new different features and design.
- **Chapter 6** - This chapter describes the evaluation process to evaluate the platform's new interface and its importance, as well as what modifications were done after the usability test and why they were necessary.
- **Chapter 7** - The final chapter presents all conclusions drawn from the work done throughout this thesis as well as what further work should be done in the future iterations.

BACKGROUND

The preservation of cultural heritage and soundscapes is important, as these two concepts are directly related to a place's identity. Regarding European cultural heritage, the historic city centres are one of the most relevant elements [22]. As such, the cities attract a considerable amount of visitors that can affect said heritage. Thus, conservation is key in order to ensure cultural heritage is unharmed but still accessible.

Évora, a Portuguese city, has a rich history, making it a relevant case study for exploring cultural heritage, with a focus on its extensive musical record. In this particular case, the musical activities contribute to the city's soundscape, which is considered very rich. As a consequence of its relevance, the city aims to promote and share the mentioned soundscape through a digital platform developed previously.

However, the platform can benefit from more immersive and interactable content and features. In order to extend the platform, it is important to understand some concepts and definitions and how they relate to soundscaping and geographic information systems (GIS). In section 2.1, the concept of soundscape is discussed and how it relates to cultural heritage, more specifically musical heritage. In the following section 2.2, sound and some audio formats are analysed. Similarly, in section 2.3, a brief analysis of image and video display is presented. Afterwards, in section 2.4, timelines are discussed, particularly the existing one in the prototype. Finally, in section 2.5, the concepts of gamification and storytelling and their impact are analysed.

2.1 Soundscape

A soundscape is the collection of sounds that emanate from landscapes [43] and other physical areas. This is a consequence of the landscape itself being composed of various different sounds [11], such as people's footsteps, rushing water, machinery, the wind

blowing and dogs barking. These examples come from different sound sources, because they come from elements that coexist.

Although there are many ways to distinguish them from one another, sounds are constant and always present, they are a dynamic property of any landscape and are not always the same. Even a very specific geographical landscape will most likely have different sounds in different stages of the day, and even more so when the timeline is expanded to decades, for example.

For those reasons, it is possible to conclude that the soundscapes give an important insight on the surrounding context. It becomes possible to reconstruct certain scenarios and events, because sounds are recorded and measured with accuracy in mind [43]. But this goes both ways, since you can also recreate the soundscape of an older era. Paintings, books, old city plans and many other documents hold considerable information about these eras, and recreating their soundscape is only a matter of precision [58].

As previously mentioned, cultural heritage is not limited to physical instances. It can be either tangible or intangible [57]. One particular immaterial instance of interest is sound, which plays a major role in soundscapes. Heritage in general is a source of identity of past communities, with attributed value by its people [10] and society.

Music is an art form that combines many different sounds. It is a powerful means of expression that transcends language, present in many different cultures. This includes not only the present, but the past as well, dating back as far as prehistory. As it becomes part of the identity of a community, the concept of musical heritage becomes equally important when researching a city's soundscape.

2.2 Sound

As mentioned before, sound is one of the elements that the user will directly interact with the most. It has a way of making people feel connected to their surrounding environment. For example, in tourism, people's interactions do not depend solely on visual stimuli but on combinations of the other senses, particularly hearing [6]. In fact, listening and walking involve the same capacity of connection [3] which, when considering the auditory atlas, is easy to take advantage of.

There are many studies in this particular field, that are set to explore different sounds and what effects they have on the human body, for example. Music, for instance, is very open to subjective observations, as the boundary that separates music from noise is very thin and fuzzy. Even though there are certain examples that can be easily separated, music itself can be perceived as pleasant or unpleasant [27], based on the person's preferences.

Besides the soundscapes that can be experienced on the streets of the historic city, Évora has a very vibrant musical heritage, which also comes into play with this subject. The recreation, capture and reproduction of sounds is crucial for a better representation and more enjoyable interaction. For that reason, knowing that sound can be categorised in different ways, depending on how they are created and consumed, there are a few

topics to be studied. Focusing in the audio formats is key, as well as how to obtain them. There are two formats that are considered the most basic and common forms of sound: monaural and stereophonic.

2.2.1 Monaural

Monaural sound, commonly referred to as mono, sound is the most basic method of recording and reproducing sound, which paved the way to large improvements that had to be made. In fact, many devices still use this technology, such as smartphones, especially for sound capture.

Since this method only uses one channel, the headphones will transmit the same exact sound to both of the user's ears, as if the source was directly in front of them and producing sound evenly [50]. In most cases, this is not an accurate representation of reality and even less so in outer areas.

Although it could still be used and get the message across, much information would be lost and the experiences would suffer.

2.2.2 Stereophonic

Stereophonic sound, also known as stereo sound, is an upgrade of mono sound. It is present in most devices of the modern age, because most consumed auditory media uses this technology primarily, such as movies, music and video games. Instead of just one channel, this method uses two - both to record and to reproduce sound. But the audio format is not everything, because it is also dependent on the setup that is used.

Speakers, which transform electrical signals into audible sounds, come in various different forms. For example, a mono speaker would never be able to reproduce a stereo sound as it was meant to be played, because there is only one speaker. Auxiliary software and hardware can be used to convert a stereo sound into a mono sound, but it would lose the properties that set it apart in the first place.

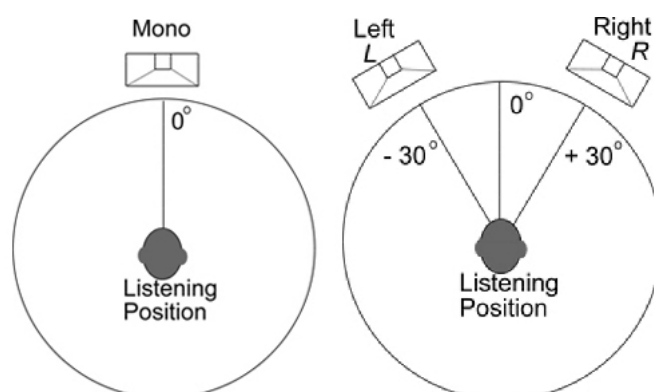


Figure 2.1: Mono sound (left) and stereo sound (right) as perceived by a listener¹.

¹<https://difference.guru/difference-between-mono-and-stereo/> (Accessed on 12/12/2019)

However, sounds can be played in more than two channels. One case is **surround sound**, which is fairly common in movie theatres and similar contexts. They do not usually require the same amount of microphones as output channels to record, because it is a technique that is heavily based on post recording editing. This means the editor will manually set different content for the different channels with specific intensities. A more complex setup than the one depicted in figure 2.1 is used around the listener. This technique uses sound localisation in order to achieve sound spatialisation, something that will be discussed in the next subsection. However, surround sound is beyond the scope of this project, because earbuds and headphones, which are what the user will most likely use when interacting with the platform, have only two channels: left and right.

Using two channels is a much better option for many reasons. Considering recording alone, the same sound will have different time-of-arrivals and intensity in different channels, because of the way sound propagates through air. Afterwards, when that sound is played through two channels as well, the result is much different. Unlike with mono, it no longer seems that the source of the sound is in front of the listener, but positioned somewhere else, or even in motion.

This makes it a stronger technique when compared to mono, because it can represent the soundscape in a more accurate and powerful way. However, there are still some evident issues, such as how well can it replicate what the listener should be hearing or how can the listener locate sounds.

2.2.3 Spatial Audio

Abbey Road Studios², the birthplace of stereo, defines spatial audio as “any audio which gives you a sense of space beyond conventional stereo, allowing the user to pinpoint where sound is coming from, whether this is above, below, or a full 360 degrees around you.”.

Sound environments do not usually have just one source. They are composed of multiple sources, spread around different areas. In the real world people can be easily directed with audio cues, since they can locate them. Spatial audio has that same goal and as a consequence, more and more applications are adhering to this technology in an effort to create better and more immersive experiences.

It is also been increasingly used in order to evaluate the acoustic environment in soundscape research [26]. However, spatial audio is not the specific technique itself, but has some different reproduction methods. Two of them, which are common regarding soundscape studies, are binaural and ambisonics.

It is worth mentioning that spatial audio and these two techniques are often referred to as 3D sound or 360 audio, with no clear distinction. Although all of these terms seem to be loosely used with the same meaning, 3D sound and 360 audio are usually associated

²<https://www.abbeyroad.com/> (Accessed on 02/01/2020)

with VR experiences³. An example would be a VR environment where artificially placed sound sources produce sound as the user interacts and walks through it.

2.2.3.1 Binaural

Binaural audio is very similar to stereo audio, in the sense that it also uses two channels to record and to play sound. The main difference resides in how the sound is recorded. In this case, it captures the sound in a complex way that can be considered more realistic. This method commonly uses a, sometimes partial, dummy human head, with microphones instead of eardrums and replicas of human ear canals and exterior [15] as depicted in figure 2.2.



Figure 2.2: The *Neumann KU 100* binaural microphone [38].

Although there are binaural recording devices that do not follow this anatomy, the general idea is that the two microphones are always at the same distance of each other, as are our ears, and that they are positioned where the listener's head would be. Therefore, the perception of binaural sounds is related to the geometry of the individual listener's ears, head and shoulders, which in this field is often referred to as Head-Related Transfer Function (HRTF) [46].

When listening to binaural sound, headphones and other earpieces are preferred over speakers. This is because they are capable of delivering separate recordings to each ear, and better reproduce the environment where the audio was recorded. The user will be listening to everything as intended, without any ambient noise or spatial inaccuracy (for example if the left speaker was further than the right speaker, but when it was recorded the left microphone was closer than the right microphone). In a larger scale, it also makes more sense to depend on what is common user hardware, as opposed to two channel playback devices or scattered speakers.

Binaural audio, however, shares one of the downsides of the other formats mentioned so far. The recorded audio is rendered in a head-locked position, meaning that it does not track the listener's head movement. If the user was hearing a sound on his left and turned his head as if to face it, the sound would still be on his left and not in front of him.

³A clearer distinction of what is a VR experience is presented in section 2.3.2

Disregarding head orientation, the sound environment is fixed in respect of the user's head, and not the external world. This is where head trackers come in. As the name implies, they track head movement and use that information to determine changes in the relative positioning of the audio [54]. Some common head trackers are gyroscopes and optical cameras. Head trackers can, however, introduce latency in the experience, as calculations are being computed and are not trivial to implement. This will be addressed further on.

Still, binaural sound is used in many different immersive experiences. It can be seen as an improvement of regular stereo sound that can better mimic what the listener would be actually hearing.

2.2.3.2 Ambisonics

Ambisonics is a method that captures and recreates a sound field in full-sphere surround [26] around a particular point in space. Once again, audio is extended to be more realistically perceived by the user by what is the leading recording technique for interactive spatial audio reproduction [25]. It is another multichannel approach, usually recording with 4 microphones arranged in a tetrahedral array.

However, its recording method is not the only reason that sets it apart. Instead of having one channel being mapped to a specific speaker, as is done in binaural and even surround audio, ambisonics contains the representation of a sound field. In fact, ambisonic microphones are also known as sound field microphones. This way, the sound field can change, based on the listener's head orientation instead of remaining in a static position, a problem that was mentioned in the previous section. This is why it is said that it creates a sphere around the microphone, as depicted in figure 2.3.

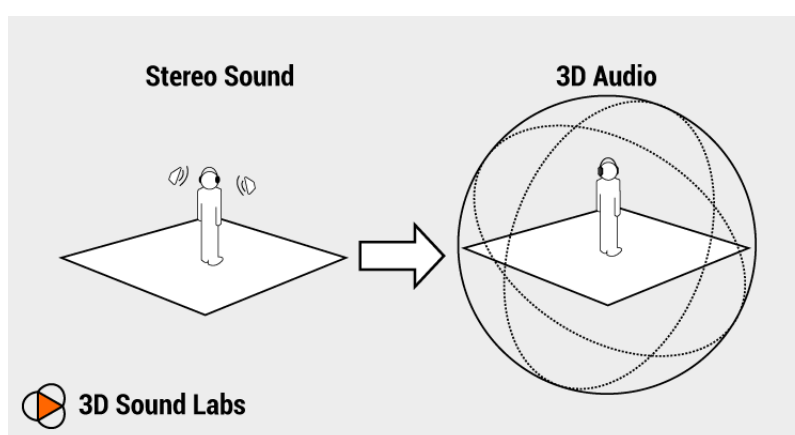


Figure 2.3: Comparison between stereo and 3D (spatial) audio [20].

Not only that, the audio can be decoded into a format that matches the speaker setup. In the very common case when users use headphones, they only have access to 2 output channels. But with ambisonics, the user will still be able to perceive the spatial audio

effect because it can be decoded to a binaural output [53], which the headphones will have no trouble recognising.

2.3 Image

Similarly to sound, image has different ways of being displayed and interacted with, impacting the way the user himself sees the system. In the context of real life objects and landscapes, the choice to use high quality photographs and videos to depict the environment is definitely a simple, common but effective approach. This does not mean that it is the best or only way.

2.3.1 360-degree experience

Another possible approach, that can be seen as an upgrade on photography and videography, is the 360-degree experience. This term is one of the many used to describe the same thing, such as spherical photo and interactive panorama. All these names can be easily extracted from its description, which will follow.

This technology, which can be applied to both image and video, is an interactive take on the more common panorama photography, with the particularity of encompassing a full 360-degree around a set point in space. This creates a spherical image that contains the surroundings of said point. Users can then interact with the image to see any portion of the panorama, as if they were looking around by moving their heads.

These images can be captured in different ways but still produce a similar outcome. Such is possible thanks to image stitching⁴ software and techniques. The two main formats used are the **equiangular** and **cubic** formats. The former is a single image where the width has to be twice the height, meaning a 2:1 aspect ratio. The latter uses 6 images, arranged like the faces of a cube in a horizontal cross. Each face has a 90 by 90 degree field of view, showing the left, front, right, back, zenith and nadir⁵.

Although in the late 19th century cameras capable of producing panoramas, including 360-degree photograph, were already being manufactured [19, 33], the advance of technology in the 21st century and the exploration of virtual reality and interaction with this type of visual elements caused the creation of better tools to capture this experience.

This strategy quickly gained traction due to the fact that 360-degree photos enable users to better understand what they are looking at, with the option to move and pay attention to different details at a time. A couple of examples where this interaction can be easily seen working well is the portraying of properties in the context of real-state [19] or even virtual tours of museums and other historical places, such as *Palácio da Pena* in Sintra, Lisbon (Portugal).

⁴Image stitching handles the combination of multiple photographs with overlapping sections in order to create a single panorama or high-resolution image.

⁵Zenith is the point directly above the camera or person, while nadir is the point directly below the camera or person. In the equiangular format, they are both stretched to a line, making it harder to edit.

Virtual tours, mentioned in the last paragraph, are made of sets of 360-degree images and/or videos, that can have added information about certain elements of the tour, usually accessible via web or mobile. This type of tours is used to promote tourism through different interactions that spark the user's interest. Previous tests and examples [40] have gathered good feedback, which is usually related to the quality of the scenes and clarity, specially in comparison to still images.

2.3.2 Virtual Reality

First, it is important to grasp the concept of virtual reality. It is a computer-generated simulation of an environment that can be interacted with in a physically and seemingly real way⁶, possible with certain devices. Although it is increasingly talked about in the present, this notion is not recent. Decades ago, in 1968, Ivan Sutherland built what is considered to be the first-ever head-mounted display system, the culmination of his work with a student over 3 years, after publishing an article where he explained that a computer could be used to create an entire virtual world [24]. Another similar technology mentioned regularly would be augmented reality. As the name differences imply, AR does not intend to immerse the user in a completely synthetic world, as does VR, but enhance the real-world environment by superimposing virtual objects in real time [12]. AR particularly is not an option for this project, but it does come with its advantages when compared to VR, such as requiring less power which means it is more accessible through modern smartphones and technology. It is also important to understand that VR and 360-degree video experiences are not the same. Despite media and general marketing using the terms interchangeably, they have key differences in their main features, from development to consumption. To summarise, VR uses a digital environment with many possibilities of interaction, creating a new experience, while 360-degree videos consist of real world filmed footage with limited interactions.

The recreation of soundscapes themselves can also be used in virtual reality. This technique works very well in museums and exhibitions for educational purposes, because VR device(s) can be used by everyone without having to own one, and the users can visit, for example, heritage sites [29] that were otherwise inaccessible. In many cases, the soundscapes have to be rebuilt based on what information there is because the spaces, or part of them, have been actually lost [58].

However, it is understandable that the application of VR to soundscapes that are current is also just as possible. But VR devices are not as accessible and portable as smartphones. Even when phone-based VR is an option, many of features are missing and the quality is lesser, not to mention the processing power.

⁶https://www.lexico.com/definition/virtual_reality (Accessed on 10/07/2020)

2.4 Timeline

Timelines are an effective way of displaying important events and information in a specific period of time, ordered chronologically. They can be used to indicate milestones or other major points in a simple, but understandable way. However, timelines do not have to necessarily exist on their own. They can be used in combination with other elements, such as maps. This way, the spatiotemporal aspect of the information becomes clearer. The World War Two Timeline Project⁷ is a basic example that portrays this very well. Even more focused on the map component is the Google Maps Timeline⁸, which shows a personal timeline of the user's location.

In both cases, the timeline does not only show information regarding events or locations, but also acts as a filter. This means that the user can interact with the timeline and, when a new date is selected, new data will be displayed. This is a typical behaviour in apps that use this combination of tools and is, in fact, already implemented in the existing platform.

However, the existing timeline usability needs to be improved. Users mostly mentioned that it was hard to understand how it worked and that the visual changes were not clear, meaning that "(...) it is necessary to rethink the [timeline's] presentation and promote a more detailed temporal search." [47].

2.5 Gamification and Storytelling

In 2002, British game designer Nick Pelling coined the term "gamification" for the first time, as a way of describing "game-like accelerated user interface design to make electronic transactions both enjoyable and fast" [30]. Only over a decade later would it see widespread adoption [16].

Although this concept has since evolved and been worked on by many other authors over the years, the general idea is that game-design elements are introduced in non-gaming environments in a way that boosts quality and productivity of actions, user activity and other attributes [23]. This produces a more enjoyable experience for the user, which usually means more interaction with the application.

Some obvious examples are the addition of point systems, badges and levels which can be obtained with common interactions and later be explored in a leaderboard. This mechanic can be applied in many ways to many different contexts, such as finance, health and sustainability [17].

Gamification is used regularly in learning environments, as to boost the learner's motivation, engagement and enjoyment [28]. Cultural tourism, although not directly, has a component of learning. The visitor learns about the city's story, heritage, people and culture in general. The benefit from gamification is clear in this environment, as the

⁷<http://www.cannonade.net/timemap.php> (Accessed on 29/01/2020)

⁸<https://www.google.com/maps/timeline> (Accessed on 29/01/2020)

user will have a tool that encourages them to keep going, while also guiding them. The implementation in this project is definitely one extension to be considered, based on its possible application in tourism in the city of Évora. This mechanic has already been used, and still is, in tourism-related contexts [59] and has proven to drive up engagement.

However, gamification is hard to design, since most gaming elements are too complex to be directly transferred over and must adapt to the environment and specific context. The end product should benefit the user in a way that makes sense. In [36], it is mentioned that the elements must be submitted to a certain transformation that requires a specific psychological and motivational understanding.

Storytelling is another technique that improves the user's experience, not by directly referenced gaming elements, but by narratives. Stories are everywhere, specially in the modern world, ready to be consumed. They are available in various forms with different goals. For example, a story is a common and important part of successful videogames, more specifically its content and how it is told. In this case, the objective is usually to be entertaining, but can also be educational or have moral implications. The lack of captivating content leads the player to not enjoy himself as much and even getting distracted with their surroundings. Subsequently, the player has a subpar experience that, in some cases, they end up abandoning. In the context of tourism, this would mean that information would go unread and interactions ignored to some extent. All of this is due to the fact that people detect patterns in information [48], making stories a powerful tool to convey information and emotion.

Usually, storytelling is a term for sharing or creating a story. It is an important element that, when well done, can have a positive impact in how effectively the information is passed on. Not only that, good storytelling experiences reinforce the users' engagement and interest [42]. It is understandable why in some contexts, people pay more attention and learn more when the facts are embedded in a story, rather than when they are just bullet points to read out loud.

The desire for cultural knowledge is crucial for tourists that want to understand what is around them. An important asset to consider here is the geo-localisation of the user and their surroundings. Since it is possible to tell where the user is, has been, and how close he is, and was, to points of interest, the storytelling can easily benefit from this information and opens up an array of possibilities. But storytelling should also include the case when visiting the website at a fixed location (e.g. at home). In this context, the geo-localisation is of no use, but with minor adjustments, no user is set aside. This way, everyone can learn and enjoy the platform through storytelling.

However, this is not the only reason to consider such feature. Although it is often used in museums and tours to create virtual guides [34] that accompany and interact with the user, it can directly take advantage of the cultural history and heritage to create something even greater. Rather than just creating a completely artificial mission that contains some factual information, history itself can be relived, specially when combined with some of the other elements mentioned so far. In particular, applications like this

can improve the communication strategy of a cultural heritage site “by conveying more information to the visitors, and, thanks to the possibility of delivering the application on the web, by continuing to support the knowledge of the historical site also after the physical visit; by emotionally engaging the audience, leaving a persistent memory of the site through the character’s personality, who acts as a representative of the site identity.” [34].

As useful as it is, it is a powerful tool that needs to be used strategically. Much like gamification in general, it should not be implemented if there is no tangible benefit. This means that first, it is important to know that it is possible to generate at least one good story and that it will help the people that interact with it. With that in mind, its high versatility and potential make it a feature to explore in the scope of this project.

The implementation of such feature is usually not dependent on programming language or environment. But, as mentioned, it should not be taken lightly, and the elements should be studied carefully. Poor understanding of this concept has lead, and will continue to lead, to failure [36].

For that reason, a simple yet effective procedure is suggested. The steps loosely mentioned are short descriptions of what is a recommended guideline in [36], which has very detailed and crucial steps and observations, gathered from interviewing and studying the market.

In a series of steps, the first one is to identify what are the problems that require or could benefit from gamification. Clear objectives are key for guiding the user. Secondly, a deep analysis of both application context and users is required because, as mentioned, the technology must be appropriate for the type of users that are being targeted and for the general aims of the platform. In this step, balance is very important. After that comes the ideation of the design itself. How the gaming patterns and elements are used together and to motivate certain behaviours (for example, do task X to unlock badge Y). Then, iterative prototypes are suggested. In order to test, rethink and remake any of the content that is being experimented with. Afterwards, is the implementation step, where the chosen gamification design is decided, prepared and implemented. This is a complex phase and is presented in the activity diagram depicted in figure 2.4. Following that is the step of evaluation, where the approach implemented is tested and evaluated. There are many different ways of doing so, such as choosing a specific group to test on, or even observing directly what and how the entire user base is doing. Lastly is the step of monitoring. Everything should be up and running, but some see gamification as a never ending process, because as the application grows, so can the challenges, rewards and such. Monitoring is essential to manage, because gamification is now a part of the project and as such, has an important impact in its overall performance and user interaction.

It is important to mention that although no model of implementation or guideline is presented for storytelling, it is a similar and sensitive process, in which the focus are not gaming elements, but an immersive story.

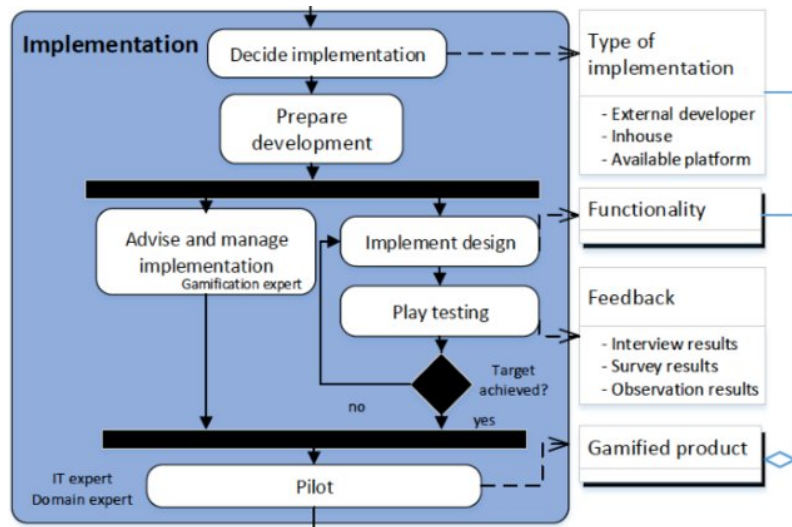


Figure 2.4: The implementation phase of the proposed gamification design guideline [36].

2.6 Conclusions

Soundscapes are the main aspect of this project. As such, their accurate representation is in the project's best interest, and that includes a careful study and analysis of its elements and how the users will interact with them. As mentioned before, although there is a base project that already displays information to some degree, there is always room to grow and be ambitious.

That said, in terms of recording and playing audio, it is clear that ambisonics is the ideal option for the project. As previously mentioned in subsection 2.2.3.2, it is designed to be interacted with, not just listened to, which is fundamental in this context for the user experience. The main challenge is working with the recording hardware in a way that the setup maximises the quality of the content. As for the actual recording quality, which also affects the playback, it depends on what hardware is used and how.

As for images, the choice of taking an approach that uses 360-degree images is not just by default, but because it is also very informative and because it allows an immersive context even without certain equipment. In the current state of the project, they can replace regular pictures in order to give a better view of certain areas. An approach based on 3D modelling without VR devices is also possible. Instead of demanding that the user enters a virtual world, 360-degree panoramas of a 3D modelled environment would be created. This allows a VR interaction, for example visiting a past location, without having the user resort to VR devices.

In section 2.4, timelines are briefly discussed, as well as the current implementation. The poor engagement of the feature could be a consequence of the timeline being constantly displayed on top of the page. It could be mistakenly blending in as a header, instead of what it actually is - a filter. If the visual timeline is not a requirement, it could

be moved to somewhere else, such as filter tab or even embedded in the already existing search feature. However, there are some suggestions that were made that could be experimented with first, such as subtitling the timeline or changing the marker's colours based on the selected period.

As for storytelling and gamification in general, the benefits are obvious in the sense that they would improve user engagement. This could sway the user to add more sounds to the platform, actively participating in its growth, and even revisiting locations in order to improve exploration. Most common gamification approaches, which consist of achievements, points and leaderboards, require some way of identifying the user. Since user accounts are not in the project's interest currently, those can not be implemented here. However, one idea to be considered is the use of QR Codes, spread around several points of interest in the city that, once scanned, would provide information immediately. This AR experience could also be used along the previously mentioned achievements, in which a certain amount of codes would give one or more rewards. Regarding storytelling, one proposition is to expand the existing itineraries with audio. While following a certain itinerary, different sounds would be played, relevant to the current location of the user.

More in-depth analysis of examples regarding the discussed points in this conclusion will follow in the next chapter.

RELATED WORK

In this chapter some platforms that have similar or relevant functionalities to this dissertation's project, from web to mobile apps, are presented. It is worth mentioning that although some examples appear categorised in this section, they are not exclusive to that subsection. This means that all the examples share some common approaches and components, but they are divided for convenience regarding their main relevant aspect.

3.1 Soundscapes

As mentioned several times before, there are examples that already use some sort of combination of the elements mentioned above in the context of tourism, exploring the cultural heritage and expanding on the audiovisual experience. These are described in the following subsections.

3.1.1 PASEV's Platform

The most relevant reference of this dissertation is the prototype of the platform itself¹ and the dissertation in which its development took place [47].

The platform displays a map centred in the city of Évora, with various markers on it, each representing a location. These locations have details and information that are shown when the user interacts with the marker. At the first click, a name, picture, its source and address are shown to the user, as depicted in figure 3.1. They can then click on a button to see more content. This reveals various tabs that contain information, sound, images, videos and a bibliography. The default selection is the information tab which, besides the previously mentioned information, has a description. Bibliography shows a list of references and the other tabs grant access to the different types of multimedia content.

¹<https://pasev.di.fct.unl.pt/> (Accessed on 02/17/2020)

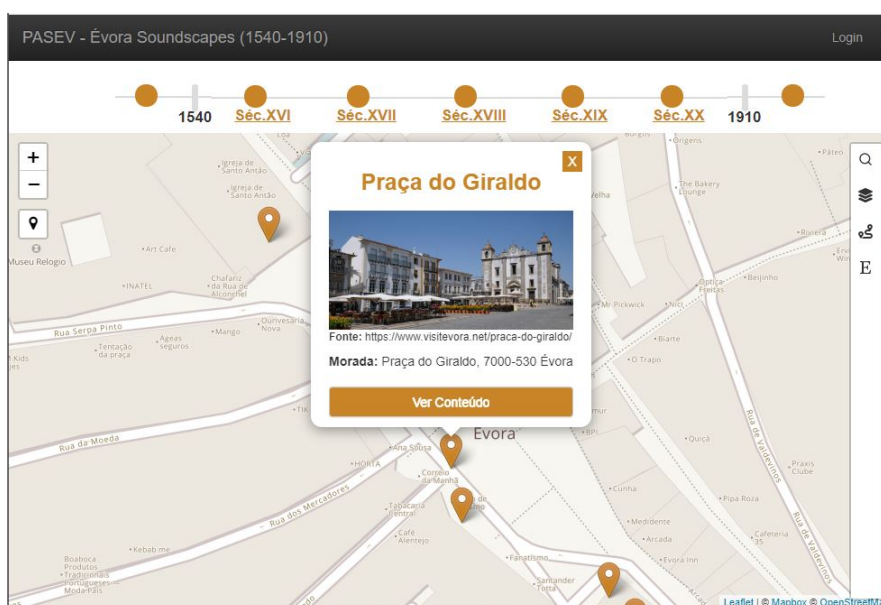


Figure 3.1: PASEV’s platform centred in the selected location of “Praça do Giraldo”.

The markers appear on the map according to the filters that are activated, displayed in the form of a timeline on top of the map. Each filter is identified by a period of time that is relevant to the location. Although this can be used to find specific locations, a search functionality is available. This feature allows the user to find locations by name and events by type, location or sound category. After selecting an element from the list of results, the map is centred on that location. If it is an event, its information will be displayed in the event tab, which closes the search environment. Events have many attributes: a name, type, date, location, duration, sound categories, sound description among others.

In the same sidebar that contains the event and search tab, there are two more tabs. The first one gives the user the option of changing between different base maps, include Évora’s city plan and show either old buildings or reference sites’ bounds. The second one shows the available itineraries. Upon selecting one, the other markers disappear from the map and only the relevant locations stay, with numbers according to the itinerary order. The markers that stay have the same behaviour as before, but now a line can be seen connecting the locations, as a suggestion of the path to follow.

Users can zoom in and out of the map, as well as show their location, if they grant access to that information. Furthermore, there is a log in option where the logged in administrator can manage the platform, adding locations and their details, as well as more events and itineraries.

It was created with a mobile first approach, which means that it was built and designed based on how it would appear and work in a mobile browser first. This gives the user access to all functions everywhere, at any time. This is not only a common approach in mobile tourism, but in general as well.

3.1.2 Historical Soundscapes

Historical Soundscapes is a website designed to explore the historical urban soundscapes in Andalusian cities, such as Seville and Granada, Spain² as can be seen in fig. 3.2. Their main goal is to map the biggest number of historic sonic events in these cities, thus creating an interactive database. Much like PASEV's prototype, this platform presents a map with different points of interest the user can interact with, revealing more information about the selected location. This information includes details about historical events and itineraries, which include relevant images, videos and audio in order to explore the specific soundscape.

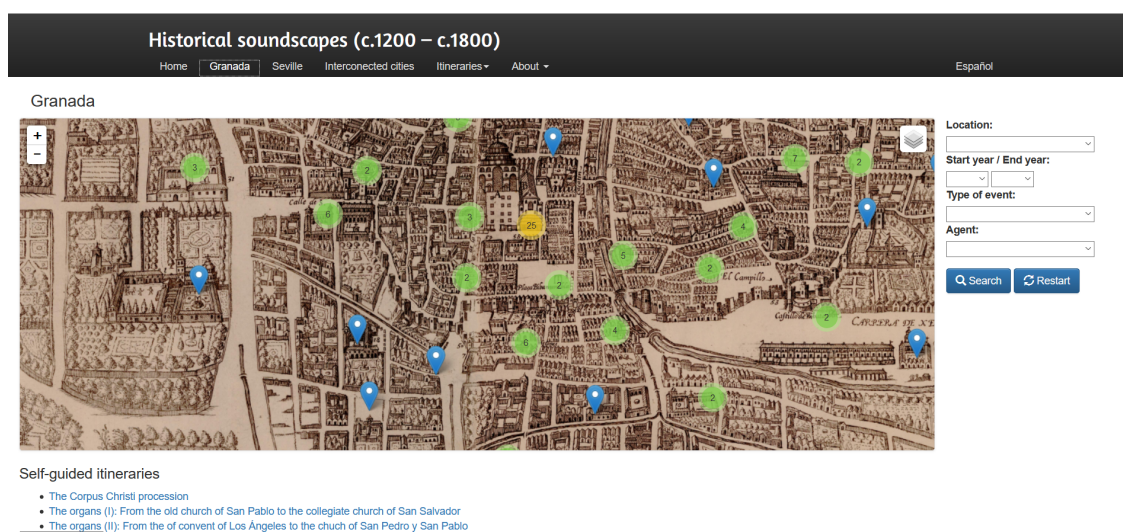


Figure 3.2: Screenshot of Granada's section in the Historical Soundscapes website.

Users can also choose between Spanish and English languages, explore other cities around the world and search for specific information through a list of filters. There are similarities between the Historical Soundscapes project and PASEV's platform regarding content handling and how to share it, making it a promising case study.

3.1.3 Radio Aporee

Radio Aporee is a global soundmap³, a project that started in 2006 and which combines sound recordings and cartography. Available in both web and app versions, it has collected many different sounds, from all around the world, from various users. However, this collection keeps on growing, as it still has an active community that keeps contributing to a successful crowdsourced database. For example, 600 recordings were captured in Portugal by people from around the globe.

It is integrated with both Google Maps and Open Street Map, meaning that although it does not use images to identify recording locations, they are still easy to pinpoint. In

²<http://www.historicalsoundscapes.com> (Accessed on 20/08/2020)

³<https://aporee.org/maps/info> (Accessed on 28/01/2020)

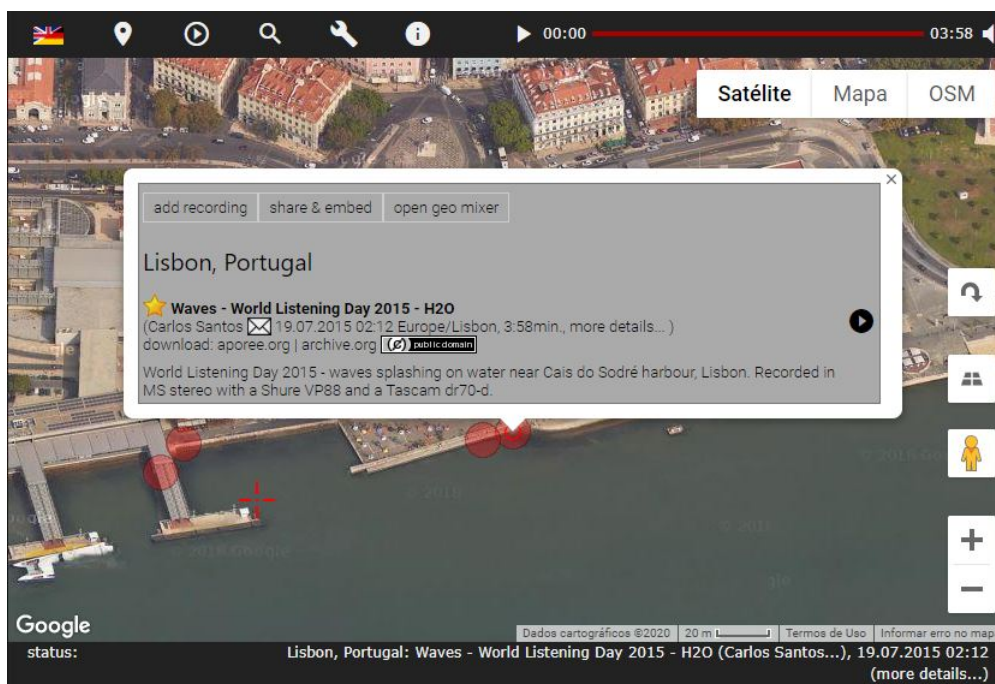


Figure 3.3: A recording selected and its basic information in Radio Aporee’s website.

the main page, there are two possible interactions, besides navigation, when clicking anywhere in the map. If the click is in a tagged recording (identified by a small red circle), basic information about the recording will be displayed and the sound will automatically start playing, with options to pause, play or mute. This interaction is depicted in figure 3.3, with the map centred in Portugal’s capital, Lisbon. If the click is anywhere else, such as an empty area, the user can choose to add a new location. Then, a form will be displayed, asking for the submission of the audio file and some information about it. Note that by clicking on a tagged recording, the user can also add a new recording, but it will not generate a new tag. The recording will instead join the existing one.

When looking at a recording in the map, the user can choose to see more details about it or about the author. Both will direct the user to a new page. In the recording case, the user will be able to see all of the basic information along a list of metadata features, such as frequency, latitude and longitude. As for the author page, the user gains access to a list of all of the recordings made by that user. Although there is no notion of social networking in the platform, users can send a private “comment” to another user based on a recording. The platform is continuously checked, with the goal of keeping the collection clean and with the highest quality content possible.

It has some other important features and tools for those interested in phonography and the art of listening. Not only does it have a search function to find recordings, either by sound or by location, it has an interesting tool called “geomixer”. This allows the user to add as many channels as he wants and add a different recording (from the collection) to each one. The recordings added can be chosen randomly, by the user or even by location,

in which the user creates a “journey” by ordering different locations and the recordings will adapt. In the end, the channels will play and the user can interact with the experience via some basic settings.

3.1.4 Sonic Babylon

This project consisted of an interactive sound garden [3], where the users could not only hear the soundscape as they moved through, they could also plant or prune sounds. The visitor’s position was being tracked and the engine would play the sounds accordingly.

In 2009, the first installation of this project took place at the Noosa Regional Gallery, Australia. However, the project could easily be used in other areas, regional or urban environments, and in different contexts, usually depending on the sounds used. It definitely was an application ahead of its time, as it created interactive and creative spatial sound experiences.

Sonic Babylon, due to its high versatility, was able to grow and be used in other similar projects, by one of its creators, Dr. Leah Barclay [3]. One, of particular interest, is the Cypress Trilogy. Explained briefly, it is an interactive performance installation⁴ that combines different soundscape elements from the Noosa Biosphere Reserve, with live performances. It ends with the sounds from the Sonic Babylon installation, projections and lighting set amongst the trees and the Noosa River.

3.1.5 MoSART

MoSART (which comes from *Mobile Soundscape Appraisal and Recording Technology*) is a free mobile application that allows users to record and evaluate their surrounding soundscapes. It saves a 30 to 120 second audio clip along with the geographical location and user evaluation, which is obtained through a series of questions during the recording.

These questions, which are based on the Swedish Soundscape-Quality Protocol, may vary depending on previous answers and rely on the understanding of what the soundscape is and how the user feels towards it, as can be seen in figure 3.4. The form has the ultimate goal of categorising the user’s experience as one of four: boring, calm, lively and chaotic [9].

The goal of the app itself is to study noise pollution and how soundscapes are perceived differently for different people. The user only has access to his own history, which serves as a personal soundscape diary. Although slightly unclear, entities such as event organisers and municipalities could use the app to see what parts of an event, for example a festival, are too boring or too chaotic and act on it. The app is a work in progress and requires a considerable amount of data and testers, mostly throughout a long period of time, before other conclusions can be drawn.

⁴https://leahbarclay.com/portfolio_page/cypress-trilogy-2010/ (Accessed on 28/01/2020)

The screenshot shows the MoSART app interface. At the top, a purple bar contains the text "MoSART Recording...". Below this, the question "How do you perceive the auditory environment?" is displayed, followed by the instruction "Tap to select value". There are four horizontal sliders, each with a dark grey circular marker. The first slider is labeled "pleasant" on the left and "unpleasant" on the right, with the marker positioned towards the "pleasant" end. The second slider is labeled "lively" on the left and "boring" on the right, with the marker positioned towards the "boring" end. The third slider is labeled "calm" on the left and "chaotic" on the right, with the marker positioned towards the "chaotic" end. The fourth slider is labeled "eventful" on the left and "uneventful" on the right, with the marker positioned towards the "eventful" end. Below the sliders is a progress indicator consisting of five small grey circles, with the first one filled. At the bottom, there are two buttons: "Previous" (grey) and "Next" (blue).

Figure 3.4: Example of a question asked during the evaluation process.

3.1.6 Hush City

Hush City is also a free mobile application that gives its users the ability to tag different areas and add details about it [44], but in a public manner and focusing specifically on identifying quiet areas. The idea is to continuously crowdsource a map of silent spots and form a growing community of people looking for exactly that, for different peaceful activities such as reading a book or just relaxing.

The app, initially limited to Germany but now available worldwide, offers many different features that enrich the atlas with much more than just a compilation of identified zones. That said, the user can, after tagging the quiet (or not so quiet) area, record a sample of the soundscape, leave feedback regarding the area and add pictures, also captured by the user at the moment. All of this will be public, so that it is accessible for other users to interact with. For querying the data, there are also filters that the user can use to find relevant matches, such as sound pressure levels and semantic descriptors [45].

It is clear that this project aims to increase awareness towards the importance of protecting certain soundscapes, while also providing an answer to its userbase that is searching for them. Although not directly used in tourism, visitors still benefit from this interaction and it is possible to observe its positive impact on the community.

3.2 WONDER 360

Virtual tour applications with interactive 360 experiences are becoming increasingly common, as entities such as museums want to become more enjoyable and accessible. These apps benefit from complete information about exhibitions, while providing a new and different experience to the visitor, even if remotely.

WONDER 360 [52] is a free mobile application that offers a 360-degree virtual tour with panoramic views of the Renwick Gallery's WONDER exhibition. This gallery, which is a branch of the Smithsonian American Art Museum, is located in Washington, DC (USA).

It uses phone-based VR, although the headset is optional. The exhibit itself, fully accessible through the app, was created by nine different contemporary artists to celebrate the gallery. The immersive installation is also enhanced in the app with video interviews with many of the artists and the curator, as well as details relevant to the art.

In the virtual tour, the user can visit the different rooms and hallways connecting them, but cannot move freely. The app relies on the gyroscopic sensors of the mobile device to follow where the user is looking at. This is also how the visitor interacts with their surroundings, since the interactable areas are identified by a small white tag that, when looked at for a certain amount of time, triggers a response. This response that consist of showing details or messages, moving to a different area or starting one of the video interviews.

A small but important detail is the addition of sound. The still 360-degree panoramic photos are clearly high quality and the movement shows little to no latency, but that is all they are capable of doing on their own. The ambience sound, which consists of the amalgam of people walking, talking and the resulting echo, builds an even more realistic experience. It feels as if more people were visiting the exhibition and that at any time, some could walk past you, as it would happen in a real-life visit. The image becomes almost a video that is static, while retaining all of its previously positive features.

This app is a prime example of what is mentioned in section 2.3.2 about the differences of 360-degree experiences and virtual reality, given that it consists of a set of images with sound and not an actual digital world. Because of this, it has limited interactions, but manages to get the point across nonetheless.

3.3 TravelPlot Porto

Gamification and storytelling are features that are also becoming increasingly common. More specifically, in the context of tourism, it is used to promote user engagement and interaction with their surroundings and with the platform itself.

The TravelPlot Porto⁵ app describes itself as a fun and engaging way of visiting Porto. Porto, also known as Oporto, is the second largest city in Portugal and is also very rich

⁵https://sigarra.up.pt/feup/pt/noticias_geral.ver_noticia?p_nr=13274 (Accessed on 01/27/2020)

in terms of history. This app offers a way of exploring that exact history, including monuments and important figures, through a treasure hunt around the city.

Previously available on multiple platforms, such as web and iOS, the app is no longer supported and only exists in the App Store for Android. The hunt took place during two months in 2012, and since then not much has been said. However, since it was developed within the scope of a thesis, its work is well documented. Like expected, the behaviour is similar to a tourist guide, spreading information about points of interest, events and even offering discounts in partnered businesses.

But, as mentioned, the app is not just a common digital guide, with locations to visit and information to read. The treasure hunt has people looking at specific and important details in the places they visit, as well as interacting with locals and other tourists in order to succeed.

The treasure hunt involved a virtual character called Peter. The users were meant to help him, an English tourist, save the very famous Port wine. There was an entire narrative surrounding this mission, in which the main goal was to gather Bacchus' chalice and the remaining treasure, scattered around the city of Porto. All of this before another virtual character, Filipe, did the same. In total, there were 9 chapters and 42 locations to visit. An important detail when combining storytelling and actual history is the chronological order of the story. In this case, as the user progresses through the chapters, they are also progressing through different eras in ascending order. This is done for the sake of historical accuracy.

3.4 Conclusions

In the first section, regarding soundscapes in section 3.1, five different systems were discussed. The first one is the prototype that will be extended in this dissertation. It displays relevant information and offers an array of features and possible interactions that make for a better touristic experience. Its mobile first approach has the goal of making sure the user is always presented with a familiar and working interface. Extending these features with more and different types of resources will also give the user a better insight of the city's soundscape.

After that, the second example explores the ability of recording different sounds in different ways and locations, anywhere in the world, while also documenting it publicly online. The crowdsourcing aspect is very important in this case, because the platform is solely dependent on people's accurate contributions. It is also proof that it is, in fact, possible to maintain and share the soundscaping knowledge for those who are interested. The main gist of it does have similarities with PASEV's current base project, in the sense that users can freely participate to add sounds and browse a geographical library of information. Its "geomixer" feature also raises interesting questions in what the users would like to be able to do, even if they do not know it yet. For example, a similar

feature to the journey component could be an improvement to be made, where the user automatically explores different points of interest in its path or in a timeline.

Afterwards, Sound Babylon was briefly mentioned and analysed. Although it does not show an exactly common application of the technology surrounding soundscapes, it does reveal what it is capable of and how it can be used. The experience, described as a sound garden, where the user walks and hears different sounds as their position changes is a characteristic that could be implemented in the mobile approach, using geo-location to adapt. This also closely relates to what is mentioned in the previous paragraph's last sentence.

Then, two mobile apps were analysed. Despite being part of small communities, they also depend on crowdsourcing in order to be able to share information, either privately or publicly. They depict how the same soundscape can be interpreted differently and their importance in the user's experience. Be it a tourist or a local resident, their input and evaluation is crucial to understand the soundscape.

Afterwards, one brief example of a virtual tour app was presented. This approach worked very well in the closed environment of the gallery. Since there is no implementation of an actual virtual world, the app can be seen as a collection of 360-degree images that are linked. These connections from one picture to another are definitely an interesting approach to consider. Furthermore, other details such as the position and interaction of hotspots were also studied.

Although some apps use a central character [4, 21, 34] to tell the story, almost as a companion that can both narrate it and also guide the user, this is not always the case. There can also be a subtler approach, in which the user might not even really know that they're following a story. For example, when following a predetermined path with a relevant chronological order, the user could be following the footsteps of an historical figure. In this situation, the experience is not interrupted by a character on the outside, because the user becomes that character. There is also the option where no association or direct contact is made, meaning the story is simply read with no other involvement from the tourist or their surroundings. This lack of engagement could be disadvantageous. With that in mind, not only is storytelling a must in this project, it is also better to consider either a character that befriends the user, or an environment where the user can seamlessly become the central figure himself.

SOLUTION DESIGN

In this chapter, the preparations for the implementation, and all the work that precedes it, are analysed. In the first section, the existing prototype and its features are described, to serve as the foundation for the work that follows. This includes the corresponding architecture, as portrayed in [47]. The following section surveys the available hardware to record 360-degree videos and images and spatial audio. It also addresses the field work performed in order to test such hardware and record the content to be used in the platform. In the next section, the technologies used throughout this thesis are listed and briefly explained. Lastly, the platform's various requirements are listed.

4.1 Prototype

This thesis is based on the expansion of the prototype that came as a result from the previous dissertation [47]. As such, it is important to both understand what was done and why, as well as how to the platform works.

There were 4 types of resources the user mainly interacts with and were related to one another:

- **Locations** - Also known as “points”, each location holds its respective details, including its geographic coordinates, and a collection of multimedia files;
- **Files** - The multimedia files that belong to a location, including documents, images, videos and audio;
- **Itineraries** - A collection of locations and the specified path connecting all of them;
- **Events** - Holds its details, mostly textual but can also include multimedia content.

The main page had five identifiable elements: navigation bar, timeline, map controls, sidebar and the interactive map, all of which can be seen in fig. 4.1 and fig. 4.2, in desktops/laptops and mobile devices respectively.

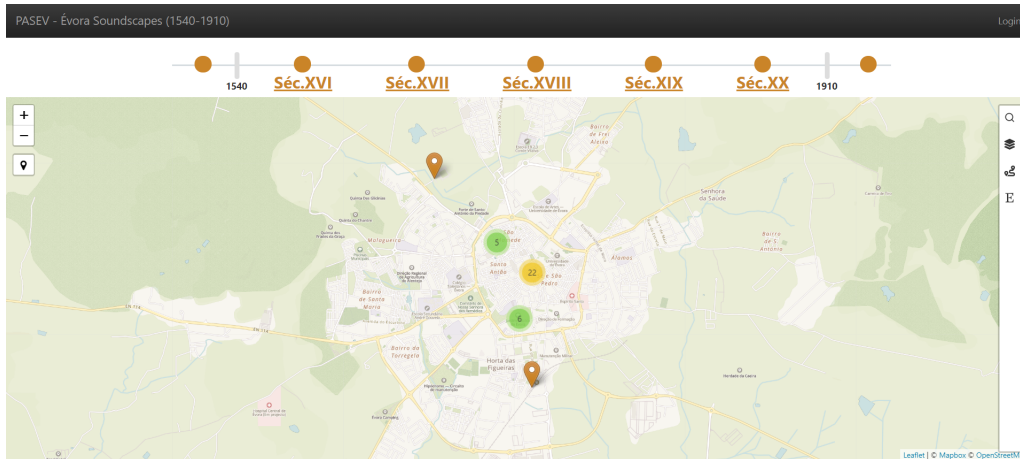


Figure 4.1: Prototype's main page in desktops/laptops.

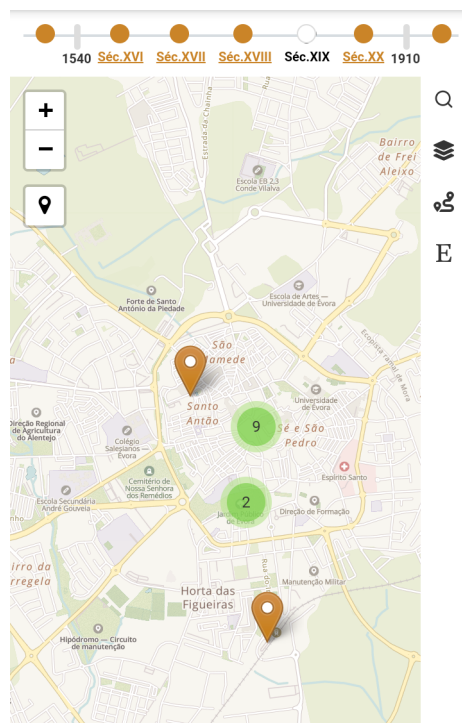


Figure 4.2: Prototype's main page in mobile devices.

The navigation bar stated the project's name and included a login option that was only useful for administrators, as there were no user accounts. This login required an e-mail and password, already existent in the system, in order to proceed and access the back-office.

Right below the navigation bar is the timeline, a time period based filter. It had seven

(7) different elements, including the period before 1540, 16th to 20th centuries and the period after 1910. These can be better seen in fig. 4.3. These elements had multiple different states, differentiated through visual cues:

- Century with black font and unfilled button – Locations of that century were being filtered;
- Century with orange font and orange filled button - Locations of that century were not being filtered, therefore shown in the map;
- Underlined century – At least one location of that specific unfiltered century was in the current map window.



Figure 4.3: Prototype's timeline with the 19th century being filtered.

The meaning of these visual cues, however, was not always clear for users, as well as the actions that achieved such states. In fact, previous results [47] revealed that 64.9% of the total user sample did not understand what the orange century and button element meant.

The map controls can be seen on the top left of the map in fig. 4.2. These are controls provided by Leaflet by default, which enable users to zoom in or out and activate geolocation. However, the geolocation was only partially implemented as the user's coordinates were inaccessible across the platform and were only used to display the user's location in the map.

The map itself, the central component of the page and perhaps the platform, was also provided by Leaflet and could be customised in its corresponding settings tab, to be described along the sidebar. It displayed interactable orange markers according to the locations' geographic coordinates, which clustered once the map was too zoomed out. When accessing a marker's content, the user will find the location's details and its galleries of files, as seen in fig. 4.4. The galleries then display the available content in a grid or in list form.

The sidebar houses all of the other features in the prototype that interact with the mentioned resources. They are, top to bottom on the right side of fig. 4.2:

- **Search** - Text input to find locations or events by name, with additional customisable search for events;
- **Map settings** - Three different base map options (OpenStreetMap, MapBox and Esri), one city plan overlay with opacity slider and additional geographic elements for other POI;
- **Itineraries** - Itinerary interaction tab;



Figure 4.4: Giraldo Square location’s content divided into (right side, top to bottom) “Info”, “Sound”, “Images”, “Videos” and “Bibliography”.

- **Events** - Event search and display.

When a tab is selected, it opens an element with the same height as the sidebar but much wider. In mobile screens, this covers the map entirely, as seen in fig. 4.5 which will be discussed in the following paragraph.

The search function displayed a list of locations or events depending on the user’s input. Upon selecting one location off of the corresponding list, the tab closed and the map centred around the selected location. If it was an event, the whole tab’s content was replaced with the event’s details with an option to go back. The event also had references to locations or itineraries which could be used to trigger their specific actions.

The map settings were composed of different options which could be toggled on or off, affecting the interactive map accordingly.

The itinerary tab displayed a list of all the existing itineraries. When the user selected one, the corresponding list of locations and its total distance were displayed inside the tab. The map also updated, by removing all markers of every location that did not belong to the itinerary and connecting the rest with the itinerary’s path. This interaction can be seen in fig. 4.6.

The events tab displayed a list of all the existing events. Upon selection, the tab’s content was replaced by its details, much like after being found in the search tab.

Lastly, the prototype included many tools in the back-office in order to add new resources to the platform. Only administrators that are successfully logged in can access

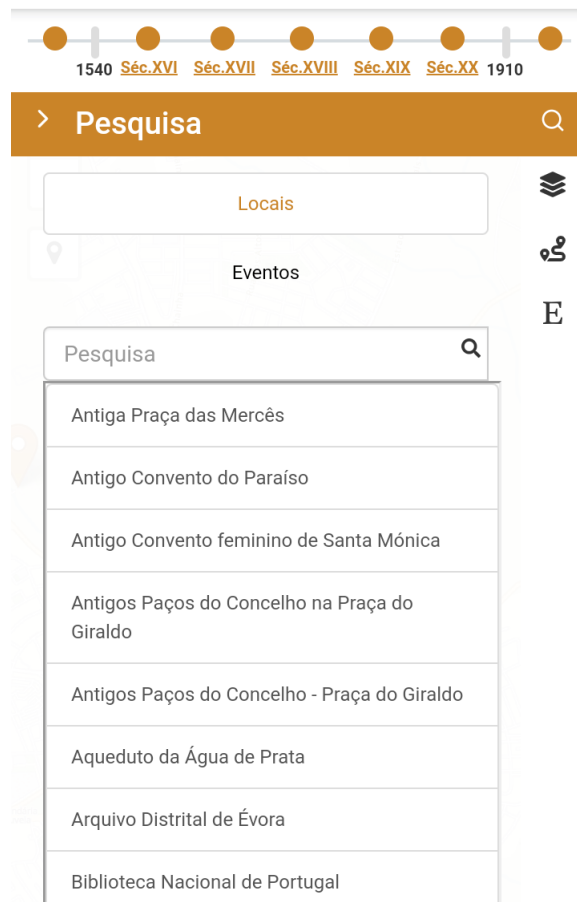


Figure 4.5: Prototype's search tab, with locations search in focus, displaying its result list.

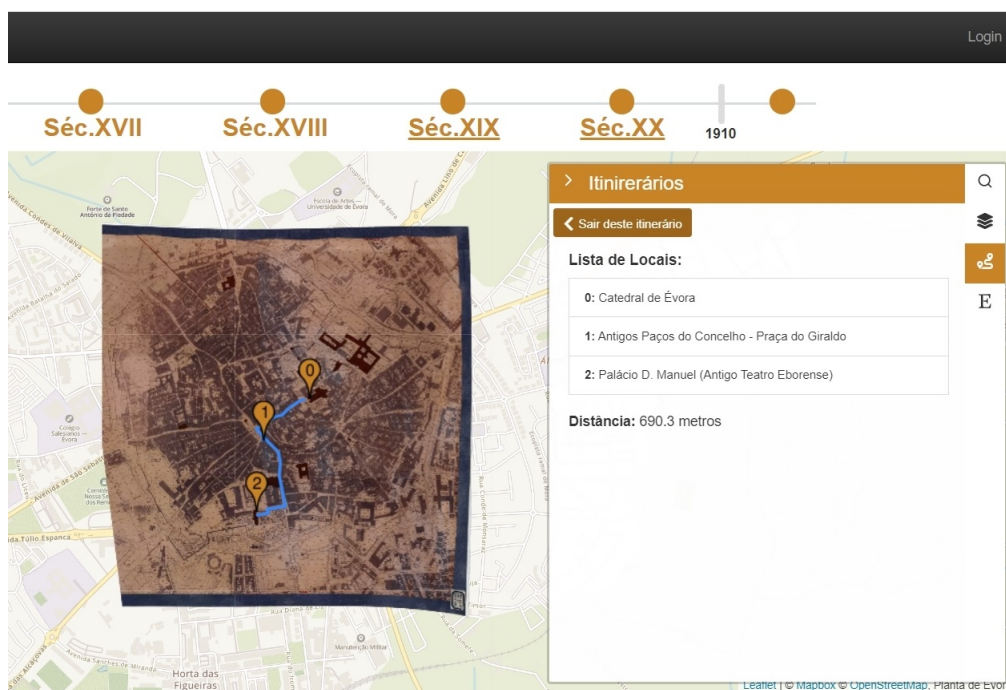


Figure 4.6: Active itinerary in the prototype, being displayed over the old city plan.

it. It displayed an interactive map along a collection of tabs, from which one could be selected and activated. The administrators could then add the four types of resources mentioned, as seen in fig. 4.7.

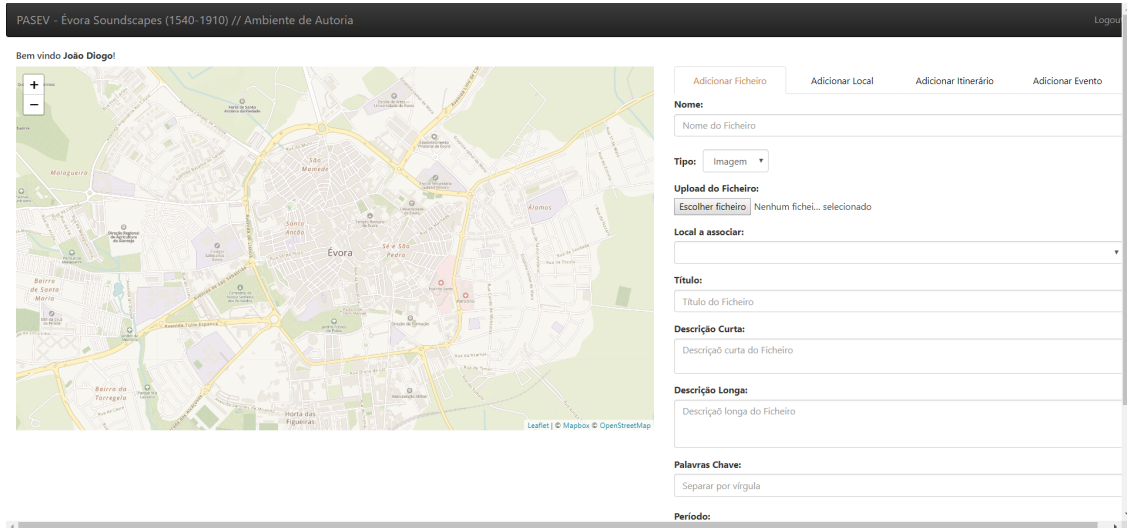


Figure 4.7: Prototype’s back-office with (right side, left to right) “Add Files” (selected), “Add Location”, “Add Itinerary” and “Add Event”.

As for the prototype’s architecture, it was first presented in [47]. The multitier architecture is described as having a presentation layer, a logical layer and a data layer, all with various components as can be seen in fig. 4.8. It is a simple yet effective approach for the platform. This structure remained, as will be asserted during the implementation chapter, because no new technologies were directly inserted in the architecture, as most of them are used independently or externally, such as the hardware or video editing programs.

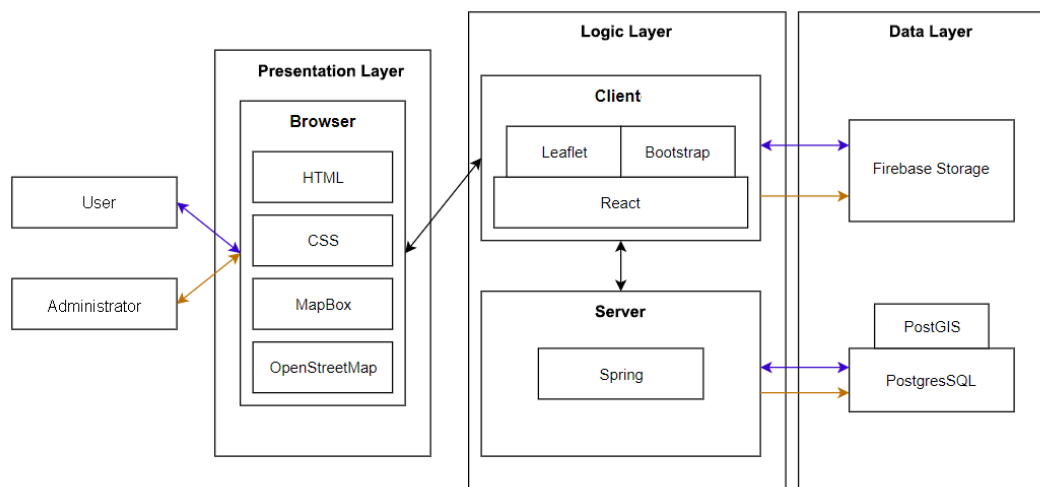


Figure 4.8: The system’s architecture (user interactions in blue, administrator interactions in orange and mutual interactions in black) [47].

The presentation layer is responsible for displaying all the information visually and allowing users to interact with it. This layer uses HyperText Markup Language (**HTML**) and Cascading Style Sheet (**CSS**), which are both core technologies for building web pages. The former is a markup language, meaning its elements are the page's building blocks as it describes the structure by using a combination of tags. The latter is used to format said building blocks, styling them in various ways. The styling definitions are usually stored in external files which allow for an easier manipulation. When both these technologies are combined, the interface can be informative, responsive and intuitive. This layer also includes MapBox and OpenStreetMap, which concerns the platform's main focus around an interactive map. OpenStreetMap is the platform's base map and MapBox is used to display the city's plan over it.

The logic layer is divided into two parts, which are the client and the server. The server was developed using Java and Spring, following the Model-View-Controller (**MVC**) pattern, and the client was developed using React. The client encases the JavaScript tools and libraries React, Leaflet and Bootstrap. It is responsible for interacting with multiple web services. This includes external services, such as MapBox and Firebase, but it also handles all the data sent and received from the server through HyperText Transfer Protocol (**HTTP**) requests. The server interacts with the database in order to create and return resources that the client uses.

The third and final layer is the data layer which consists of two components: the Fire-base storage and the database in PostgreSQL. The former is, as mentioned, a Backend as a Service (**BaaS**) used to store multimedia content. This includes all official and crowd-sourced multimedia content, but not the 360-degree images or videos. The images have to be uploaded to a host that provides a direct, short link because of the way the 360-degree image display library works. One such example, which is being used with a free account without any major setbacks, is Imgur¹. For the 360-degree videos to provide the best experience with spatial audio, YouTube is used as the host of such content because it handles, in high quality and for free, spatial metadata automatically. The database had all the necessary tables and respective attributes in order to achieve the prototype's goals. Its database can be seen in fig. 4.9, being that its evolution will be discussed in chapter 5.

4.2 Technology

This section introduces the technologies used in the platform's development in order to maintain the prototype's features and structure, as well as add features based on the project's future requirements and constraints. This includes software, back-end frame-works and front-end libraries.

¹<https://imgur.com/> (Accessed in 20/10/2020)

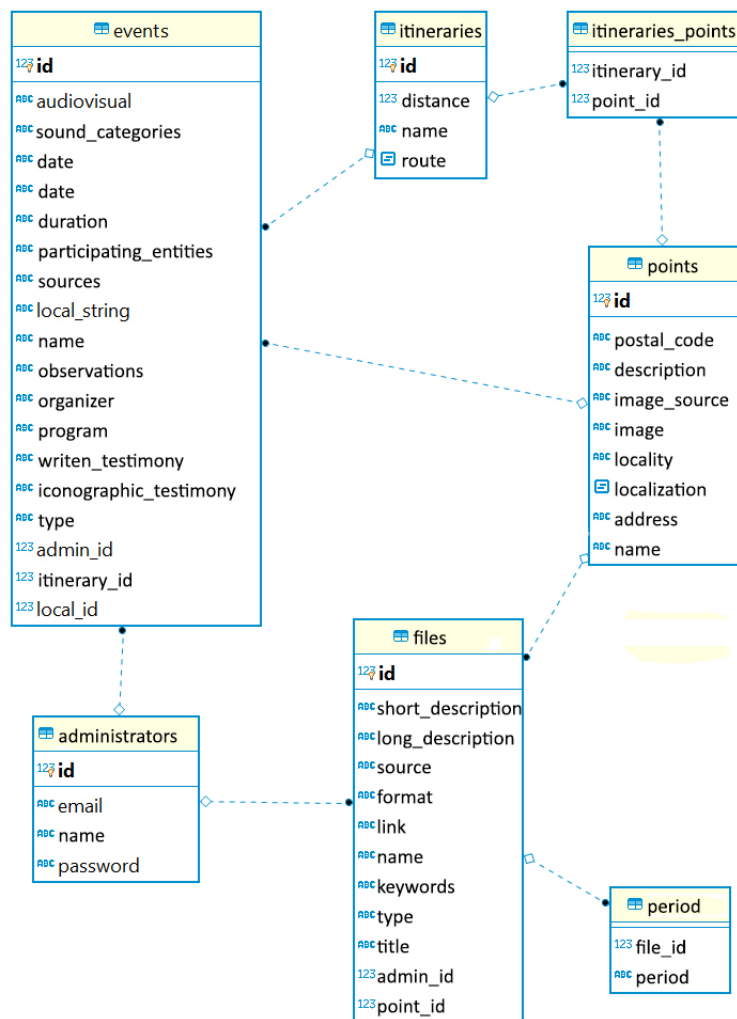


Figure 4.9: Prototype’s database schema.

React

React is a JavaScript library used for building user interfaces². It is based on components, which allow developers to compose bigger and more complex components, thus creating a flexible user interface (UI). It is a front-end library that uses the extension JavaScript Extensible Markup Language (JSX) which makes it easier to write HTML and CSS in React. These components can be either functional components or class components. Although the former were used by default whenever stateful mechanisms were involved, this changed in February, 2019³ when React Hooks were officially introduced. This way, functional components could be used for more than presentational purposes only, as they became more flexible and like their counterpart. This library and a collection of exclusively class components were already used in the first prototype of the platform and

²<https://reactjs.org/> (Accessed on 10/09/2020)

³<https://reactjs.org/docs/hooks-intro.html> (Accessed on 10/09/2020)

will continue to be used for that reason and its short learning curve, already mentioned in the first dissertation regarding this project [47].

React Bootstrap

Bootstrap⁴ is a front-end open source framework used for building responsive, mobile-first web platforms. It is a collection of many different styles, achieved by using both JavaScript and CSS, to be used in HTML elements. Besides this, its grid system is an important foundation for mobile-first UI. Since it's CSS and an open source framework, styles can be easily modified. React Bootstrap⁵ is Bootstrap rebuilt for React. It replaces the Bootstrap JavaScript with specific React components that behave as expected in Bootstrap itself, without unnecessary dependencies like jQuery.

Spring

Spring⁶ is an open source framework used in web application development. It uses the common MVC pattern, which separates different aspects of the application based on their purpose and relations. The Model encapsulates the application data, the View defines the output the client will interpret and the Controller processes user requests in order to build appropriate responses. In this project, the data is in saved in a database which Spring interacts with, the user requests follow Representational State Transfer (REST) convention and the output is received by the client in JavaScript Object Notation (JSON) format. This back-end framework was already in use from the first prototype and will continue to be so. As previously mentioned [47], it is efficient and easy to use, with an active community and documentation.

PostgreSQL

PostgreSQL⁷ is an open source relation database management system that uses and extends the Structured Query Language (SQL). It has many different additional features and powerful add-ons, such as the PostGIS spatial database extender. This particular add-on is relevant to the project, because it adds support for geographic objects that allow different queries based on them to be run in SQL.

OpenStreetMap

OpenStreetMap⁸ is a free editable map of the world, result of the collaborative efforts of its users. The data obtained through crowdsourcing includes surveys, GPS device pings and photography. It is used in many different contexts but is often seen in web platforms

⁴<https://getbootstrap.com/> (Accessed on 10/09/2020)

⁵<https://react-bootstrap-v3.netlify.app/> (Accessed on 10/09/2020)

⁶<https://spring.io/> (Accessed on 10/09/2020)

⁷<https://www.postgresql.org/> (Accessed on 10/09/2020)

⁸<https://www.openstreetmap.org> (Accessed on 10/09/2020)

or even mobile applications. Thanks to its cooperative nature, it can easily reflect real-life changes on a global scale.

MapBox

MapBox⁹ is a platform that provides custom online maps for many different applications. As is mentioned in the previous dissertation, in this project it is used as an extension, because of its custom maps and tilesets which can be developed in MapBox Studio. MapBox Studio¹⁰ is a MapBox service that allows developers to build their own maps and tilesets, with different georeferenced data and features. This tool generated tiles based on the different historical maps of the city of Évora that can be toggled on and off on top of the platform's map.

QGIS

QGIS¹¹ is an open source GIS that supports editing, viewing and analysing of geospatial data. In this project, it was used to georeference images of the historical maps of the city in order to make their display as accurate as possible. This process will be discussed in chapter 5, but the result is then exported in GeoTIFF format, a Tagged Image File Format (TIFF) file with georeferenced information, that can be used directly in MapBox Studio. It was also previously used [47] to generate GeoJSON files that represent relevant areas.

Google Drive & Forms

Google Drive¹² is a cloud-based file storage developed by Google in 2012. Though this service includes an official Application Programming Interface (API) to upload, download, search and share files, in this context it is only used to host officially approved content, such as images and documents. The API is not used for uploading because the content's management follows PASEV's own criteria.

Google Forms¹³ is a free survey tool that allows users to create forms with a set of questions. The collected data can then be used to generate documents and graphics, in order to analyse the results. In this context, it is used in two different ways – to populate the database and to record feedback in from usability tests. PASEV's members fill in the database related forms, which they also use for personal organisation, with information important to populate the database for the first time. This includes, for example, the already approved locations with their respective details. As for the feedback forms, once usability tests are completed, the forms will gather the tester's inputs. This process will be explained in detail further ahead.

⁹<https://www.mapbox.com/> (Accessed on 10/09/2020)

¹⁰<https://www.mapbox.com/mapbox-studio/> (Accessed on 10/09/2020)

¹¹<https://qgis.org/en/site/> (Accessed on 10/09/2020)

¹²<https://www.google.com/intl/en/drive/> (Accessed on 10/09/2020)

¹³<https://www.google.com/forms/about/> (Accessed on 10/09/2020)

Firestore

Firestore¹⁴ is a BaaS platform developed by Google with a wide array of tools and services. Although the platform utilises its own database and server, which will be discussed further ahead, the user submitted multimedia content is hosted in Firestore's Cloud Storage, which can be used to securely upload, download and delete files. Currently, this approach is being used as a temporary solution under a free license.

4.3 Data Compilation

Part of this thesis includes not only displaying spatial multimedia content, but also recording it. This is a complex process, that includes preparation and post-editing, but compensates the lack of content and ensures quality. This section goes into detail about the available hardware that exists and is used, as well as the work done in collecting said content. This includes the resources recorded in the city of Évora over the course of 2 days.

4.3.1 Sound capture hardware

With the advancement of technology and interest in this field, it is expected that multiple brands, existing or new, offer different solutions. There is no product that answers all needs universally, but there is an extensive line-up of options that could be better choices than the other, given the problem at hand. The following list contains some of the most popular microphones that are capable of recording ambisonics or binaural audio and are in a considerable quality and price range.

Zoom H3-VR Zoom H3-VR¹⁵ is capable of recording in multiple modes. It uses a combination of 4 microphones, which enables it to record in the ambisonics multichannel format, binaural and regular stereo. It does not have the physical ear canal appearance, because this particular microphone can mimic the frequency response of the human head and ears, thanks to custom head related impulse responses (developed by Google). This device provides a high quality spatial recording, being also very sought out when recording spatial audio. It has an extensive array of features that increase its versatility, making it both practical and accessible.

3Dio 3Dio¹⁶ is a brand with a set of high-quality professional products to record binaural audio. These microphones resemble the ones in figure 2.2, but consist only on the pair of ears connected to each other with a protecting case between them. This device is held in high regards in the binaural sound community, being one of the top choices for recording it despite its high price. It is also used regularly in ASMR videos. Although its

¹⁴<https://firebase.google.com/> (Accessed on 10/09/2020)

¹⁵<https://www.zoom-na.com/products/field-video-recording/field-recording/zoom-h3-vr-handly-recorder> (visited on 12/30/2019).

¹⁶<https://3diosound.com/> (visited on 12/30/2019).

form makes it harder to move in a natural way, it comes with a handle that can be used to hold the device.

Hooke Verse Hooke Verse¹⁷ is another product used for recording binaural audio. Instead of using a fake ear canal to position the microphones, it uses a more familiar approach that consists of in-ear microphones with the shape of the common earbuds. It connects to an app available in most devices via Bluetooth and saves a file of what is recorded. It uses a custom codec to reduce latency, since it is being recorded wirelessly. All of this makes it a good option to record sounds while moving, specially because they are attached to an actual person that is interacting with their environment in the way they are supposed to.

After surveying what exists in the market and taking into consideration their advantages and disadvantages, the decision to purchase the **Zoom H3-VR** was made. The price-quality ratio is attractive and its flexibility and portability stood out, as well as the ability of recording ambisonic audio. At first, the absence of the prosthetic ears or in-ear microphones, that appear to be common in this type of hardware, could be discouraging, but the fact is that the previously mentioned **HRTF** accomplishes a realistic and accurate experience nonetheless.

4.3.2 360 cameras

Similarly to what is explained briefly in the previous subsection, multiple brands and products came to meet new and different needs. A few examples follow, with special focus in their relevant features to the project.

Ricoh Theta Z1 Launched in 2019, this is one of Ricoh's¹⁸ multiple 360-degree cameras. It consists of dual fisheye lenses which, although undocumented, record slightly over than 180-degrees each. It also offers free apps for smartphones and desktops, as well as some relevant plugins. It is capable of recording in 4K resolution and has a built-in microphone that uses 4 channels. The dimensions of the still images are 6720 x 3360.

GoPro Max Also launched in 2019, this is the most recent 360 camera that the famous camera brand GoPro has to offer¹⁹. It consists of dual 180-degree lenses that take high quality photos and has automatic stitching in-camera, although a free app for editing is available, both on mobile and desktop versions. It also has a touchscreen that can be used to access its settings. The dimensions of the still images are 5760 x 2880.

Insta360 ONE X The Insta360 ONE X²⁰ is another good example of a product from a well established brand. With a wide array of different options for both consumer and professional cameras, this particular camera stands out. Launched in 2018, it has similar quality and consists of dual 200-degree lenses, with automatic stitching via app. The wider angle and the fact that they are closer to each other than in previous products

¹⁷<https://hookeaudio.com/what-is-binaural-audio/> (visited on 12/30/2019).

¹⁸<https://theta360.com/en/about/theta/z1.html>

¹⁹<https://gopro.com/en/us/shop/cameras/max/CHDHZ-201-master.html>

²⁰<https://www.insta360.com/product/insta360-onex>

benefits the stitching process. Has a small LCD screen and buttons to access and manage the settings. The dimensions of the still images are 6080 x 3040.

Similarly to the last paragraph of subsection 4.3.1, a decision was made based on what was analysed from the 360-degree camera pool. In the end, the **Ricoh Theta Z1** was selected because, although its price is relatively higher, so is its flexibility in regards to editing and customisation, which contribute to creating a pleasant experience. Albeit only being able to record 25 minutes in a row and around 47 minutes total in its max settings, it tips the scale in its favour with the high quality detail in 4K resolution.

4.3.3 Field Work

The process of recording spatial content comes as the result of field testing with the aforementioned hardware and software, which was arranged in order to adjust settings and be aware of potential issues. The initial experimental recordings, which included both 360-degree video and ambisonics audio, were performed in NOVA School of Science and Technology's campus. The tests were made in three different environments with different characteristics, using a tripod with the camera on top, the microphone on the bottom and the camera's app on a smartphone. The first one was outdoors and in a windy location, the second was also outdoors but in a sheltered location and finally, the last one took place indoors in a hallway. The mobile app handled the stitching of the dual fisheye camera automatically, saving them as equirectangular video files in the camera's internal storage. The recorded audio and videos were then transferred into a computer and analysed, edited and exported into their final format.

This set of tasks were performed before any major development in the web platform took place. Nonetheless, these tests were sufficient to determine some basic but important concepts about the process.

Firstly, the setup is a very important factor. Not only should the tripod be levelled, it should also be positioned in a spot that has enough light to record well and has, as little as possible, additional noise sources, such as vehicles or wind. The microphone's gain setting should also be adapted, depending on how close it is to the sound source, to avoid both peaks and inaudible clips. An example of this setup *in situ* can be seen in fig. 4.10. The camera's default settings are maximum quality and shortest length of time but can be changed accordingly. After both devices have started recording, a single clap or finger snap that can be seen and heard is needed to synchronise both audio and video while editing.

In case the camera's automatic stitching option is off, which it is by default, the video file must be converted from dual fisheye format to equirectangular in Ricoh Theta's own computer software before continuing.

Editing these files is a necessary task. After importing them, the first step is to unlink the video from its audio, because the camera also records sound, albeit stereo, and delete the audio. Afterwards, using the clapping or snapping sounds as reference, the files must



Figure 4.10: Recording setup consisting of a tripod with a camera on top and a microphone on the bottom, in Remédios Convent's cloister.

be synchronised. After doing so successfully, the clips must be trimmed for their duration to match and remove unnecessary sections from the start and end of the clip. Because of existing VR presets in the editing software, the audio is automatically handled as multichannel with 4 channels and 360-degree video. When exporting, the corresponding format and preset also take care of injecting spatial metadata in the resulting file.

The file is then uploaded to YouTube, which recognises and automatically handles the mentioned metadata and enables users to interact with the video and audio spatially.

When this was done for the first time and tested in the platform, the next step was to gather interesting resources from the city of Évora, such as churches' interiors and the sound of their respective bells ringing. Images, videos and audio were recorded from multiple locations, both indoor and outdoor, at different times of the day. The locations were the following, in no particular order:

- *Catedral de Évora* (Cathedral of Évora)
- *Igreja de São Francisco* (São Francisco Church)
 - *Capela dos Ossos* (Bones Chapel)
- *Praça do Giraldo* (Giraldo Square)
- *Jardim Público* (Public Park)
- *Jardim de Diana* (Diana Garden)
- *Mercado Municipal 1º de Maio* (Municipal Market)

- *Convento dos Remédios* (Remédios Convent)

The same methodology was used in order to obtain these files.

4.4 Requirements

After analysing the prototype, gathered information from meetings with the project and future work proposed in [47], the platform's requirements were updated and established. Three types of requirements can be considered: functional, data and design, all of which will be analysed in the following subsections.

4.4.1 Functional

When considering the prototype's features and the previously state objectives, the functional requirements for the platform expansion are the following:

- **Spatial content visualisation** - The platform must be able to display the gathered spatial multimedia content, allowing users to interact with it;
- **User content submissions** - Users must be able to submit multimedia content through the platform and access other users' approved submissions;
 - **File submission** - Image or video files from the user's machine can be submitted;
 - **Live recording** - Audio files can be recorded using the machine's microphone, if available, and submitted.
- **User submissions management** - Administrators must be able to manage content submitted by users, by approving, editing or rejecting it;
- **Timeline adjustments** - The timeline's structure must be reworked to fit a new design and solve usability concerns;
- **Featured content** - Display of featured content in a separate container, to draw attention to specific select resources;
- **Thorough back-office** - A back-office with more actions per resource, giving administrators the option to fully manipulate the platform;
- **Slider galleries** - This type of galleries allow for all elements to be displayed in the same place, which is specially beneficial in mobile devices;
- **Geolocation and distance** - Track the user's geographic coordinates (latitude and longitude) through geolocation and calculate distances based on this information, such as the distance to a selected location in an itinerary;

- **Functional maintenance** - Every functional aspect not mentioned in this list must be kept, or otherwise updated, in newer versions.

4.4.2 Data

As already mentioned, there are four (4) main resources - locations, files, itineraries and events - each with a list of attributes. **PASEV** is responsible for gathering most of this information and, most importantly, revising it. Thus, any modification done to a resource's structure must be in agreement with the project's concepts. The structure for locations and events remain the same, but itineraries and files are slightly different.

Locations are geographic points with cultural relevance, specially musical, containing different descriptive elements and files.

Events may refer to historical demonstrations of civic, religious, military or popular nature. Its information is temporally contextualised and may include a reference to an itinerary or location, as well as multimedia content.

Itineraries can be considered historic or touristic, as their display and expected interaction differ from one another. In the future, this aspect is to be explored further in gamification and storytelling aspects.

Files are linked to a location. They are available in various formats, depending on their type, which now includes spatial multimedia content. This mean this type of content is stored in the same place and in the same way as uni-dimensional content. Thus, both can be displayed accordingly and interacted with.

Crowdsourced content, albeit not necessarily a "file", is also linked to a location. The distinction between the two types is based on their attributes, which differ greatly. Both are stored in the Firebase storage and hold a title and description, but crowdsourced content has credits and a timestamp, whereas the other does not.

4.4.3 Design

The prototype's interface design needed to be improved in order to reflect necessary changes to address the usability issues raised in [47] and encase the new features. This particular process, which will be detailed further ahead, was accompanied by a designer.

- **Responsiveness** - The platform must be responsive in order to adapt and work intuitively with any screen size. This is a common requirement in modern web platforms and was already supported in the prototype, which must remain;
- **Usability** - The platform must be easy to successfully use from an operator's point of view;
- **Gallery separation** - The multiple types of galleries require proper separation and accessibility;

- **New city plan** - The prototype's city plan was a temporary solution which must be replaced;
- **Navigation bar** - The navigation bar and sidebar should be merged, to have only one external element that simultaneously access features and identify the project;
- **Brand** - On the subject of identification, a brand must be developed and inserted in platform.

4.5 Conclusions

The analysis of the prototype, its technologies and its evaluation were crucial to map the requirements for this thesis and the future iterations. Only after understanding the system's architecture and already contained resources can one prepare to expand said system. Similarly, knowing what technologies were used was important to both prepare the upcoming modifications and add other tools or libraries to help in such context. React, for one, had to be extended with more packages to fulfil the requirements, much like the server and database. However, the platform's evaluation was key to assert what required immediate attention and how certain issues could be prevented as to improve the user experience.

Data and its collection, despite being an ongoing process, also impacted the requirements. The project gathers, verifies and submits data through the existing Google Forms, which can then be manually inserted into the platform. The uni-dimensional content was mostly consolidated during the previous dissertation, although much of it is still being processed. Spatial multimedia content, however, is lacking in quantity and involves a more complex process, both in recording and editing. As such, the time constraints and lack of balance between the amount of content imposed the need for an approach to manage content and its display.

The specifications about necessary changes and functionalities emerge from what was covered in this section. Thus, the implementation is discussed in the following chapter.

IMPLEMENTATION

Throughout this thesis the platform was extended with new features and modifications in order to enrich the user's interaction with the platform, which aims to provide a pleasant experience while exploring the city's soundscape. This chapter describes the process and various different aspects that were involved in the conception and development of this platform.

In the end, this chapter also includes a conclusion about the decisions that were made and the work done.

5.1 Interface Design

A new interface design for the platform was proposed by Camila Wohlmuth¹, focused on the prototype and the new functionalities. This design was based on an independent expert evaluation, as well as the results of the previous usability tests [47]. It was an iterative process, as new issues came up from personal testing and suggestions from within the team. Besides the element composition and responsive layouts, the design consisted of a colour palette, as can be seen in fig. 5.1, based on Évora's own palette. Not only does the palette's exact tint and shade represent the city, it is also distinctive enough for people with colour vision deficiency.

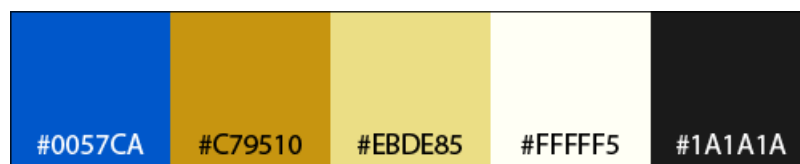


Figure 5.1: The platform's main colour palette.

¹A peer consulting as a designer for the project, currently working on her PhD.

In 2010, web designer Ethan Marcotte coined the term “responsive web design” [35] for the first time, in a webzine article. In this article, Marcotte explains that there are more browsers, input modes and devices than ever before and the way forward is to support the usual optimal viewing experience but make designs more flexible and adaptive. They also provide a list of examples, suggestions and technologies, such as CSS media queries and jQuery, to achieve this. Bootstrap, which is used in this project and was released one year after the article, uses jQuery (as of version 3.3) and these CSS features to create a responsive environment. However, this library can be extended in order to generate responsive but platform specific designs. This is supported by the fact that Bootstrap is open-source and that React can calculate specific measures in real-time, as well as use conditional rendering. One such example is the navigation bar, which extends Bootstrap’s navigation bar using JavaScript to add further customisation, as seen in fig. 5.2. These elements were reworked partially to become more intuitive and reflect new changes, which will be discussed further ahead.

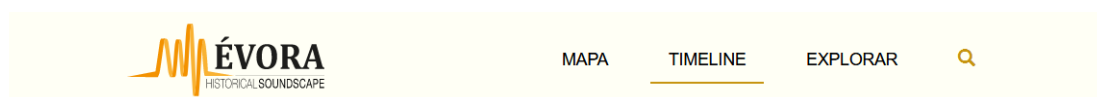


Figure 5.2: Customised navigation bar with the timeline element selected.

In a smaller screen, the navigation bar replaces the elements with a hamburger menu and moves the search icon, as seen in fig. 5.3.

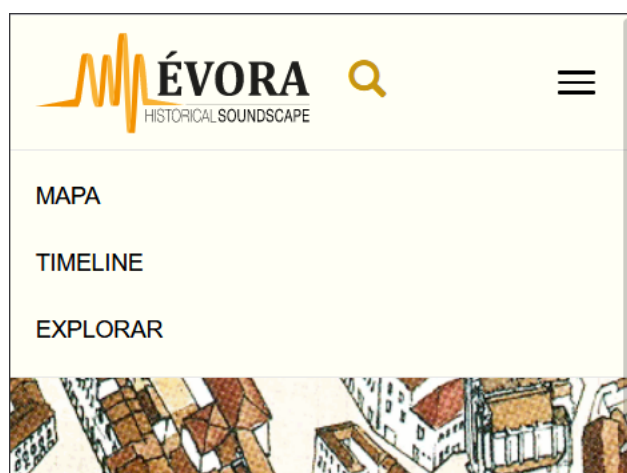


Figure 5.3: Navigation bar on a smaller screen, with hamburger menu toggled on.

An alternative to responsive web design when considering a mobile-first approach, or mobile devices in general, is a separate mobile website. Instead of adaptive code and markup, a script detects the user’s device type and redirects them to the mobile-optimised website, under a different URL. In [8], this dichotomy is explored and discussed, with a great amount of practical examples. One of the major advantages of responsive web design is the fact that only one set of content must be maintained and updated at a time, as well as content-parity between mobile devices and desktops, because users recognise

similar patterns and elements. Nevertheless, it also has its disadvantages, like a slower performance, caused by larger page sizes and loading times. The analysis concludes that one is not always better than the other and is instead dependent on use cases and suggests guidelines to improve the user's experience. In this project's case, given the fact it already relied on responsive web design, the goal was to reinforce these techniques for more flexibility.

5.2 Database

Databases are often used in web applications in a very similar way as they are used in desktop applications, because they handle persistent structured data and provide means to manage their contents. The platform's performance is enhanced by the fact that data can hastily be added, modified or even removed in real-time, as well as being gathered in one organised place. However, for these same reasons, the created schema must be suitable for the type of information that needs to be stored.

As this technology and concept grew, so did Database Management Systems (**DBMS**), which are defined as systems that “[enable] users to define, create, maintain and control access to the database” [14]. As stated in the previous subsection 4.2, PostgreSQL was the selected Relational Database Management System (**RDBMS**) with its PostGIS extension that supports geographic objects. In order to work along Spring, some configurations were necessary. This process, already described in [47], essentially required specific dependencies in order for the Java Database Connectivity (**JDBC**) **API** to allow **SQL** queries with a PostgreSQL database with the PostGIS extension.

Other than relational information and simple data types, databases can also save multimedia content (e.g. images). These can be stored either by their path or by storing the actual content. In the latter, multimedia data can be saved as a Binary Large Object (**BLOB**) or by converting it into a base64 format. However, by simply storing their path, the content is already hosted in a separate file system, which means the database has no need to interact with the file data itself. Although **DBMS** are not always the best option to store large objects, managing both database and content storage separately but consistently is a challenge [7]. The latter method does take up less database space, separates resources accordingly and is less expensive. For this reason, all multimedia content in the platform is hosted in a Google Drive and Firebase's file storage and not in the database, which only stores their path.

Although the current schema retained most of the tables in the prototype's schema, new tables were added and some small changes were performed as necessary according to the new requirements. The old schema and the new one can be seen in fig. 4.9 and fig. 5.4, respectively.

In addition to the common data types found among most **SQL** extensions, this database uses one special data type provided by PostGIS, which is 'geometry'. This type can take several forms in 2 to 4 dimensions, but only two are used in this context: **point** and

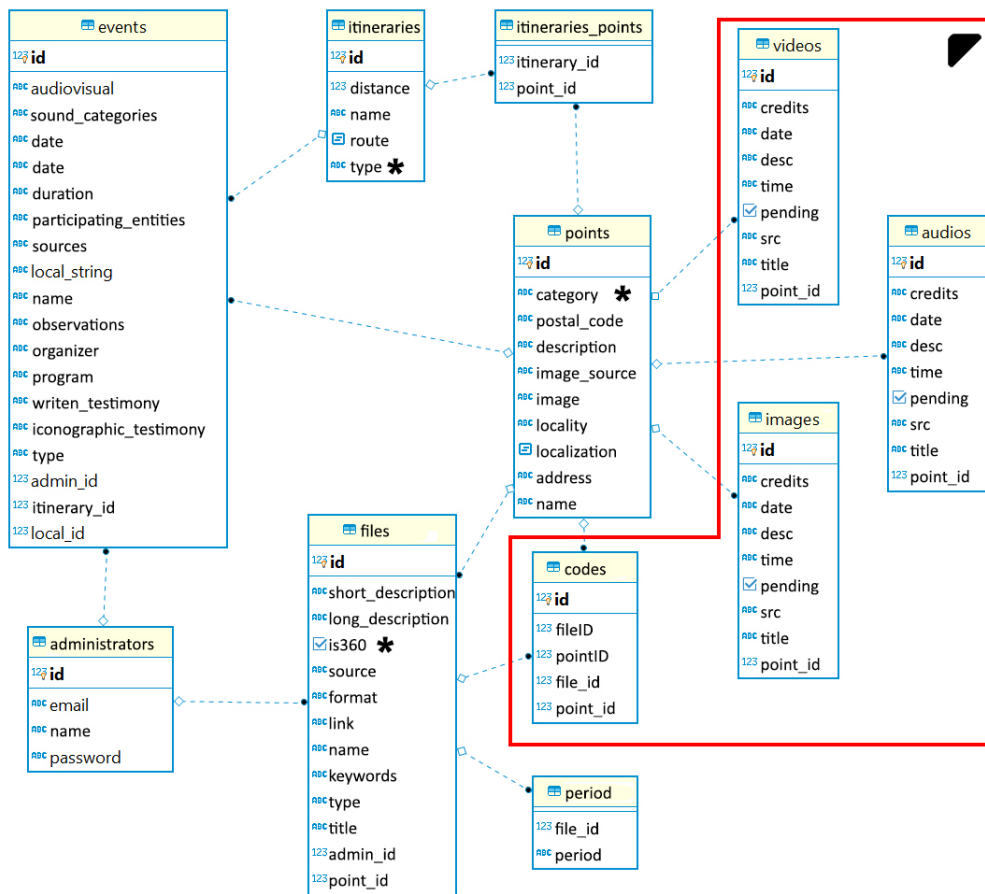


Figure 5.4: Latest version of the database’s schema, with a red rectangle indicating new tables and an asterisk indicating new properties. An empty dot to a filled in black dot represents a one-to-many relationship.

linestring. The former stores the coordinates of a particular point in space and the latter stores the path between locations, following an ordered series of two or more points. These complex data types allow for easier creation, storage and access.

The table “administrators” encases the necessary information about administrators’ login details, so that only they can access the back-office securely. This table has a “one-to-many” relationship with events and files, which will be addressed further ahead.

The table “points” represents the locations which are identified by coloured markers in the interactive map and are one of the first resources the users interacts with. Points have the expected textual properties, such as address, name and description, but also a localisation attribute which uses type ‘geometry’: a PostGIS point containing its latitude and longitude. A new attribute introduced in this schema is the category attribute, which can be one of four: “Churches”, “Interior Spaces”, “Exterior Scapes” and “Monuments”. This allows for them to be not only filtered according to their category, but also displayed in a different colour. Points have a “one-to-many” relationship with events, codes, videos, audios and codes, all of which will be addressed further ahead.

Table “itineraries” contains the itineraries. It includes its total distance, name and type, which is a new attribute, which can be either “Historic” or “Touristic”. This differentiates between itineraries with historical context and suggested itineraries for tourists to follow and visit the city’s various **POI**. The route attribute is of type ‘geometry’, and uses a linestring to store two dimensional geographical information. It has a “one-to-many” relationship with events, because “Historic” itineraries will be more than likely associated with one specific event.

Table “itineraries_points” is on the “many” end of an “one-to-many” relationship between both “itineraries” and “points” to simulate the “many-to-many” relationship that is shared between them. This means that one point can be used in multiple itineraries and that one itinerary can have multiple points. Hence its only attributes being foreign keys.

Events can be found in its homonymous table, with only textual information regarding it and the respective foreign keys necessary, as it is one the “many” end of multiple “one-to-many” relationships, as can be asserted from the previous paragraphs.

Files are stored in a table with textual information, an additional flag (*is360*) that indicates whether it represents spatial content or not and the foreign keys to points and administrators. The *boolean* flag was necessary in order to separate and handle content appropriately when it is spatial, such as displaying an interactable window for 360-degree images. The table has an “one-to-many” relationship with “codes” and “period”.

The new table “codes” is used to maintain the relationship between a code and a file from the table “files”. This is used when scanning a **QR** code, to confirm the code exists and can be used to reach its identified file. Despite having the respective foreign keys, it also has numerical attributes for the IDs. This may seem redundant, but because of the lazy nature of both objects when accessing a code - this means that the file and point objects are never returned along the specified **QR** code - the only way to access the IDs are by including them as attributes of the entry itself.

The table “period” has the foreign key for the file it is referring to and a textual list of the periods it includes.

The three tables “videos”, “audios” and “images” are used to contain the crowd-sourced content and have the same attributes. One alternative was to have one single table for all of the crowdsourced multimedia content with one additional column identifying its ‘type’, however this did not allow for content specific attributes to be added without using *null* values. As an example, the videos and audios tables could be altered to include a time length attribute, but this would not be the case for images. Thus, the decision was to store them separately.

5.3 Web platform

This section addresses the many elements displayed in the web platform, in order to implement the expected features and changes. This includes a thorough approach based

on the technologies used, because, for one, certain JavaScript functions and CSS properties are not supported globally across all browsers. This is due to browsers having different JavaScript engines to interpret and execute the language, as well as rendering engines to transform HTML and CSS into the page's visual elements. These engines come as a result of the implementations by different browsers throughout the years [37].

These limitations are usually documented and during the platform's development, new elements were always verified through the use of an external tool² that visually displayed compatibility issues across the most popular browsers. However, a perfect cross-browser solution is often impossible because the pages will never display exactly the same in every single browser. Instead, the goal is to standardise the interactions and main flow, avoiding major discrepancies between different browsers.

In this implementation, several of React's features were used, such as component nesting, one-way data binding³ and state. All of these are related and thus contribute to a sturdier structure, as components store relevant information in their state, which can then be passed down to child components that access it. Lifecycle methods also help to manipulate the platform during certain phases, namely when a component finished mounting or is going to be unmounted. The former allows, in this case, for data to be retrieved via web services and populates arrays with all the resources (e.g. locations and events). The latter is often used to cleanup, for example remove event listeners or stop an interrupted web service. This combination of features and methods was used throughout the platform's development, as will be asserted in the following subsections.

5.3.1 First time user screen

When the user visits the platform for the first time, the displayed page is different from what it will be in future visits. Although it contains the framing elements, such as the navigation bar and the footer, the interactive map is replaced by a background image and a button to advance to the map screen. This area will be used to include other elements, such an introduction, a tutorial or even a 360-degree video.

When the main container component is mounted, the state is initiated with a flag that specifically detects if it is the user's first visit, by accessing the browser's local storage. Local storage is a type of browser storage that stores the data in 'items' with no expiration date. When the flag is true or non-empty, the platform's main interaction screen will be displayed. When the flag is empty or *null*, since *localStorage.getItem()* returns *null* if the item does not exist, the first time user screen will be displayed. Only when the user clicks the button to advance will a function be triggered to update the state and set the item to true with *localStorage.setItem()*. Interacting with any footer card or navigation item will also trigger this function, as all of these are related to the map. This way, the next visit

²<https://caniuse.com/> (Accessed on 10/10/2020)

³Data flows to nested child components from higher-order parent components.

will repeat the process of initiating the flag according to the local storage item which has been updated.

It is important to note two aspects about local storage. Firstly, it is device and browser dependent, meaning that it is relative to one browser in one device. Using the same browser in a different machine will access a different storage. Similarly, using different browsers in the same machine will also access a different storage. Secondly, users may edit local storage by using Developer Tools which are available in most popular browsers. In this case, this does not pose a security threat because the first time user screen does not contain sensitive information and is in fact expected to be accessible in future iterations after the user has already advanced.

As the map is not displayed in this screen, the resources are not loaded when the main container is mounted, to avoid performing requests unnecessarily. The lifecycle method *componentDidMount()* is responsible for loading the aforementioned resources, but does not do so if the flag is empty, *null* or false. Thus, the mentioned function that alters the local storage item also runs these requests in order to populate the empty arrays.

5.3.2 Overlay map

An old city plan was displayed over the base map in the prototype. However, this was a temporary image, as it was dark toned and was not very sharp, which did not body well with the overall platform. Thus, a new map of the city of Évora replaced it. This map, which can be seen in fig. 5.5 was drawn by Portuguese artist António Couvinha using watercolours.

When the city plan's image was processed, it was ready to be georeferenced, a vital step in its integration in the platform. Georeferencing is the process of adding geographic information to an image according to how it maps with the real world. Generally, these georeferenced images are used over a real map and, the more accurate they are, the better they align with it. Using the software QGIS this was done by selecting points manually in both the image and a real world map and calculating the corresponding coordinates. After a significant amount of points were inserted and the mean error is acceptable, georeferencing can be stopped and the image will be generated in the appropriated format.

The image was then uploaded to MapBox Studio in order to create a tileset, which can be loaded dynamically via their [API](#). The tileset is used instead of the image directly because it offers better performance with GeoTIFF files and both loading times and appearance are improved.

The prototype initiated with no map over the base map, which is no longer the case. However, similarly to the prototype, the map can be toggled on or off, and its opacity can be changed in increments or decrements of 10%. Both these actions are achieved by manipulating the Leaflet layers directly, which already provide functions for this type of management. These layers, specifically tile layers, can be added, removed and edited dynamically. As such, when a user toggles off the city plan, the corresponding layer is



Figure 5.5: Évora's city plan by artist António Couvinha.

removed from the interactive map's list of elements. In addition to this overlay map starting already toggled on, the initial zoom was increased in order to draw focus to the city plan itself which is considered a major visual improvement.

5.3.3 Footer

The footer consists of 3 cards that represent featured content. Currently they are itineraries, locations and events, as can be seen in fig. 5.6. Their purpose is to give the user immediate access to specific content. Multiple implementations were discussed in this particular aspect of the platform, mainly how to select what content is featured. One approach was to create a new table in the database that would store information about the type and ID of the featured content.

However, since the card types are yet to be decided and the main focus was on creating a functional card to perform tests on, only the itineraries card is functioning and it selects 3 existing itineraries as featured content. This is achieved by introducing a piece of state that stores the first 3 itineraries returned in the same request that populates the itineraries array.

The cards are displayed side by side and will decrease in width the more narrow the screen, until it reaches a point where they are instead displayed one at a time, with arrow buttons to advance or go back. When the screen's own width is equal to or over 680

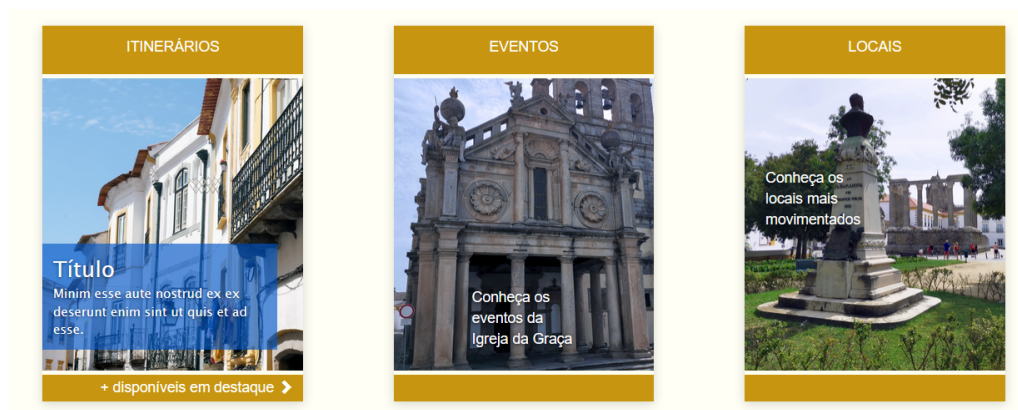


Figure 5.6: Footer cards with featured content for, from left to right, itineraries, events and locations.

pixels, the card's width change is achieved by using [CSS media queries](#). When it is not wider than 680 pixels, the one card display is achieved through conditional rendering, along specific state to know what card the user is on, which can be updated by triggering functions in the arrow buttons.

Each card has the image and details of one specific element of the featured content list of that type, and an option to show, by name, the rest of the elements in the list. This can be seen in [fig. 5.7](#), which displays the only currently expandable card. Once an element is clicked, it is selected, and the platform reacts accordingly.



Figure 5.7: Expanded footer card with featured content for itineraries.

In order to access this functionality, a button to scroll up and down was introduced in mobile devices. This was necessary because the map uses the screen's entire height (minus the navigation bar) in smaller screens and it detects and handles scrolling differently. This button uses JavaScript's *window* object, which is supported by all browsers,

and its `scrollTo()` method in order to either scroll to the top or the bottom. Similarly, the button is displayed depending on the current scrolling position, which is obtained from Safari using `document.body.scrollTop` and every other major browser using `document.documentElement.scrollTop`. This interaction can be seen in fig. 5.8, being that the left screen is the platform's initial state and the right screen is the platform after the button being clicked.

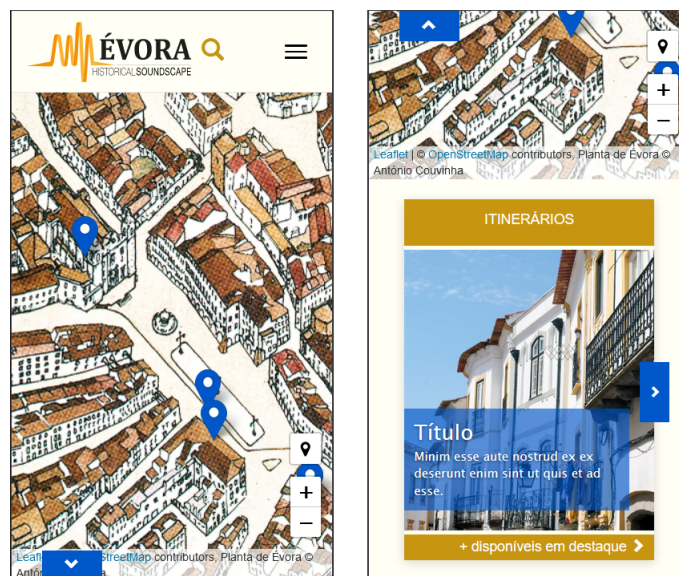


Figure 5.8: Platform's initial state (left) and the platform's state after clicking the scroll button (right).

5.3.4 Navigation bar

The prototype relied on a sidebar to execute most of the user actions, such as searching for a specific event or location, activating an itinerary or changing the map settings. This sidebar was inside the map itself taking up a considerable amount of space, as was seen in 4.2. Map control options, such as geolocation and zoom, are other possible interaction elements that are usually presented inside the map. When users are performing other actions, such as typing in the name of a location they want to find, their focus is shifted away from the map. Hence, there is no imperative reason to keep the sidebar and its functionalities anchored to the map.

The sidebar itself was dissolved and its features reintegrated in the navigation bar. Besides what was previously mentioned, the navigation bar was already present but was only used to identify the project, although it disappeared in mobile devices, leaving the platform with no identification whatsoever. Thus, the idea was to build an interactable and reactive navigation bar with all the previous sidebar features and more.

Since this bar is present at all times, a separate class component was created using both Bootstrap and custom code and styling. Bootstrap has built in elements with many CSS

specifications that create a responsive navigation bar, but the implemented customisation was necessary as to create an unique and immersive component.

For one, the navigation bar colour was changed and the height was increased, regardless of device or screen size, as was seen in fig. 5.2. The navigation bar houses four navigation items:

- Map (*MAPA*) – base map and historical overlay map options;
- Timeline (*TIMELINE*) – toggle the timeline;
- Explore (*EXPLORAR*) – access itineraries and future features;
- Search (magnifying glass icon) – search locations and events.

The map settings are essentially the same as they were before, although with small styling tweaks to fit the design and one more option for the overlay map mentioned in subsection 5.3.2.

The timeline option toggles the timeline display on and off, according its previous state. The component is rendered over the map rather than on top of it, meaning it will not push the map display but cover a small portion of it. This was achieved by using CSS properties “position” and “z-index”, as to not disturb the page’s layout.

The explore item has one option that lists the itineraries. After clicking an itinerary, the list is replaced by details of said itinerary: list of locations, length in kilometres and estimated duration. Although the first two details mentioned are inherent to the database resource, the estimated duration is calculated based on the average human walking speed. It averages around 1.25 meters per second [51] and, when combined with the itinerary’s length, results in a fairly accurate duration time. In case the user is using the geolocation feature, an additional detail shows the distance between their current location and the itinerary’s selected location. Much like the previous attribute, this has to be calculated in real time. This is achieved by using the Haversine formula, a formula used in navigation to calculate “great-circle distances between two points on a sphere from their longitudes and latitudes” [13]. The user’s location is detected every 10 seconds, which is Leaflet’s default value, and distance d is calculated with r being the Earth’s radius between two geographic points with longitude and latitude (ψ, ϕ) in the following way:

$$d = 2r \sin^{-1} \left(\sqrt{\sin^2 \left(\frac{\phi_2 - \phi_1}{2} \right) + \cos(\phi_1) \cos(\phi_2) \sin^2 \left(\frac{\psi_2 - \psi_1}{2} \right)} \right)$$

The user can go back to the itinerary list or go forward, confirming the itinerary and triggering the map changes. These map changes remain the same as the prototype but this interaction with the updated design can be seen in fig. 5.9.

The search function behaves differently depending on the device’s size, taking two forms: desktop and mobile. Once again, conditional rendering is used to render the feature according to what was detected based on the screen’s width and height. In the

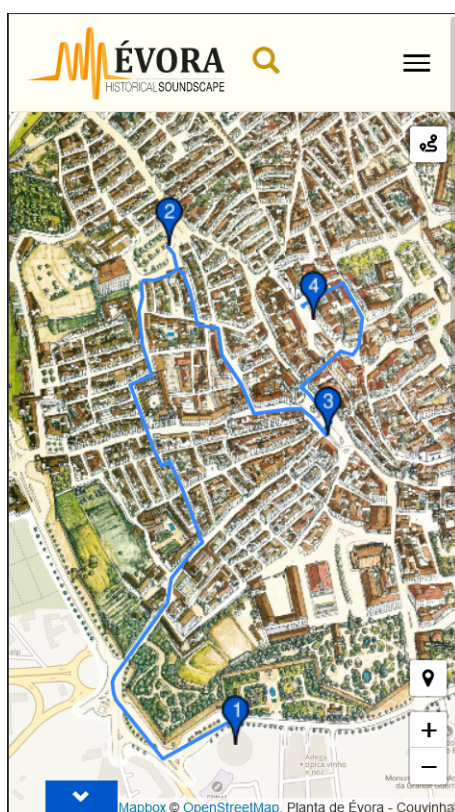


Figure 5.9: Display of a selected itinerary, in a mobile device.

desktop form, the user can use the text inputs to search both locations or events by name. In the mobile form, the functionalities are and do the same, but there are two separate folder-like tabs. Each tab has its input and list. As the text input is updated, a search is performed locally, by iterating the array of the specific resource type and comparing each entry. The comparison is done using JavaScript function *search()*, which searches a string for a specified value and returns the match's position in the string, or -1 if no match is found. Because the arrays for events and locations are populated with all the corresponding content from the database once the page is mounted, this reduces the amount of queries performed to the server and also updates the list dynamically. Once a location is selected, the map zooms on that location and the marker's pop-up appears. If an event is selected, the search window's content is replaced by all of the event's details and information, with an option to go back.

5.3.5 Timeline

The timeline is one of the components that was changed the most due to its unclear interactions and intrusive presentation. Its width would shrink to match the device's width, meaning it would get as infinitely small as possible. In smaller smartphones (such as the iPhone 5 or the Samsung Galaxy S) this would cause overflow issues and impractical minimal buttons.

With a new functional navigation bar, the first change to address, both in desktop and mobile devices, was to make the timeline an option. As was described in subsection 5.3.4, the component can now be toggled on or off. It is important to note that even when the timeline is toggled off, its filters remain unchanged and are not reset. This is because the timeline does not actually contain the portion of state relative to the filters, its parent does. On account of that the parent is always mounted, the state can only be manipulated and never lost, unless the page is refreshed. Once the state and corresponding functions are passed down to the child, the timeline component, it can access the properties and use them.

Equally important and related to device size was the timeline's responsiveness. Instead of simply decreasing the size of the elements, at a certain point the timeline splits in two. Only half of the elements are presented at once, with a navigation button to change between sub-components, so as not to impair the readability and ability to interact with, as can be seen in fig 5.10. This is achieved by using conditional rendering and state to store what the current sub-component being displayed is, because all other functionalities remain the same, as per mentioned in the previous paragraph.

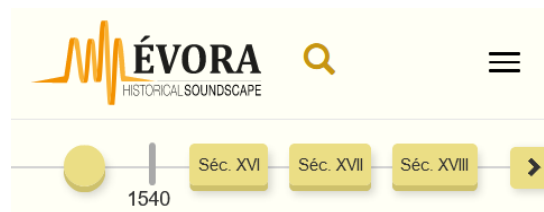


Figure 5.10: Timeline's first sub-component as displayed in an iPhone 8's screen.

Lastly, the timeline's elements were also transformed. The appearance was heavily reworked to fit the design but, more importantly, to eliminate concerns raised during the evaluation phase in [47]. One such change was eliminating the underlined state, mentioned in chapter 4, which was not helpful, caused confusion and conditioned the interface design. Users did not know when or how to interact with the timeline, nor what it did. The visual cues were changed to fit the new palette and were improved in order to be more straightforward. By removing the underlined state, only two states remained - unfiltered and filtered locations.

A pushed in button means it is activated, meaning the filter for that century is on. These changes can be seen in fig. 5.11. Once a button is clicked, the state is updated and a request is sent to the server. This request includes the updated state as a parameter, as it will be used to remove any file from the list of locations regarding that time period. If a location has had all of its content filtered, it will not be included in the list to be returned, meaning its marker will not be displayed on the map. On the other hand, if it does have at least one unfiltered file, it will be included in that same list. As for the initial overall state, with all points being shown, all the buttons are pushed out – because the filters are off – which draws attention to the fact they can be interacted with.

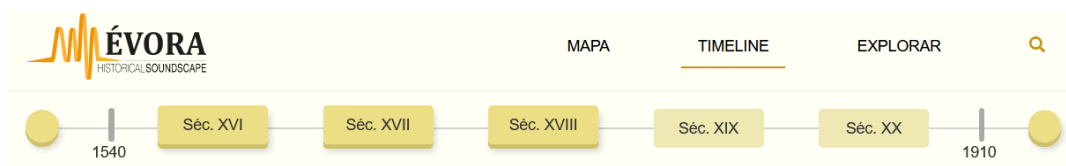


Figure 5.11: Timeline component as displayed in a large screen, filtering the 19th and 20th centuries.

5.3.6 Back-office

In this section, the changes were smaller. They consisted mostly of matching the new colour palette, adding a new tab and tweaking the old design.

The login logic was reworked. Initially, after clicking “Login” or accessing the corresponding [URL](#), the user was redirected to the main page with a new modal⁴ in focus. This component was where the user, presumably an administrator, could login. One issue was that in order to trigger this action, the browser would repeat all the initial requests when the main page was loaded, such as requesting all locations or events. Since this action is hidden behind a specific [URL](#), it is unlikely to get there by mistake, which justifies the login becoming its own page. This new page, accessible through a privately disclosed [URL](#), consists of a simple form with the username and password input, along options to go back, attempt to login and hide or reveal the password, as seen in fig. 5.12

This was achieved by using the package React Router, as it was possible to add a Router in the application. It is important to note that React follows Single-Page Application (SPA) principles, meaning it is used to dynamically rewrite the page content instead of loading new pages. This allows the user to navigate between different components, while the platform updates its browser history and [URL](#). By using a router in the main “App” container, the default path lead the user to the main flow, another path lead to the login page and another one to the management page.

Both the login and management components access the browser’s session storage with `getItem()` to find an item “token”. This item is updated with `setItem()` along the authentication token every time a successful login is performed, and removed in every logout. In both contexts, if the token is nonexistent or invalid, the user will be redirected to the login page, otherwise the router will redirect them to the management page, as it means a successful login was performed and it has not yet expired. Manual logins are performed through the basic access authentication method. The client sends an encoded string containing both the e-mail and the password in the “Authorisation” header in a request to the server. The server then responds with [HTTP](#) code 200 (OK) if the information is legitimate and with [HTTP](#) code 401 (Unauthorised) if the request was denied.

The navigation bar was also updated to match the customised bar in the platform’s

⁴Container with relevant information that requires interaction. It disables the main window but keeps it visible, usually with a black transparent overlay, as to not disrupt the workflow.

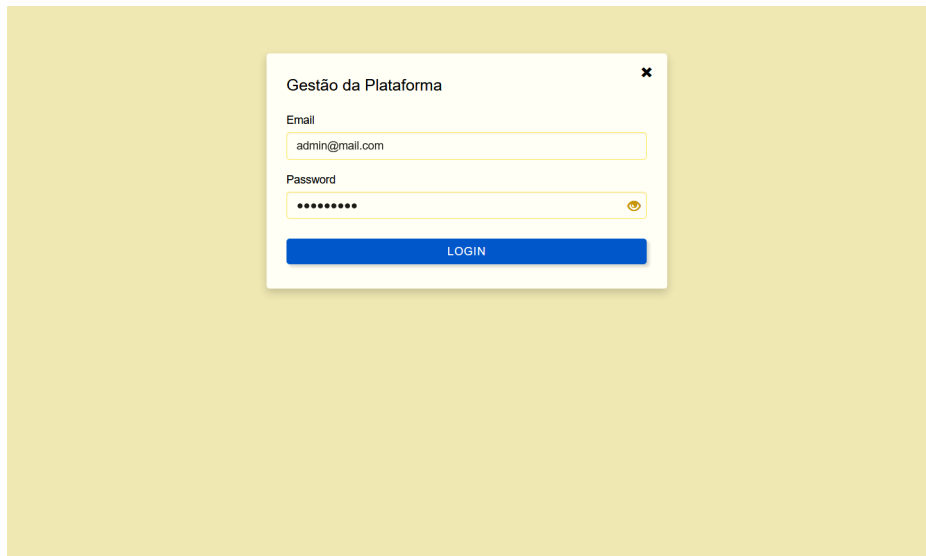


Figure 5.12: Login page for administrators to access the back-office.

main page, keeping its only option to log out.

Previously, logged in administrators could add four types of resources to the database and display them in the platform – locations, files, itineraries and events. However, this was the only possible action. Therefore, in order to edit or delete content, the developer had to manually interact with the database. This means the prototype could not be maintained solely by an administrator without additional database management knowledge. As to give administrators more management opportunities, the forms were reworked to include a delete option. Not only that, locations and events have can have their attributes directly edited. Files and itineraries, due to the nature of some complex attributes, should not be edited because it is simpler to delete and add a new one altogether. These changes were also reflected in the server, which had to accommodate new [REST](#) requests to delete and edit. The delete action in particular benefited from the cascading property of some attributes in the database, as several use cases influenced the outcome.

Due to the new crowdsourcing feature, there was a need to manage the gathered material as well. A new tab was introduced to include a list of submitted content, with the options to approve, edit or deny a single or multiple submissions. Administrators can also sort by date of submission or filter what listing to see by type. This tab can be seen in [fig. 5.13](#).

With these changes, the platform is sustainable from the administrator's point of view, being that they can easily manipulate the database's content. In order to guarantee consistency, various use cases including different kinds of relationships between resources were tested manually. For example, when deleting an itinerary originally associated with an event, the event will not be deleted. Similarly, if the event was deleted instead of the itinerary, the itinerary will not be deleted because it can still exist, realistically. However, when a location is deleted, any itinerary or file associated with it is also deleted because

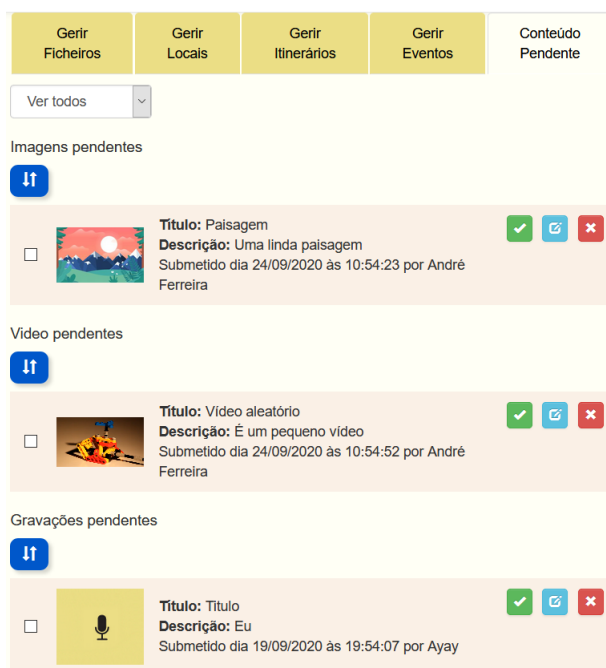


Figure 5.13: Back-office tab to handle submitted pending content.

they become inaccessible.

5.3.7 QR code scanning

This feature’s goal was to allow users to scan QR codes, most likely in or near the locations displayed in the platform, in order to show specific multimedia content in the platform. Although the content was already accessible, the idea was to show featured images, videos or audios through a more interactive way that could later be used in a storytelling or gamification context. However, due to lack of further advancements regarding the creation of these QR codes, which would have to be printed in plaques or stickers and placed in authorised places, the feature is considered to not be fully implemented and usable.

The user’s main interaction is fully working but hidden. For this, React package “react-qr-scanner” was used, which provides a component for reading QR codes from the available cameras. The scanner, provided by the aforementioned package, scans every 500 milliseconds - the default value which may be customised -, once activated. After each scan, it may detect a code successfully or not, but in case the former happens, the location’s content modal is opened, focused on the code’s specific file. When scanning a code, the platform checks its structure and compares it to what is stored in the database. This is achieved by querying the database for the identified code and checking if the scanned code’s file and location ID match the ones in the database.

In the back-office, a new tab was added, although it is also currently hidden. This tab allows the administrator to generate QR code information, by selecting a location and one of its file. When both are selected and the form is submitted, an entry is added to

the database. This action also prints the text to be used in the generation of the QR code itself, as seen in fig. 5.14. Although not implemented, package “qrcode.react” was tested in parallel to generate the codes from the resulting text. This package provides a highly customisable component that generates codes visually and dynamically according to its state, which can later be downloaded. The code generation was not implemented in the hidden solution because the feature is not going to be used until a further point in time, where codes will most likely be displayed in physical form. Moreover, multiple QR codes can have the same information.

Figure 5.14: QR code creation tab after successfully submitting new information, with the necessary text to generate a code and a button to copy it.

5.4 Conclusions

The implementation of several concepts was discussed throughout this chapter. As raised in chapter 4, the multitier architecture for the prototype designed in [47] was unchanged. Despite the conservation of this aspect, elements in all layers were transformed in order to encase the new features and improvements. As this iteration came to be, it became apparent that the prototype and its respective evaluation by both users and experts were fundamental in creating new versions with the given feedback.

The design had to be heavily reworked to reflect clearer interactions and integrate all of the planned features. The system’s responsiveness was imperative and multiple components required special attention in order to achieve this. The timeline was one of them, as its display was impractical. Moreover, the navigation bar in which the previous component is inserted into, did not exist and need to be created and adapted to various screen sizes without reducing visibility and, more importantly, functionality. The connection with the city of Évora was solidified by the use of familiar elements. This included the colour palette and images used in the feature cards and the first time user screen.

The database did not undergo such heavy modifications because it was unnecessary, but was still updated accordingly, mostly due to crowdsourced content and future QR codes, as was seen in fig. 5.4. The REST methods created to communicate with such

changes, albeit linear, had to follow numerous use cases for a smooth interaction, particularly for administrators.

The capture and editing of spatial multimedia content was likely the most demanding process due to all the steps involved - setup, multiple recordings, editing, rendering and submission - and the possible hurdles - noise and time constraints. Albeit recording only 2 days worth of content, the entire process took weeks. Nonetheless, in the end the results were as expected, with both high quality and detail. The present documentation is equally as important, as it exposes what material and environment is necessary and how to proceed.

EVALUATION AND REDESIGN

This chapter describes the platform's evaluation process regarding the many features implemented and reworked. It includes details about the tasks and questionnaires used by users and design experts, as well as their results. It also includes the modifications done in the next iteration, in order to address any issues or necessary changes.

6.1 Evaluation

With the new established design and functionalities, it was necessary to test how users would interact with the platform, to ascertain what problems would be encountered and what could be done to avoid or correct them. Usability testing, which was found to be useful for this purpose, is one of the most common techniques used, with many possible approaches using different materials [41].

In 2000, Jakob Nielsen [39] explained why only five users were required for an effective usability test. Elaborate tests with large amounts of users are considered a waste of resources because, as Nielsen explains it, the insight given by users above this number does not balance out its cost and productivity. Instead, they suggest an iterative process, where five users evaluate one design, which then evolves according to their findings, to be tested by a batch of five different users, and so forth. However, each case has its own particularities and there are some exceptions to this rule of thumb. When a platform has distinct groups of users, each group, consisting of an identically small amount of users, should perform the test. Not only that, if the study collects a great deal of quantitative data, larger amounts of users provide a tighter confidence interval.

Because of this, and much like in the dissertation [47] regarding the first prototype of this platform, the chosen methodology for testing was to provide the user with a list of tasks and a post-test questionnaire. There are two possible groups of users, which can be

defined as common users and administrators. Both groups are expected to interact with the map and the different features, in order to explore the city's soundscape, but the latter can access the back-office and manage the platform while the former participated in an A/B testing for a specific feature. Usability experts were also asked to be a part of this process, evaluating the platform individually and documenting issues, such as usability heuristics violated. These 3 types of tests were divided in the following way:

- Common users – 30 anonymous participants, 15 tests in laptop/desktop devices and 15 in mobile devices, in different browsers of the user's choice;
- Administrators – 4 participants in laptop/desktop devices, which are the only **PA-SEV** members that will be using the back-office;
- Usability experts – 2 participants, each testing in both mobile and desktop devices.

Ideally, all tests would have been performed in person, but due to current constraints as a consequence of COVID-19, the testing was performed mostly online through voice chat and a shared screen between the user and the supervisor.

As for the materials, the task list presented to common users and usability experts consisted of 10 tasks in total, which can be found in appendix **A** in Portuguese and in appendix **B** in English. However, the administrator group had a list that consisted of 6 more tasks, specific to the platform's back-office, which can be found in appendix **H** in Portuguese and in appendix **I** in English. Before carrying out the tasks, the user was briefly introduced to the project's goals and the process they were about to be a part of. The user was also encouraged to think aloud and ask questions during the test.

The post-test questionnaire, which was filled in privately by the testers, was shared and answered in Portuguese for convenience and can be seen in full in appendix **C**. A translated version in English can be found in appendix **D**. It was divided in 3 sections:

- User profile – although users remain anonymous, it is important to understand if and why they are part of the target audience (e.g. people who like to travel or are interested in cultural heritage);
- System Usability Scale – created in 1996 by John Brooke, this is the most widely used questionnaire regarding usability [31]. It consists of 10 standard five-point statements, which can be converted to a score between 0 and 100. However, this score can also be split into two factors: learnability and usability [32], which provide further details;
- Platform and features – questions related to certain functionalities and design aspects of the platform are asked. This way, the questionnaire can ensure that users focus and criticise specific sensitive elements that require special input, in order to reaffirm their usability (e.g. the timeline, which was previously regarded as difficult to use and understand [47]).

The final component of the post-test questionnaire includes questions that can gather both qualitative and quantitative data, but mostly the latter. Therefore, users can answer directly, in a simplified way, to questions that do not require deep input but can still elaborate on others that do. However, since quantitative data can be deceiving [56], two final questions give the user the option to write freely about anything, by describing any general issues they encountered and giving suggestions on the platform. Moreover, a short open talk after the test and the questionnaire also provided meaningful insight with some of the users. An additional quantitative aspect was measured during the test, which was the time the user took to finish each task. The goal was to see what the average time per task was, to understand if there were any major deviations and why.

6.1.1 Task time

The previously mentioned task time was only measured for the 30 users in their usability test. It is worth noting that the first task was ignored for this measurement, because it was not an important element of the iteration and merely a temporary aspect. Table 6.1 and table 6.2 display the results, the former in desktops/laptops and the latter in mobile devices.

Table 6.1: Average time and its standard deviation per task and overall in desktops/laptops.

Task	Standard Deviation	Average
#1	- - -	- - -
#2	00:36:44	01:44:44
#3	00:55:11	01:16:52
#4	00:55:56	02:32:40
#5	00:42:26	01:40:48
#6	01:30:59	05:40:40
#7	00:42:35	01:38:00
#8	00:36:32	00:52:48
#9	00:38:37	01:57:00
#10	00:12:19	00:23:16
OVERALL	03:18:09	17:46:48

As expected, the average time in desktop devices is slightly smaller, albeit with a larger standard deviation, because a larger screen allows for better recognition of specific elements. A good example would be the navigation bar, which becomes a toggleable list in small screens, but displays items fully in larger ones. The relatively small standard deviation in both cases shows that answer times were mostly clustered, thus one can conclude that most users behaved similarly in most tasks. Since, for the most part, interactions were positive, this serves as a good basis to process further data, both qualitative and quantitative.

Table 6.2: Average time and its standard deviation per task and overall in mobile devices.

Task	Standard Deviation	Average
#1	---	---
#2	00:38:50	01:54:48
#3	00:48:49	01:39:08
#4	00:50:26	02:42:00
#5	00:43:10	02:10:12
#6	01:24:40	06:11:40
#7	00:31:50	01:44:52
#8	00:12:26	00:39:36
#9	00:36:34	02:23:32
#10	00:17:58	00:31:32
OVERALL	02:38:32	19:57:20

6.1.2 Questionnaire data processing

The data gathered during the entire process was crucial in evaluating possible weak points and identifying solutions and improvements. Although verbal comments and discussions took place during the tests, the questionnaires that are filled in afterwards include all of the users' written input about specific details. Albeit equally important, the administrators' data will be presented and discussed separately in some instances, because the 30 users represent a sample, whilst the 4 PASEV members are the entire current population of administrators.

The resulting graphs for the 30 users can be found in appendix E in Portuguese and F in English. Likewise, the resulting graphs for the 4 administrators can be found in appendix L in Portuguese and in appendix M in English.

The following subsections will analyse the answers by both groups in the three questionnaire sections.

6.1.2.1 User profile

Out of the 30 users, 22 were male and 8 were female and for the 4 administrators, 2 were male and 2 were female. The age groups for both type of users can be found in table 6.3.

Table 6.3: Age groups of all participants in the usability tests.

Age group	Common Users	Administrators
Less than 18	1	0
18-24	12	0
25-30	15	1
31-45	2	1
Over 45	0	2

Regarding common users, the distribution in different career fields can be seen in

fig. 6.1. Despite doing the test in either a desktop/laptop device or mobile device, all users were asked to rate their experience with both types of devices. Their answers can be seen in fig. 6.2 and fig. 6.3. Half (15) of the users said they had no knowledge of Évora's geography, 3 said they did and 12 said they somewhat did. When asked if they used any type of apps during their travels, 93.33% (28) answered positively. Of these 28, 25 mentioned GPS, 19 online maps and 7 online guides. The browsers used, which can influence heavily how users interact with and see the platform's interface, in desktop/laptop devices can be seen in fig. 6.4 and in mobile devices in fig. 6.5.

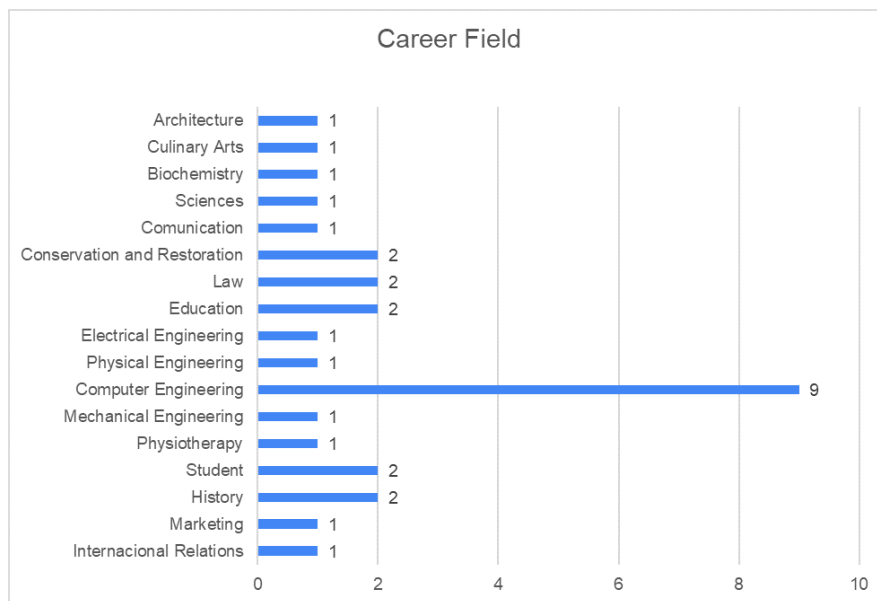


Figure 6.1: Answers to 'Career Field' of the 30 users.

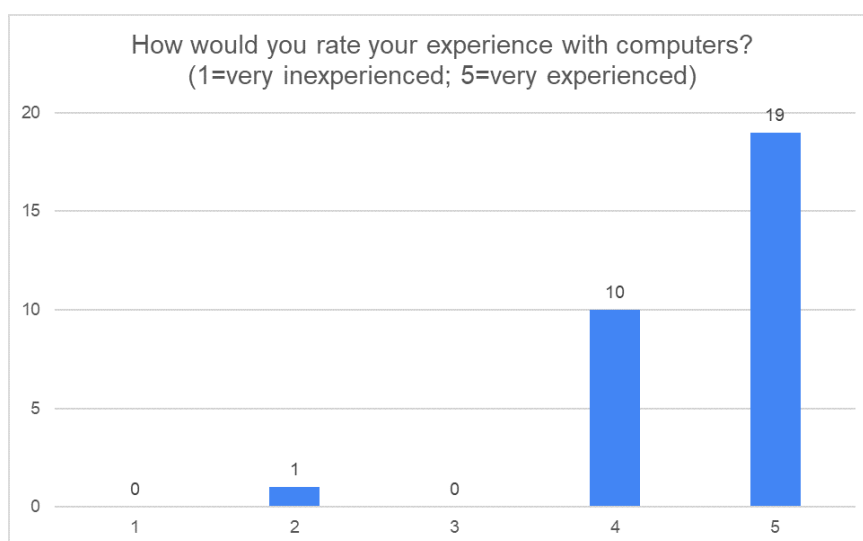


Figure 6.2: Answers to 'How would you rate your experience with computers?' from the 30 users.

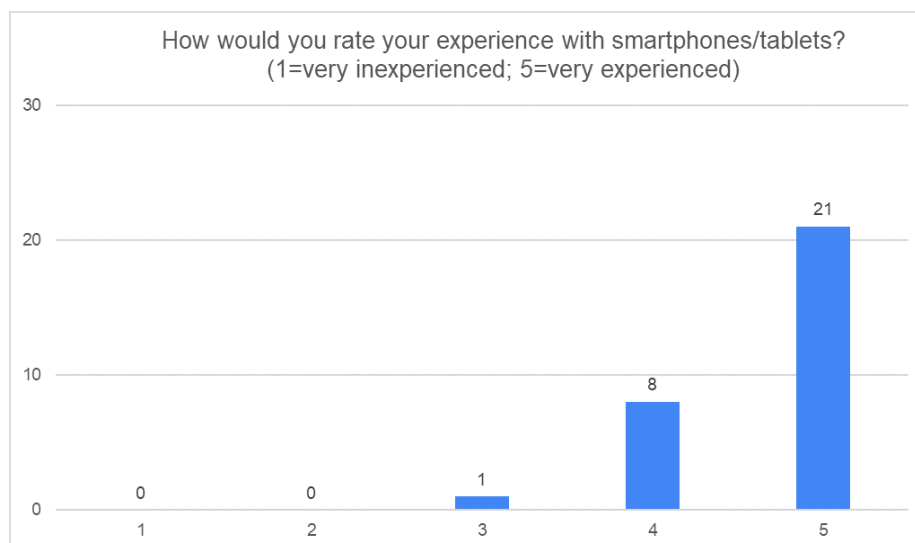


Figure 6.3: Answers to 'How would you rate your experience with smartphones/tablets?' from the 30 users.

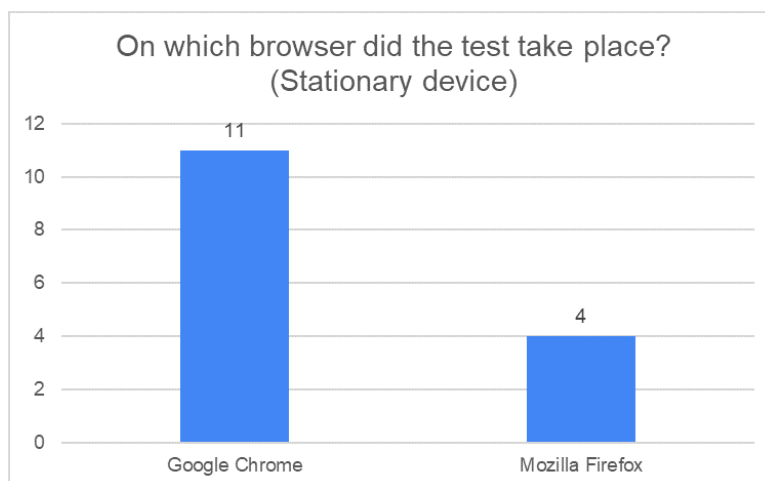


Figure 6.4: Answers to 'On which browser did the test take place?' from 15 users in laptop/desktop devices.

As for the 4 administrators, their career fields were Musical Arts, Musicology, Music and History. The self evaluation on experience with both types of devices can be seen in fig. 6.6 and fig. 6.7. Only one of the administrators answered negatively to the question 'Are you familiar with Évora's geography?'. Similarly, only one answered negatively to the question 'Do you use any kind of mobile applications while travelling?'. The other 3 then mentioned using **GPS**, with one also mentioning online maps. All tests were performed in a desktop/laptop device for convenience, one in Safari and the rest in Google Chrome.

6.1.2.2 System Usability Scale

As briefly mentioned, this scale, is commonly used to measure a platform's usability. The 10 questions, each with five possible response options ranging from "Strongly Disagree"

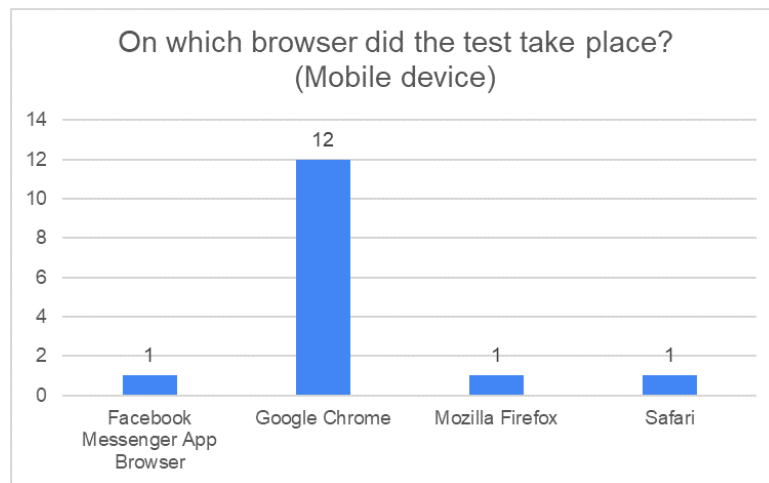


Figure 6.5: Answers to 'On which browser did the test take place?' from 15 users in mobile devices.

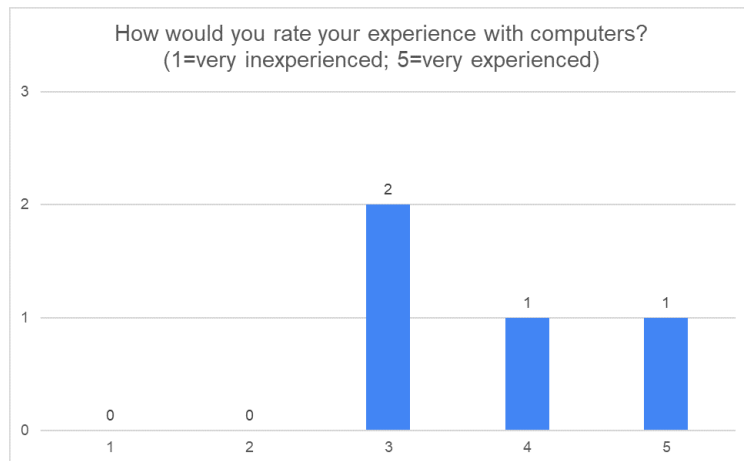


Figure 6.6: Answers to 'How would you rate your experience with computers?' from the 4 administrators.



Figure 6.7: Answers to 'How would you rate your experience with smartphones/tablets?' from the 4 administrators.

at 1 to “Strongly Agree” at 5 are the following:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

Every odd numbered question has a positive connotation, while every even numbered question has a negative connotation. From the answers to these questions, the following values can be extracted:

- SUS Score;
- Learnability;
- Usability.

To calculate the SUS Score, one must subtract 1 from each of the odd numbered questions (i.e. with positive connotation) and subtract the value of the other questions from 5. The 10 new values will then be summed and multiplied by 2.5. The result will range from 0 to 100 but should not be interpreted as a percentage.

This score alone can be used to draw some conclusions, as the higher the value, the better. For example, in order to better interpret this result, an eleventh question could have been used to choose an adjective and rate the platform’s user-friendliness [2]. Despite the qualitative appreciation, this also included a linear SUS score grading system based on the “letter grades given at most universities”, which consisted of a familiar A to F evaluation. But the SUS score could also be looked at relatively to its corresponding percentile range. Several years of work and data culminated in a curved grading scale [49] that offers more insight about the score’s meaning, with 68, the average SUS score, at the centre of its C grade. The latter scale can be found in table 6.4.

Table 6.4: Grading scale according to SUS Score and respective percentile range.

Grade	SUS Score	Percentile Range
A+	84.1-100	96-100
A	80.8-84.0	90-95
A-	78.9-80.7	85-89
B+	77.2-78.8	80-84
B	74.1-77.1	70-79
B-	72.6-74.0	65-69
C+	71.1-72.5	60-64
C	65.0-71.0	41-59
C-	62.7-64.9	35-40
D	51.7-62.6	15-34
F	0.0-51.6	0-14

The learnability factor can be extracted by focusing on only two of the questions: #4 and #10. Since both are even numbered questions, their values are subtracted from 5, then summed and multiplied by 12.5.

The usability factor can be extracted by focusing on all the other questions that were not used to calculate the learnability's score. The same treatment for odd and even numbered questions is repeated, all 8 values are summed and multiplied by 3.125.

Both these values, as expected, will also be numbers between 0 and 100. As the factors are what constitutes the **SUS** score, it is safe to assume that the same grading scale could be used. However, for convenience, only the **SUS** score will be graded, despite the factors also being displayed. Table 6.5 and graph 6.8 represent the 15 users' **SUS** results in desktops/laptops and table 6.6 and graph 6.9 represent the results in mobile devices.

As can be seen in these tables, the average **SUS** score is not only above the mentioned average of 68, but over 80.8 in both types of devices, hence graded as an A. Its separate factors, learnability and usability, are also at high values. Looking at the individual scoring, the worst experiences can be identified by 3 Cs and 2 Fs.

As for the administrators' scores, which can be seen in table 6.7 and graph 6.10, the results were more contrasting, resulting in an average grade of 72.5 (B-), which is still over the average score. But two of the scores were graded as C and F, similar to the scores mentioned in the previous paragraph. All of these instances will be looked at further ahead, to understand what went wrong with the users' and administrators' experiences.

6.1.2.3 Platform and Features

This is the section where both groups were asked specific questions about the new or updated features, in order to get a better feel of how certain elements and details were being interpreted. Most of these questions also used a five point answer, to rate how much one agrees with a certain statement. A 1 point answer means "Strongly Disagree", a

Table 6.5: System Usability Scale scoring for 15 users in desktops/laptops.

User	Grade	SUS Score	Learnability	Usability
1	C+	72.5	75	71.875
2	A+	87.5	87.5	87.5
3	A+	100	100	100
4	A+	87.5	100	84.375
5	A+	87.5	87.5	87.5
6	C	65	87.5	59.375
7	A	82.5	100	78.125
8	A-	80	100	75
9	C	67.5	75	65.625
10	A-	80	100	75
11	A+	87.5	100	84.375
12	A+	87.5	75	90.625
13	A+	87.5	100	84.375
14	A+	85	100	81.25
15	A+	90	100	87.5
Average	A	83.17	92.5	80.83
	Maximum	100	100	100
	Minimum	65	75	59.375

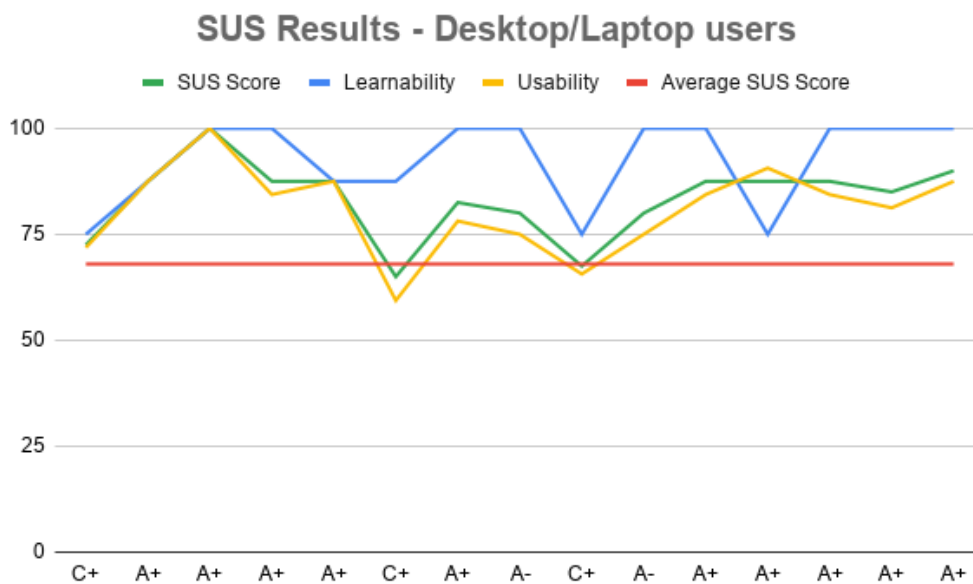


Figure 6.8: Graph depicting the System Usability Scale scoring for 15 users in desktops/laptops.

Table 6.6: System Usability Scale scoring for 15 users in mobile devices.

User	Grade	SUS Score	Learnability	Usability
1	F	47.5	75	40.625
2	B	75	100	68.75
3	A+	95	100	93.75
4	A+	90	100	87.5
5	A+	85	100	81.25
6	F	40	50	37.5
7	A	82.5	100	78.125
8	A+	85	100	81.25
9	A+	87.5	75	90.625
10	A+	85	87.5	84.375
11	A+	100	100	100
12	A+	85	100	81.25
13	A+	85	100	81.25
14	A+	90	100	87.5
15	A+	95	100	93.75
Average	A	81.83	92.5	79.17
	Maximum	100	100	100
	Minimum	40	50	37.5

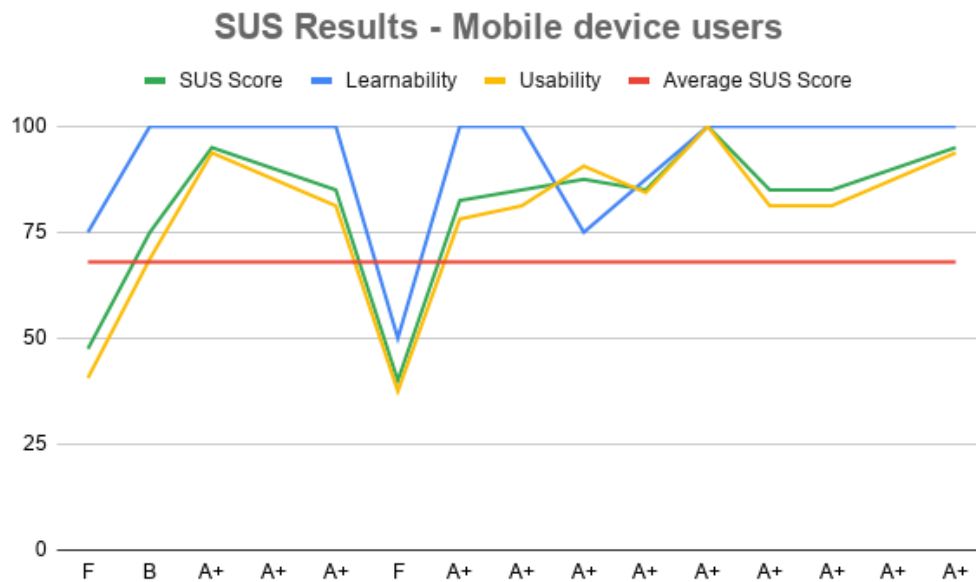


Figure 6.9: Graph depicting the System Usability Scale scoring for 15 users in mobile devices.

Table 6.7: System Usability Scale scoring for 4 administrators in desktops/laptops.

User	Grade	SUS Score	Learnability	Usability
1	A+	87.5	75	90.625
2	A+	90	100	87.5
3	C	70	87.5	65.625
4	F	42.5	37.5	43.75
Average	B-	72.5	75	71.875
	Maximum	90	100	90.625
	Minimum	42.5	37.5	43.75

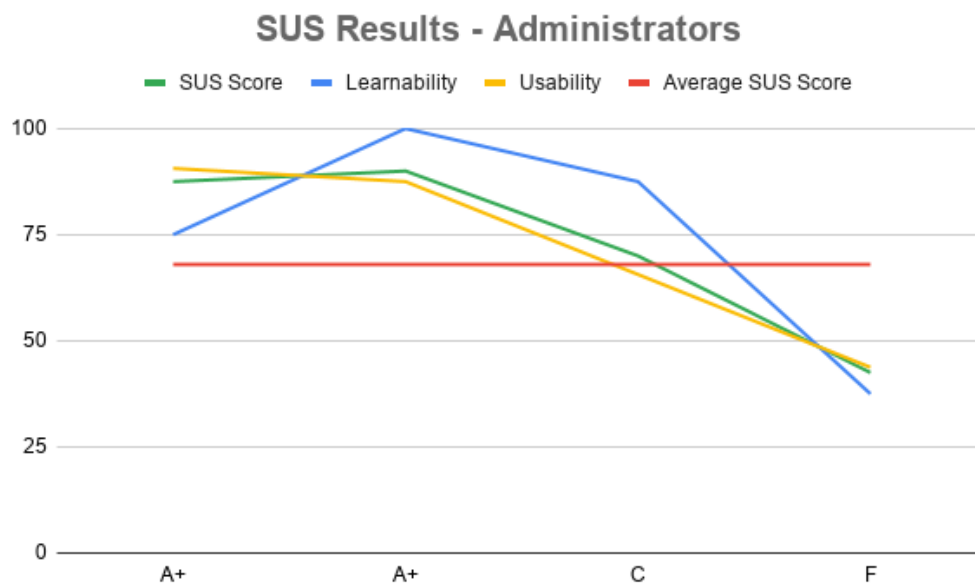


Figure 6.10: Graph depicting the System Usability Scale scoring for the administrators in desktop/laptops.

2 point answer means “Disagree”, a 3 point answer means “Indifferent”, a 4 point answer means “Agree” and a 5 point answer means “Strongly Agree”.

70% (21) of the users agreed (4 or 5 point answers) that the navigation bar was easy to use, but 4 were neutral (3 point answer). The second statement still tipped to the positive connotation side, but had more mixed answers, as can be seen in fig. 6.11. The next statement was similar but in regards to the historical cartography options. However, the answers were exclusively positive, with 80% (24) of the users using a 5 point answer and the rest using a 4 point answer. The different reactions between these two statements are mostly due to poor feedback when changing the base map and, according to some users, the lack of interest or knowledge of different base maps. In fact, many of them assumed they were looking at a Google Maps map, which was not one of the original three options.

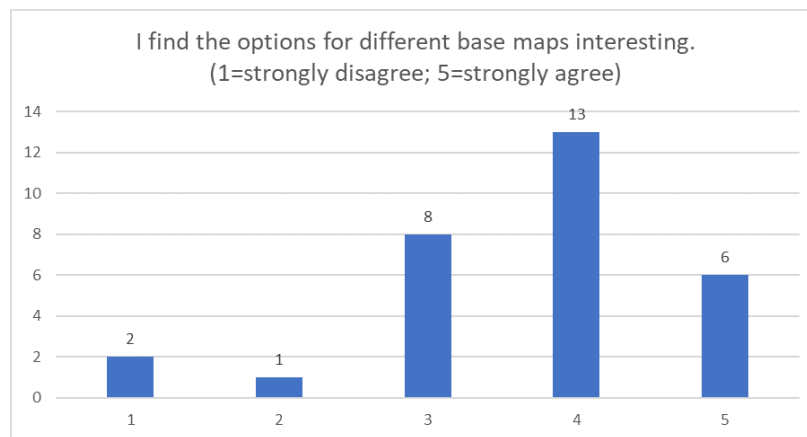


Figure 6.11: Answers to 'I find the options for different base maps interesting' from 30 users.

The following five questions gathered information on how users felt about the crowd-sourcing feature and interaction with the spatial multimedia content. The feedback was overwhelmingly positive, with the exception of the second statement, as can be seen in fig. 6.12. Even then, the discrepancy was not heavy. Some users were unsure if the microphone was already recording or not, and in one exceptional case it would not start to record because the laptop's microphone was being used by another software, as the supervisor and user were in a video call.

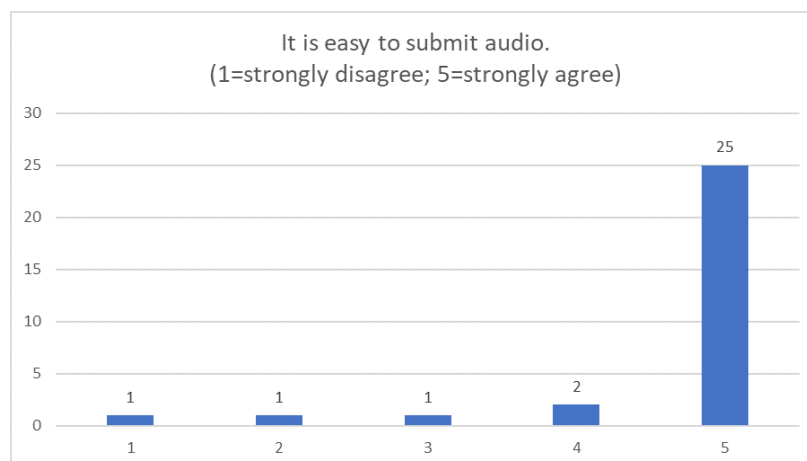


Figure 6.12: Answers to 'It is easy to submit audio' from 30 users.

The next statement is the first one related to the timeline. As can be seen in fig. 6.13, the most popular answer was neutral, followed by positive feedback and then negative. It is clear, however, that the answers are much more heterogeneous than the previously observed. This is true for every statement related to the timeline, as the following two received mostly negative (1 or 2 point answers) feedback, as can be seen in fig. 6.14 and fig. 6.15. Afterwards, a question regarding how the timeline works specifically, with only one correct answer, was posed. Fig. 6.16 depicts the results, but the following is a list of

the options and respective percentages:

- New geographical elements appear in the map besides the markers - 0%
- Every location associated with the 19th and 20th century appear in the map - 33.33% (10)
- Every location associated with at least one of the filters disappear from the map - 36.7% (11)
- **Correct answer** - Every location associated with just the 19th century, with just the 20th century or with just the pair disappear from the map - 16.7% (5)
- The base map is changed - 0%
- None of the above - 13.3% (4)

This means only 5 of the 30 users understood what the timeline was doing. As previously explained, the timeline filters content of all locations based on the century(ies) selected and when all the content of a location is filtered, it disappears from the map. This gave users the wrong idea about what the timeline was doing and several of them mentioned that they only got a glimpse of such when looking at this question - because it is not an open-ended question, but a question with a set of predefined responses. Other issues regarding this will be discussed further ahead in the redesign, but a conclusion that can be drawn from this is that not only is the timeline a difficult element to integrate, the question was presented poorly and might have led to inaccurate results.

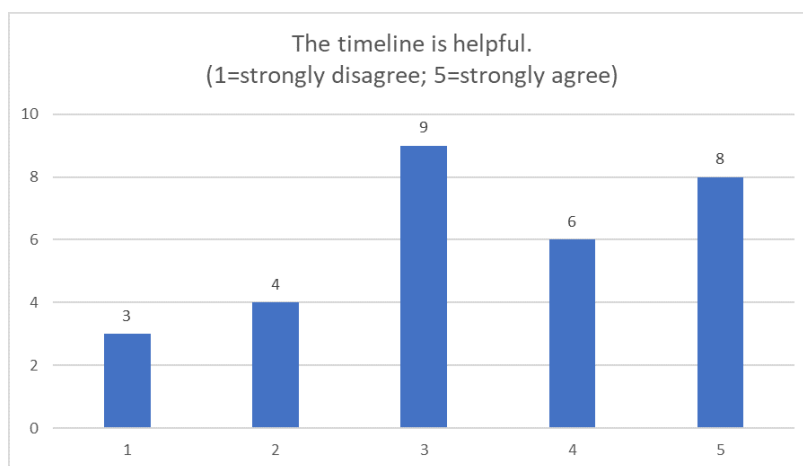


Figure 6.13: Answers to 'The timeline is helpful' from 30 users.

The next question is where users found out they participated in an A/B test. This means 50% encountered one particular presentation of a feature, while the other 50% encountered another. Once a location disappeared because of the timeline filters, half of the users could still see that location in the search results, but greyed out and with an

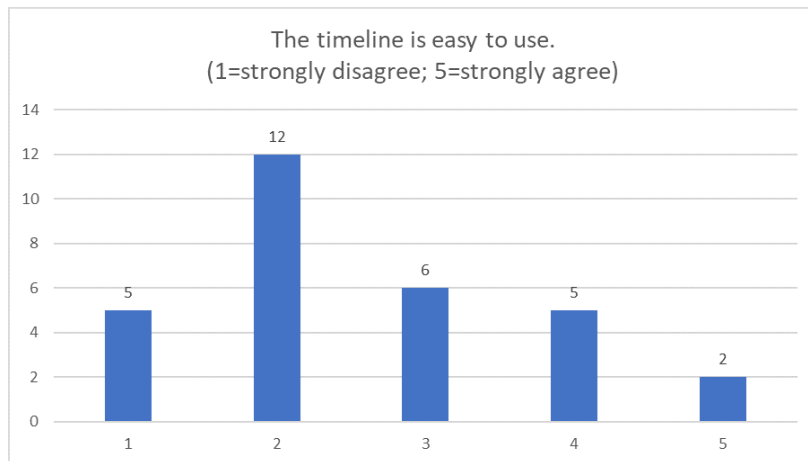


Figure 6.14: Answers to 'The timeline is easy to use' from 30 users.

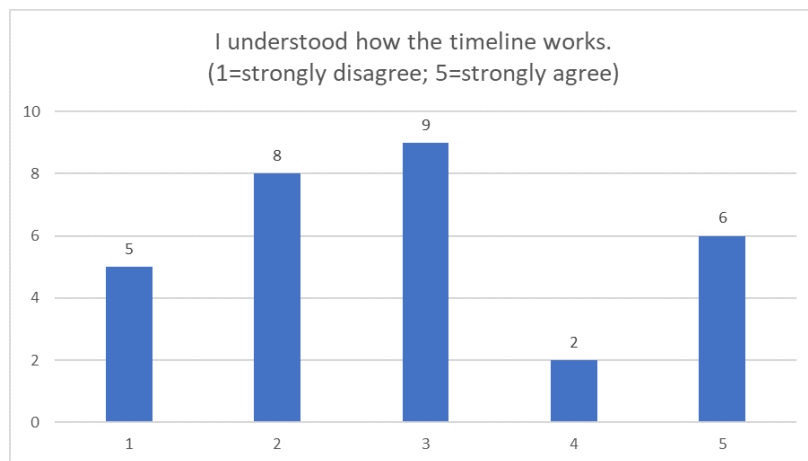


Figure 6.15: Answers to 'I understood how the timeline works' from 30 users.

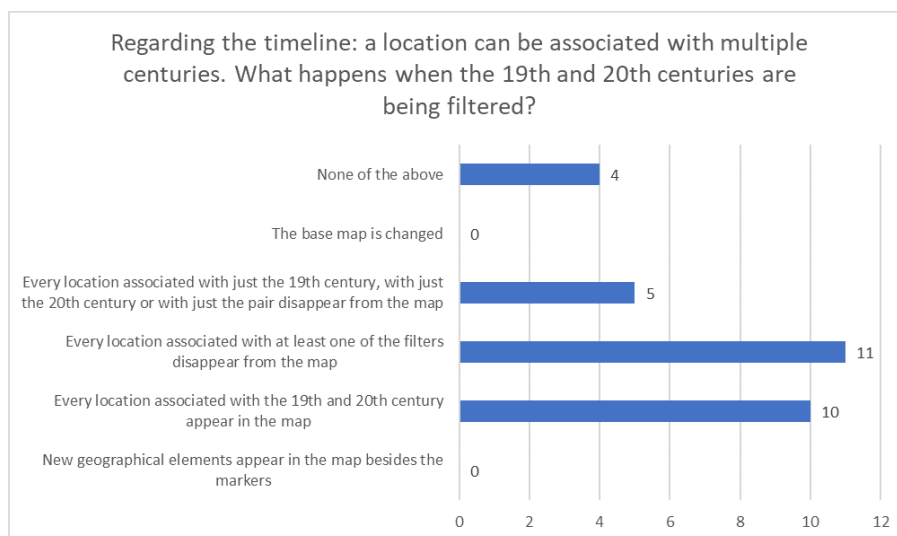


Figure 6.16: Answers to 'Regarding the timeline: a location can be associated with multiple centuries. What happens when the 19th and 20th centuries are being filtered?' from 30 users.

crossed eye icon, as to indicate it was there but was invisible. The other half could not find the location in the search results because it would simply not be there. 83.33% (25) of the users preferred the former, 10% (3) were indifferent and the remaining 2 preferred the alternative. Most users justified this by saying they prefer a visual indication of why the location can not be opened than to be looking for something in a list until, or if at all, they remember the filters removed the location from the map.

Users found that both locations and events were easy to search, with the exception of one user which, in both cases, answered indifferently.

A question regarding what happened to the map when an itinerary was activated was posed, with multiple options as answers:

- **Correct answer #1** - A path connecting the different locations appeared on the map - 93.3% (28)
- A path connecting my current location to the next location appeared on the map - 6.7% (2)
- **Correct answer #2** - A new icon appeared on the map - 46.7% (14)
- **Correct answer #3** - The markers that do not belong to the itinerary disappeared from the map - 66.7% (20)
- The content screen of the itinerary's first location appeared - 3.3% (1)
- Other - 3.3% (1)

The correct answers were mostly identified, except for #2. Upon further inspection, this was due to the icon being relatively small, specially in large screens, and blending in with the map. Users suggested a new colour, a larger icon or even a blinking animation. The one user that replied 'Other', included in his input that he was not able to activate the geolocation - however, this is unrelated to the itineraries, because it still is possible to activate an itinerary and perform the corresponding tasks. Despite the positive results, when users were asked right after if they found the interaction to be intuitive and to elaborate on the subject, only about 33.33% answered 'yes'. Most users agreed that the buttons were confusing, there was not enough feedback on the actions they performed and in general it was a clunky interaction. This will be better looked at further ahead.

In the final close-ended question, half (15) of the users replied they encountered some issues while using the platform, which were mostly related to the timeline and itineraries.

As for the 4 administrators, most initial statements had similar results to the users', the exception being 1 user that 'disagreed' (2 point score) with the historical cartography being interesting, 'strongly disagreed' (1 point score) with image submission being easy and 'disagreed' with audio submission being easy. Further ahead, despite finding the timeline interesting, easy to use and understandable, only 1 user selected the correct answer when asked how it worked in a practical example.

All administrators selected the #1 correct answer for the itineraries, but only one selected the #2 correct answer and no one selected the third one. After this, new back-office specific questions were asked. These questions, which can be found in appendix K and J, had positive answers, with the exception of the question 'I find it important to be able to manage the elements in this way' which had 1 user stay 'indifferent'.

6.1.3 Expert evaluation

Along the usability tests and questionnaires, one expert evaluation was also performed in this iteration. It was, however, partial because of time constraints and a temporary power outage that caused the platform to go offline. It can be found in appendix G, bearing in mind it includes feedback on the design and features until the end of task 6.

This evaluation mentioned some of the issues identified by other users, such as the 'Map' menu covering part of the screen and understanding the timeline's states. All occurrences were rated either a 2 (minor usability problem) or a 3 (major usability problem) in the common 0 to 4 scale, meaning none was an imperative change but all were important nonetheless.

Other issues found by the expert included aesthetic details, such as typography and component positioning, but also some confusion in the galleries presentation that could lead to errors.

6.2 Redesign

After the evaluation and testing steps were completed, the requirements to address the encountered issues and further improvements were noted. This section describes the changes performed to the interface design, as well as some functionalities, based on the results presented in section 6.1. The main goal is to prepare the version for a new iteration, much like what has been done to accomplish the current one.

Browser support

Although the prototype was accessed regularly throughout its implementation, some browsers and features were not tested entirely. Certain JavaScript functions and CSS properties can not be used in some versions, usually outdated, of specific browsers. This is expected and should not break the website's flow or interfere heavily with the user's interaction. In fact, in most cases, such as this one, it is a minimal percentage of users that might be hindered.

During the testing, one supervised user noticed that the galleries were not being displayed correctly in Safari. The browser was interpreting the galleries' style properties differently due to a forced flex box inside the responsive layout. This was easily fixed by tweaking the respective style properties and similar issues were taken care of in other smaller components.

Recording

In task 6, users were required to record a sound within the platform and submit it. As previously discussed, they were not always sure the microphone had started recording because the main difference between the states of not recording and recording are a subtle change from a red circle to a red square, as can be seen in fig. 6.17.



Figure 6.17: Not recording and recording states, left to right, as displayed before the usability test.

In order to make this more evident, a small text label was introduced on top of the button displaying “A gravar...”¹, as can be seen in fig. 6.18.

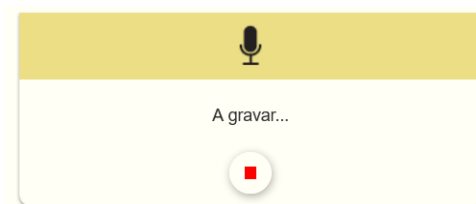


Figure 6.18: Recording state as modified after the usability test.

Itineraries

In task 9, users interacted with the itinerary feature, so as to activate one and analyse it. However, the interaction with this menu was deemed counter-intuitive and many participants had to resort to trial and error or asking the supervisor for help in order to complete the task. The insight given both during the test and in written format in the questionnaire revealed that users felt the buttons’ appearance did not match what they thought they would do and were considered to be the source of the problem. The previous design for the itinerary menu can be seen in fig. 6.19.

Most users initially thought the bottom row of buttons allowed them to advance through different itineraries or the different locations in the menu. That is why, as per task 9a., users were unsure the itinerary was active or not, because they had already selected it and could not find any way to activate it. In reality, the left arrows button lead the user back to the list of all itineraries and the right arrows button activated the selected itinerary. Despite the itinerary showing up in the map once activated, the menu remained with the same buttons, albeit with different actions. The left arrows button was

¹“Recording...” in English.

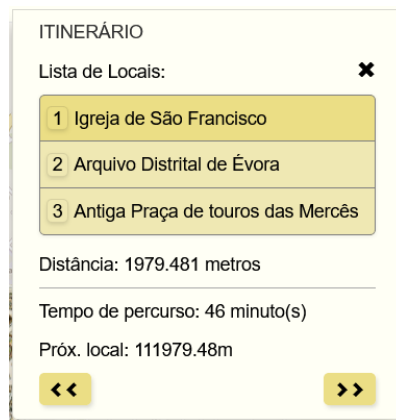


Figure 6.19: Interaction menu with selected itinerary, as displayed before the usability test.

used to deactivate it and the right arrows button did nothing. The cross on the top right corner closed the menu without ever interfering in the itinerary's state. This button was also used incorrectly in task 10, when users were asked to deactivate the itinerary.

Thus a redesign regarding the buttons was undoubtedly necessary and was done so to clarify their actions. As can be seen in fig. 6.20, in order to activate an itinerary, the user has to click on a button in the same position as before, but with a new icon for a check mark. To the left of that, the user can still go back to the list of all itineraries, also with a new and simpler icon. When an itinerary is active, the check mark is replaced by a cross, which identifies it as the way to deactivate the itinerary, and the button to go back is removed. The top right corner button's icon was replaced with a simple arrow pointing up, to indicate a minimising action.



Figure 6.20: Interaction menu with selected itinerary (left) and activated itinerary (right), as modified after the usability test.

Furthermore, the icon that appeared on the top left of the map when an itinerary was activated went unnoticed in more than half of the tests. In an effort to avoid this in the future, its colour and background colour were changed to draw more attention to it, while respecting the colour palette. This can be seen in fig. 6.21.

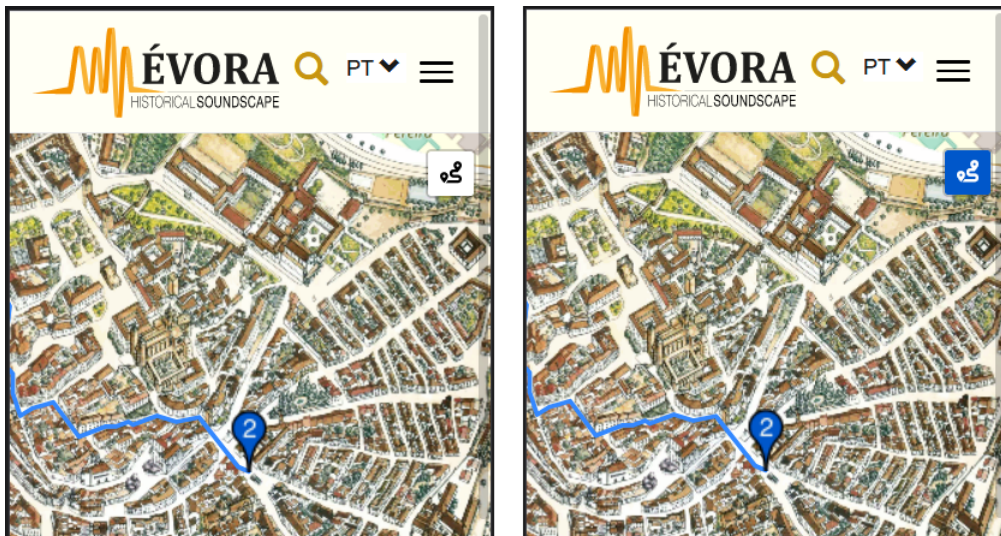


Figure 6.21: Old icon presentation (left) and new icon presentation (right) when an itinerary is active.

Map options

Throughout the tests in mobile devices, users were confused in task 2a. This task asked users to change different map settings, such as the base map and the historical cartographic overlay images. However, the changes caused by selecting different options were usually unnoticeable because only a small portion of the screen was free of the menu in most devices, as can be seen in fig. 6.22.

Moreover, some users commented on the base map options and their value. They mentioned that they did not know the differences between the base maps and that even upon seeing the visual changes and being explained what each of them are, they did not find it an interesting feature to have. This meant that it was something users did not want to interact with and that it was taking up much necessary space.

With these two important pieces of feedback, a decision was made to only have one static base map and remove the other options, as well as to remove other navigation bar elements, while this tab was opened. This has only been done in mobile devices, because it is a temporary modification that requires further discussion and can be seen in fig. 6.23.

Timeline

In task 4, users interacted with the timeline and had to go back to it, temporarily, in task 5, in order to deactivate the filters. These tasks revealed that most users, as mentioned previously, did not understand how the timeline functioned.

They did not immediately realise that it was a filter, even after clicking some of the buttons. Derived from this, they could not figure out when the filter was active or inactive. Some attributed this to the colour scheme, mentioning that the most vibrant colour should mean it was active, not the other way around. This scheme can be seen in fig. 5.11, where

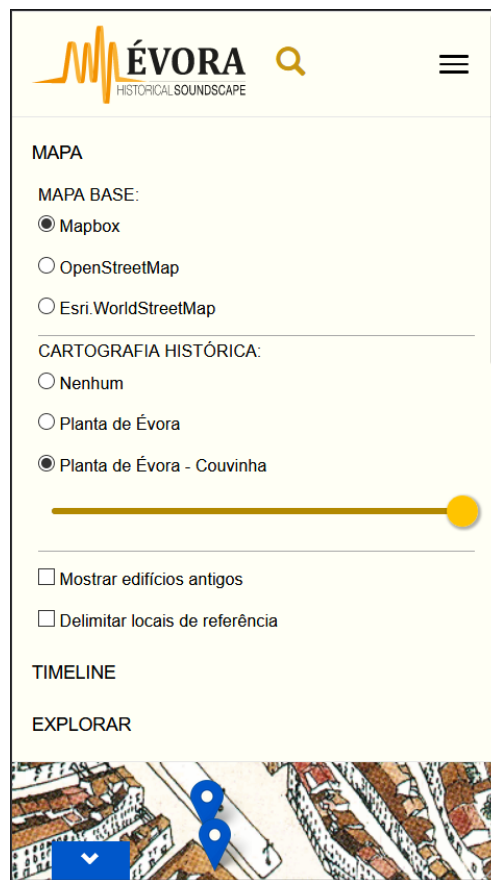


Figure 6.22: Different options for the map settings, as displayed before the usability test.

all filters are inactive, except for the 19th and 20th centuries. Others mentioned that they did not understand if a clicked in button meant the filter as on or off.

Some even mentioned that, prior to seeing the questionnaire, the timeline was filtering by the location's construction or inauguration year. Upon further inspection, this misconception was expected because users have no way of knowing, from the screen, where they only see the navigation bar and map, that each file of multimedia content is associated with a specific, or combination of, period(s) of time. Moreover, when all the multimedia content of a location is filtered, the location disappears from the map. Due to the current lack of implemented content, this happened often and was what caused users to think it was filtering locations.

This represents an issue that can not be easily handled by only reworking the timeline's design. The solution had to consider the fundamental aspect of figuring out how to properly prepare users to know that they are in fact filtering content which they cannot yet view.

Firstly, the timeline was altered to no longer remove locations once all of their content was filtered - their position in the map, address and description, which can never be filtered, are still relevant elements that should remain. It is expected that, in this way, users will no longer associate the timeline to the location's building period. The concept

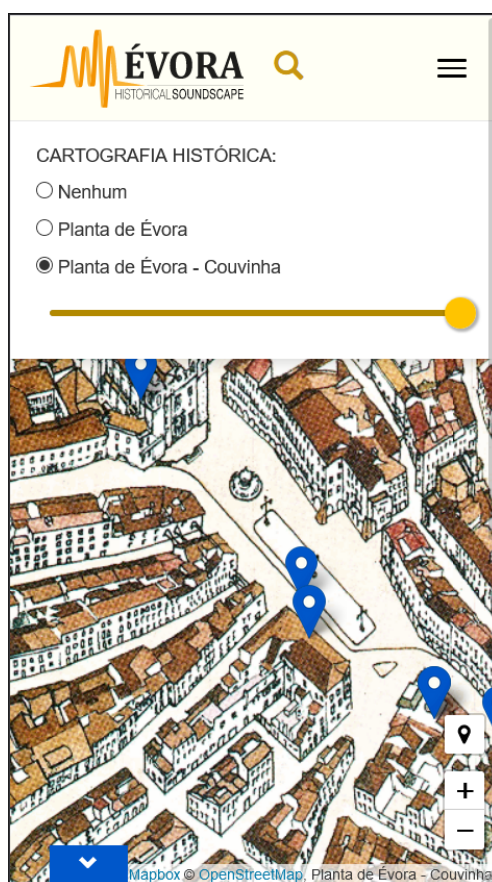


Figure 6.23: Different options for the map settings, as modified after the usability test.

of categorising locations based on their structure emerged from this, because locations could then be displayed differently and filtered based on this new category. Thus, the navigation based on what historical sounds the user wanted to look for, became more logical (e.g. churches will have more sounds related to church bells and sermons). The 4 chosen categories, which cover all existing locations currently, are:

- Churches - includes churches, convents and cathedrals;
- Indoors - includes museums, palaces and schools, among others;
- Outdoors - includes squares, parks and green areas;
- Monuments - includes the aqueduct, statues and the Roman Temple, among others.

Each category has a corresponding icon and colour, both used in the filter with the latter also used to colour the locations' markers, as can be seen in fig. 6.24. This way, even when filters are on or off, users can still tell them apart.

The timeline, which is displayed below this new filter, was slightly tweaked in order to reduce confusion. First, the button colours were inverted. This meant that the buttons were filled in with a dimmer colour first, when all filters were inactive, and filled in with



Figure 6.24: 5 locations with 4 different categories, as displayed in the map.

the brighter colour after the button was clicked, meaning the filter was activated. This change can be seen in fig. 6.25. Note the contrast between this figure and the previously mentioned fig. 5.11.



Figure 6.25: Timeline component as displayed in a large screen, filtering the 19th and 20th centuries, after the usability test.

Both filters, which are accessible through the navigation bar's new item 'Filters' that replaced the item 'Timeline', are displayed together. The timeline is in second place as to achieve the feel that it is 'secondary', filtering something within the locations, which can be filtered in the first portion. This component can be seen in fig. 6.26, along the modified navigation bar.

Language toggle

The platform's internationalisation was a feature suggested by some users during the usability tests, as well as previously discussed with the administrators. This functionality

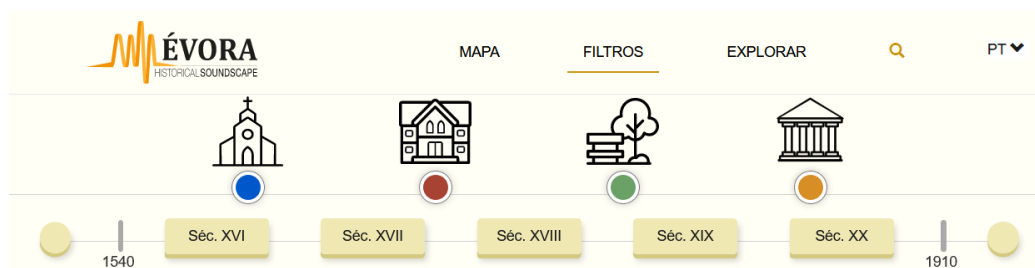


Figure 6.26: New location category filter and timeline layout.

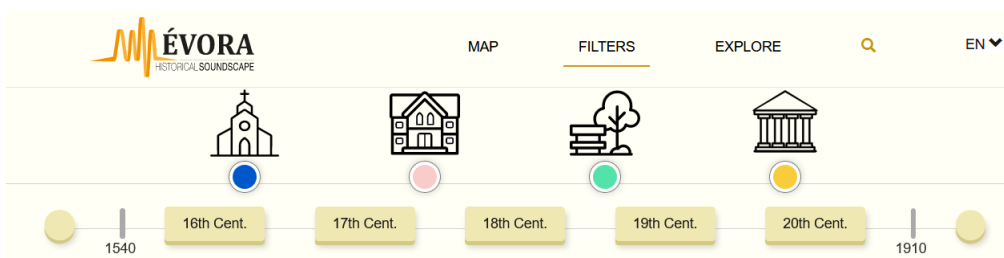


Figure 6.27: New location category filter and timeline layout in English.

was not implemented in the first redesign because it already had many changes to evaluate, both content and front-end wise. After all tests were done, a toggle between the two expected languages (Portuguese and English) was introduced in the top navigation bar and all of the text, excluding resources obtained from the database such as locations, events, itineraries, files and their details, was internationalised.

In React, this can be done using the 'react-i18next' library, by creating **JSON** files for each language with the same structure regarding the keys and providing the translated text as values to the matching key. A short example showcasing the navigation bar items' key-value pairs can be found in table 6.8.

Table 6.8: Key-value pair example used in the JSON files with different values depending on language.

Key	Value (pt)	Value (en)
"mapopt"	"MAPA"	"MAP"
"filteropt"	"FILTROS"	"FILTERS"
"exploreopt"	"EXPLORAR"	"EXPLORE"

When all necessary text is included in the separate **JSON** files, components that include any of the mentioned text must be wrapped in the higher order component provided by the library, in order to be able to call the integrated function $t()$ which, once given a valid **JSON** key, returns the matching value in the previously selected language. This allows for a one-line solution instead of multiple conditional instances and, more importantly, no code repetition.

The language toggle can be seen in fig. 6.26 on the top right, as well as the Portuguese version of the filters' item. The same, but in English, can be seen in fig. 6.27 as well as the mobile's navigation bar in fig. 6.28.

Since the database resources are not yet internationalised, this means that any interaction with them will always be in the "default" language, Portuguese. For example, once a location is clicked, it will still display its name in Portuguese, despite the surrounding elements being in English. Database internationalisation is a larger, more complicated step that requires further investigation and a more careful approach and, as such, will only be implemented in further iterations.

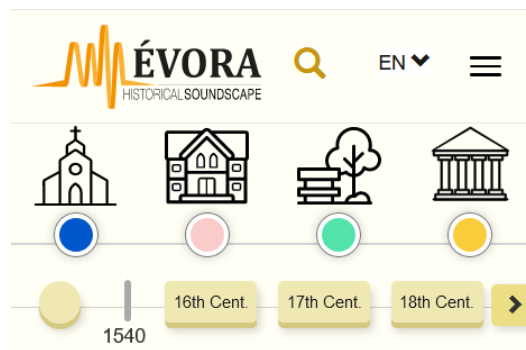


Figure 6.28: New location category filter and timeline layout in English in smaller screens.

6.3 Conclusions

The total of tests performed was thirty-five (35). Thirty (30) were common users, split in half for desktops/laptops and mobile devices, four (4) administrators and one (1) expert in desktops/laptops. This makes up a considerable sample that generated both quantitative and qualitative data, which contributed for a successful evaluation. Qualitative data was vital in understanding deeper concerns raised by the users, as well as suggestions, whereas quantitative data was important when gathered from questions about less complex problems and tasks, as it was easier to read. The analysis of the results allowed for conclusions to be drawn and address the issues in the redesign section.

This was the part of the process where some of the requirements could be perceived as achieved or not, particularly the one regarding usability. The SUS average scores, calculated among the 15 desktop/laptop users, 15 mobile device users and 4 administrators were all over 68, which is considered the average SUS score. Overall, the platform and its updated content and functionalities were well received, but the scale also allows to detect deviations in the experience which are equally important to determine possible issues. In total, five (5) results were below the average score, across the three groups, and the possible occurrences were carefully analysed when designing the new iteration. Although not necessarily following the same average value, the system's learnability and usability were also calculated and revealed positive feedback, with the same exceptions.

The timeline was one of the components expected to have a “larger reformulation” [47] and to have special focus in the evaluation phase. The tasks regarding that specific element gathered both quantitative and qualitative data, which was mostly heterogeneous with a negative tendency. This was perceived as seventeen (17) users did not find the timeline easy to use and thirteen (13) users did not understand how it worked. The question addressing its actual functionality was leading, as it included options instead of requesting the tester's text input. The timeline still required clarification and, although it has been updated based on these results, will still need to be carefully evaluated and possibly redesigned in future iterations.

The administrators encountered no major issues interacting with the platform, although one (1) administrator did classify the importance of the back-office as “indifferent” and had some trouble following that section’s tasks. The back-office has since been slightly tweaked to have more intuitive buttons.

The expert evaluator determined some usability concerns and the respective (Nielsen) heuristic being violated. Most of the stated occurrences included the same concerns raised by all the other users, with focus in “visibility of system status” and “error prevention”, which were minimised in the redesign.

It is worth noting that this is an extremely important part of the iterative process, as can be asserted from this chapter. As seen, immediately after the analysis, new necessary modifications emerged and they are to be evaluated in further iterations, as the upcoming results are expected to surpass the current ones.

CONCLUSIONS AND FUTURE WORK

This chapter presents the conclusions drawn from the work developed throughout this thesis and what to expect from the project's future iterations and possible improvements on this solution.

7.1 Conclusion

This dissertation's main objectives were to extend and improve the prototype as well as capturing 360-degree images and videos and spatial audio, while documenting both processes and results. It was expected that the platform would function as a public repository of information regarding Évora's historical soundscapes, while providing modern and interactive solutions. This included many different aspects, such as introducing new features, transforming past features and a design overhaul.

The specific objectives, which mostly include the implementation of features, can be seen in the Introduction chapter in section 1.3. By analysing this information and the dissertation's body, one can assert that the platform's requirements were completely fulfilled. Despite gamification, as mentioned in chapter 1, being one of the project's goal but not necessarily this thesis', QR codes were partially implemented. The component is to be used in further iterations that will include gamification, such as new theses that are starting to be developed. The structure was updated to better store itineraries, which can be linked to events, to improve the storytelling element but can also be used in future gamification aspects.

The spatial multimedia content had to be captured in specific conditions, such as specific times of the day, locations and setup. The initial plan was to capture a considerable amount of original content and then integrate it. However, the current COVID-19 pandemic and the circulation restrictions combined with the geographical distance between

the team and the city in question somewhat hindered this plan. Nevertheless, a 2-day trip took place resulting in six (6) 360-degree images and nine (9) 360-degree videos. Additionally, one (1) 360-degree video and one (1) spatial audio file were recorded in 2020's European Researchers' Night (November 27th). All audio was recorded separately from the video, meaning audio files can be generated, but were not included. Despite this hurdle, the content is high quality and was displayed and interacted within the platform, serving as a reference point.

Thus, this dissertation provided the [PASEV](#) architecture with structure, research and a strong base that the other applications can depend on.

Given the somewhat limited state of the art regarding soundscape exploration, and much more limited when in web format, the built platform successfully achieves responsiveness, flexibility and immersive interaction with the city's soundscape. It is evidenced in the previous thesis on this subject [47], but one can also assert the new features and improvements were well received based on the positive feedback by the 30 users, 4 administrators and expert evaluators, which benefited from the modern and more intuitive design. Although the usability scores remained within a small range when comparing the prototype's results in [47] and the following iteration's results in this dissertation, possible issues were already detected and will be handled in a new iteration. This iterative process prepares the project for future evaluations and modifications, while leaving space for the platform to grow with new features and content. Some suggested or incomplete work will be discussed in the following section.

7.2 Future Work

Although the solution was successfully implemented, the project is not over and there are more concepts to explore, as there is always room for improvement and new functionalities or even new technologies.

First and foremost, it is important to note that an expert evaluation was already performed on the newest version of the platform. This was not included in chapter 6 because it is only one step of many in the current iteration. Much like what was done previously, it is advised that a user evaluation is performed as soon as possible, in order to transform the platform according to both points of view. The expert evaluation, which can be found in appendix N, addresses some crucial aspects such as internationalisation and possible violations of Nielsen's heuristics regarding "visibility of system status" and "user control and freedom".

Most of the locations available to explore are not final elements because many of their properties are still being thoroughly checked and changed. This includes textual attributes such as the title and description, but also the coordinates and multimedia content. This work is to be done by the specialised members of [PASEV](#), which is aided by the platform's back-office.

For similar reasons that are given in the previous paragraph, the internationalised version of content in English is also yet to be implemented. This includes not only the correctly translated textual attributes of the resources, but also the restructuring of the database in order to accept and access them. However, database internationalisation is a complex endeavour that requires much more insight in the subject and a careful approach. The structure needs to change in order to allow it, but the code must also adapt to various use cases, depending on how the administrators intend to proceed when managing the resources. For example, to insert a new location, administrators could either be required to insert both Portuguese and English simultaneously or separately. Similarly, when deleting a location, it could either delete both versions, or only one at once. The use cases become more complex when considering relationships and, if not mapped properly, could lead to data inconsistency.

It was suggested by one of the administrators during the usability test that events should be prominent. In the current iteration, events are mostly textual elements, with the possibility of some multimedia content, displayed within the search tab. The goal was to include a selected event in its own modal window, much like a location's galleries and description, in order to detach it from the search tab. Despite this suggestion implying a substantial modification, as event's properties vary depending on the event itself, its representation could benefit from some normalisation much like the location's presentation. As such, it could be integrated in a new iteration, because it requires further investigation and, more importantly, testing.

As mentioned several times, the current front-end code uses React. More specifically, it uses class components which, at the time the prototype was built, was the default approach to build components with state. Since React Hooks, this changed drastically, as mentioned in 4.2. Although there are no official plans to deprecate class components, functional components are now stateful and can include lifecycle methods, along other necessary features previously only available to class components. Functional components are easier to read, test and require less code, which is beneficial in large projects such as this. Thus, the preference for this relatively recent type of component is expected in most contexts. The transition, however, is not seamless in larger projects. As the prototype's design and functionalities already needed to be reworked, this change was not considered an urgent modification. Nevertheless, it is an adjustment that will improve the code's maintenance, which benefits everyone in the long run.

The platform also uses Bootstrap, an open source framework used to build responsive web design. Although not necessarily outdated, it uses Bootstrap 3, an older version of the framework. As tools such as this advance, it is a good idea to keep up with its progress to use, presumably, better and improved components. In this case, Bootstrap 4, released in 2016, had some changes that caused it to drop support for Internet Explorer 8 and 9, iOS 6 and the *Glyphicon*¹ icon font. All of these are important changes to have in mind,

¹<https://www.glyphicons.com/> (Accessed on 10/10/2020) - "a library of precisely prepared monochromatic icons and symbols, created with an emphasis to simplicity and easy orientation."

but the fact is that they are more and more common among web development. For this, it is worth considering updating the framework and finding solutions to any issue that might come up, such as finding a new icon library or even creating a customised one. However, it is also worth noting that Bootstrap 5 Alpha has already been launched with its own set of changes, such as the drop of Internet Explorer support entirely, based on the browser's own support being terminated in the coming years.

The implementation of QR codes in the platform must be finalised. As it stands, the feature can be implemented and used, but would require specific usability tests, possibly *in situ*, and improved back-office management. Currently, administrators can introduce new codes, without the element's visual generation, but can not edit or delete existing codes nor access a list of all available codes.

It is also wise to include references in the web platform to the other platforms and mobile apps being developed, when completed. This is usually seen in the footer, which currently does not exist in the traditional sense, where different links are provided. This way, one can access all the available resources to explore the city's soundscape.

BIBLIOGRAPHY

- [1] C. Ardito, M. F. Costabile, A. De Angeli, and R. Lanzilotti. “Enriching archaeological parks with contextual sounds and mobile technology.” In: *ACM Transactions on Computer-Human Interaction* 19.4 (2012). ISSN: 10730516. DOI: [10.1145/2395131.2395136](https://doi.org/10.1145/2395131.2395136).
- [2] A. Bangor, T. Staff, P. Kortum, J. Miller, and T. Staff. “Determining what individual SUS scores mean: adding an adjective rating scale.” In: *Journal of usability studies* 4.3 (2009), pp. 114–123. ISSN: 1931-3357.
- [3] L. Barclay. “Augmenting Urban Space with Environmental Soundscapes and Mobile Technologies.” In: *Soundscape: The Journal of Acoustic Ecology* 16.1 (2017), pp. 21–36. ISSN: 1607-3304.
- [4] C. Bassano, S. Barile, P. Piciocchi, J. C. Spohrer, F. Iandolo, and R. Fisk. “Storytelling about places: Tourism marketing in the digital age.” In: *Cities* 87.June 2018 (2018), pp. 10–20. ISSN: 02642751. DOI: [10.1016/j.cities.2018.12.025](https://doi.org/10.1016/j.cities.2018.12.025).
- [5] D. Benyon, A. Quigley, B. O’Keefe, and G. Riva. “Presence and digital tourism.” In: *AI and Society* 29.4 (2014), pp. 521–529. ISSN: 14355655. DOI: [10.1007/s00146-013-0493-8](https://doi.org/10.1007/s00146-013-0493-8).
- [6] S. Bernat. “Soundscapes and tourism – towards sustainable tourism.” In: *Problems of Sustainable Development* 9.1 (2014), pp. 107–117.
- [7] S. Bhattacharya, C. Mohan, K. W. Brannon, I. Narang, H. I. Hsiao, and M. Subramanian. “Coordinating backup/recovery and data consistency between database and file systems.” In: *Proceedings of the ACM SIGMOD International Conference on Management of Data* (2002), pp. 500–511. ISSN: 07308078. DOI: [10.1145/564748.564749](https://doi.org/10.1145/564748.564749).
- [8] K. Bohium. “Responsive Web Design, Discoverability, and Mobile Challenge.” In: *Library Technology Reports* August-Sep (2013), pp. 29–39. URL: <https://journals.ala.org/index.php/ltr/article/viewFile/4507/5286>.
- [9] K. A. van den Bosch, T. C. Andringa, W. J. Post, W. A. Ruijssenaars, and C. Vlaskamp. “The relationship between soundscapes and challenging behavior: A small-scale intervention study in a healthcare organization for individuals with severe or profound intellectual disabilities.” In: *Building Acoustics* 25.2 (2018), pp. 123–135. ISSN: 20598025. DOI: [10.1177/1351010X18775022](https://doi.org/10.1177/1351010X18775022).

- [10] A. Brandellero and S. Janssen. "Popular music as cultural heritage: Scoping out the field of practice." In: *International Journal of Heritage Studies* 20.3 (2014), pp. 224–240. ISSN: 14703610. DOI: [10.1080/13527258.2013.779294](https://doi.org/10.1080/13527258.2013.779294).
- [11] A. L. Brown, T. Gjestland, and D. Dubois. "Acoustic environments and soundscapes." In: *Soundscape and the Built Environment* December (2016), pp. 1–16. DOI: [10.1201/b19145-2](https://doi.org/10.1201/b19145-2).
- [12] J. Carmigniani and B. Furht. *Handbook of Augmented Reality*. July 2011. 2011, pp. 2–46. ISBN: 9781461400646. DOI: [10.1007/978-1-4614-0064-6](https://doi.org/10.1007/978-1-4614-0064-6).
- [13] N. Chopde and M. Nichat. "Landmark Based Shortest Path Detection by Using Dijkstra Algorithm and Haversine Formula." In: *International Journal of Engineering Research and Applications (IJERA)* 3.3 (2013), pp. 162–165.
- [14] T. Connolly and C. Begg. *Database Systems – A Practical Approach to Design Implementation and Management*. 6th. Pearson, 2014. ISBN: 9781292061184.
- [15] B. Costerton. *A systematic review of the most appropriate methods of achieving spatially enhanced audio for headphone use*. Tech. rep. 2013. URL: <https://pineconeresearchlabs.wordpress.com/2013/05/01/pr01/>.
- [16] S. Deterding, D. Dixon, R. Khaled, and L. Nacke. "From game design elements to gamefulness: Defining "gamification"." In: *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, MindTrek 2011* March 2014 (2011), pp. 9–15. DOI: [10.1145/2181037.2181040](https://doi.org/10.1145/2181037.2181040).
- [17] S. Deterding, K. O'Hara, M. Sicart, D. Dixon, and L. Nacke. "Gamification: Using game design elements in non-gaming contexts." In: *Conference on Human Factors in Computing Systems - Proceedings* January (2011), pp. 2425–2428. DOI: [10.1145/1979742.1979575](https://doi.org/10.1145/1979742.1979575).
- [18] S. L. Dumyah and B. C. Pijanowski. "Soundscape conservation." In: *Landscape Ecology* 26.9 (2011), pp. 1327–1344. ISSN: 09212973. DOI: [10.1007/s10980-011-9635-x](https://doi.org/10.1007/s10980-011-9635-x).
- [19] EyeSpy360. *The History Of 360 Photography*. 2017. URL: https://www.eyespy360.com/en-us/blog/The__History__of__360__Photography.html (visited on 12/30/2019).
- [20] Q. Feret. *3D Sound Labs Design*. 2017. URL: <https://www.behance.net/gallery/56504805/3D-Sound-Labs-create-a-new-design-identity> (visited on 02/05/2020).
- [21] S. Ferreira and A. P. Alves. "Location based transmedia storytelling : The travelplot Porto experience design." In: *Revista Turismo y Desarrollo* 17/18 (2012), pp. 95–99.

- [22] M. García-Hernández, M. de la Calle-Vaquero, and C. Yubero. “Cultural heritage and urban tourism: Historic city centres under pressure.” In: *Sustainability (Switzerland)* 9.8 (2017). ISSN: 20711050. DOI: [10.3390/su9081346](https://doi.org/10.3390/su9081346).
- [23] J. Hamari, J. Koivisto, and H. Sarsa. “Does Gamification Work? — A Literature Review of Empirical Studies on Gamification.” In: *Proceedings of the 47th Hawaii International Conference on System Sciences* January.6-9 (2014). ISSN: 15301605. DOI: [10.1109/HICSS.2014.377](https://doi.org/10.1109/HICSS.2014.377).
- [24] B. J. Harris. *The History of the Future - Oculus, Facebook, and the Revolution That Swept Virtual Reality*. Dey Street Books, 2019. ISBN: 9780062455963.
- [25] J. Y. Hong, J. He, B. Lam, R. Gupta, and W. S. Gan. “Spatial Audio for Soundscape Design: Recording and Reproduction.” In: *Applied Sciences (Switzerland)* 7.6 (2017). ISSN: 20763417. DOI: [10.3390/app7060627](https://doi.org/10.3390/app7060627).
- [26] J. Y. Hong, B. Lam, Z. T. Ong, K. Ooi, W. S. Gan, J. Kang, J. Feng, and S. T. Tan. “Quality assessment of acoustic environment reproduction methods for cinematic virtual reality in soundscape applications.” In: *Building and Environment* 149.May 2018 (2019), pp. 1–14. ISSN: 03601323. DOI: [10.1016/j.buildenv.2018.12.004](https://doi.org/10.1016/j.buildenv.2018.12.004).
- [27] E. H. Idrobo-ávila, H. Loaiza-Correa, L. van Noorden, F. G. Muñoz-Bolaños, and R. Vargas-Cañas. “Different Types of Sounds and Their Relationship With the Electrocardiographic Signals and the Cardiovascular System – Review.” In: *Frontiers in Physiology* 9.MAY (2018), pp. 1–18. ISSN: 1664042X. DOI: [10.3389/fphys.2018.00525](https://doi.org/10.3389/fphys.2018.00525).
- [28] M. Jackson. *Gamification Elements to Use for Learning*. Tech. rep. 2017. URL: https://trainingindustry.com/content/uploads/2017/07/enspire\{}_cs\{}_gamification\{}_2016.pdf.
- [29] B. Jiménez Fernández-Palacios, D. Morabito, and F. Remondino. “Access to complex reality-based 3D models using virtual reality solutions.” In: *Journal of Cultural Heritage* 23 (2017), pp. 40–48. ISSN: 12962074. DOI: [10.1016/j.culher.2016.09.003](https://doi.org/10.1016/j.culher.2016.09.003).
- [30] B. Kim. “Understanding Gamification.” In: 51.2 (2015), p. 37. DOI: [10.5860/1tr.51n2](https://doi.org/10.5860/1tr.51n2).
- [31] J. R. Lewis. “The System Usability Scale : Past , Present , and Future The System Usability Scale : Past , Present , and Future.” In: *International Journal of Human–Computer Interaction* 34.7 (2018), pp. 577–590. ISSN: 1044-7318. DOI: [10.1080/10447318.2018.1455307](https://doi.org/10.1080/10447318.2018.1455307). URL: <https://doi.org/10.1080/10447318.2018.1455307>.
- [32] J. R. Lewis and J. Sauro. “The Factor Structure of the System Usability Scale The Factor Structure of the System Usability Scale.” In: July 2009 (2014). DOI: [10.1007/978-3-642-02806-9](https://doi.org/10.1007/978-3-642-02806-9).

BIBLIOGRAPHY

- [33] Library of Congress. *A Brief History of Panoramic Photography*. URL: <https://www.loc.gov/collections/panoramic-photographs/articles-and-essays/a-brief-history-of-panoramic-photography/> (visited on 12/30/2019).
- [34] V. Lombardo and R. Damiano. “Storytelling on mobile devices for cultural heritage.” In: *New Review of Hypermedia and Multimedia* 18.1-2 (2012), pp. 11–35. ISSN: 13614568. DOI: 10.1080/13614568.2012.617846.
- [35] E. Marcotte. *Responsive Web Design*. 2010. URL: <https://alistapart.com/article/responsive-web-design/> (visited on 08/11/2020).
- [36] B. Morschheuser, J. Hamari, K. Werder, and J. Abe. “How to Gamify? A Method For Designing Gamification.” In: *Proceedings of the 50th Hawaii International Conference on System Sciences (2017) Hicss (2017)*, pp. 1298–1307. DOI: 10.24251/hicss.2017.155.
- [37] M. Mulazzani, P. Reschl, M. Huber, M. Leithner, S. Schrittwieser, and E. Weippl. “Fast and Reliable Browser Identification with JavaScript Engine Fingerprinting.” In: *Proceedings of W2SP (2013)*, pp. 1–10.
- [38] G. Neumann. *Dummy Head - KU 100*. 2018. URL: <https://en-de.neumann.com/ku-100> (visited on 12/20/2019).
- [39] J. Nielsen. *Why You Only Need to Test with 5 Users*. 2000. URL: <https://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/> (visited on 10/07/2020).
- [40] A. Osman, N. Wahab, and M. Ismail. “Development and Evaluation of an Interactive 360 Virtual Tour for Tourist Destinations.” In: *Journal of Information Technology Impact* 9.3 (2009), pp. 173–182.
- [41] F. Paz, F. A. Paz, D. Villanueva, N. Pedro, and R. Gallo. “Heuristic Evaluation as a Complement to Usability Testing : A Case Study in Web Domain.” In: (2015). DOI: 10.1109/ITNG.2015.92.
- [42] R. Pera. “Empowering the new traveller: storytelling as a co-creative behaviour in tourism.” In: *Current Issues in Tourism* 20.4 (2017), pp. 331–338. ISSN: 13683500. DOI: 10.1080/13683500.2014.982520.
- [43] B. C. Pijanowski, L. J. Villanueva-Rivera, S. L. Dumyahn, A. Farina, B. L. Krause, B. M. Napoletano, S. H. Gage, and N. Pieretti. “Soundscape Ecology: The Science of Sound in the Landscape.” In: *BioScience* 61.3 (2011), pp. 203–216. ISSN: 0006-3568. DOI: 10.1525/bio.2011.61.3.6.
- [44] A. Radicchi. *HUSH CITY APP*. 2016. URL: <http://www.opensourcesoundscapes.org/hush-city/> (visited on 12/29/2019).

- [45] A. Radicchi, D. Henckel, and M. Memmel. “Citizens as smart, active sensors for a quiet and just city. The case of the “open source soundscapes” approach to identify, assess and plan “everyday quiet areas” in cities.” In: *Noise Mapping 5.1* (2018), pp. 1–20. ISSN: 2084879X. DOI: [10.1515/noise-2018-0001](https://doi.org/10.1515/noise-2018-0001).
- [46] N. Raghuvanshi, J. Snyder, R. Mehra, M. Lin, and N. Govindaraju. “Precomputed wave simulation for real-time sound propagation of dynamic sources in complex scenes.” In: *ACM SIGGRAPH 2010 Papers, SIGGRAPH 2010 29.4* (2010). ISSN: 07300301. DOI: [10.1145/1778765.1778805](https://doi.org/10.1145/1778765.1778805).
- [47] J. Rosário. “Uma plataforma responsiva para o Atlas Auditivo de Évora.” Master’s thesis. NOVA School of Science and Technology, 2019.
- [48] F. Rose. *The Art of Immersion: How the Digital Generation Is Remaking Hollywood, Madison Avenue, and the Way We Tell Stories*. Ed. by B. Curry. W. W. Norton & Company, 2011. ISBN: 0393341259. DOI: [10.26422/aucom.2014.0301.fern](https://doi.org/10.26422/aucom.2014.0301.fern).
- [49] J. Sauro and J. R. Lewis. *Quantifying the User Experience, Second Edition: Practical Statistics for User Research*. Vol. 38. 1. 2016, pp. 254–256. ISBN: 0128023082, 9780128023082.
- [50] A. Saxena and A. Y. Ng. “Learning Sound Location from a single microphone.” In: *Proceedings - IEEE International Conference on Robotics and Automation* (2009), pp. 1737–1742. ISSN: 10504729. DOI: [10.1109/ROBOT.2009.5152861](https://doi.org/10.1109/ROBOT.2009.5152861).
- [51] M. Schimpl, C. Moore, C. Lederer, A. Neuhaus, J. Sambrook, J. Danesh, W. Ouwehand, and M. Daumer. “Association between walking speed and age in healthy, free-living individuals using mobile accelerometry—a cross-sectional study.” In: *PLoS ONE* 6.8 (2011). ISSN: 19326203. DOI: [10.1371/journal.pone.0023299](https://doi.org/10.1371/journal.pone.0023299).
- [52] Smithsonian American Art Museum. *WONDER 360: Experience the Renwick Gallery Exhibition in Virtual Reality*. 2018. URL: <https://americanart.si.edu/wonder360>.
- [53] *Spatial Audio*. URL: <https://creator.oculus.com/learn/spatial-audio/> (visited on 02/01/2020).
- [54] P. Stitt, E. Hendrickx, J.-C. Messonnier, and B. F. Katz. “The Role of Head Tracking in Binaural Rendering.” In: *29th Tonmeistertagung - VDT International Convention November* (2016), pp. 1–5.
- [55] UNESCO. *Historic Centre of Évora*. 1986. URL: <https://whc.unesco.org/en/list/361/> (visited on 02/15/2020).
- [56] L. M. Vandecreek. “Usability analysis of Northern Illinois University Libraries’ website: a case study.” In: 21.3 (2005), pp. 181–192. DOI: [10.1108/10650750510612380](https://doi.org/10.1108/10650750510612380).
- [57] M. Vecco. “A definition of cultural heritage: From the tangible to the intangible.” In: *Journal of Cultural Heritage* 11.3 (2010), pp. 321–324. ISSN: 12962074. DOI: [10.1016/j.culher.2010.01.006](https://doi.org/10.1016/j.culher.2010.01.006).

BIBLIOGRAPHY

- [58] J. Wall. "Recovering Lost Acoustic Spaces: St. Paul's Cathedral and Paul's Churchyard in 1622." In: *Digital Studies/le Champ Numérique* (2014). DOI: <http://doi.org/10.16995/dscn.58>.
- [59] F. Xu, J. Weber, and D. Buhalis. "Gamification in Tourism." In: January (2013). DOI: [10.1007/978-3-319-03973-2_38](https://doi.org/10.1007/978-3-319-03973-2_38).

A P P E N D I X



USABILITY TEST TASKS - USERS (PORTUGUESE)

Plataforma PASEV

Teste de Usabilidade

Este teste de usabilidade pretende avaliar a sua interação como utilizador com uma plataforma desenvolvida no âmbito de uma dissertação de mestrado. A plataforma é o resultado de uma extensão de funcionalidades e melhorias em relação a um protótipo associado ao projeto PASEV. Este projeto, acrónimo de "Patrimonialização da Paisagem Sonora em Évora", tem como objetivo primário a patrimonialização da paisagem sonora¹ da cidade de Évora entre 1540 e 1910 e a promoção do turismo cultural na cidade.

O teste consiste na realização de algumas tarefas diretamente relacionadas com o novo design e as novas funcionalidades implementadas, tais como:

- Interação com os filtros da *timeline* (linha temporal) - um local filtrado não aparece no mapa;
- Submissão de conteúdo multimédia por utilizadores;
- Visualização de conteúdo multimédia espacial (e.g. imagens e vídeos 360°);
- Geolocalização em itinerários;
- Conteúdo em destaque.

Caso possível, aconselha-se o uso de *headphones*. Após realizar todas as tarefas, ser-lhe-á fornecido um questionário onde poderá avaliar a plataforma e a sua forma de interagir com a mesma. Como tal, é importante que leia cada tarefa atentamente e tenha atenção aos resultados de cada ação que realiza. Comentários verbais enquanto realiza as tarefas são encorajados, pois ajudam a revelar vulnerabilidades no sistema. Qualquer dúvida, contacte o supervisor.

Tarefas:

1. Carregue no botão azul para aceder ao mapa.
2. Carregue em 'Mapa' na barra de navegação e interaja com as diferentes opções.
 - a. Escolha diferentes mapas base e opções de cartografia histórica. Utilize o zoom, se necessário, para verificar as alterações.
3. Pesquise pelo evento "Aniversário do Príncipe D. Carlos" e clique no mesmo.
4. Abra a *timeline* e interaja com a mesma. Tente perceber o que acontece.
 - a. Depois de interagir com a *timeline*, certifique-se que está apenas a filtrar o século XIX e o século XX.
5. Pesquise pelo local "Praça de Touros (actual Arena D'Évora)" e clique no mesmo.
 - a. Expanda a caixa de texto da fonte, de forma a vê-la na totalidade.
6. Veja o conteúdo inerente ao local previamente selecionado e realize as seguintes operações:
 - a. Leia a informação apresentada no primeiro ecrã;
 - b. Aceda à galeria de imagens PASEV e clique numa imagem, para ver os seus detalhes;
 - c. Aceda à galeria de imagens submetidas por colaboradores;
 - i. Submeta uma imagem, preenchendo o formulário que acompanha o processo.
 - d. Aceda à galeria de áudios PASEV, clique num áudio e oiça-o;
 - e. Aceda à galeria de áudios submetidos por colaboradores.

¹ Coleção de sons que emanam duma paisagem específica, independentemente da sua origem (natural, humana, animal, industrial, etc.).

APPENDIX



USABILITY TEST TASKS - USERS (ENGLISH)

PASEV Platform

Usability Test

This usability test aims to evaluate your interaction as an user with a platform developed within the scope of a master's thesis. This platform is the result of extending and improving a prototype related to PASEV. This project, acronym for "Patrimonialisation of Évora's Soundscape", has the primary goal of patrimonialising the soundscape¹ of the city of Évora between 1540 and 1910 and promoting cultural tourism in the city.

The test consists of performing certain tasks directly influenced by the new design and new features implemented, such as:

- Interaction with the timeline filter - a filtered location does not appear on the map;
- Crowdsourcing multimedia content;
- Display of spatial multimedia content (e.g. 360-degree images and videos);
- Geolocation and itineraries;
- Featured content.

If possible, use of headphones is advised. After performing all tasks, you will be given a questionnaire to evaluate the platform and the way you interacted with it. As such, it is very important that you read each task carefully and pay attention to details. Verbal comments throughout the test are encouraged, as they may help reveal vulnerabilities in the system. If you have any doubts, contact the supervisor.

Tasks:

1. Click the blue button to access the map.
2. Click 'Mapa' in the navigation bar and interact with the different options.
 - a. Select different base maps and historical cartography options. Zoom in and out, if necessary, to see what changes.
3. Search for the event "Aniversário do Príncipe D. Carlos" and click it.
4. Open the timeline and interact with it. Try to understand what happens.
 - a. After interacting with the timeline, filter only the XIX and XX centuries.
5. Search for the location "Praça de Touros (actual Arena D'Évora)" and click it.
 - a. Expand the source text box, in order to see it in its entirety.
6. Access the previous selected location's content and perform the following operations:
 - a. Read the information displayed in the first screen;
 - b. Access the PASEV images gallery and click one, in order to see its details;
 - c. Access the crowdsourced images gallery;
 - i. Submit an image by filling the corresponding form.
 - d. Access the PASEV audio gallery, click one and listen to it;
 - e. Access the crowdsourced audio gallery;
 - i. Record a sound and submit it by filling the corresponding form.
 - f. Access the video galleries and interact with them. Watch and listen to the 360-degree video², while moving the screen.
7. Search for the location "Praça do Giraldo", click it and access its content.
 - a. Access the 360-degree images gallery and click in its only image. Interact with it.
8. Return to the generic map view. Activate geolocation.

¹ Collection of sounds that emanate from a specific landscape from various sources (natural, human, animal, industrial, etc.).

² 360-degree test video may not be final.

9. Search for “Passeio pelas Praças” in ‘Explorar’ and click it.
 - a. Activate the itinerary;
 - b. Try to understand what the itinerary’s average distance and time are;
 - c. Try to understand what the distance to the next location is.
10. Deactivate the itinerary. Scroll down and interact with the featured card ‘Itinerário’.

After the last task, the test is over. However, you may continue to interact with the platform and explore more in order to, possibly, elaborate on elements that will not be mentioned in the questionnaire.

A P P E N D I X



QUESTIONNAIRE (PORTUGUESE)

Plataforma PASEV - Questionário de Avaliação

Este questionário destina-se à avaliação da usabilidade de uma plataforma desenvolvida em ambiente académico, na realização de uma tese de Mestrado.

O mesmo é composto por 3 secções, a serem respondidas após se realizarem as tarefas que foram realizadas pelo utilizador. O questionário é anónimo, sendo qualquer informação privada utilizada apenas para fins estatísticos. Agradecemos que seja o mais honesto possível, de forma a permitir analisar com maior precisão a qualidade do trabalho desenvolvido.

***Obrigatório**

Idade *

- Menos de 18
- Entre 18 e 24
- Entre 25 e 30
- Entre 31 e 45
- Mais de 46

Género *

- Feminino
- Masculino
- Prefiro não dizer
- Outra:



Área de formação

A sua resposta

Como classifica a sua experiência com computadores? *

	1	2	3	4	5	
Muito inexperiente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Muito experiente

Como classifica a sua experiência com smartphones/tablets? *

	1	2	3	4	5	
Muito inexperiente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Muito experiente

Está familiarizado com a geografia da cidade de Évora? *

- Sim
- Não
- Mais ou menos

Recorre a algum tipo de aplicações durante viagens? *

- Sim
- Não



Se respondeu positivamente à questão anterior, que tipo de aplicações?

- Guias online
- Mapas online
- GPS
- Outra:

Em que dispositivo realizou o teste de usabilidade? *

- Dispositivo fixo
- Dispositivo móvel

Em que browser realizou o teste? *

- Google Chrome
- Mozilla Firefox
- Microsoft Edge
- Internet Explorer
- Safari
- Opera
- Outra:

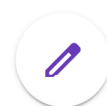
[Seguinte](#)

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)



Google Formulários



Plataforma PASEV - Questionário de Avaliação

*Obrigatório

System Usability Scale (SUS)

O 'System Usability Scale' (SUS) é uma ferramenta de fácil e rápida utilização para medir a usabilidade. Consiste em 10 questões padrão com 5 opções de resposta de "Discordo totalmente" a "Concordo totalmente". É eficaz a obter resultados válidos mesmo em amostras pequenas. (Fonte: <https://www.usability.gov>)

Acho que gostaria de utilizar esta plataforma com mais frequência. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Achei a plataforma desnecessariamente complexa. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Achei a plataforma fácil de utilizar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



Acho que necessitaria da ajuda de um técnico para conseguir utilizar a plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Considerei que as várias funcionalidades da plataforma foram bem integradas. *

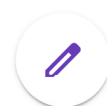
	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Achei que há demasiada inconsistência na plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Acho que a maioria das pessoas aprenderia a utilizar esta plataforma rapidamente. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



Achei a plataforma muito complicada de usar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Senti-me muito confiante a utilizar a plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Precisei de aprender muito antes de conseguir utilizar a plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

[Anterior](#)

[Seguinte](#)

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)

Google Formulários



Plataforma PASEV - Questionário de Avaliação

*Obrigatório

Avaliação da usabilidade e funcionalidades

Nesta terceira e última secção do questionário, avaliará certos aspetos específicos da plataforma, diretamente relacionados com as funcionalidades. Terá ainda a opção de expressar a sua opinião sobre outros aspetos não mencionados em perguntas de resposta aberta.

A barra de navegação é fácil de usar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Acho interessante as opções de diferentes mapas base. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Acho interessante as opções de cartografia histórica. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



A plataforma inicia com uma planta da cidade já sobreposta sobre o mapa base. Acha esta interação interessante? Por favor, justifique a sua resposta. *

A sua resposta

A submissão de imagens é fácil de efetuar. *

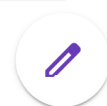
	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A submissão de áudio é fácil de efetuar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A submissão de conteúdo multimédia é interessante. *

	Discordo totalmente	Discordo	Sem opinião	Concordo	Concordo totalmente
Imagens	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Áudio	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vídeos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



A interação com imagens 360° é interessante. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A interação com vídeos 360° com som espacial é interessante. *

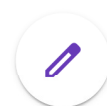
	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A timeline (linha temporal) é útil. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A timeline é fácil de usar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



Compreendi como funciona a timeline. *

1 2 3 4 5

Discordo totalmente Concordo totalmente

Em relação à timeline: um local pode estar associado a vários séculos. O que acontece quando os filtros do séc. XIX e XX se encontram ativos? *

- Aparecem novos elementos geográficos no mapa para além dos marcadores
- Todos os locais referentes aos séculos XIX e XX surgem no mapa
- Todos os locais referentes pelo menos ao século XIX ou ao século XX desaparecem do mapa
- Todos os locais referentes apenas ao século XIX, apenas ao século XX ou apenas ao par desaparecem do mapa
- O mapa base é alterado
- Nenhuma das anteriores

A tarefa 3 exige que procure um local que se encontra filtrado, depois de interagir com a timeline. Existem duas versões diferentes nesta situação: os locais filtrados ora não aparecem na listagem, ora aparecem com um ícone que representa que estão invisíveis.

Com que situação se deparou? *

- Os locais filtrados não apareciam
- Os locais filtrados apareciam com uma cor cinzenta e um ícone



Qual das abordagens acha mais intuitiva? *

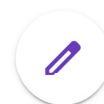
- Os locais filtrados não aparecerem
- Os locais filtrados aparecerem com uma cor cinzenta e um ícone
- Indiferente

Por favor, justifique a resposta anterior (e.g. como se sentiu ao deparar-se com a falta de informação).

A sua resposta

É fácil pesquisar: *

	Discordo totalmente	Discordo	Sem opinião	Concordo	Concordo totalmente
Locais	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eventos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Depois de ativar um itinerário, quais das seguintes ações observou? *

- Surgiu um caminho no mapa que unia os diferentes locais
- Surgiu um caminho da minha localização até ao próximo ponto
- Surgiu um novo ícone no mapa
- Os marcadores que não pertencem ao itinerário desapareceram do mapa
- Surgiu o ecrã de conteúdo do primeiro ponto do itinerário
- Outra:

Achou a interação com os itinerários intuitiva? Por favor, justifique. *

A sua resposta

De forma geral, experienciou alguma dificuldade a utilizar a plataforma? *

- Sim
- Não

Se respondeu que sim à questão anterior, por favor especifique a(s) dificuldade(s) com que se deparou.

A sua resposta

Sugestões para melhorar a plataforma.

A sua resposta



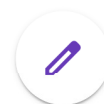
Anterior

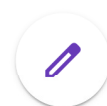
Submeter

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)

Google Formulários





A P P E N D I X



QUESTIONNAIRE (ENGLISH)

Plataforma PASEV - Evaluation

* Required

Age *

- Under 18
- 18 - 24
- 25 - 30
- 31 - 45
- Over 46

Gender *

- Female
- Male
- Rather not say
- Other:

Career field

Your answer



How would you rate your experience with computers? *

	1	2	3	4	5	
Very inexperienced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very experienced

How would you rate your experience with smartphones/tablets? *

	1	2	3	4	5	
Very inexperienced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very experienced

Are you familiar with Évora's geography? *

- Yes
- No
- More or less

Do you use any kind of mobile applications while traveling? *

- Yes
- No

If you answered yes to the previous question, what kind of applications?

- Online guides
- Online maps
- GPS
- Other:



On which device did the usability test take place? *

- Desktop device
- Mobile device

On which browser did the test take place? *

- Google Chrome
- Mozilla Firefox
- Microsoft Edge
- Internet Explorer
- Safari
- Opera
- Other:

Next

Never submit passwords through Google Forms.

This form was created inside of Faculdade de Ciências e Tecnologia da UNL. [Report Abuse](#)

Google Forms



Plataforma PASEV - Evaluation

* Required

System Usability Scale (SUS)

I think that I would like to use this system frequently. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I found the system unnecessarily complex. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I thought the system was easy to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I think that I would need the support of a technical person to be able to use this system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



I found the various functions in this system were well integrated. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I thought there was too much inconsistency in this system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I would imagine that most people would learn to use this system very quickly. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I found the system very cumbersome to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I felt very confident using the system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



I needed to learn a lot of things before I could get going with this system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

[Back](#)

[Next](#)

Never submit passwords through Google Forms.

This form was created inside of Faculdade de Ciências e Tecnologia da UNL. [Report Abuse](#)

Google Forms



Plataforma PASEV - Evaluation

* Required

Features evaluation

The navigation bar is easy to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I find the options for different base maps interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I find the options for historical cartography interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

The platform starts with a city plan already superimposed on the base map. Do you find this interaction interesting? Please justify your answer. *

Your answer



It is easy to submit images. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

It is easy to submit audio. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

Submitting multimedia content is interesting *

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
Images	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Audio	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Videos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Interacting with 360-degree images is interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



Interacting with 360-degree videos with spatial audio is interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

The timeline is helpful. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

The timeline is easy to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I understood how the timeline works. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



Regarding the timeline: a location can be associated with multiple centuries. What happens when the XIX and XX centuries are being filtered? *

- New geographical elements appear in the map besides the markers
- Every location associated with the XIX and XX century appear in the map
- Every location associated with at least one of the filters disappear from the map
- Every location associated with just the XIX century, with just the XX century or with just the pair disappear from the map
- The base map is changed
- None of the above

Task #3 asked you to find a location that was being filtered, after interacting with the timeline. There are two variations in this situation: either the filtered locations don't appear or they do appear, greyed out with an icon representing they are invisible.

Which variation did you face? *

- Filtered locations did not appear
- Filtered locations did appear but greyed out and an icon

Which variation do you think is more intuitive? *

- Filtered locations not appearing
- Filtered locations appearing but greyed out and an icon
- Indiferent



Please, justify your previous answer (e.g. how did you feel when facing lack of information).

Your answer

It is easy to search: *

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
Locations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Events	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

After activating an itinerary, which changes did you observe? *

- A path connecting the different locations appeared on the map
- A path connecting my current location to the next location appeared on the map
- A new icon appeared on the map
- The markers that do not belong to the itinerary disappeared from the map
- The content screen of the itinerary's first location appeared
- Other:

Did you find the interaction with the itineraries intuitive? Please, justify your answer. *

Your answer



In general, did you experience any issues while using the platform? *

Yes

No

If you answered yes to the previous question, please specify which issues you faced.

Your answer

Suggestions to improve the platform.

Your answer

[Back](#)

Submit

Never submit passwords through Google Forms.

This form was created inside of Faculdade de Ciências e Tecnologia da UNL. [Report Abuse](#)

Google Forms

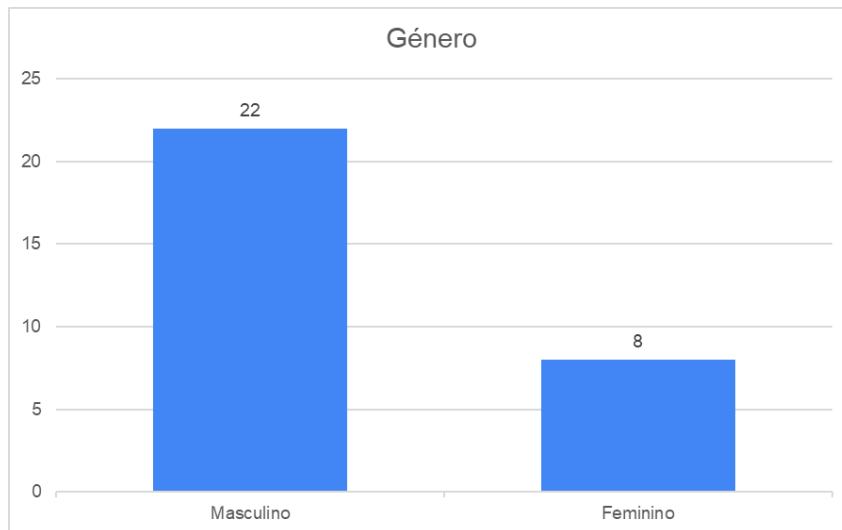
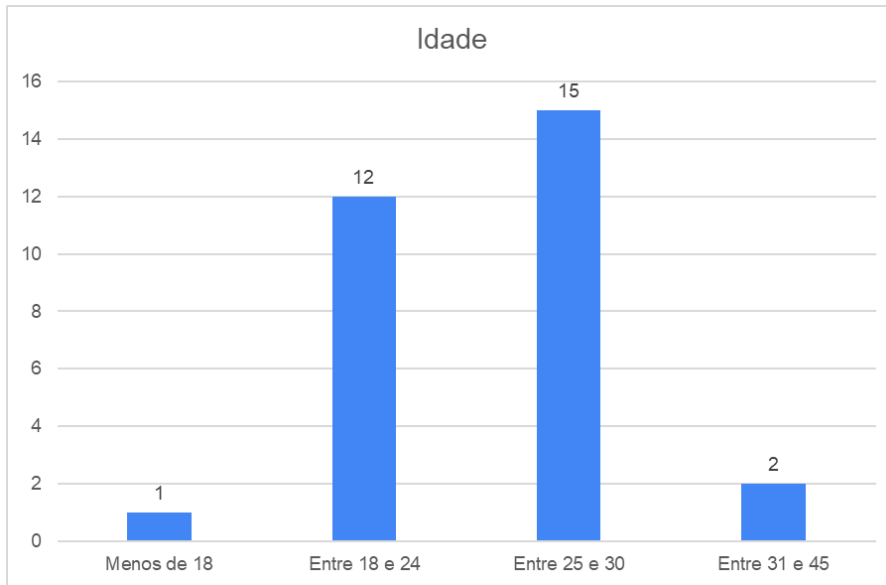


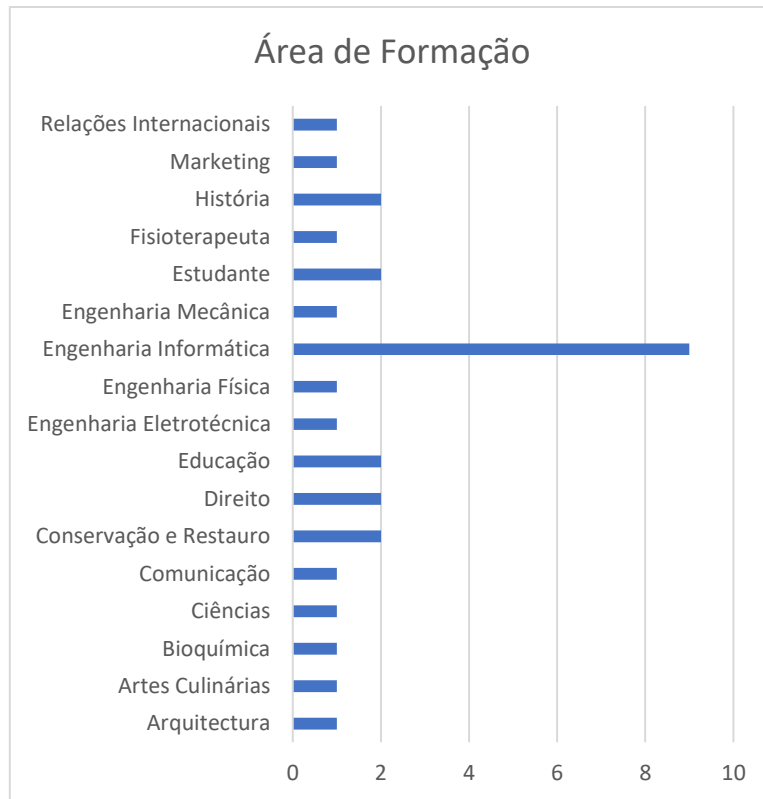
A P P E N D I X



QUESTIONNAIRE GRAPHS - USERS (PORTUGUESE)

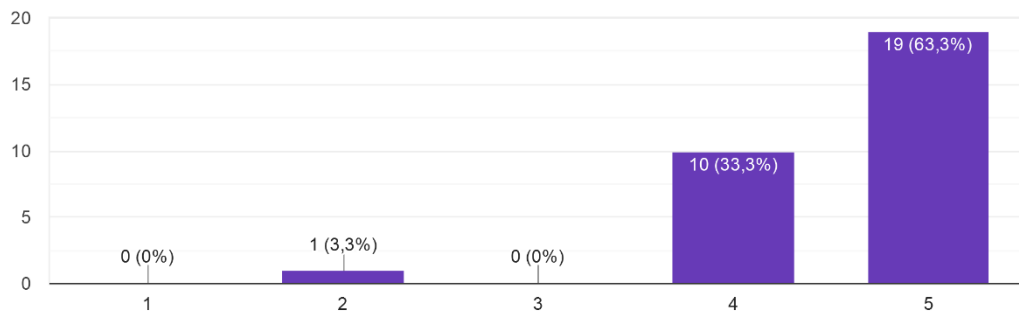
Primeira secção (first section)





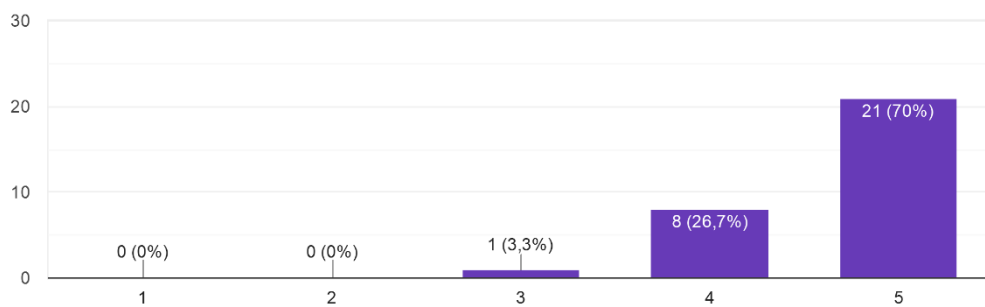
Como classifica a sua experiência com computadores?

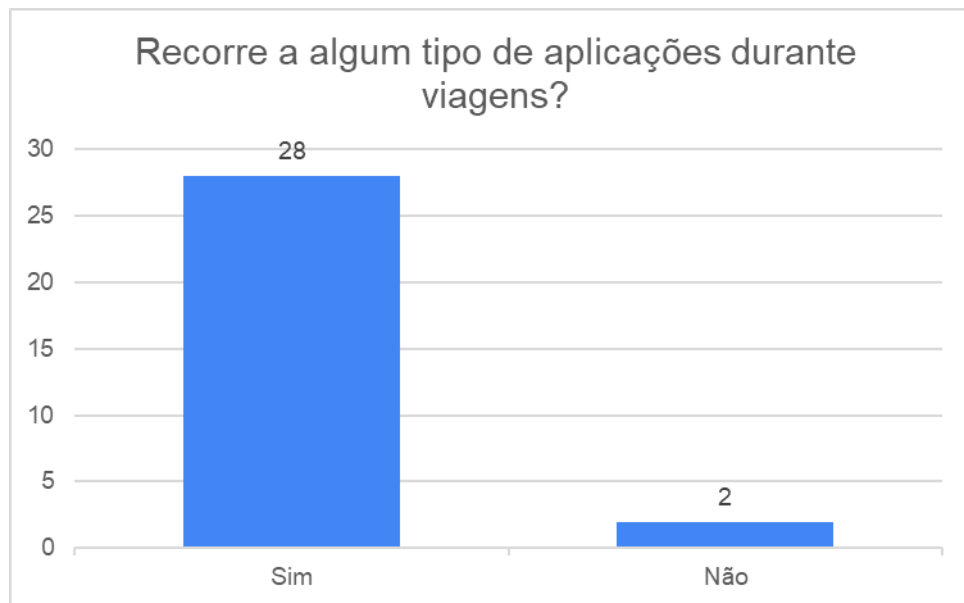
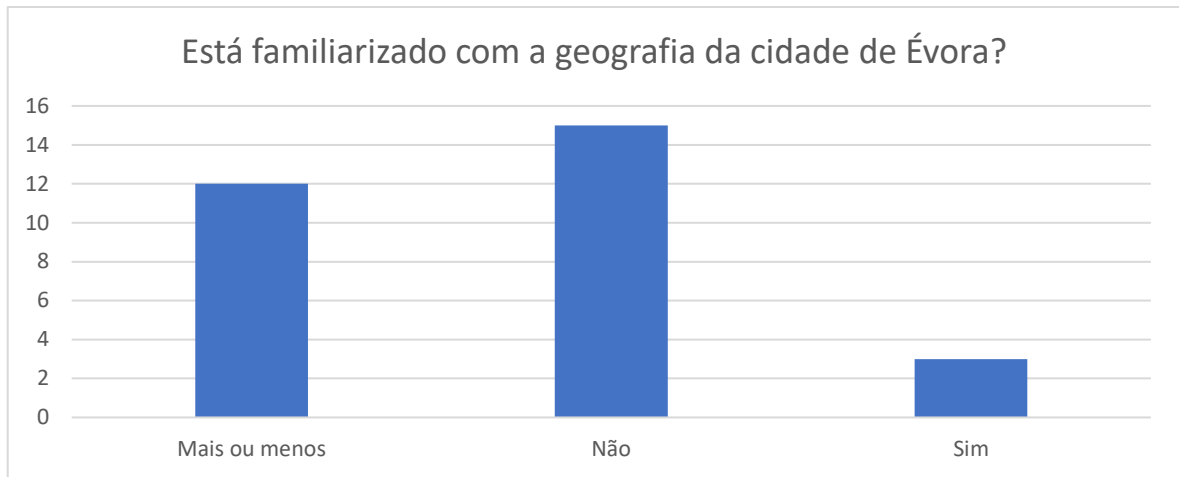
30 respostas



Como classifica a sua experiência com smartphones/tablets?

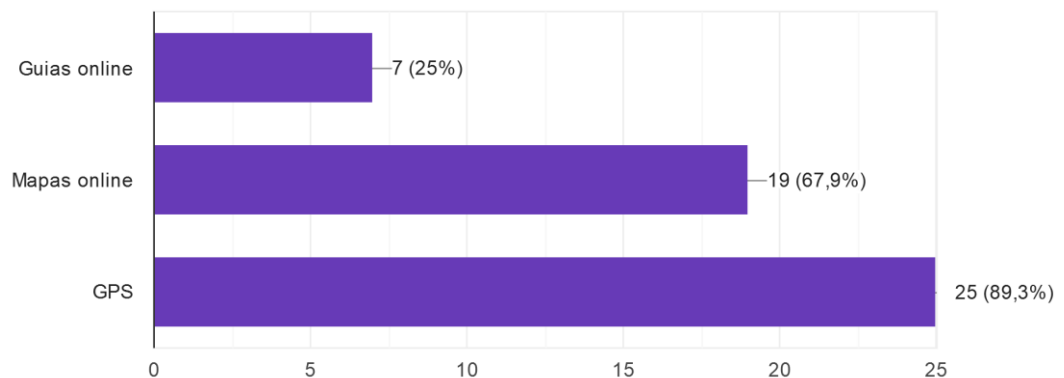
30 respostas

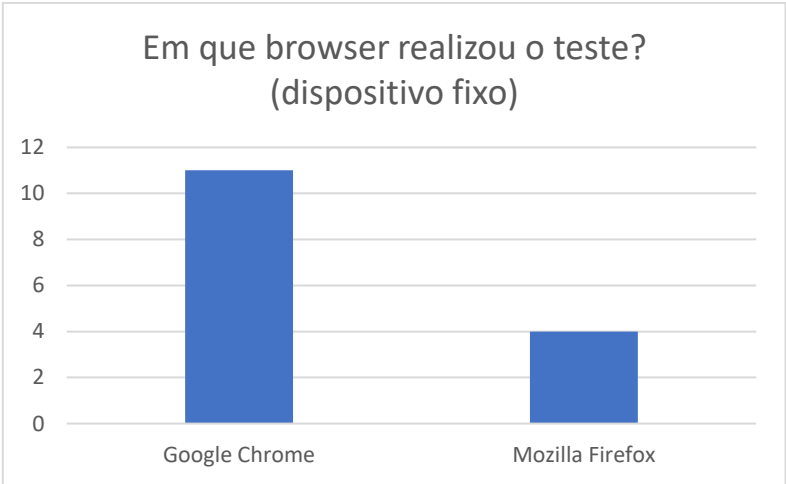
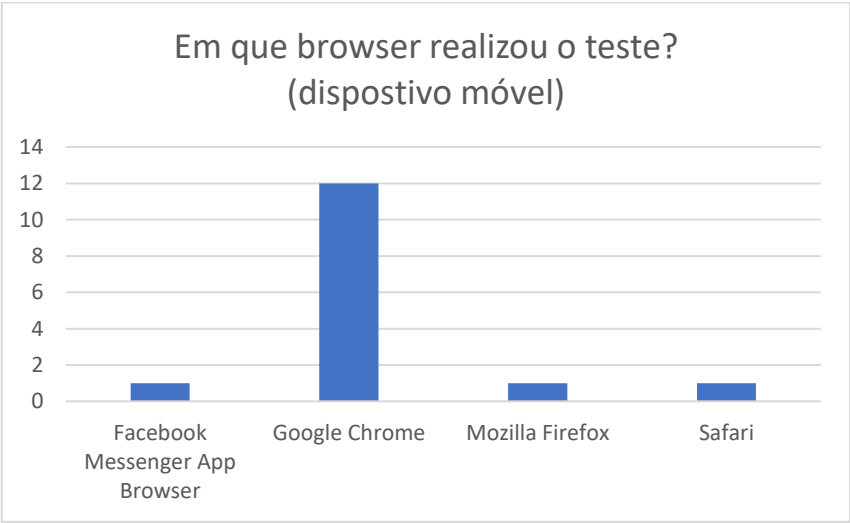
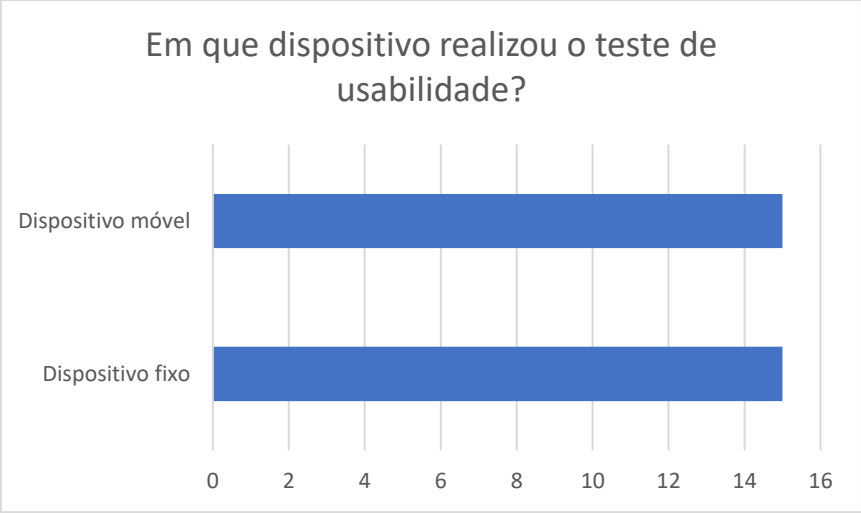




Se respondeu positivamente à questão anterior, que tipo de aplicações?

28 respostas

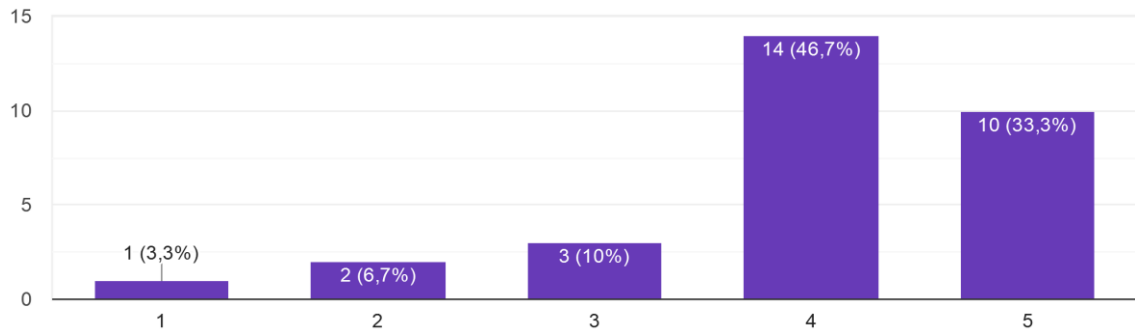




Segunda secção (second section)

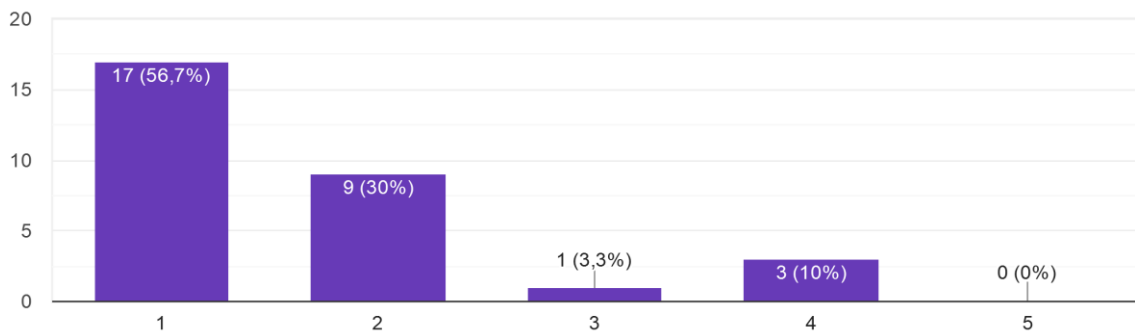
Acho que gostaria de utilizar esta plataforma com mais frequência.

30 respostas



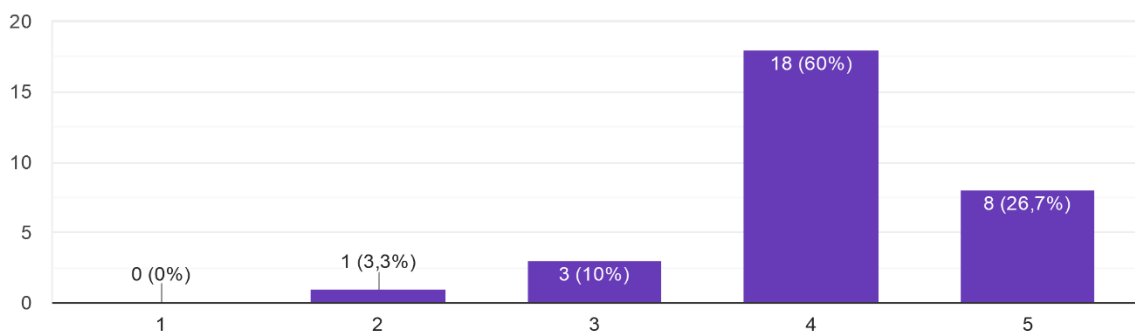
Achei a plataforma desnecessariamente complexa.

30 respostas



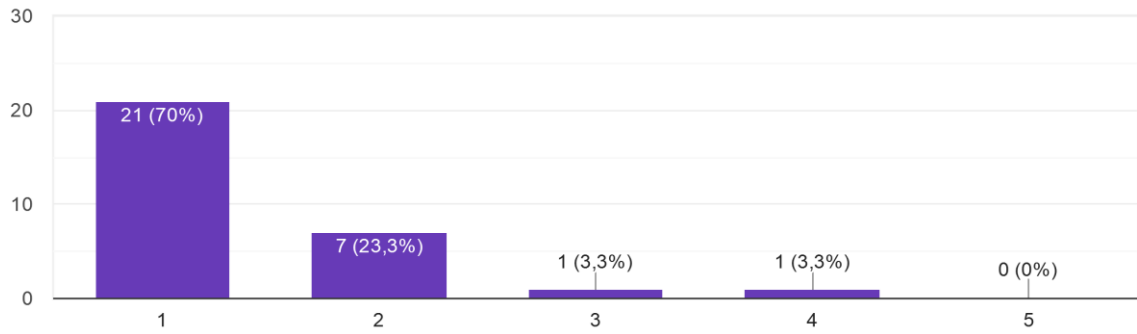
Achei a plataforma fácil de utilizar.

30 respostas



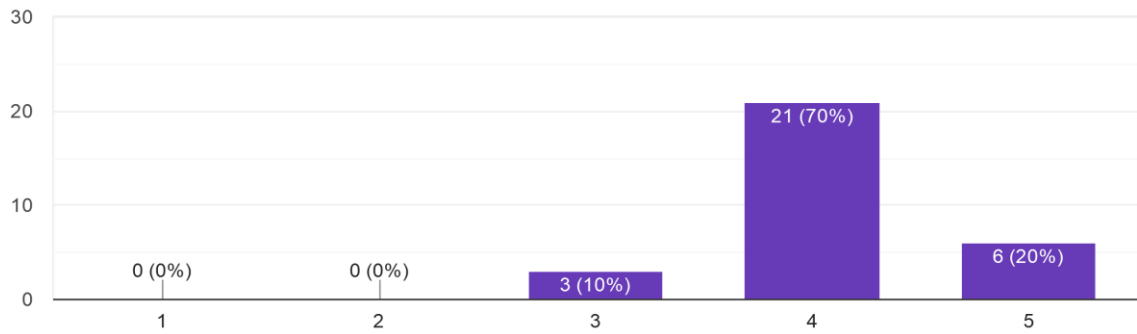
Acho que necessitaria da ajuda de um técnico para conseguir utilizar a plataforma.

30 respostas



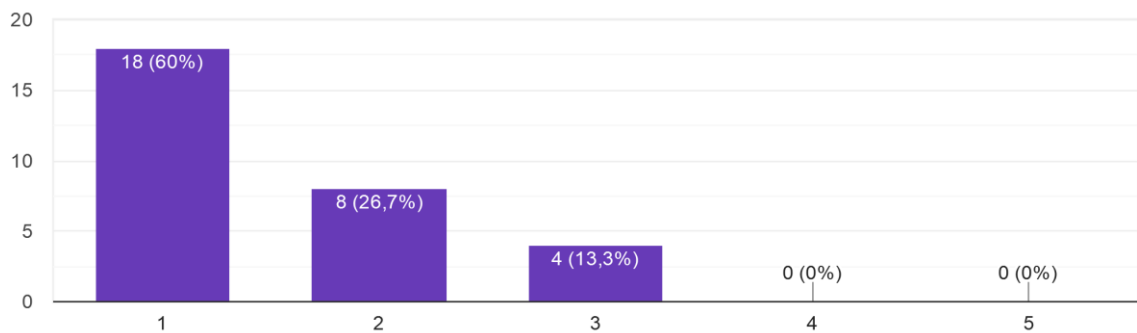
Considereei que as várias funcionalidades da plataforma foram bem integradas.

30 respostas



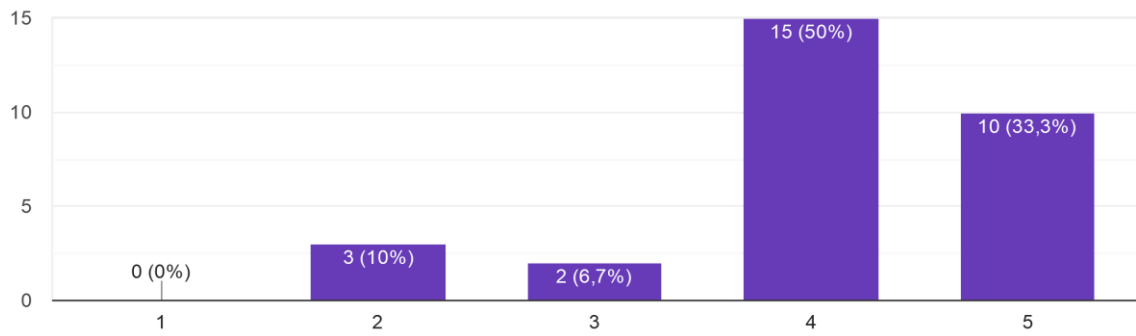
Achei que há demasiada inconsistência na plataforma.

30 respostas



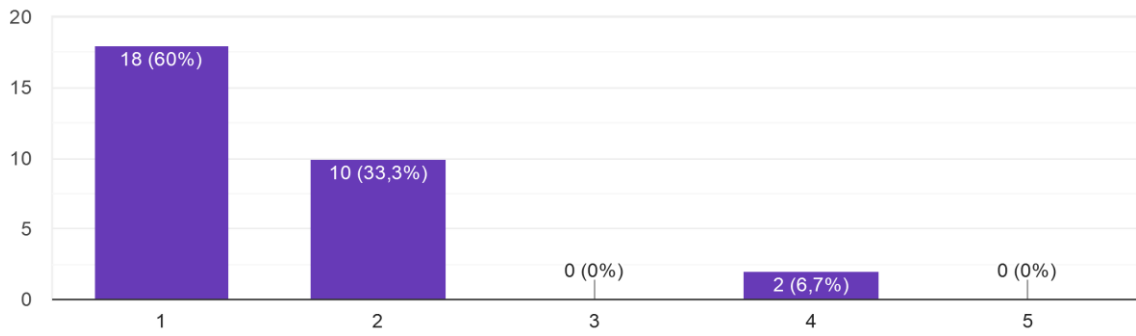
Acho que a maioria das pessoas aprenderia a utilizar esta plataforma rapidamente.

30 respostas



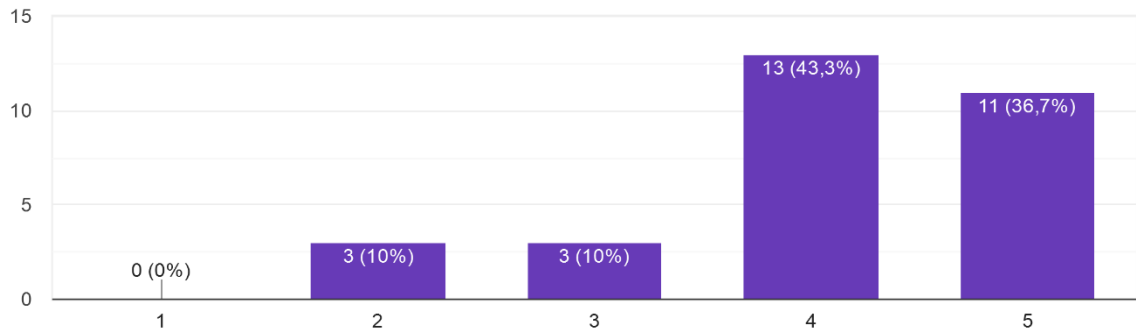
Achei a plataforma muito complicada de usar.

30 respostas



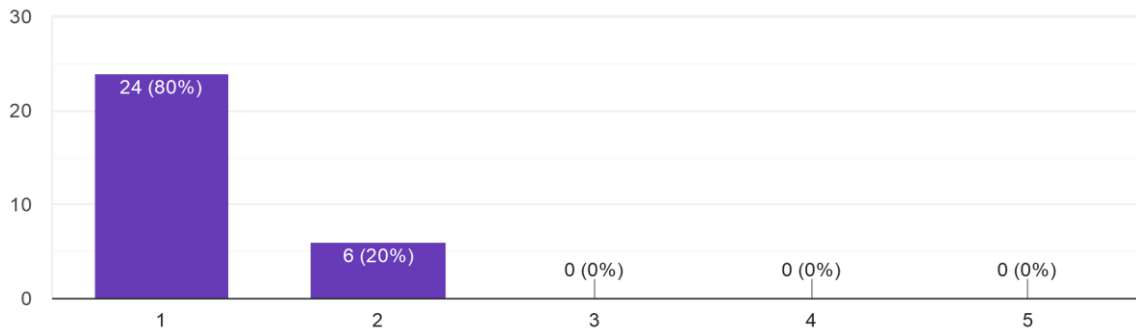
Senti-me muito confiante a utilizar a plataforma.

30 respostas



Precisei de aprender muito antes de conseguir utilizar a plataforma.

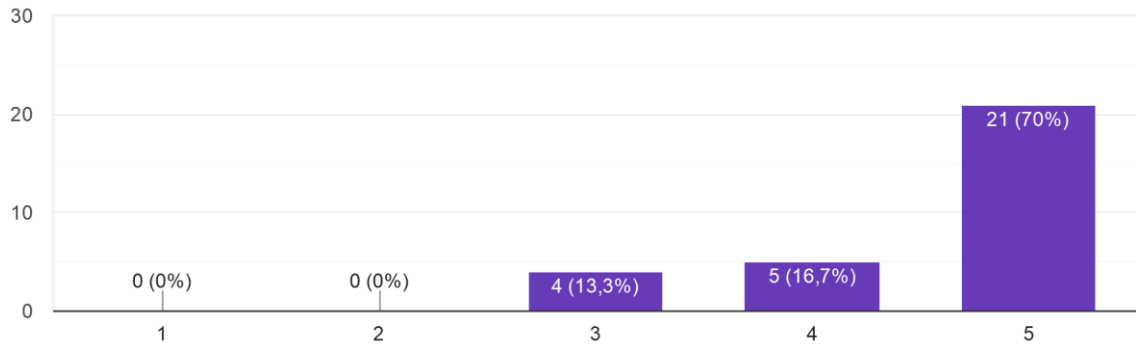
30 respostas



Terceira secção (third section)

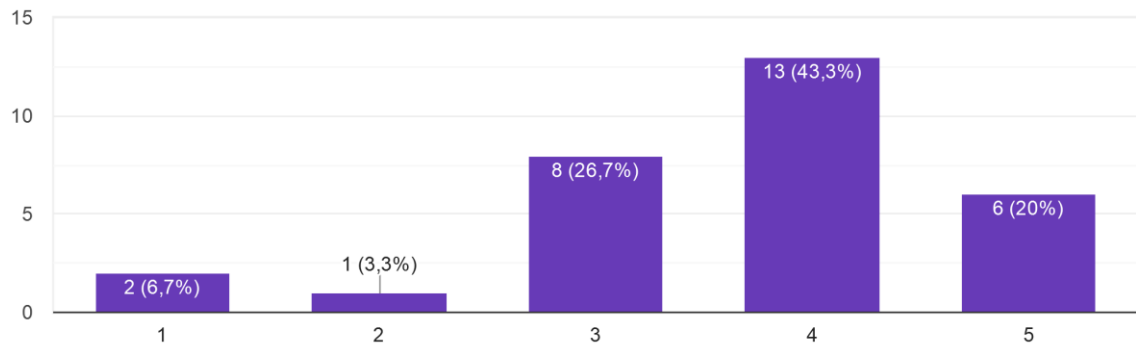
A barra de navegação é fácil de usar.

30 respostas



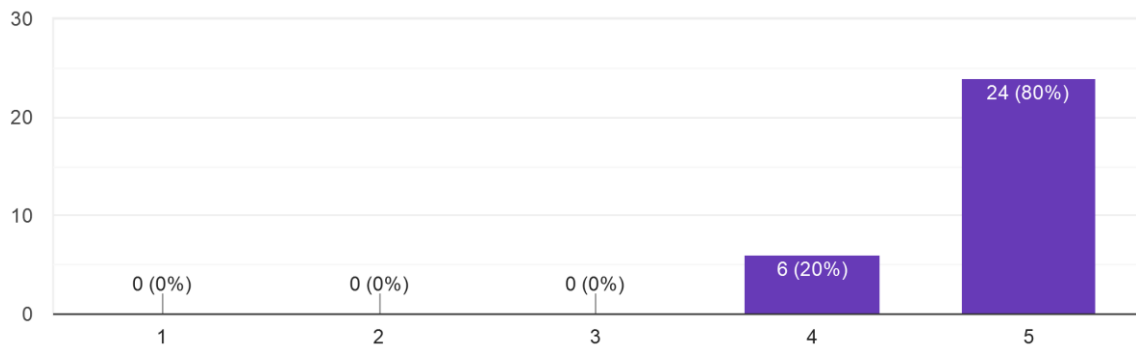
Acho interessante as opções de diferentes mapas base.

30 respostas



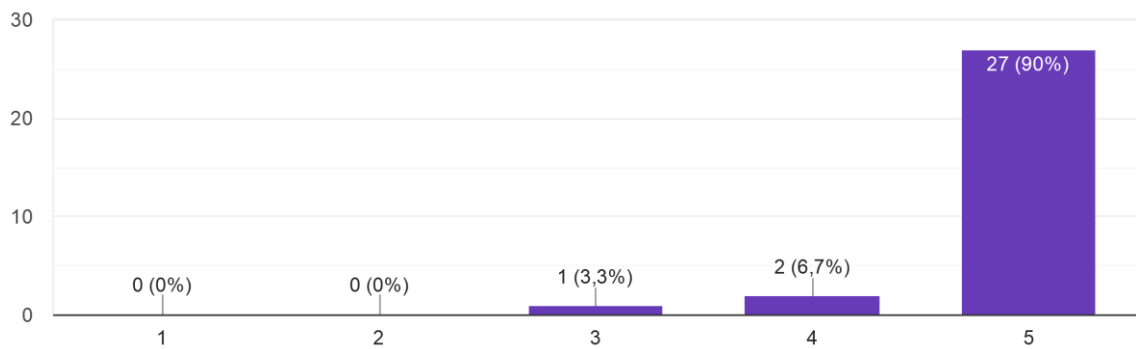
Acho interessante as opções de cartografia histórica.

30 respostas



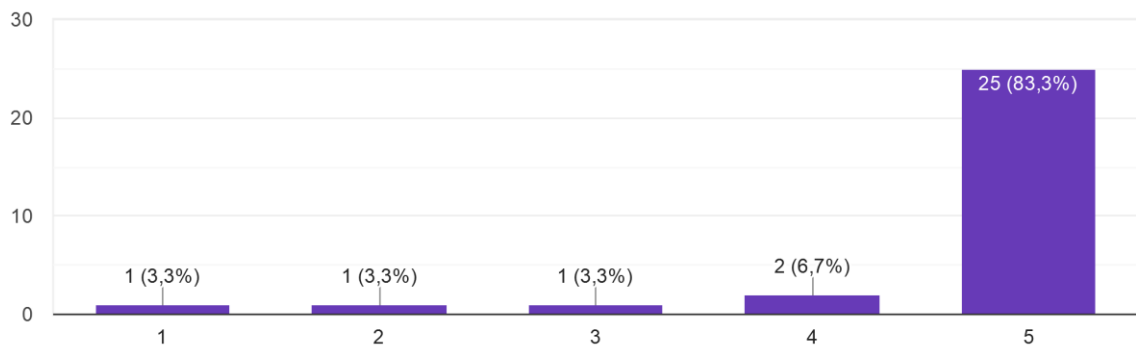
A submissão de imagens é fácil de efetuar.

30 respostas

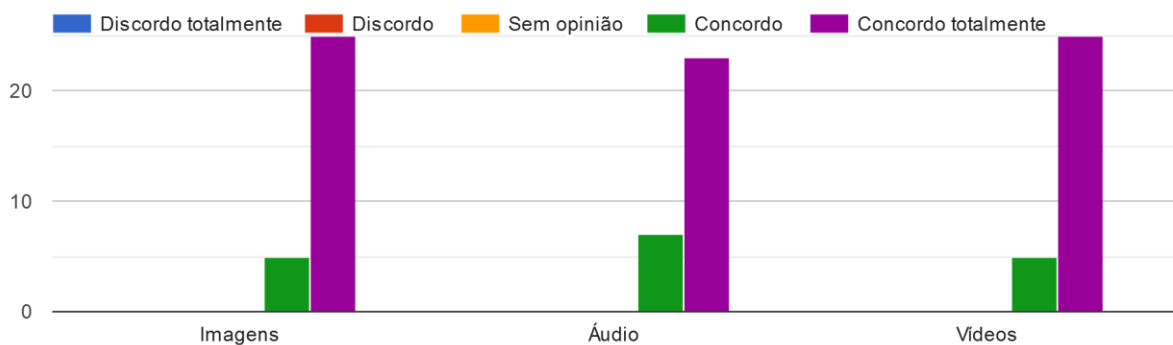


A submissão de áudio é fácil de efetuar.

30 respostas

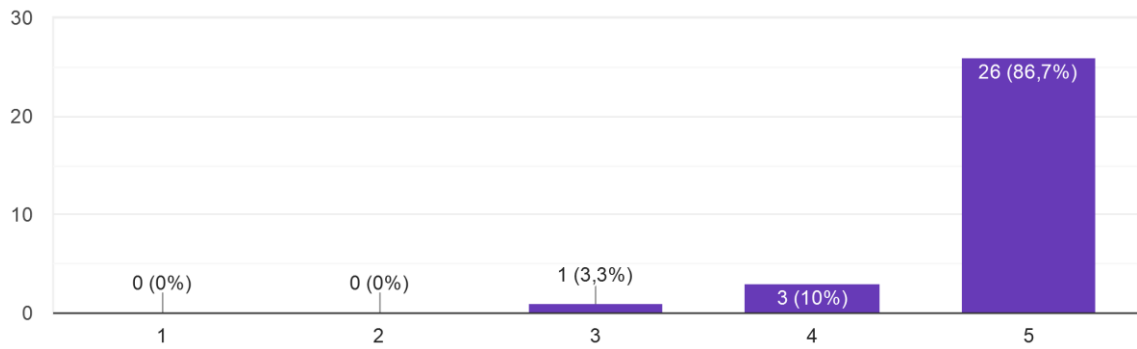


A submissão de conteúdo multimédia é interessante.



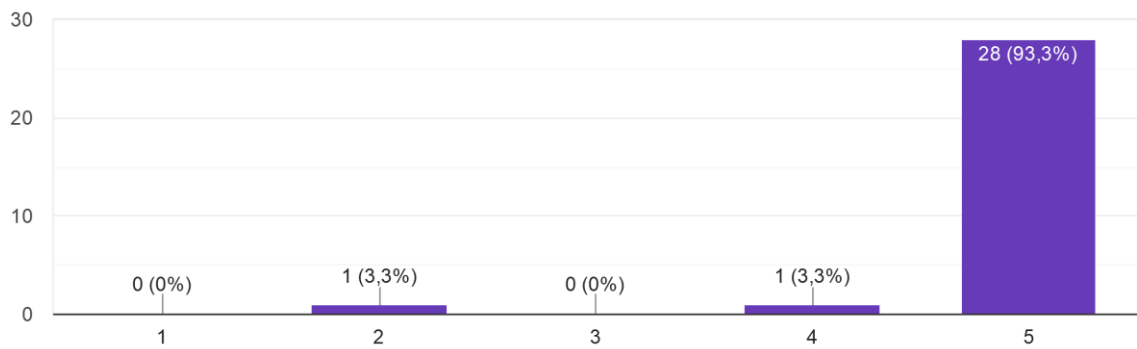
A interação com imagens 360° é interessante.

30 respostas



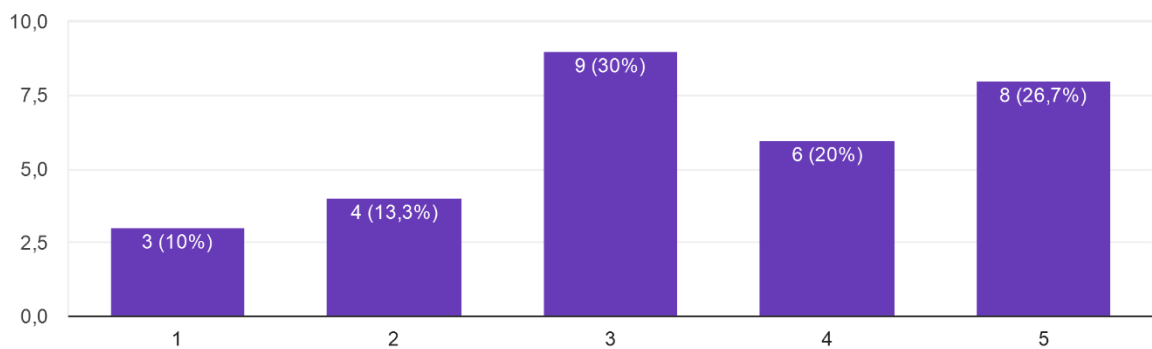
A interação com vídeos 360° com som espacial é interessante.

30 respostas



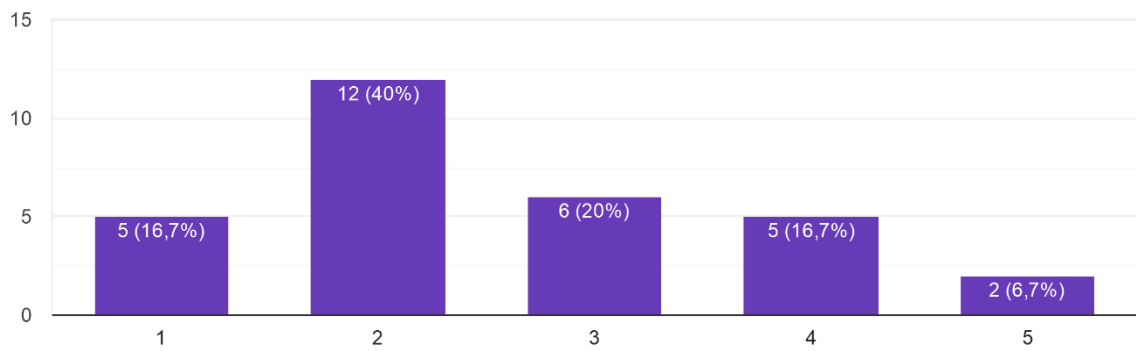
A timeline (linha temporal) é útil.

30 respostas



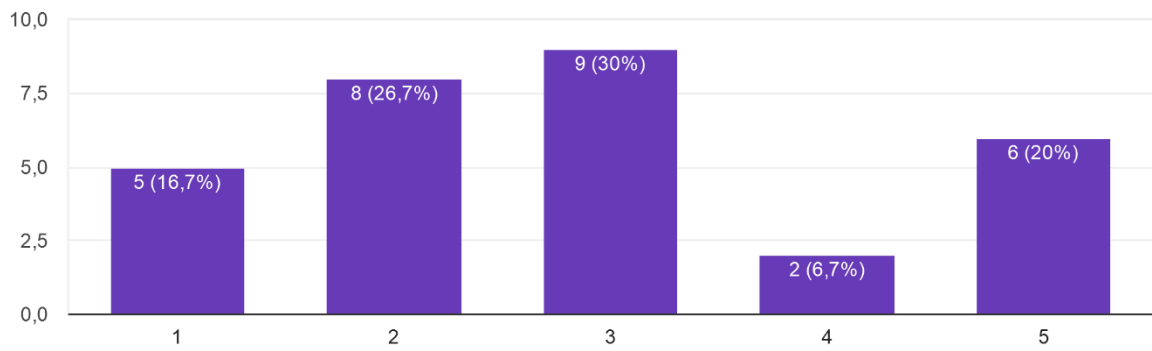
A timeline é fácil de usar.

30 respostas

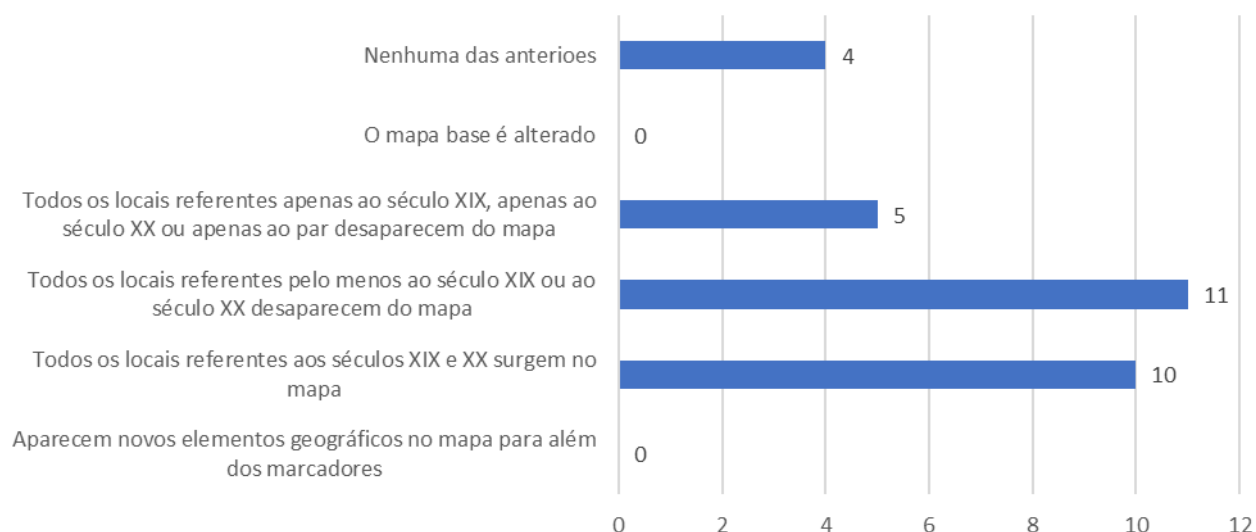


Compreendi como funciona a timeline.

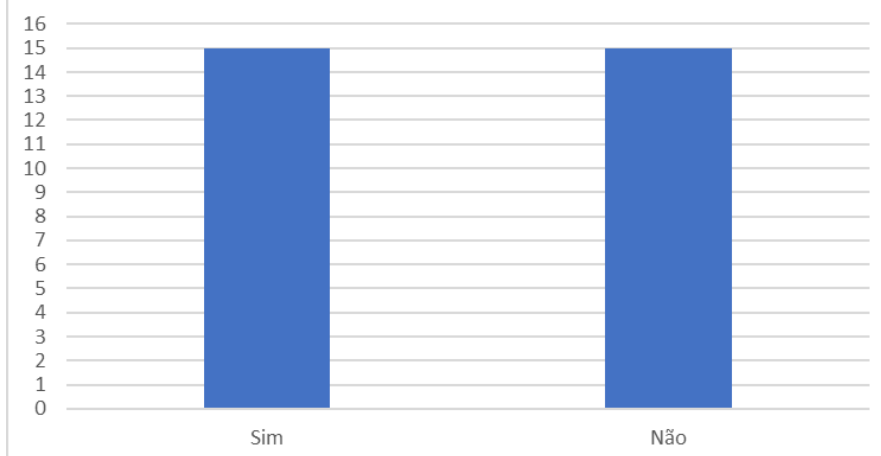
30 respostas



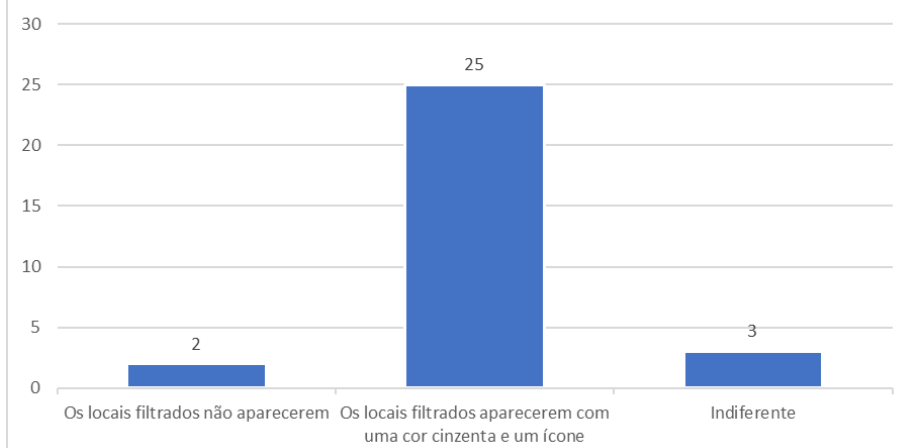
Em relação à timeline: um local pode estar associado a vários séculos. O que acontece quando os filtros do séc. XIX e XX se encontram ativos?



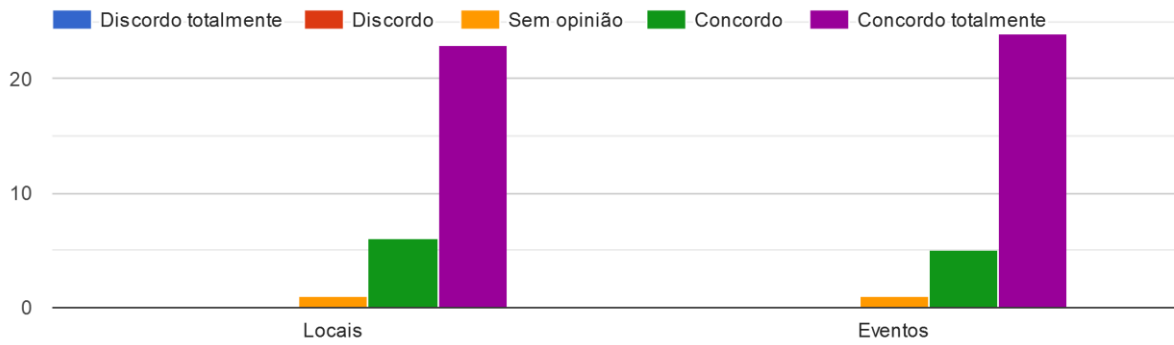
Com que situação se deparou?



Qual das abordagens acha mais intuitiva?

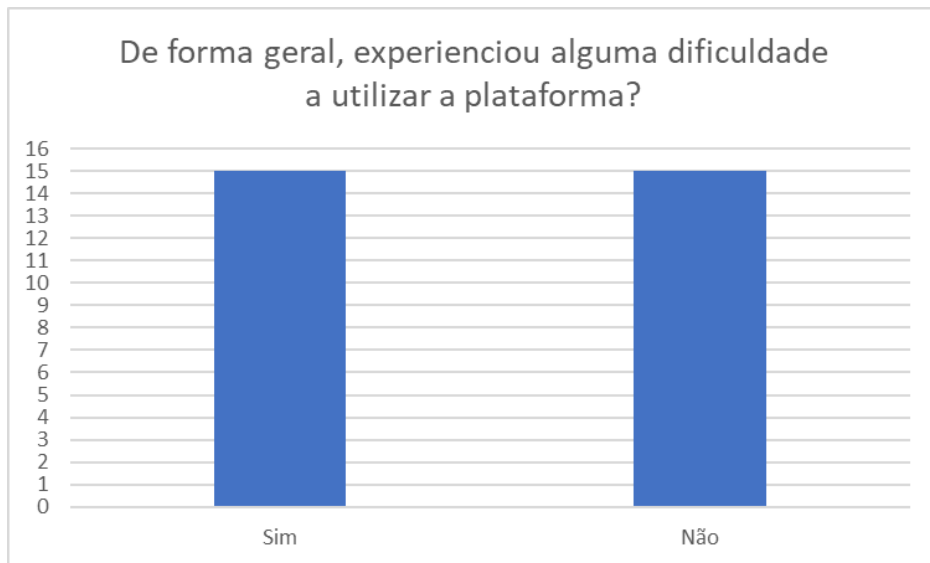
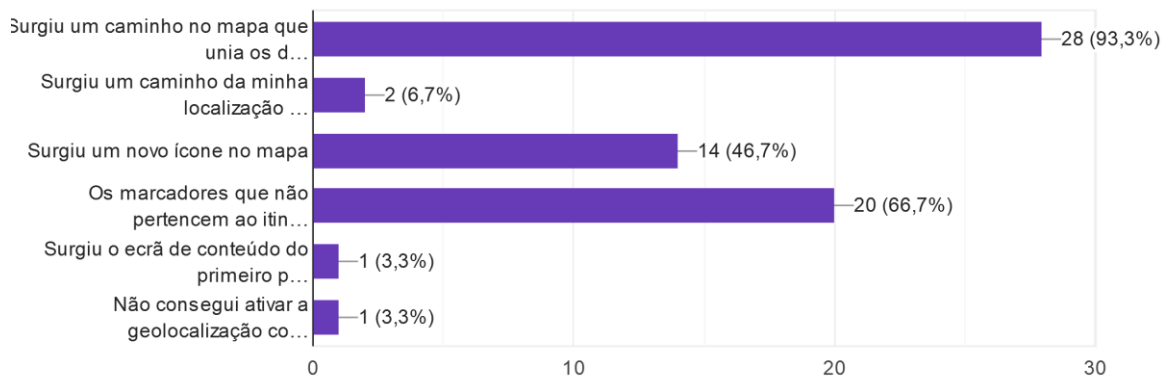


É fácil pesquisar:



Depois de ativar um itinerário, quais das seguintes ações observou?

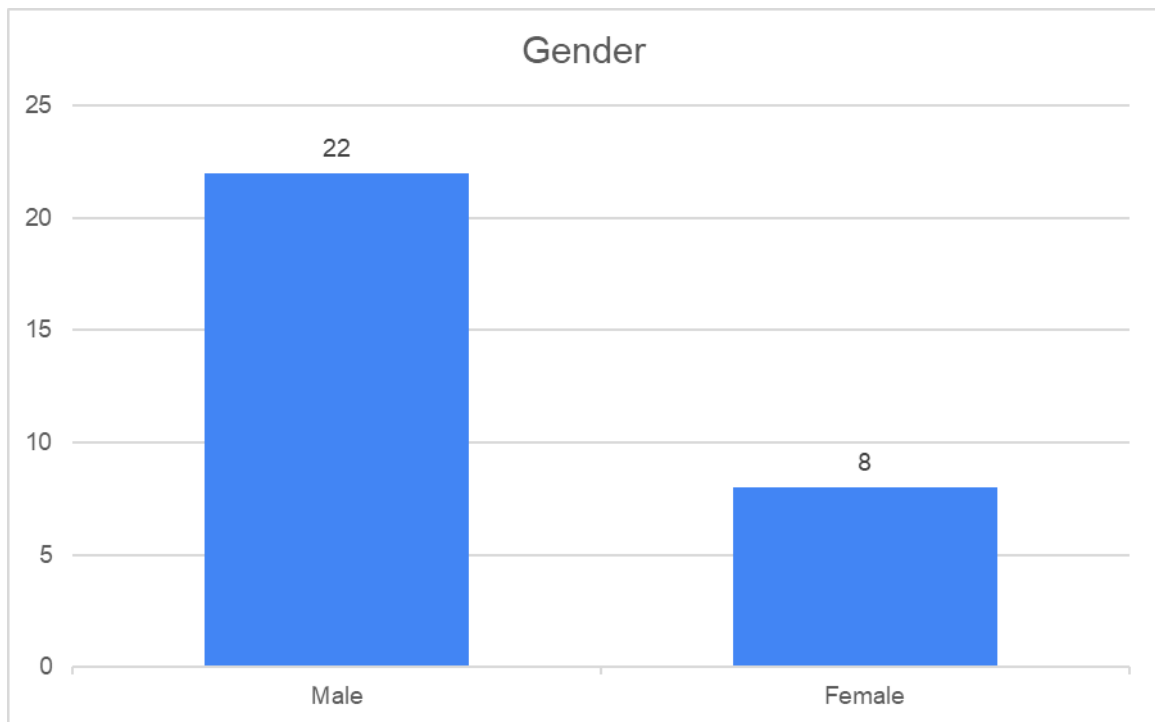
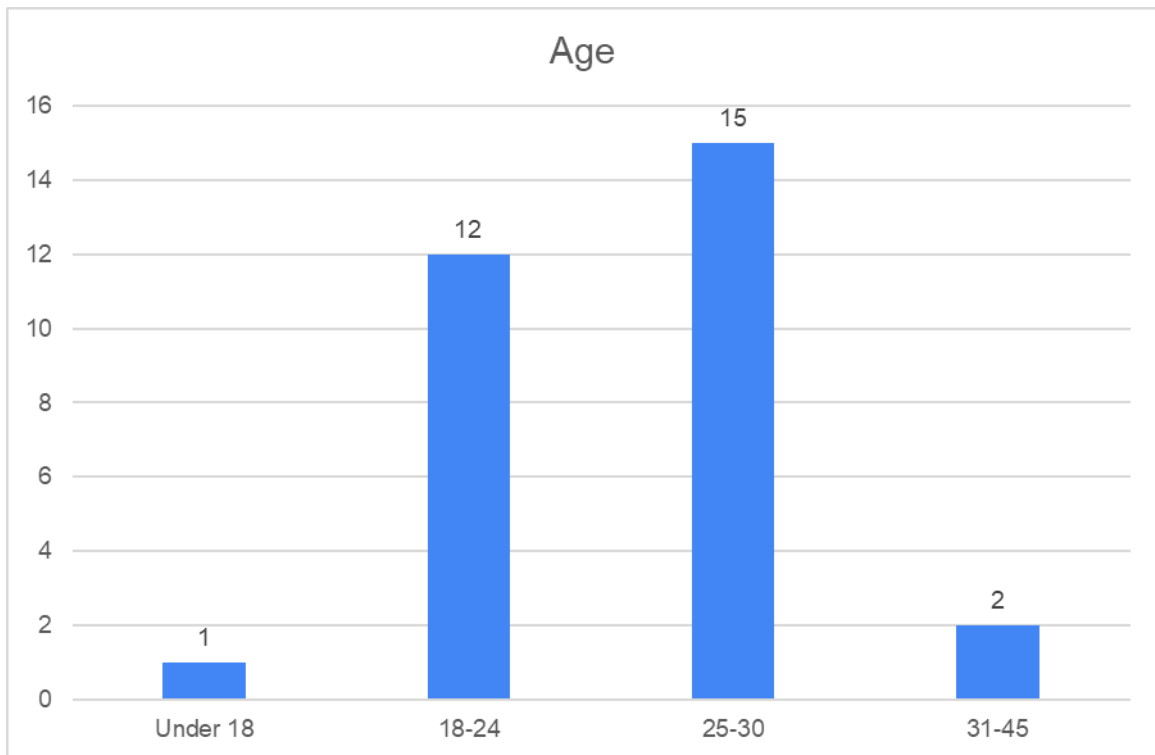
30 respostas

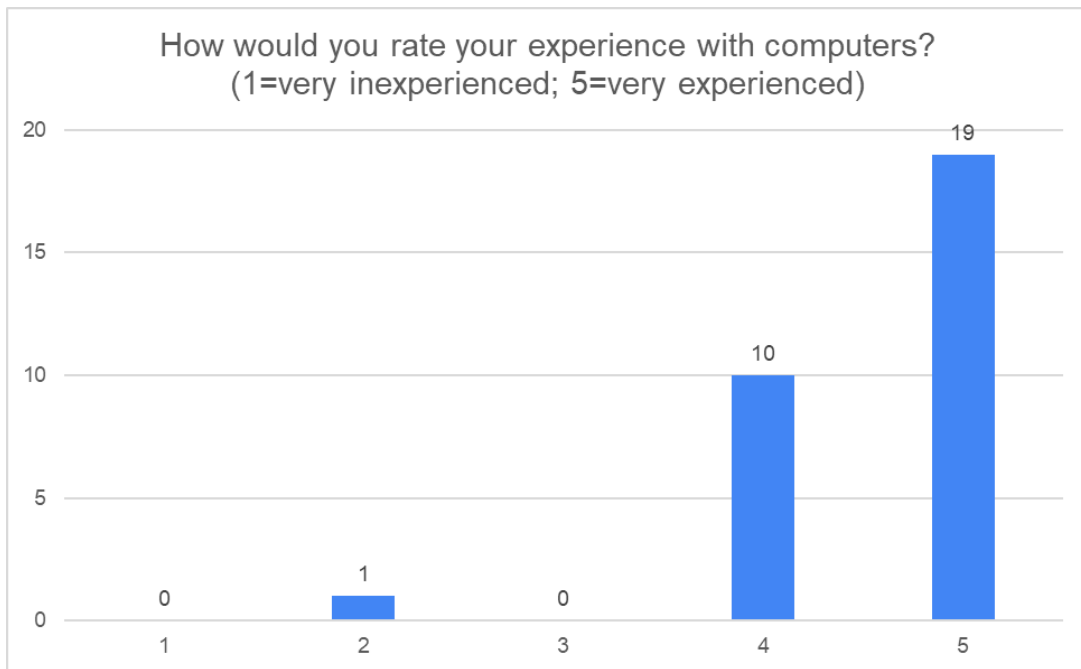
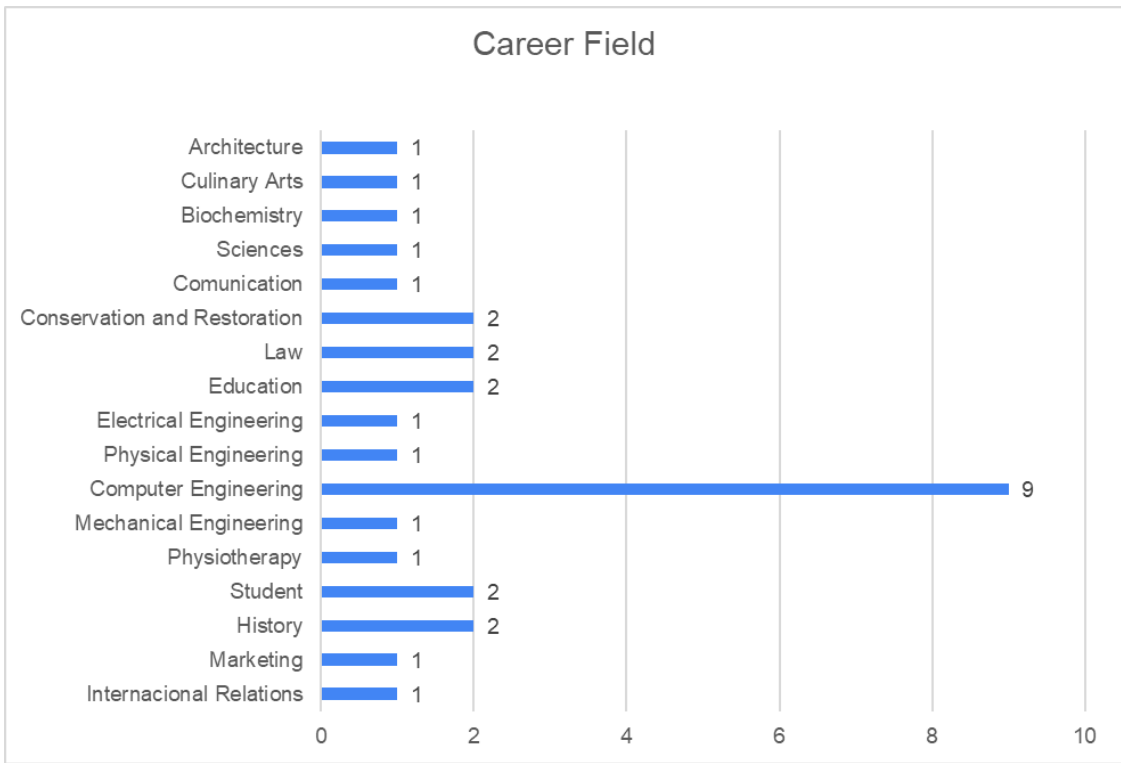


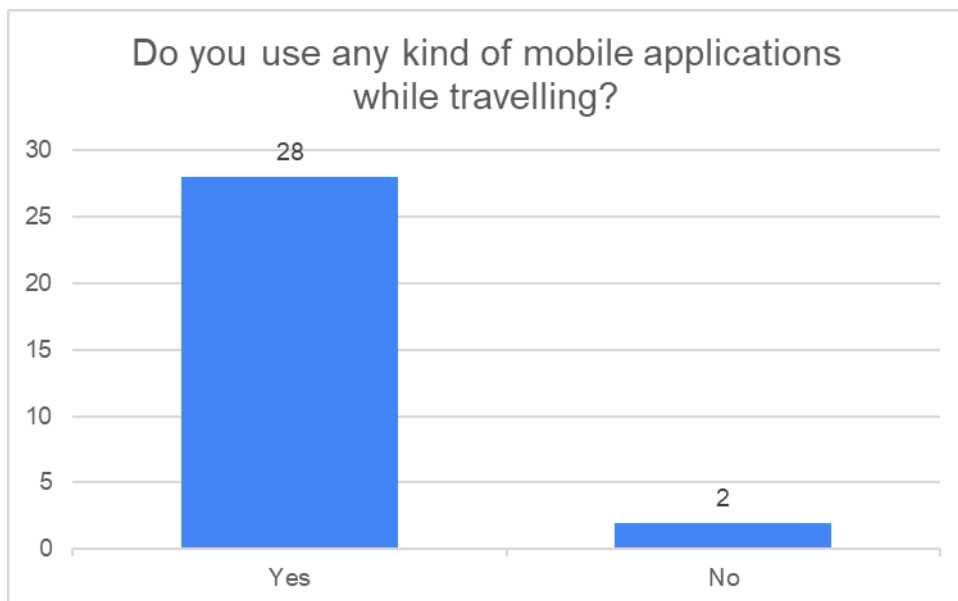
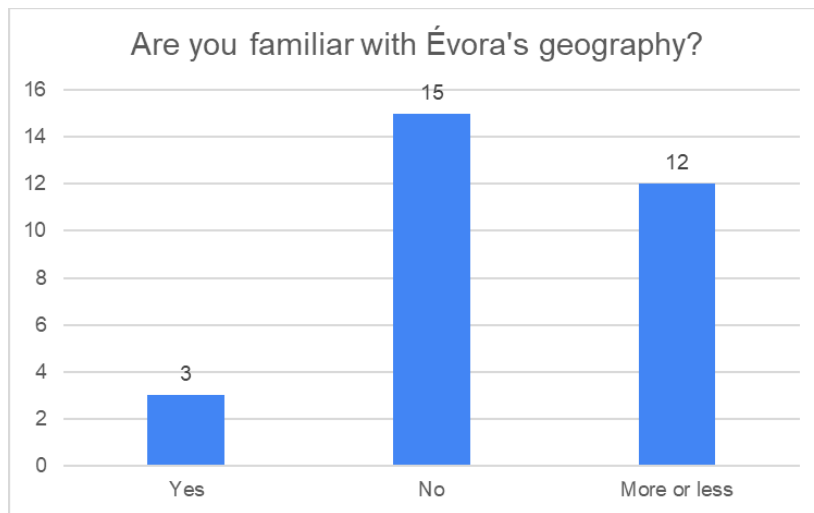
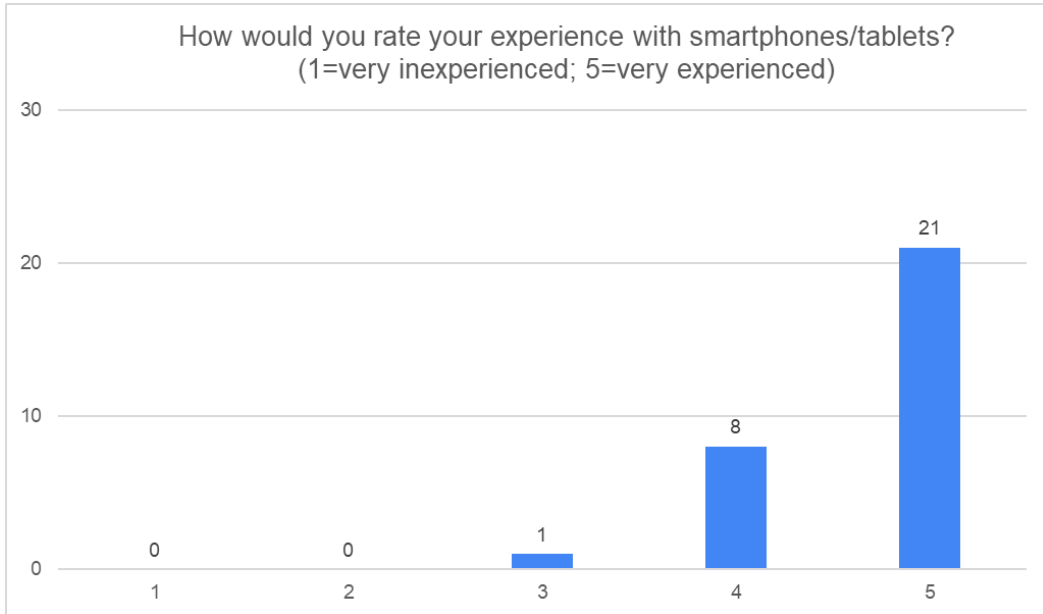


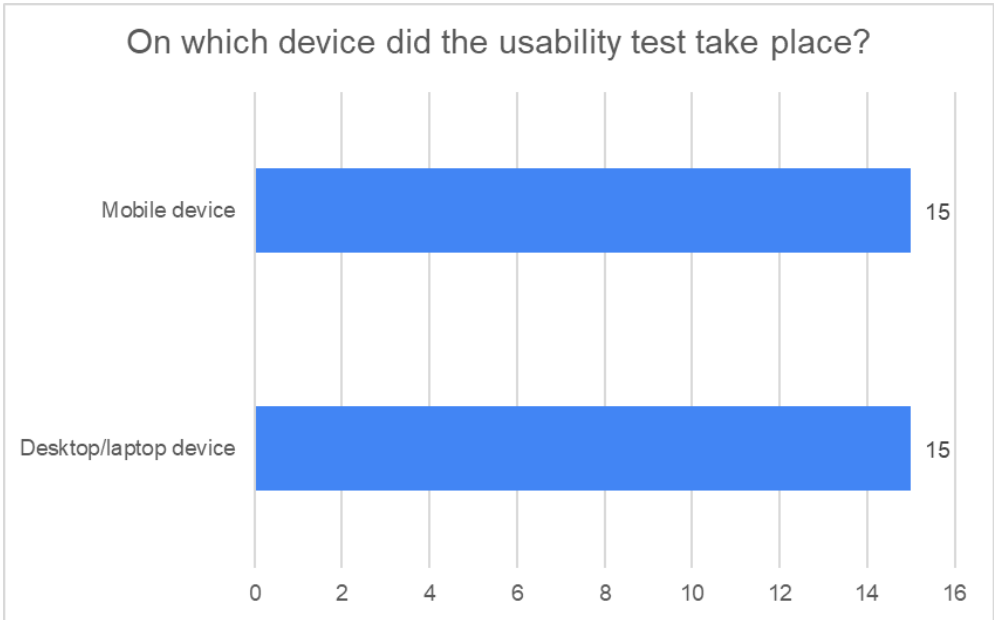
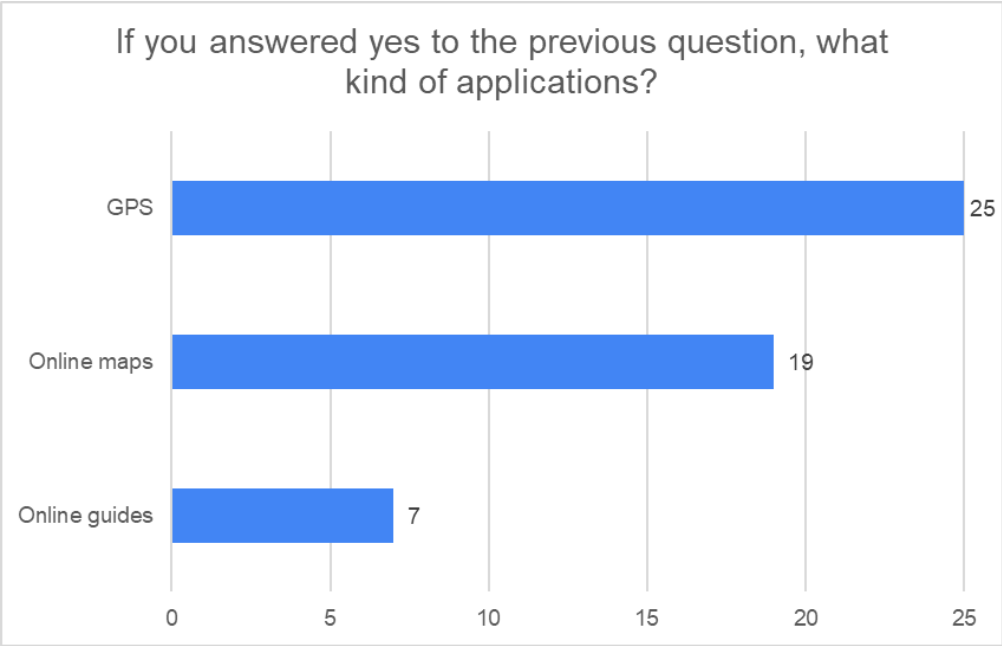
QUESTIONNAIRE GRAPHS - USERS (ENGLISH)

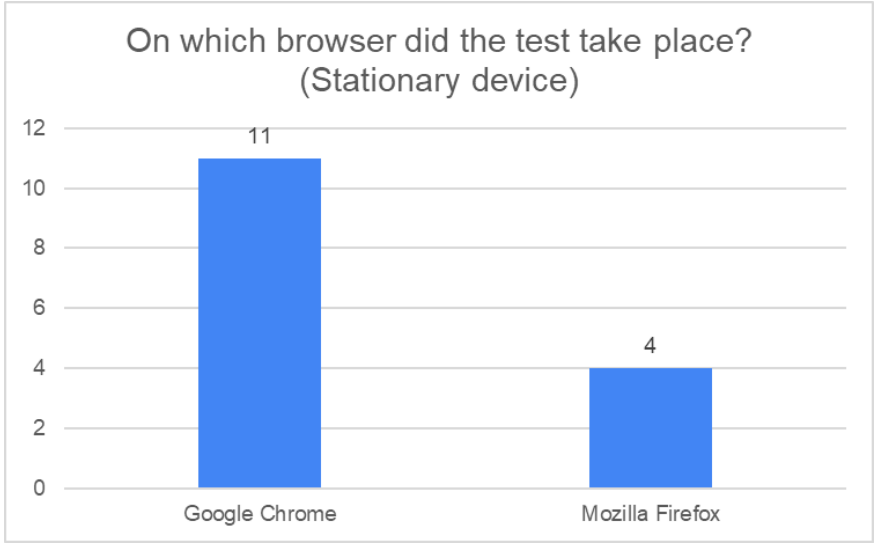
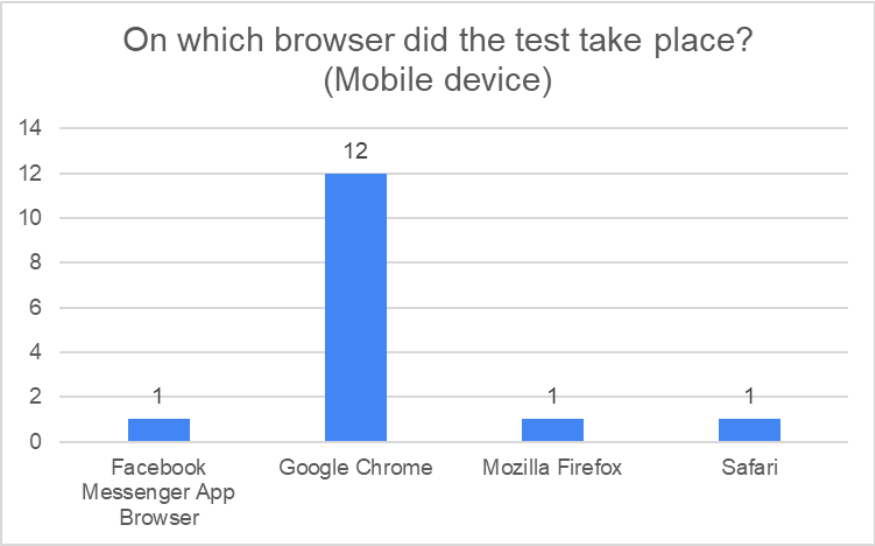
First section



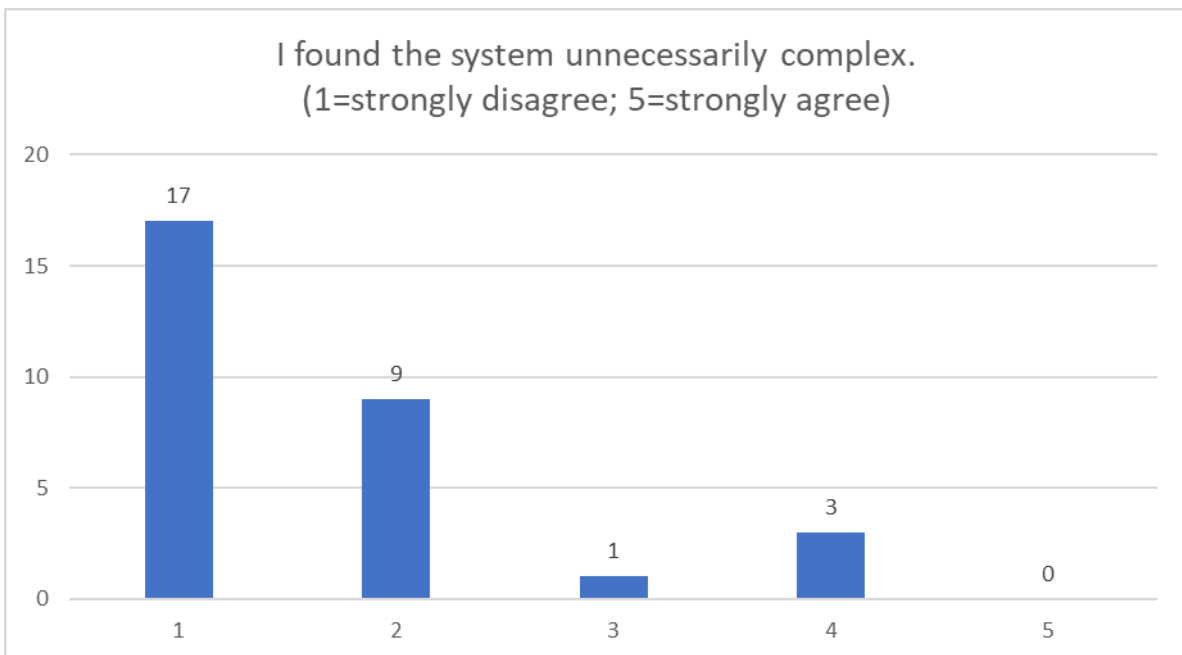
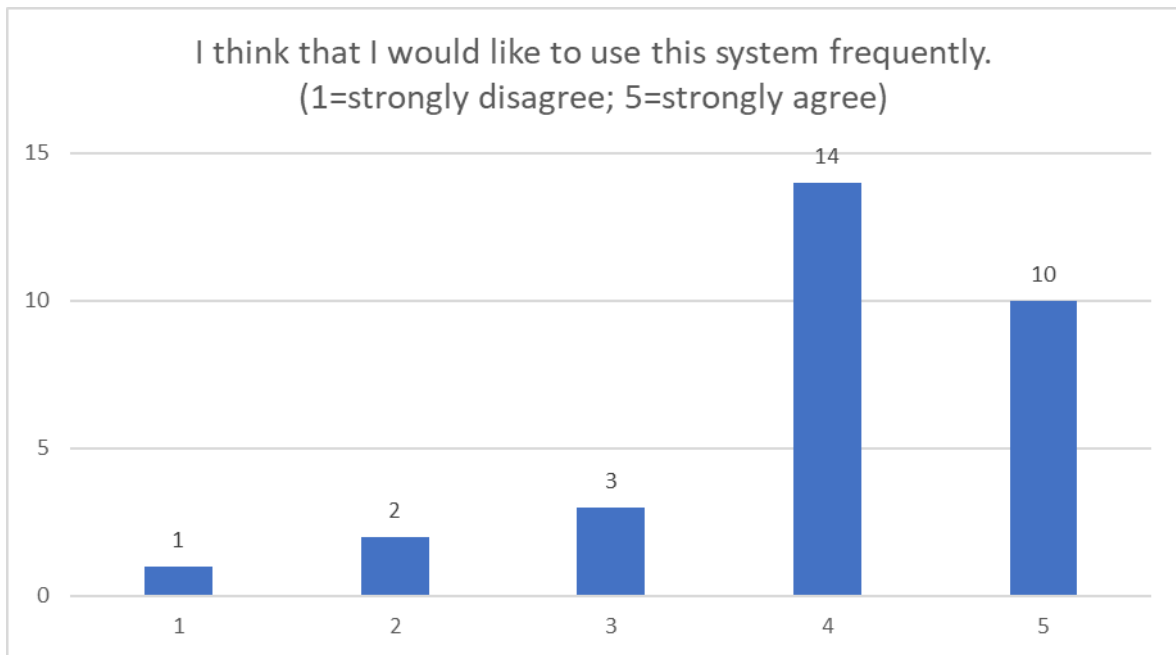


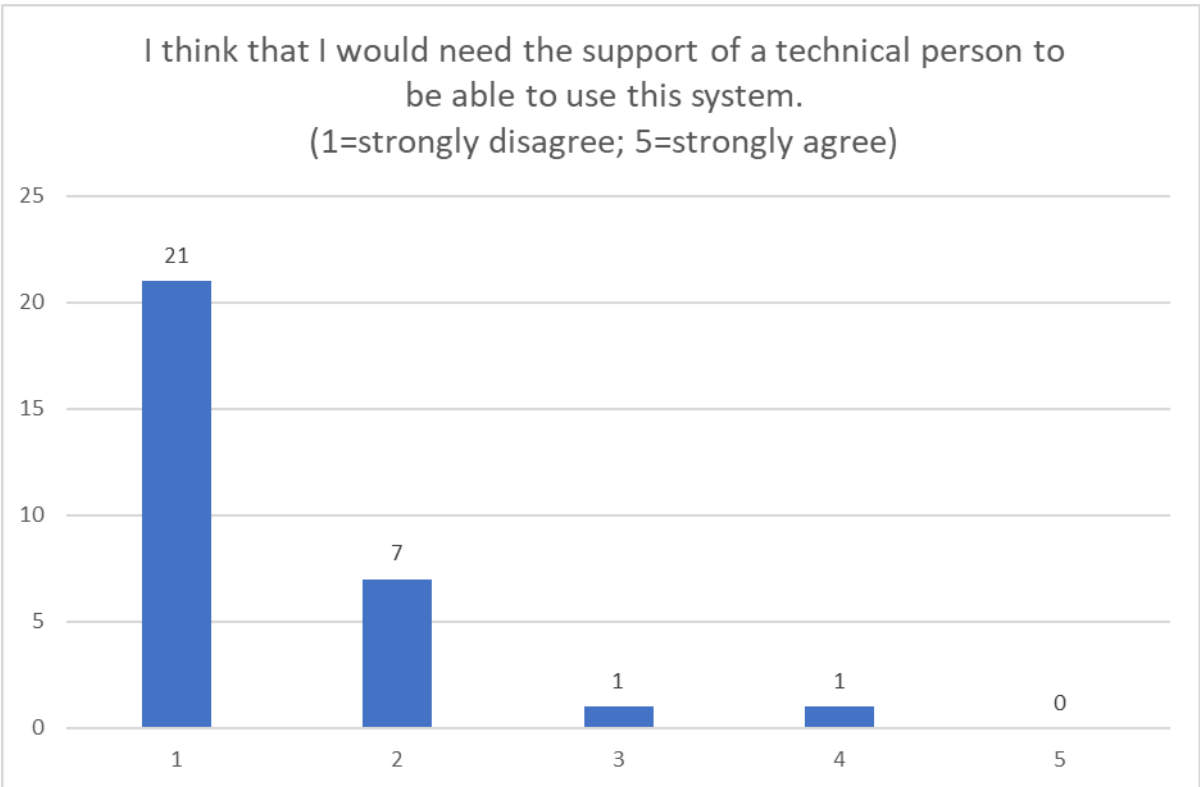
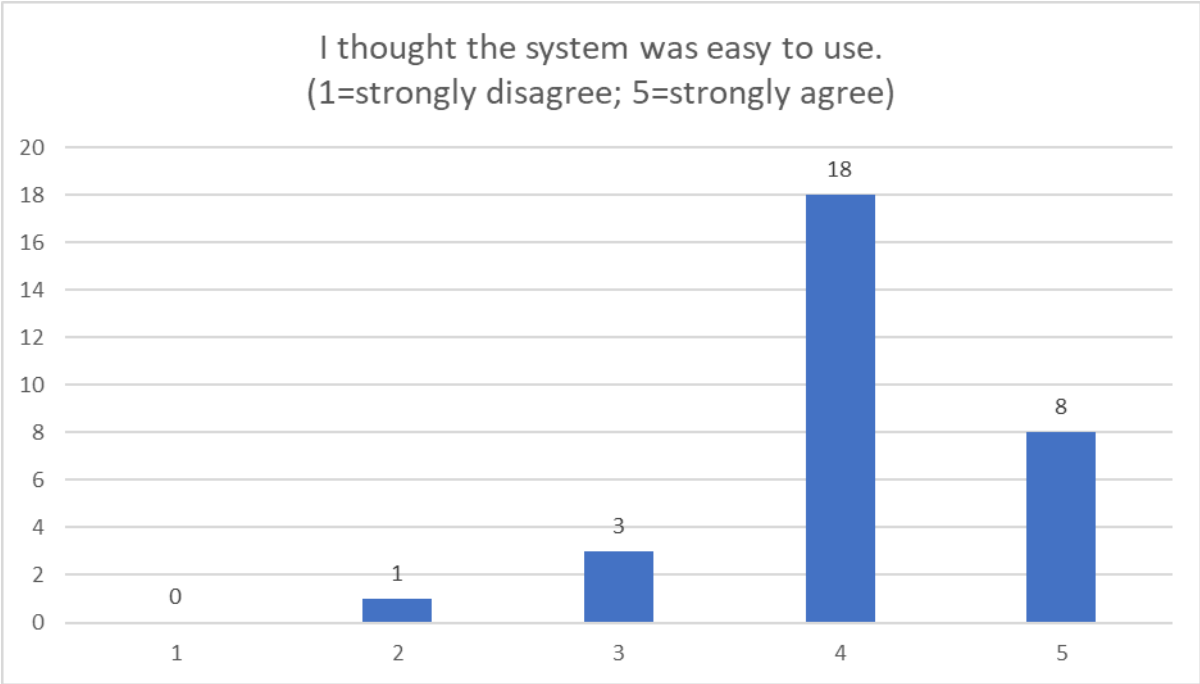






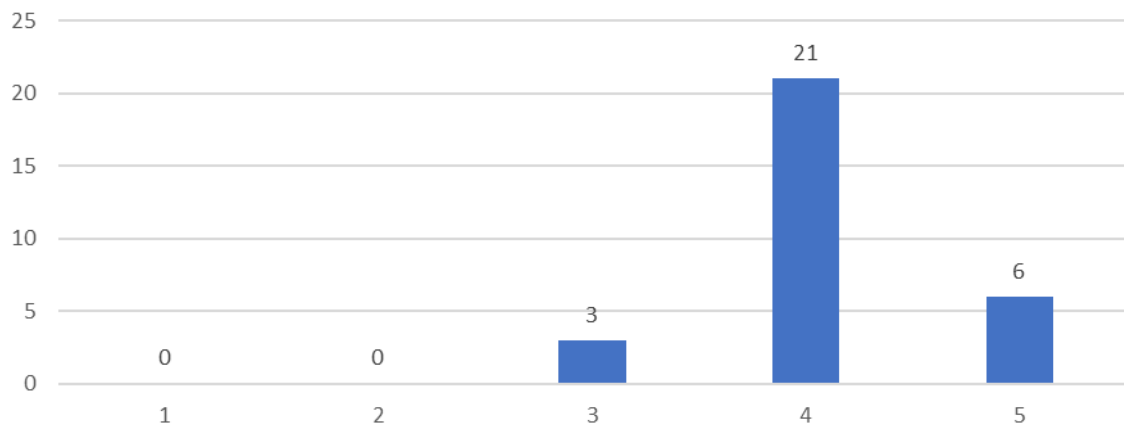
Second section





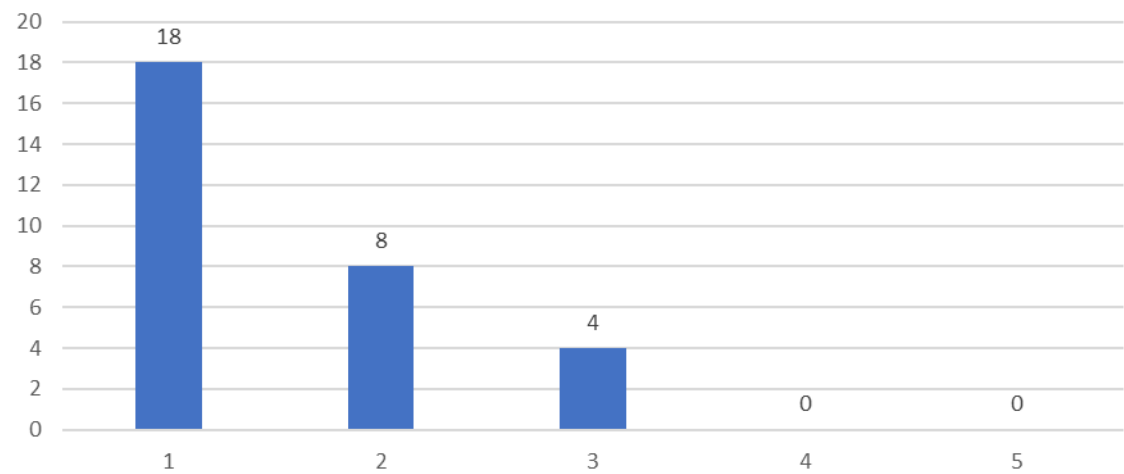
I found the various functions in this system were well integrated.

(1=strongly disagree; 5=strongly agree)

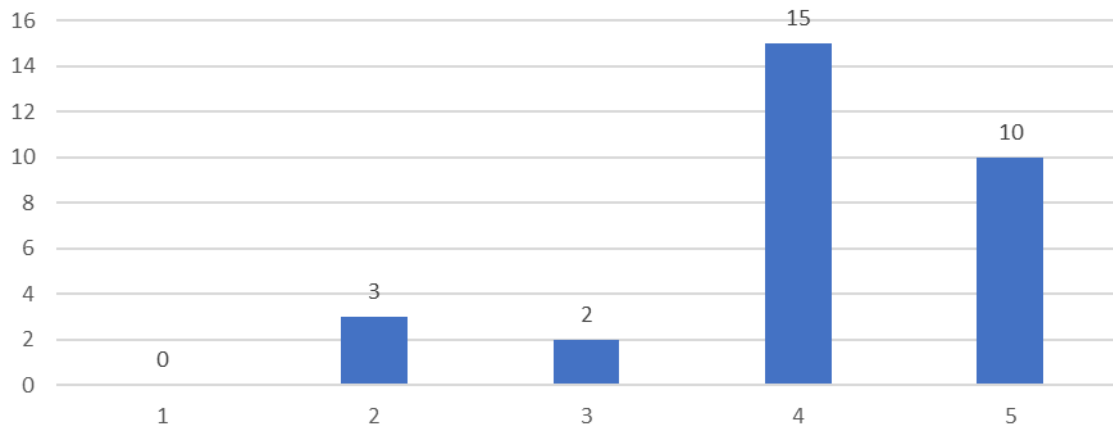


I thought there was too much inconsistency in this system.

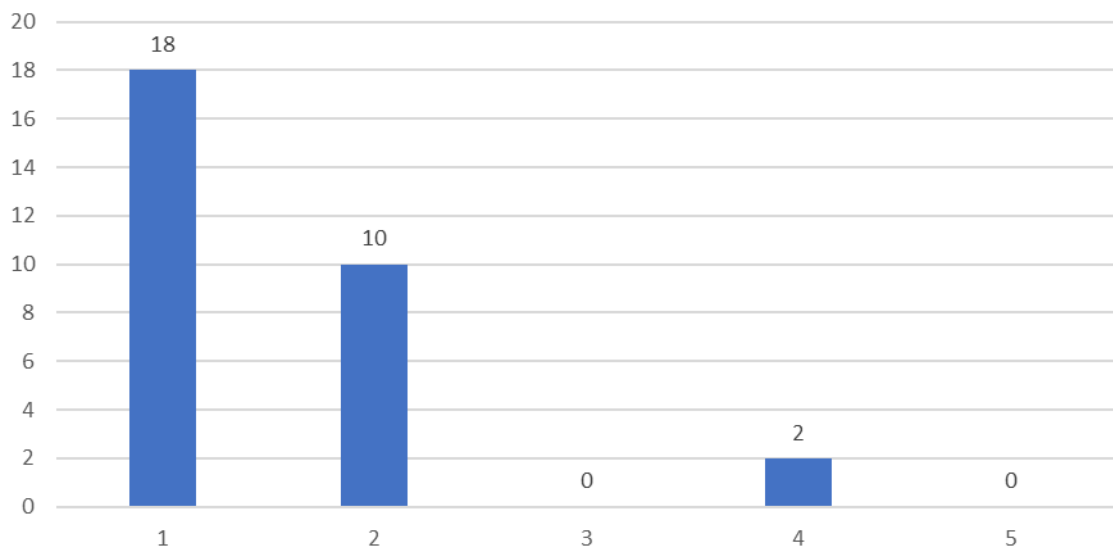
(1=strongly disagree; 5=strongly agree)

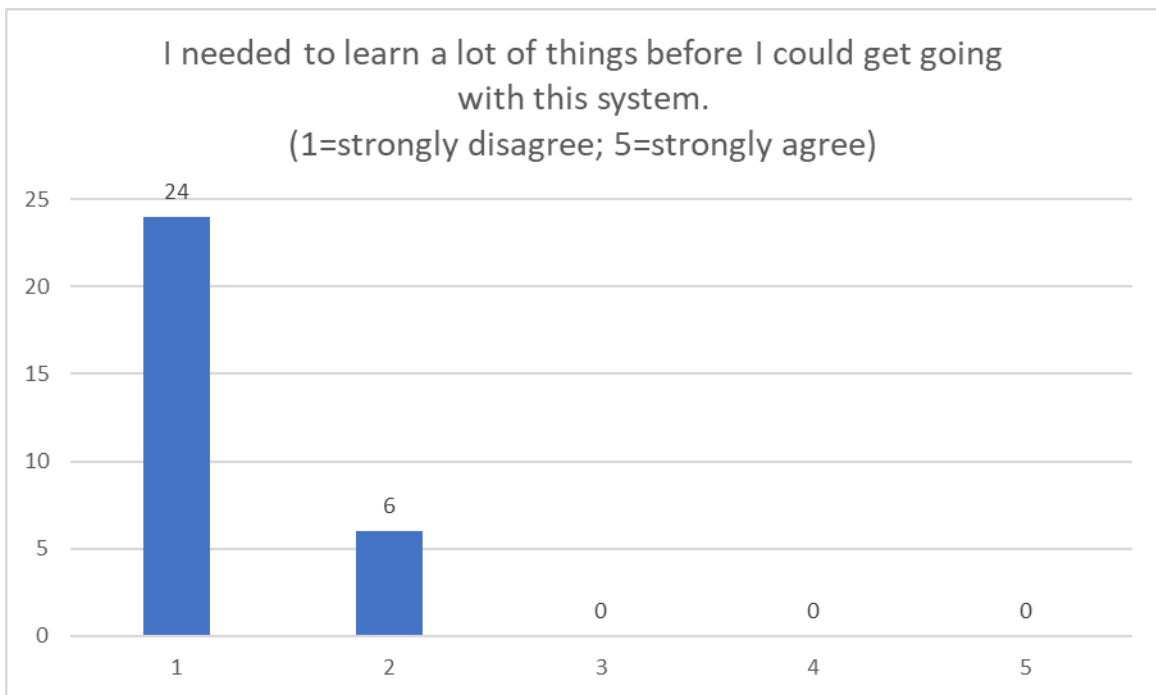
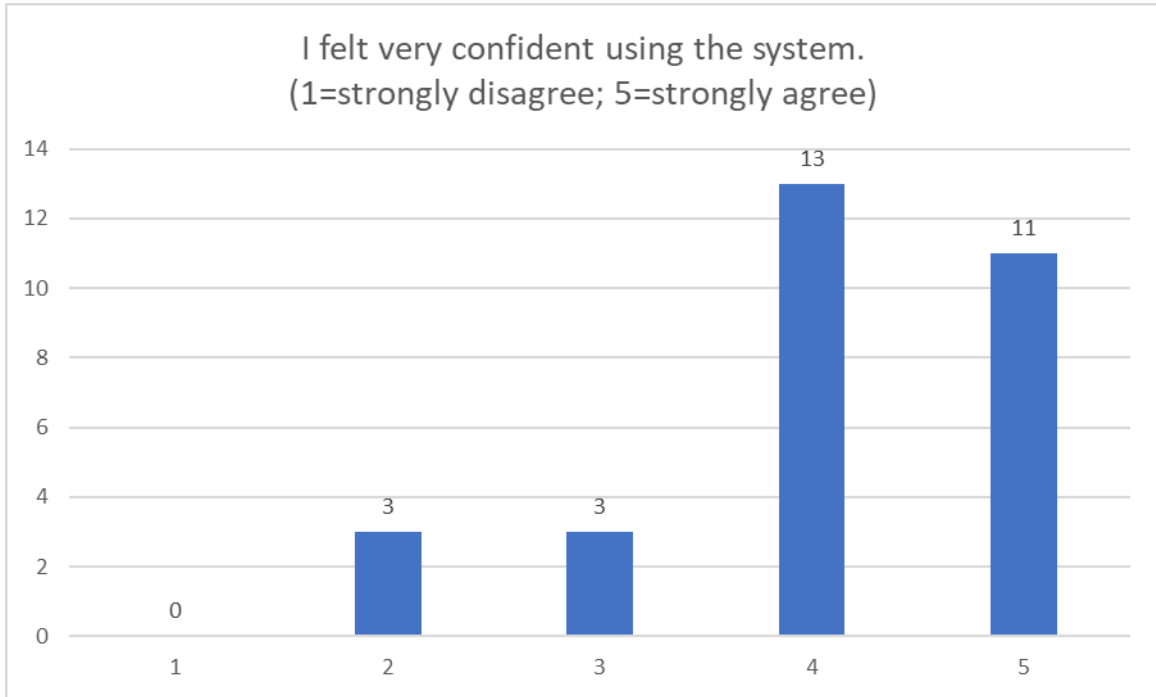


I would imagine that most people would learn to use this system very quickly.
(1=strongly disagree; 5=strongly agree)

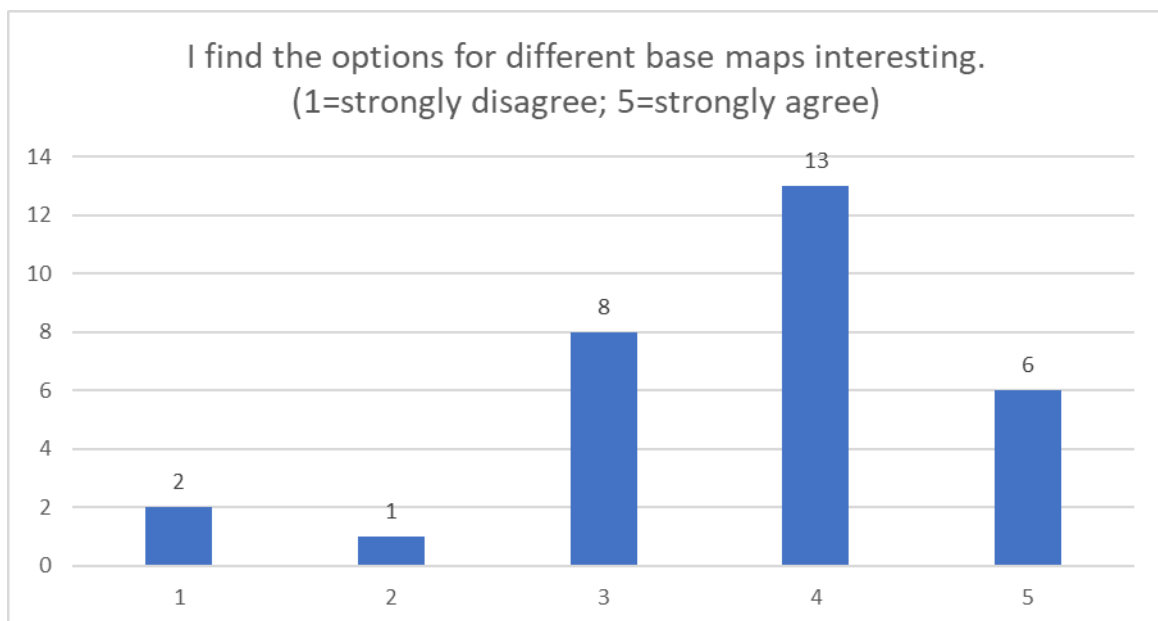
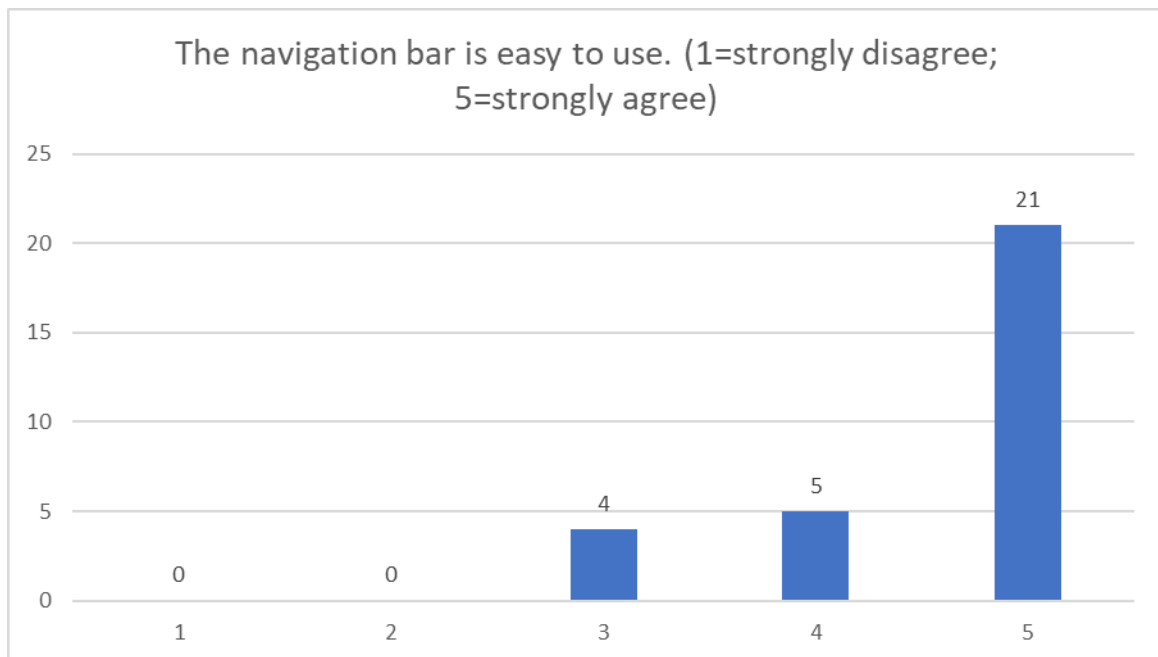


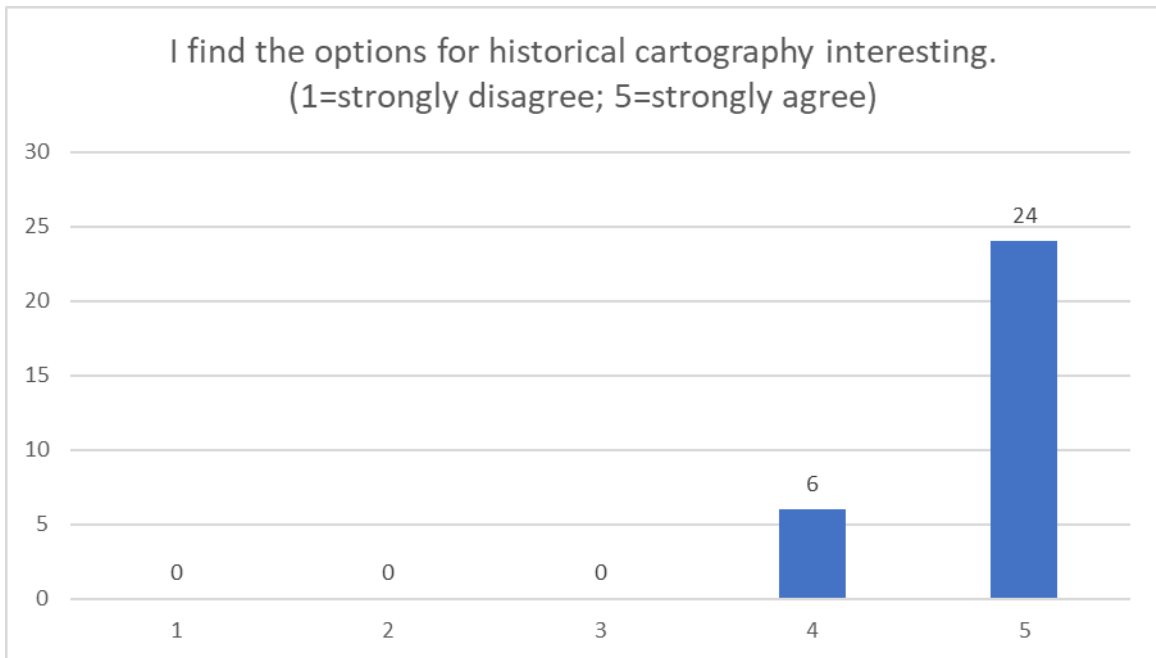
I found the system very cumbersome to use. (1=strongly disagree; 5=strongly agree)

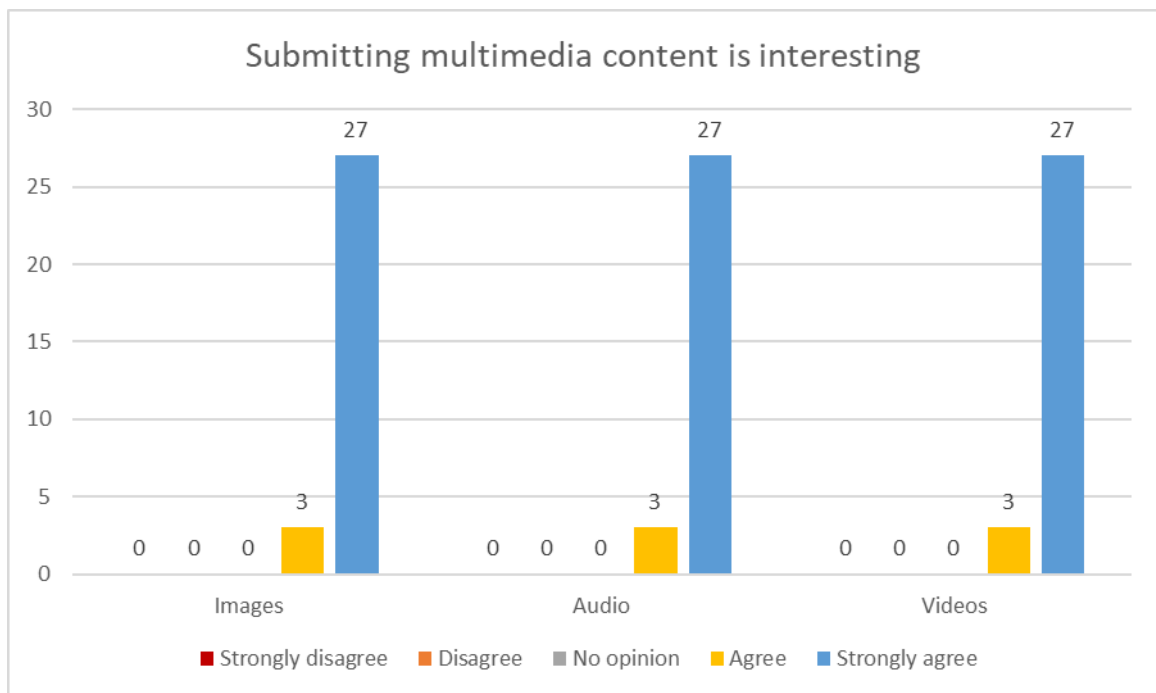
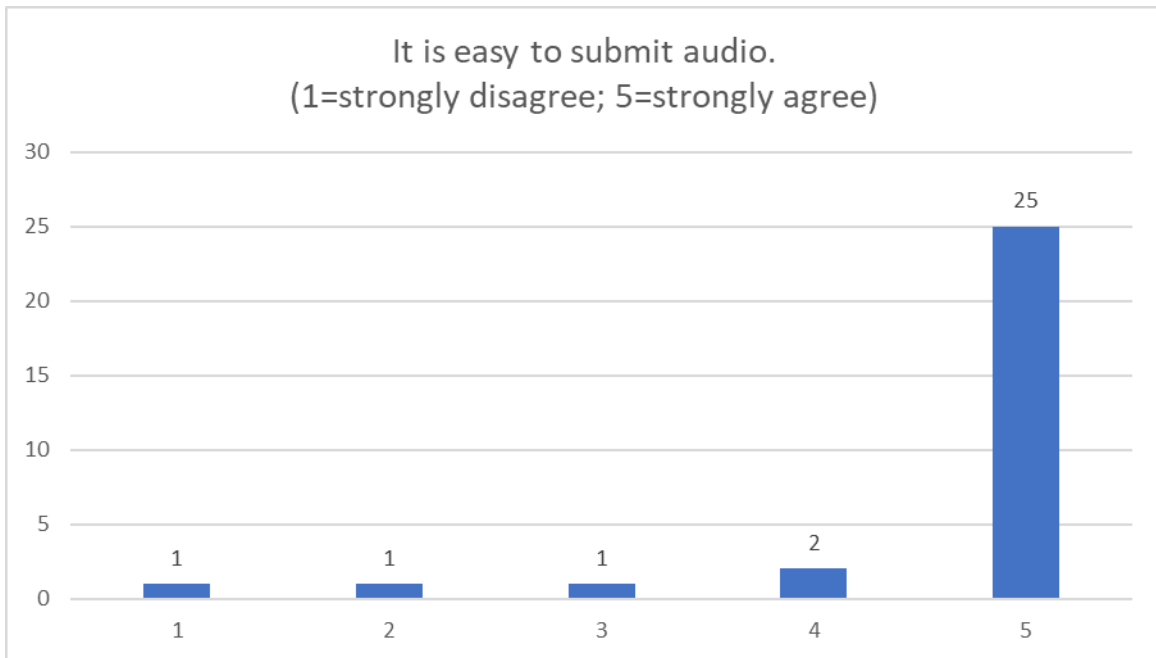


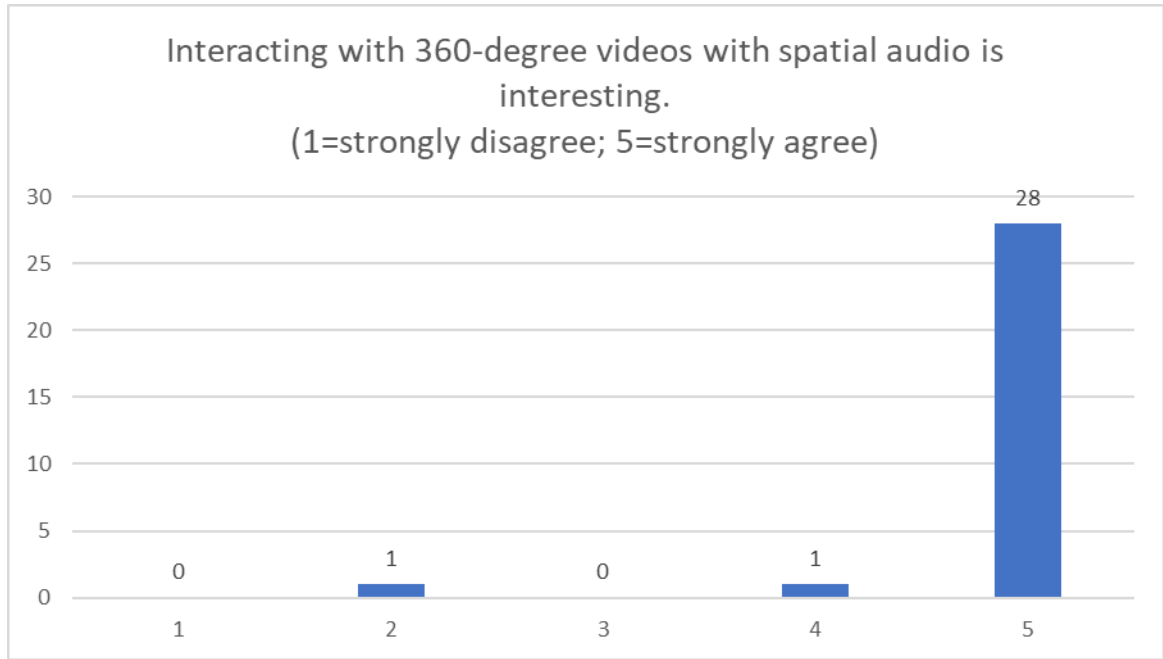
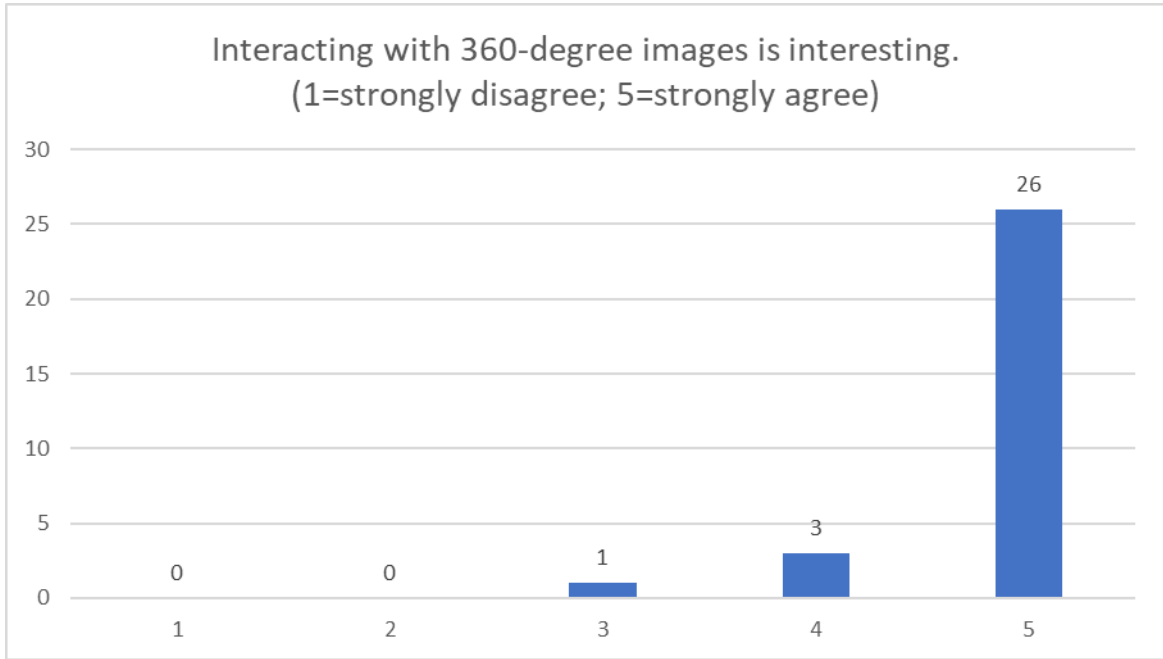


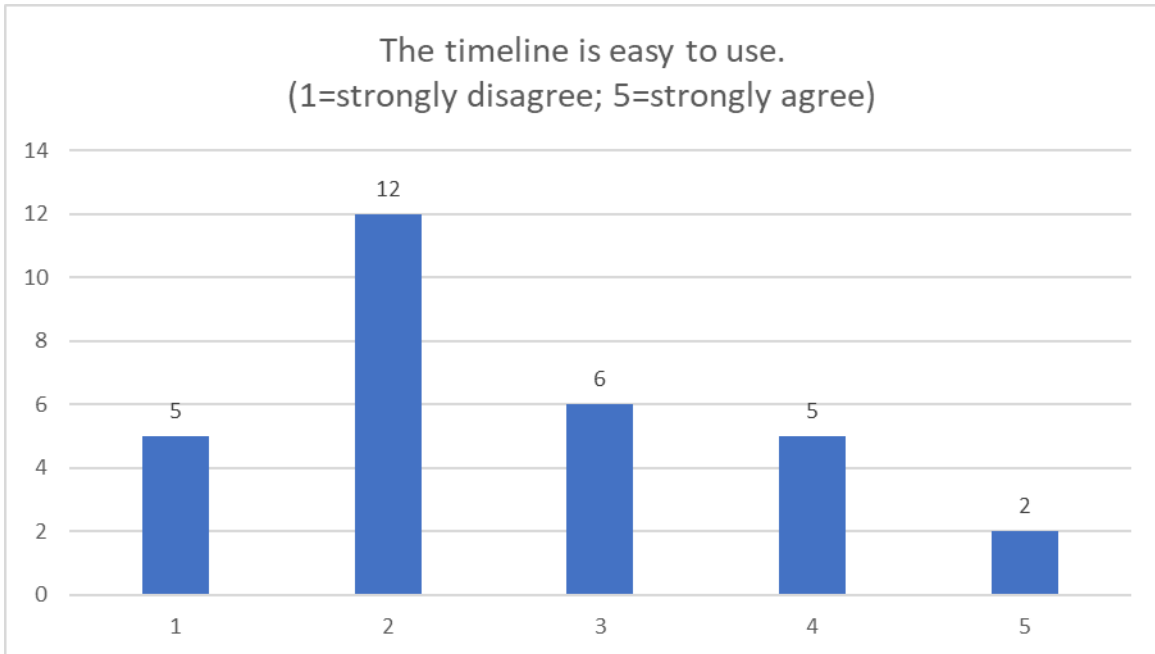
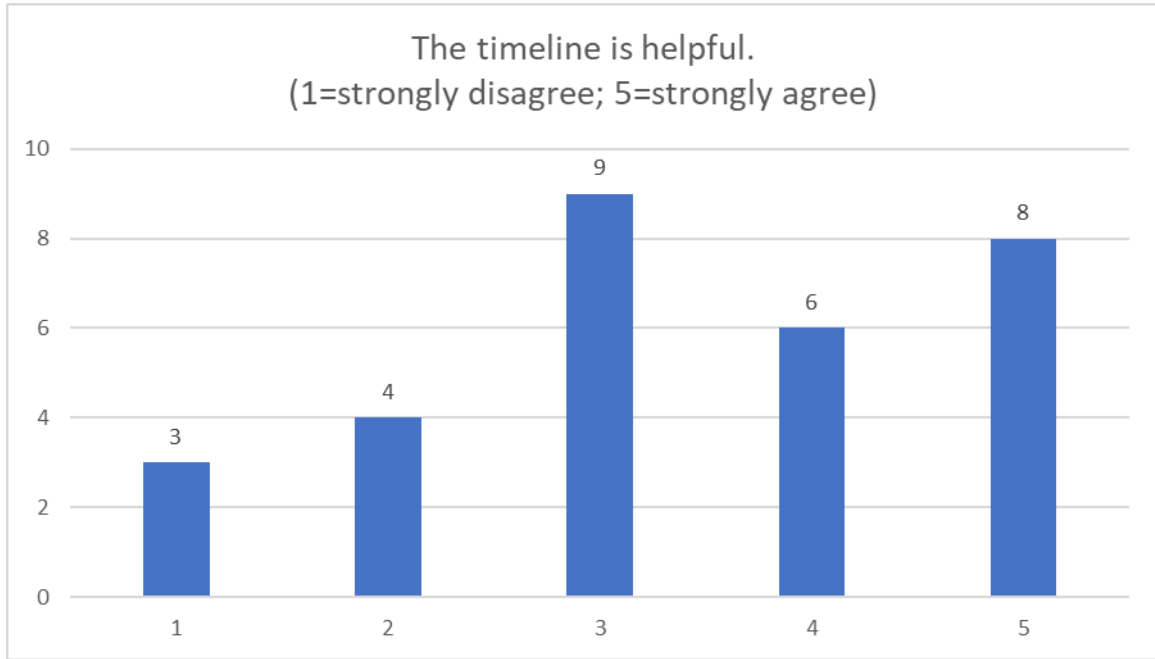
Third section

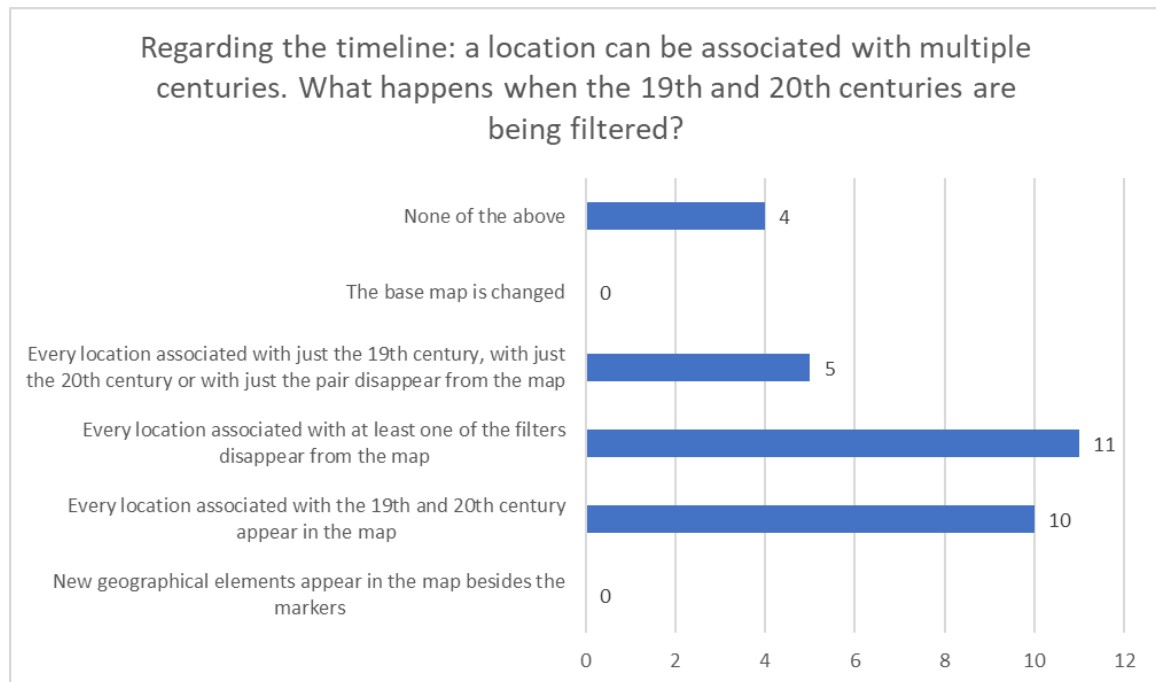
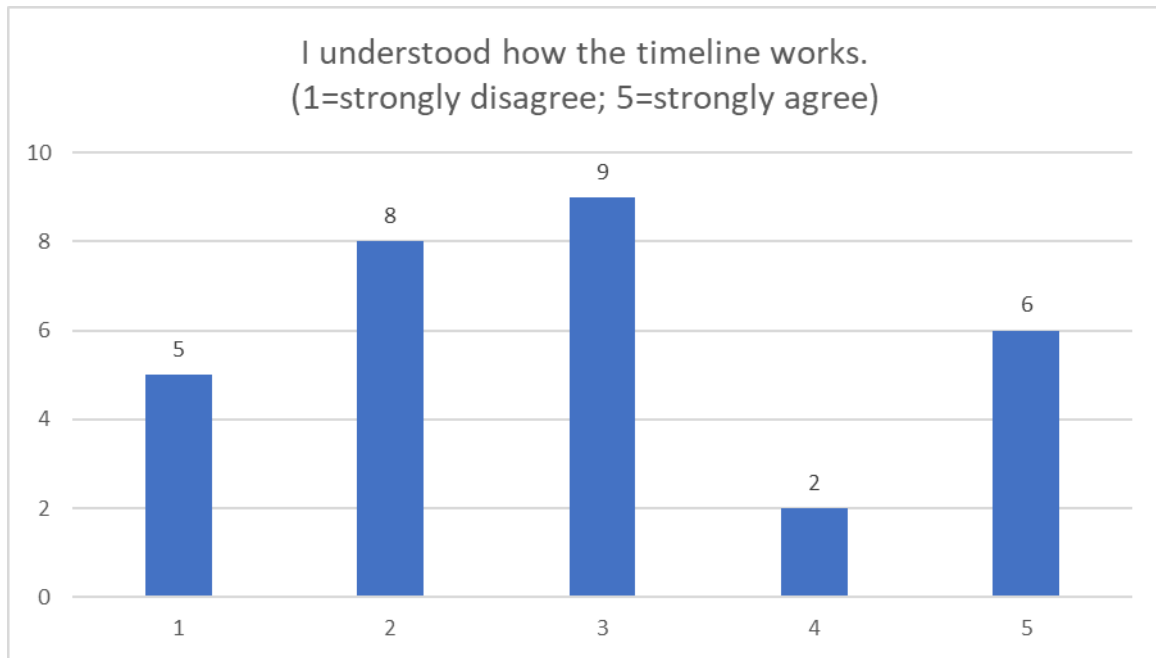


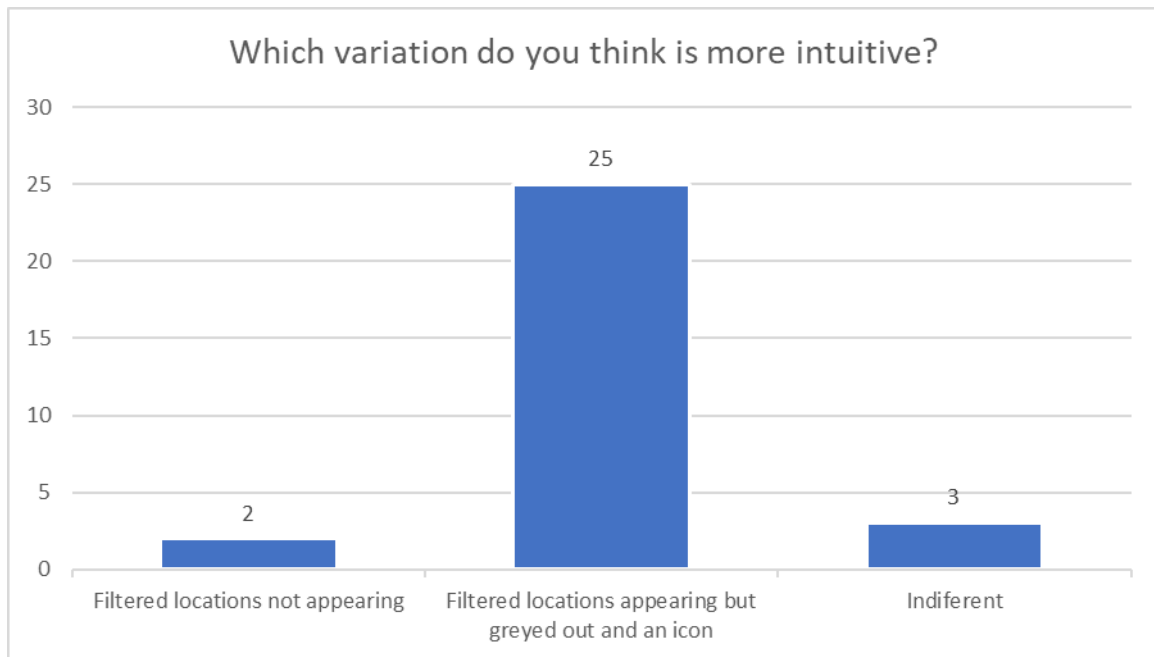
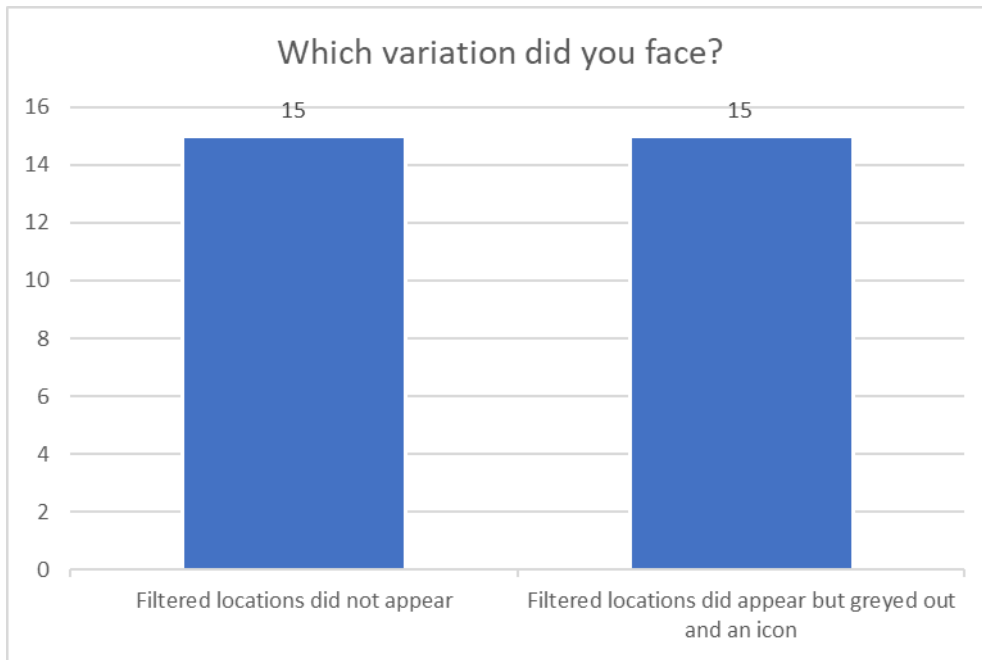


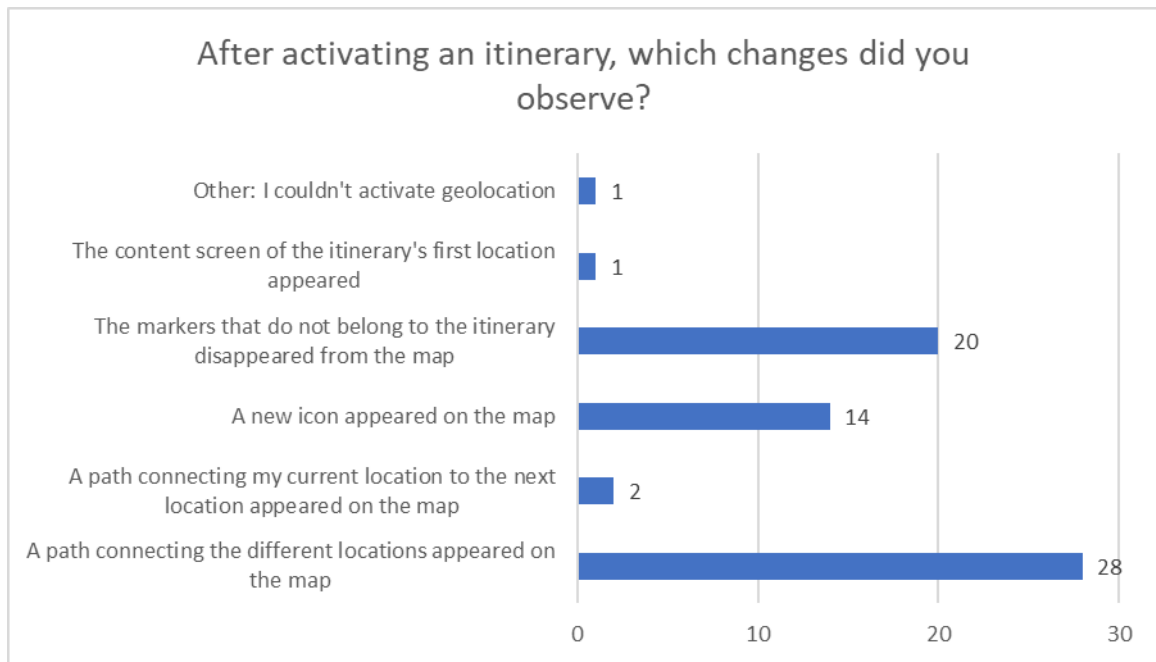
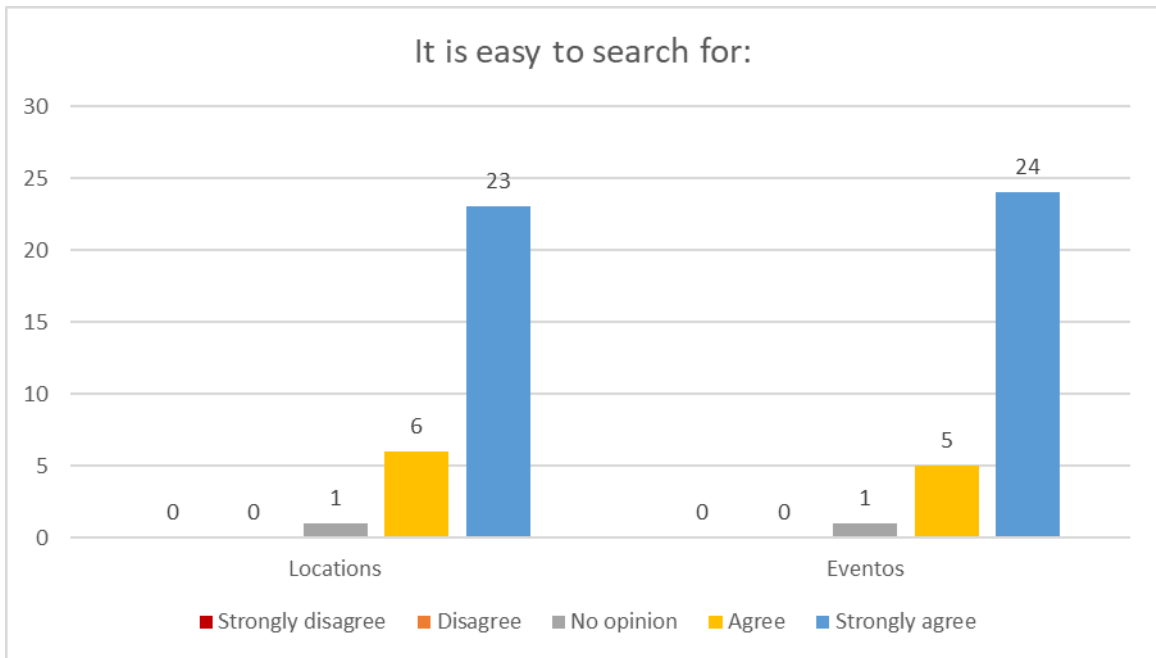


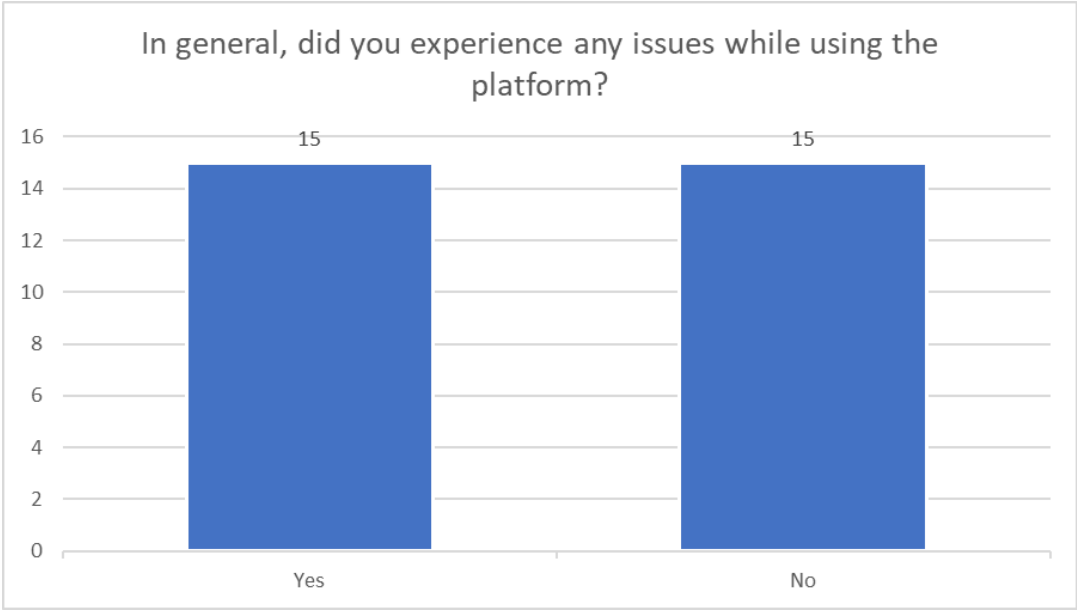












A P P E N D I X



EXPERT EVALUATION

A P P E N D I X



**USABILITY TEST TASKS - ADMINISTRATORS
(PORTUGUESE)**

Plataforma PASEV

Teste de Usabilidade

Este teste de usabilidade pretende avaliar a sua interação como utilizador e administrador com a plataforma desenvolvida no âmbito da "Patrimonialização da Paisagem Sonora em Évora". O teste consiste na realização de algumas tarefas diretamente relacionadas com o novo design e as novas funcionalidades implementadas, tais como:

- Interação com os filtros da *timeline*;
- Submissão de conteúdo multimédia por utilizadores;
- Visualização de conteúdo multimédia espacial (e.g. imagens e vídeos 360°);
- Geolocalização em itinerários;
- Conteúdo em destaque;
- Gestão no *back-office*.

Caso possível, aconselha-se o uso de *headphones*. Após realizar todas as tarefas, ser-lhe-á fornecido um questionário onde poderá avaliar a plataforma e a sua forma de interagir com a mesma. Como tal, é importante que leia cada tarefa atentamente e tenha atenção aos resultados de cada ação que realiza. Comentários verbais enquanto realiza as tarefas são encorajados, pois ajudam a revelar vulnerabilidades no sistema. Qualquer dúvida, contacte o supervisor.

Tarefas:

- **Utilizador:**
 1. Carregue no botão azul para aceder ao mapa.
 2. Carregue em 'Mapa' na barra de navegação e interaja com as diferentes opções.
 - a. Escolha diferentes mapas base e opções de cartografia histórica. Utilize o zoom, se necessário, para verificar as alterações.
 3. Pesquise pelo evento "Aniversário do Príncipe D. Carlos" e clique no mesmo.
 4. Abra a *timeline* e interaja com a mesma. Tente perceber o que acontece.
 - a. Depois de interagir com a *timeline*, certifique-se que está apenas a filtrar o século XIX e o século XX.
 5. Pesquise pelo local "Praça de Touros (actual Arena D'Évora)" e clique no mesmo.
 - a. Expanda a caixa de texto da fonte, de forma a vê-la na totalidade.
 6. Veja o conteúdo inerente ao local previamente selecionado e realize as seguintes operações:
 - a. Leia a informação apresentada no primeiro ecrã;
 - b. Aceda à galeria de imagens PASEV e clique numa imagem, para ver os seus detalhes;
 - c. Aceda à galeria de imagens submetidas por colaboradores;
 - i. Submeta uma imagem, preenchendo o formulário que acompanha o processo.
 - d. Aceda à galeria de áudios PASEV, clique num áudio e oiça-o;
 - e. Aceda à galeria de áudios submetidos por colaboradores.
 - i. Grave um som e submeta-o, preenchendo o formulário que acompanha o processo;
 - ii. Repita o processo, submetendo mais uma gravação de áudio.

- f. Acesse às galerias de vídeos e interaja com a mesma. Veja e ouça o vídeo 360^{o1}, movendo o ecrã.
7. Procure pelo local “Praça do Giraldo”, clique no mesmo e acesse ao conteúdo inerente.
 - a. Acesse à galeria de imagens 360° e clique na única imagem. Interaja com a mesma;
8. Volte para a visão geral do mapa. Ative a geolocalização.
9. Procure em ‘Explorar’ pelo itinerário “Passeio pelas Praças” e clique no mesmo.
 - a. Ative o itinerário;
 - b. Tente perceber qual é a distância e tempo médio do percurso;
 - c. Tente descobrir qual a distância até aos próximos locais.
10. Desative o itinerário. Faça scroll e interaja com a carta de destaque ‘Itinerário’.

● **Administrador:**

1. Acesse à página de *login*, adicionando /login ao fim do endereço.
2. Efetue o *login* com os seguintes dados:
 - Email: admin@mail.com
 - Password: pasev2019
3. Desenhe um novo itinerário, com quaisquer nome, tipo e locais.
 - a. Quando terminar de desenhar o itinerário, associe a um evento da sua escolha;
 - b. Adicione o itinerário e feche a mensagem de sucesso;
 - c. Elimine o itinerário que acabou de criar.
4. Edite a descrição do local “Porta de Aviz” com um texto à sua escolha;
5. Acesse ao separador de gestão de conteúdo pendente.
 - a. Filtre a listagem de modo a ver apenas as imagens;
 - b. Visualize a imagem com mais detalhe (tamanho maior);
 - c. Altere a descrição da imagem pendente;
 - d. Rejeite a imagem;
 - e. Remova o filtro, de modo a ver todo o conteúdo pendente;
 - f. Selecione e elimine ambos os áudios em simultâneo.
6. Efetue o *logout*.

A partir da última tarefa, o teste acabou. Contudo, pode continuar a interagir com a plataforma caso pretenda explorar mais e, possivelmente, elaborar mais sobre elementos que não serão mencionados no questionário.

¹ Vídeo 360° de teste não relacionado com o PASEV.

A P P E N D I X



**USABILITY TEST TASKS - ADMINISTRATORS
(ENGLISH)**

PASEV Platform

Usability Test

This usability test aims to evaluate your interaction as an user and administrator with the platform developed within the scope of the “Patrimonialisation of Évora’s Soundscape”. The test consists of performing certain tasks directly influenced by the new design and new features implemented, such as:

- Interaction with the timeline filters;
- Crowdsourcing multimedia content;
- Display of spatial multimedia content (e.g. 360-degree images and videos);
- Geolocation and itineraries;
- Featured content;
- *Back-office* management.

If possible, use of headphones is advised. After performing all tasks, you will be given a questionnaire to evaluate the platform and the way you interacted with it. As such, it is very important that you read each task carefully and pay attention to details. Verbal comments throughout the test are encouraged, as they may help reveal vulnerabilities in the system. If you have any doubts, contact the supervisor.

Tasks:

- **Common user:**

1. Click the blue button to access the map.
2. Click ‘Mapa’ in the navigation bar and interact with the different options.
 - a. Select different base maps and historical cartography options. Zoom in and out, if necessary, to see what changes.
3. Search for the event “Aniversário do Príncipe D. Carlos” and click it.
4. Open the timeline and interact with it. Try to understand what happens.
 - a. After interacting with the timeline, filter only the XIX and XX centuries.
5. Search for the location “Praça de Touros (actual Arena D’Évora)” and click it.
 - a. Expand the source text box, in order to see it in its entirety.
6. Access the previous selected location’s content and perform the following operations:
 - a. Read the information displayed in the first screen;
 - b. Access the PASEV images gallery and click one, in order to see its details;
 - c. Access the crowdsourced images gallery;
 - i. Submit an image by filling the corresponding form.
 - d. Access the PASEV audio gallery, click one and listen to it;
 - e. Access the crowdsourced audio gallery;
 - i. Record a sound and submit it by filling the corresponding form.
 - f. Access the video galleries and interact with them. Watch and listen to the 360-degree video¹, while moving the screen.
7. Search for the location “Praça do Giraldo”, click it and access its content.
 - a. Access the 360-degree images gallery and click in its only image. Interact with it.
8. Return to the generic map view. Activate geolocation.
9. Search for “Passeio pelas Praças” in ‘Explorar’ and click it.

¹ 360-degree test video may not be final.

- a. Activate the itinerary;
 - b. Try to understand what the itinerary's average distance and time are;
 - c. Try to understand what the distance to the next location is.
10. Deactivate the itinerary. Scroll down and interact with the featured card 'Itinerário'.

● **Administrator:**

1. Access the login page by modifying the address, adding */login* at the end.
2. Login using the following credentials:
 - E-mail: admin@mail.com
 - Password: pasev2019
3. Draw a new itinerary, with any name, type and collection of locations.
 - a. When you are done drawing it, associate it to an event of your choosing;
 - b. Add the itinerary and close the success message;
 - c. Delete the itinerary you just created.
4. Edit the description of the location "Porta de Aviz" to something of your choosing;
5. Access the pending content manager tab.
 - a. Filter the listing in order to only see images;
 - b. View the image in greater detail (larger size);
 - c. Modify the image's description;
 - d. Reject the image;
 - e. Remove the filter, in order to see all pending content;
 - f. Select and delete both audios at the same time.
6. Logout.

After the last task, the test is over. However, you may continue to interact with the platform and explore more in order to, possibly, elaborate on elements that will not be mentioned in the questionnaire.

A P P E N D I X



QUESTIONNAIRE - ADMINISTRATORS
(PORTUGUESE)

Plataforma PASEV - Questionário de Avaliação

Este questionário destina-se à avaliação da usabilidade de uma plataforma desenvolvida em ambiente académico, na realização de uma tese de Mestrado.

O mesmo é composto por 3 secções, a serem respondidas após se realizarem as tarefas que foram realizadas pelo utilizador. O questionário é anónimo, sendo qualquer informação privada utilizada apenas para fins estatísticos. Agradecemos que seja o mais honesto possível, de forma a permitir analisar com maior precisão a qualidade do trabalho desenvolvido.

***Obrigatório**

Idade *

- Menos de 18
- Entre 18 e 24
- Entre 25 e 30
- Entre 31 e 45
- Mais de 46

Género *

- Feminino
- Masculino
- Prefiro não dizer
- Outra:



Área de formação

A sua resposta

Como classifica a sua experiência com computadores? *

	1	2	3	4	5	
Muito inexperiente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Muito experiente

Como classifica a sua experiência com smartphones/tablets? *

	1	2	3	4	5	
Muito inexperiente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Muito experiente

Está familiarizado com a geografia da cidade de Évora? *

- Sim
- Não
- Mais ou menos

Recorre a algum tipo de aplicações durante viagens? *

- Sim
- Não



Se respondeu positivamente à questão anterior, que tipo de aplicações?

- Guias online
- Mapas online
- GPS
- Outra:

Em que dispositivo realizou o teste de usabilidade? *

- Dispositivo fixo (desktop ou laptop)
- Dispositivo móvel

Em que browser realizou o teste? *

- Google Chrome
- Mozilla Firefox
- Microsoft Edge
- Internet Explorer
- Safari
- Opera
- Outra:

[Seguinte](#)

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)



Google Formulários



Plataforma PASEV - Questionário de Avaliação

*Obrigatório

System Usability Scale (SUS)

O 'System Usability Scale' (SUS) é uma ferramenta de fácil e rápida utilização para medir a usabilidade. Consiste em 10 questões padrão com 5 opções de resposta de "Discordo totalmente" a "Concordo totalmente". É eficaz a obter resultados válidos mesmo em amostras pequenas. (Fonte: <https://www.usability.gov>)

Acho que gostaria de utilizar esta plataforma com mais frequência. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Achei a plataforma desnecessariamente complexa. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Achei a plataforma fácil de utilizar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



Acho que necessitaria da ajuda de um técnico para conseguir utilizar a plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Considerei que as várias funcionalidades da plataforma foram bem integradas. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Achei que há demasiada inconsistência na plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Acho que a maioria das pessoas aprenderia a utilizar esta plataforma rapidamente. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



Achei a plataforma muito complicada de usar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Senti-me muito confiante a utilizar a plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Precisei de aprender muito antes de conseguir utilizar a plataforma. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

[Anterior](#)

[Seguinte](#)

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)

Google Formulários



Plataforma PASEV - Questionário de Avaliação

*Obrigatório

Avaliação da usabilidade e funcionalidades

Nesta terceira e última secção do questionário, avaliará certos aspetos específicos da plataforma, diretamente relacionados com as funcionalidades. Terá ainda a opção de expressar a sua opinião sobre outros aspetos não mencionados em perguntas de resposta aberta.

A barra de navegação é fácil de usar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Acho interessante as opções de diferentes mapas base. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Acho interessante as opções de cartografia histórica. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



A plataforma inicia com uma planta da cidade já sobreposta sobre o mapa base. Acha esta interação interessante? Por favor, justifique a sua resposta. *

A sua resposta

A submissão de imagens é fácil de efetuar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A submissão de áudio é fácil de efetuar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A submissão de conteúdo multimédia é interessante. *

	Discordo totalmente	Discordo	Sem opinião	Concordo	Concordo totalmente
Imagens	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Áudio	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vídeos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



A interação com imagens 360° é interessante. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A interação com vídeos 360° com som espacial é interessante. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A timeline (linha temporal) é útil. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

A timeline é fácil de usar. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente



Compreendi como funciona a timeline. *

1 2 3 4 5

Discordo totalmente Concordo totalmente

Em relação à timeline: um local pode estar associado a vários séculos. O que acontece quando os filtros do séc. XIX e XX se encontram ativos? *

- Aparecem novos elementos geográficos no mapa para além dos marcadores
- Todos os locais referentes aos séculos XIX e XX surgem no mapa
- Todos os locais referentes pelo menos ao século XIX ou ao século XX desaparecem do mapa
- Todos os locais referentes apenas ao século XIX, apenas ao século XX ou apenas ao par desaparecem do mapa
- O mapa base é alterado
- Nenhuma das anteriores

A tarefa 3 exige que procure um local que se encontra filtrado, depois de interagir com a timeline. Existem duas versões diferentes nesta situação: os locais filtrados ora não aparecem na listagem, ora aparecem com um ícone que representa que estão invisíveis.

Com que situação se deparou? *

- Os locais filtrados não apareciam
- Os locais filtrados apareciam com uma cor cinzenta e um ícone



Qual das abordagens acha mais intuitiva? *

- Os locais filtrados não aparecerem
- Os locais filtrados aparecerem com uma cor cinzenta e um ícone
- Indiferente

Por favor, justifique a resposta anterior (e.g. como se sentiu ao deparar-se com a falta de informação).

A sua resposta

É fácil pesquisar: *

	Discordo totalmente	Discordo	Sem opinião	Concordo	Concordo totalmente
Locais	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eventos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Depois de ativar um itinerário, quais das seguintes ações observou? *

- Surgiu um caminho no mapa que unia os diferentes locais
- Surgiu um caminho da minha localização até ao próximo ponto
- Surgiu um novo ícone no mapa
- Os marcadores que não pertencem ao itinerário desapareceram do mapa
- Surgiu o ecrã de conteúdo do primeiro ponto do itinerário
- Outra:

Achou a interação com os itinerários intuitiva? Por favor, justifique. *

A sua resposta

As perguntas que se se seguem são exclusivas aos administradores e à gestão da plataforma.

Achei o login fácil de efetuar. *

Discordo totalmente 1 2 3 4 5 Concordo totalmente

Acho interessante haverem dois tipos de itinerários diferentes. *

Discordo totalmente 1 2 3 4 5 Concordo totalmente



Anteriormente, a plataforma apenas permitia adicionar locais, itinerários, eventos e ficheiros. Agora permite eliminar qualquer um dos elementos mencionados, bem como editar eventos e locais.

Acho importante poder gerir os elementos desta forma. *

1 2 3 4 5

Discordo totalmente Concordo totalmente

Por favor, justifique a resposta anterior (e.g. se acha que poder eliminar estes elementos melhora a gestão da plataforma). *

A sua resposta

Acho importante gestão de conteúdo pendente antes deste ser disponibilizado publicamente. *

1 2 3 4 5

Discordo totalmente Concordo totalmente

Compreendi como aceitar conteúdo pendente. *

1 2 3 4 5

Discordo totalmente Concordo totalmente



Compreendi como rejeitar conteúdo pendente. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Compreendi como editar conteúdo pendente. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

Acho importante poder seleccionar vários conteúdos ao mesmo tempo e aceitar/rejeitar numa só ação. *

	1	2	3	4	5	
Discordo totalmente	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Concordo totalmente

De forma geral, experienciou alguma dificuldade a utilizar a plataforma? *

- Sim
- Não

Se respondeu que sim à questão anterior, por favor especifique a(s) dificuldade(s) com que se deparou.

A sua resposta



Sugestões para melhorar a plataforma.

A sua resposta

[Anterior](#)

Submeter

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)

Google Formulários





QUESTIONNAIRE - ADMINISTRATORS (ENGLISH)

PASEV Platform - Evaluation

*Obrigatório

Age *

- Under 18
- 18 - 24
- 25 - 30
- 31 - 45
- Over 46

Gender *

- Female
- Male
- Rather not say
- Outra:

Career field

A sua resposta



How would you rate your experience with computers? *

	1	2	3	4	5	
Very inexperienced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very experienced

How would you rate your experience with smartphones/tablets? *

	1	2	3	4	5	
Very inexperienced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very experienced

Are you familiar with Évora's geography? *

- Yes
- No
- More or less

Do you use any kind of mobile applications while traveling? *

- Yes
- No



If you answered yes to the previous question, what kind of applications?

- Online guides
- Online maps
- GPS
- Outra:

On which device did the usability test take place? *

- Desktop/laptop device
- Mobile device

On which browser did the test take place? *

- Google Chrome
- Mozilla Firefox
- Microsoft Edge
- Internet Explorer
- Safari
- Opera
- Outra:

[Seguinte](#)

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)



Google Formulários



PASEV Platform - Evaluation

***Obrigatório**

System Usability Scale (SUS)

I think that I would like to use this system frequently. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I found the system unnecessarily complex. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I thought the system was easy to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



I think that I would need the support of a technical person to be able to use this system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I found the various functions in this system were well integrated. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I thought there was too much inconsistency in this system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I would imagine that most people would learn to use this system very quickly. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



I found the system very cumbersome to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I felt very confident using the system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I needed to learn a lot of things before I could get going with this system. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

[Anterior](#)

[Seguinte](#)

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)

Google Formulários



PASEV Platform - Evaluation

*Obrigatório

Features evaluation

The navigation bar is easy to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I find the options for different base maps interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I find the options for historical cartography interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

The platform starts with a city plan already superimposed on the base map. Do you find this interaction interesting? Please justify your answer. *

A sua resposta



It is easy to submit images. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

It is easy to submit audio. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

Submitting multimedia content is interesting *

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
Images	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Audio	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Videos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Interacting with 360-degree images is interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



Interacting with 360-degree videos with spatial audio is interesting. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

The timeline is helpful. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

The timeline is easy to use. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

I understood how the timeline works. *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



Regarding the timeline: a location can be associated with multiple centuries.
What happens when the XIX and XX centuries are being filtered? *

- New geographical elements appear in the map besides the markers
- Every location associated with the XIX and XX century appear in the map
- Every location associated with at least one of the filters disappear from the map
- Every location associated with just the XIX century, with just the XX century or with just the pair disappear from the map
- The base map is changed
- None of the above

Task #3 asked you to find a location that was being filtered, after interacting with the timeline. There are two variations in this situation: either the filtered locations don't appear or they do appear, greyed out with an icon representing they are invisible.

Which variation did you face? *

- Filtered locations did not appear
- Filtered locations did appear but greyed out and an icon

Which variation do you think is more intuitive? *

- Filtered locations not appearing
- Filtered locations appearing but greyed out and an icon
- Indiferent



Please, justify your previous answer (e.g. how did you feel when facing lack of information).

A sua resposta

It is easy to search: *

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
Locations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Events	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

After activating an itinerary, which changes did you observe? *

- A path connecting the different locations appeared on the map
- A path connecting my current location to the next location appeared on the map
- A new icon appeared on the map
- The markers that do not belong to the itinerary disappeared from the map
- The content screen of the itinerary's first location appeared
- Outra:

Did you find the interaction with the itineraries intuitive? Please, justify your answer. *

A sua resposta



The following questions are exclusive to administrators and platform management.

It is easy to login. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I think it is interesting to have two distinct types of itineraries. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Previously, administrators could add locations, itineraries, events and files. Now they can delete any of these elements, as well as edit events and locations.

I think it is important to be able to handle the elements this way. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree



Please, justify your answer to the previous question (e.g. do you think being able to delete elements improves the platform's management). *

A sua resposta

I think it is important to manage pending content before publicly displaying it. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I understood how to accept pending content. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I understood how to reject pending content. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

I understood how to edit pending content. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree



I think it is important to be able to select multiple submissions and accept/reject all of them at once. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

In general, did you experience any issues while using the platform? *

- Yes
- No

If you answered yes to the previous question, please specify which issues you faced.

A sua resposta

Suggestions to improve the platform.

A sua resposta

[Anterior](#)

Submeter

Nunca envie palavras-passe através dos Google Forms.

Este formulário foi criado dentro de Faculdade de Ciências e Tecnologia da UNL. [Denunciar abuso](#)

Google Formulários

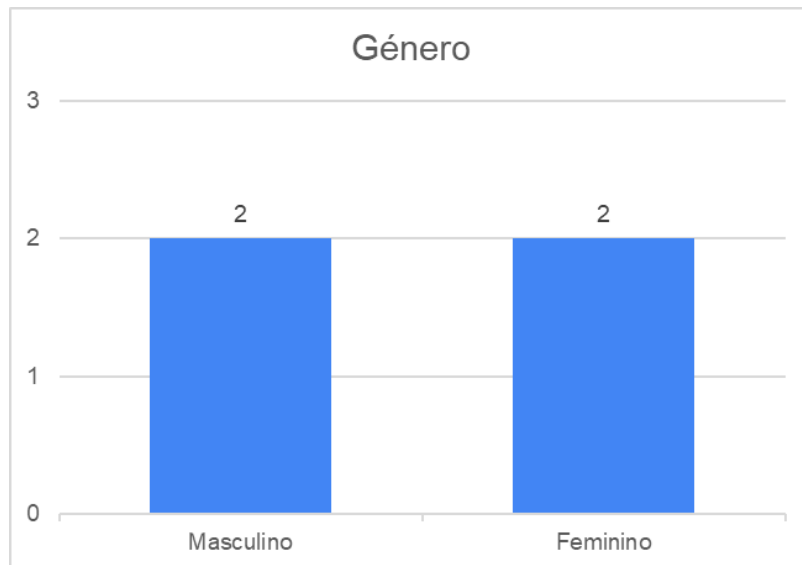
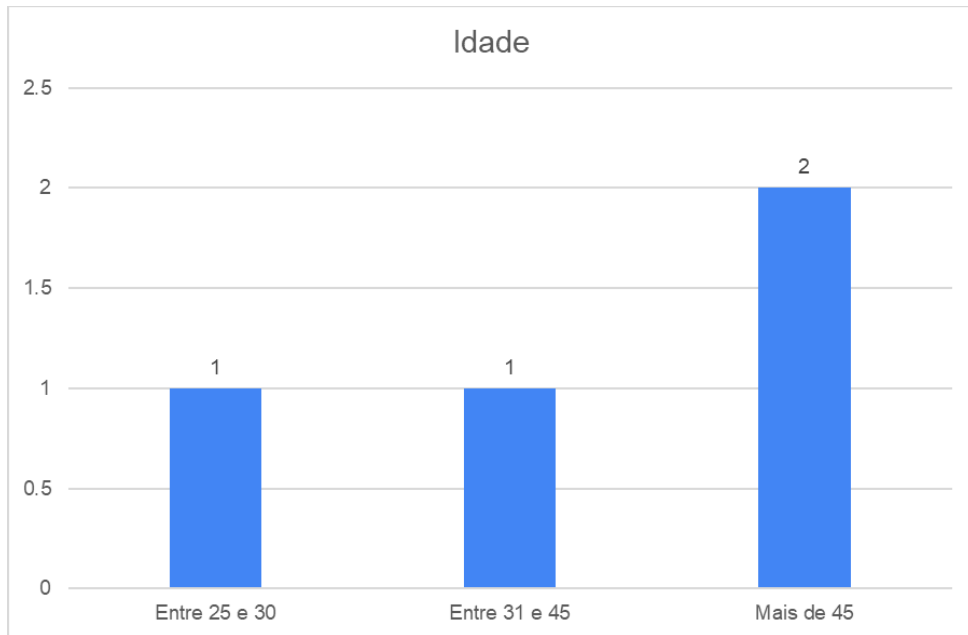


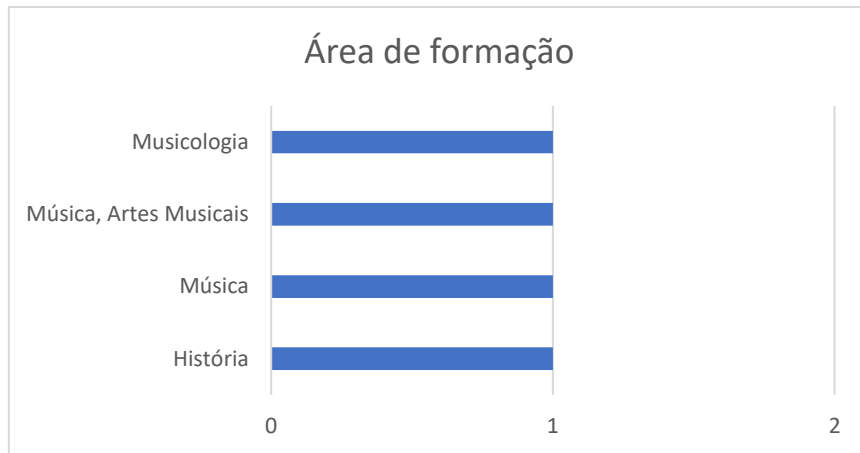
A P P E N D I X



QUESTIONNAIRE GRAPHS - ADMINISTRATORS
(PORTUGUESE)

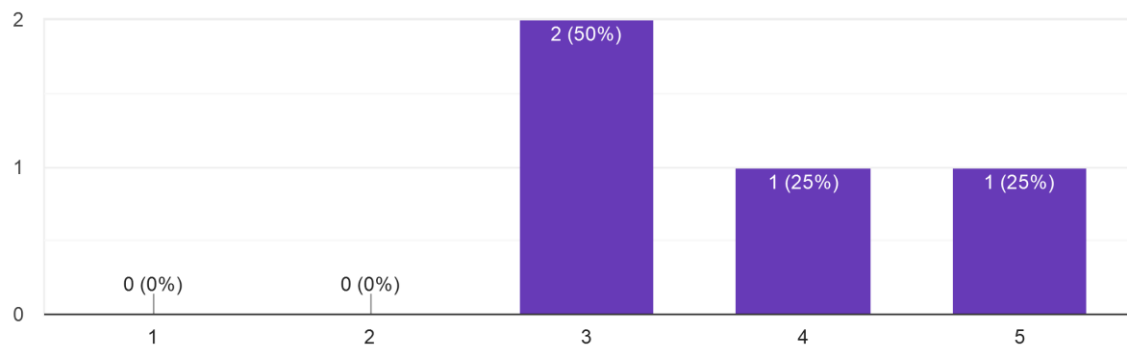
Primeira secção (first section)





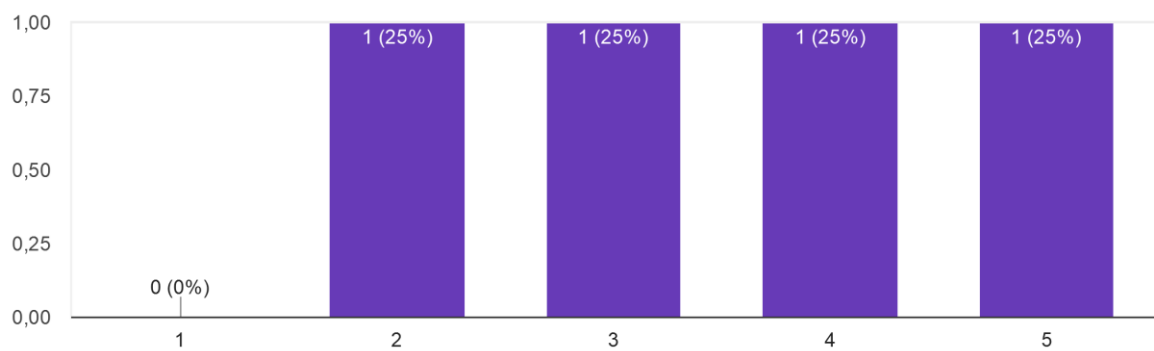
Como classifica a sua experiência com computadores?

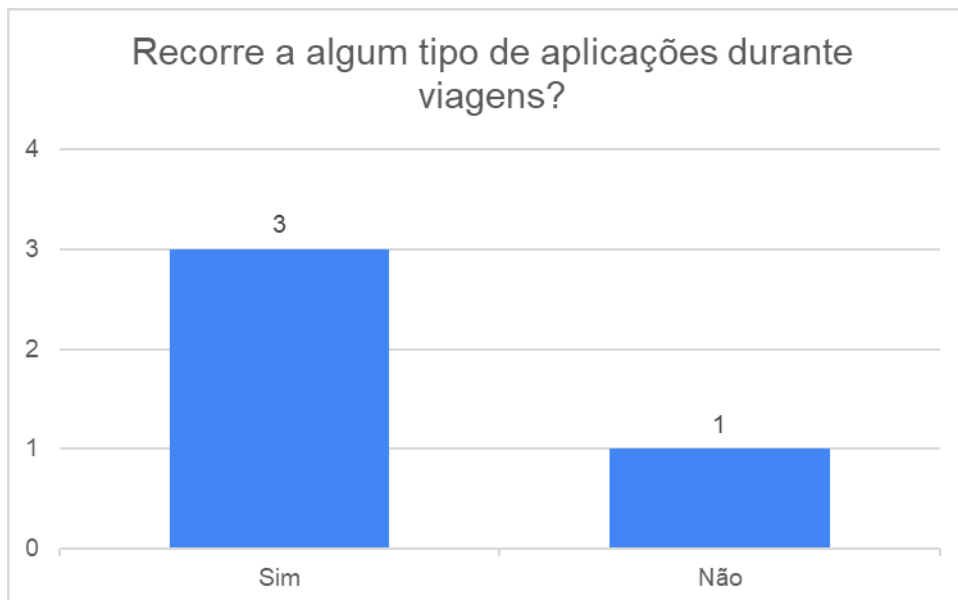
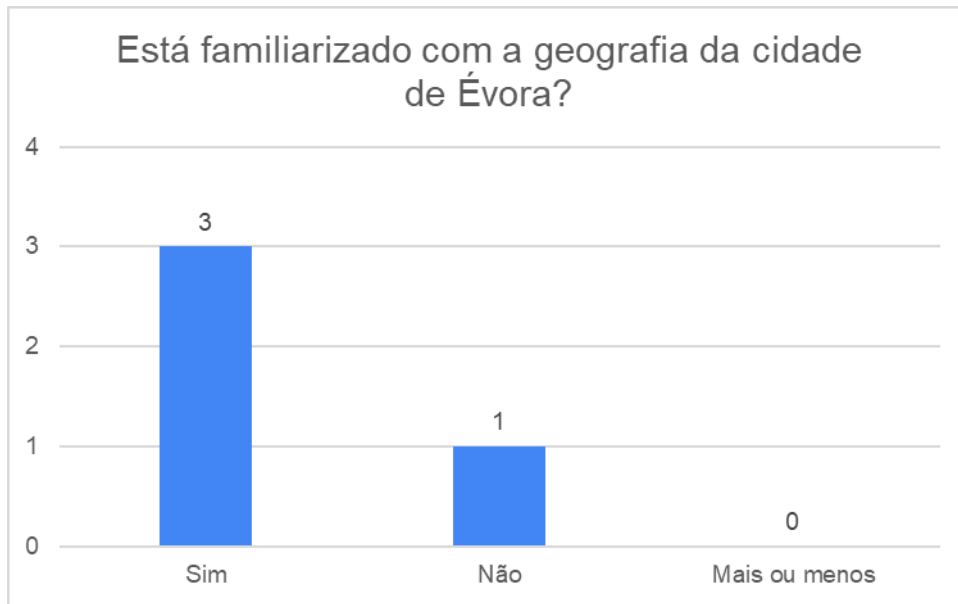
4 respostas



Como classifica a sua experiência com smartphones/tablets?

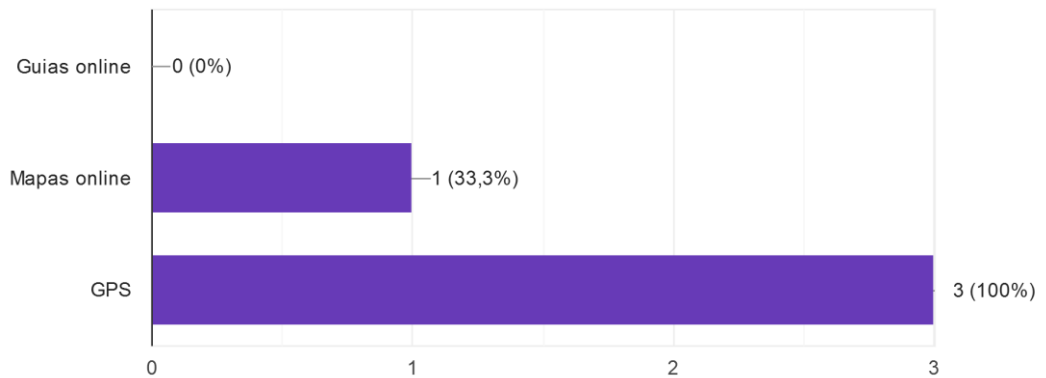
4 respostas



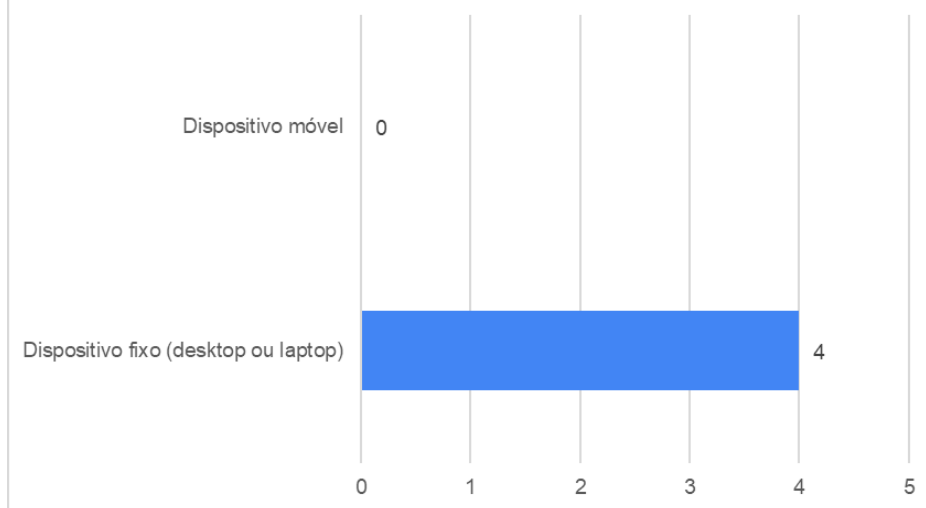


Se respondeu positivamente à questão anterior, que tipo de aplicações?

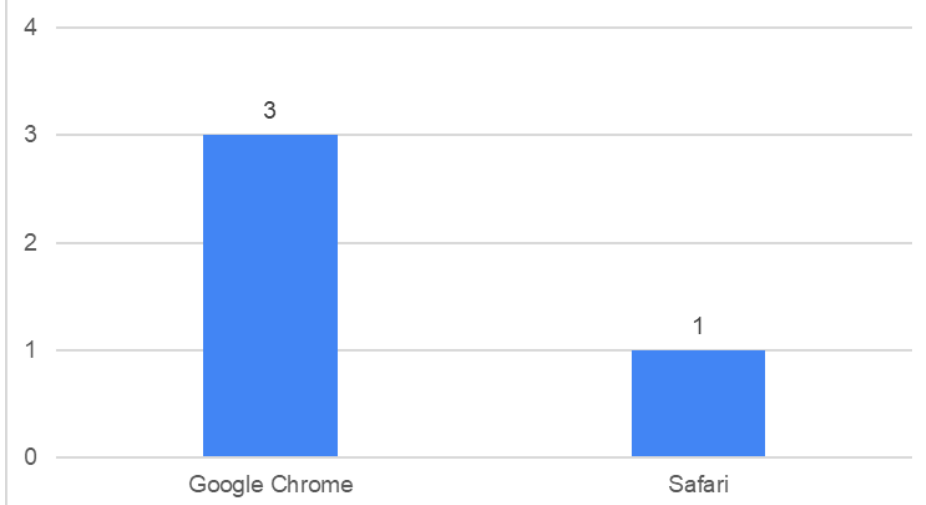
3 respostas



Em que dispositivo realizou o teste de usabilidade?



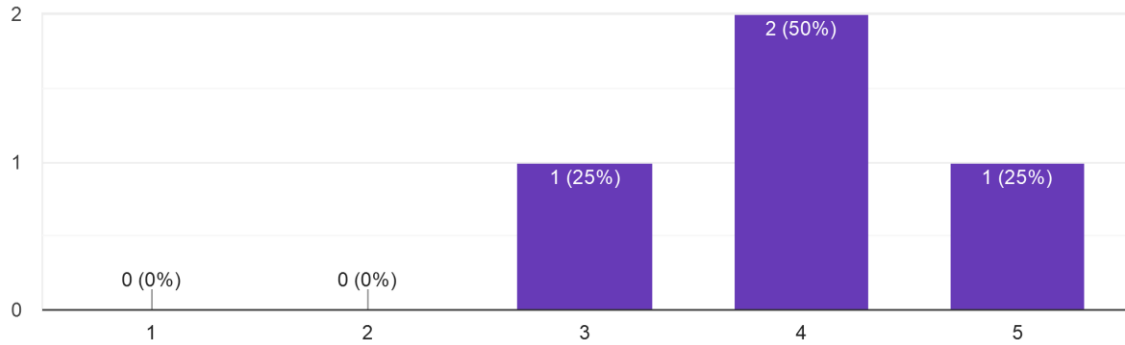
Em que browser realizou o teste?



Segunda secção (second section)

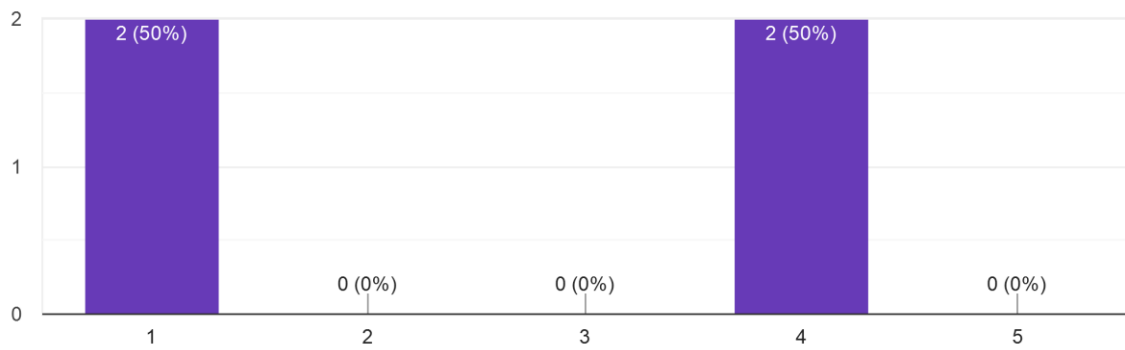
Acho que gostaria de utilizar esta plataforma com mais frequência.

4 respostas



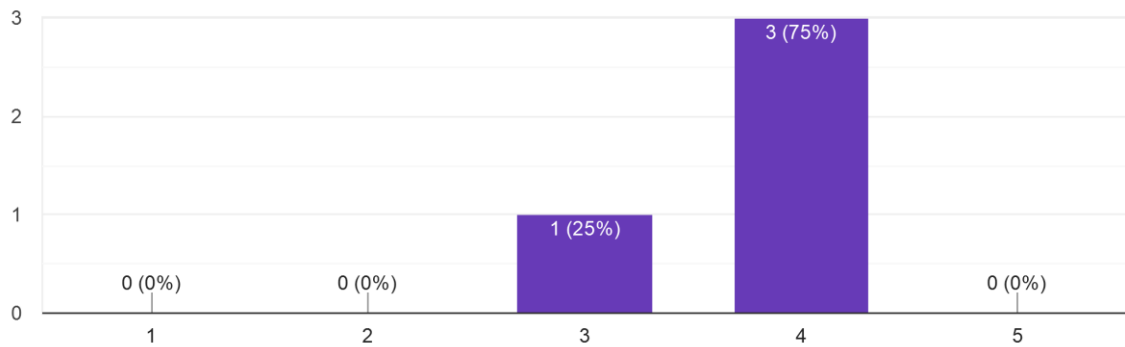
Achei a plataforma desnecessariamente complexa.

4 respostas



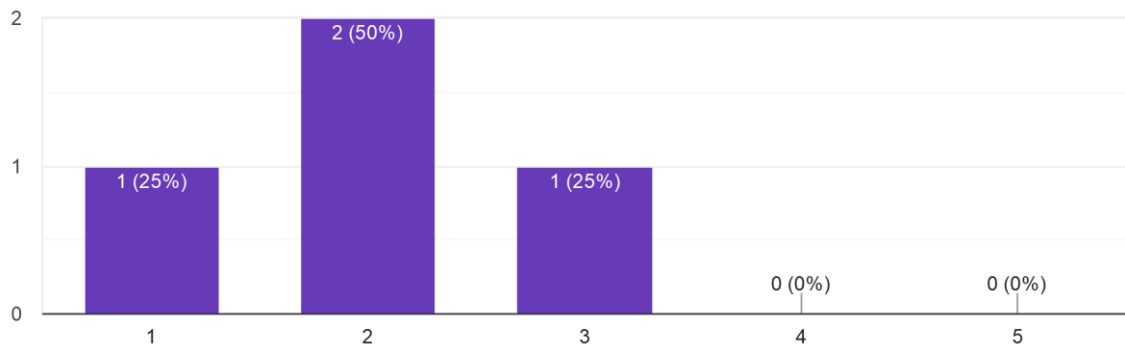
Achei a plataforma fácil de utilizar.

4 respostas



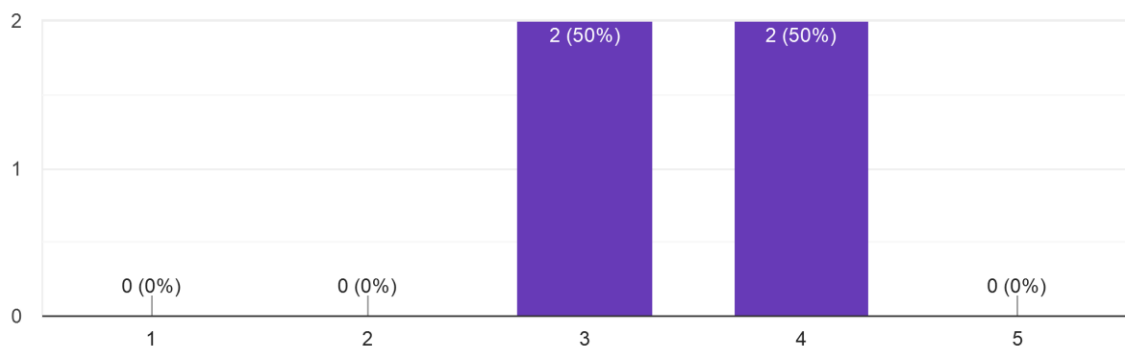
Acho que necessitaria da ajuda de um técnico para conseguir utilizar a plataforma.

4 respostas



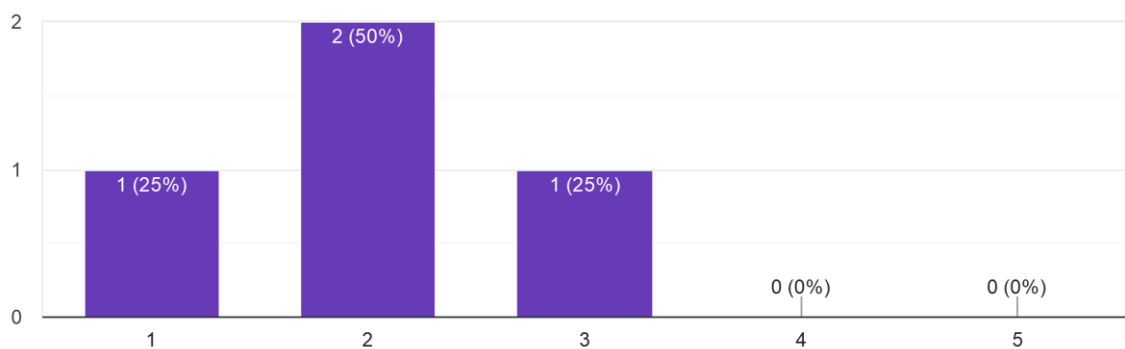
Considero que as várias funcionalidades da plataforma foram bem integradas.

4 respostas



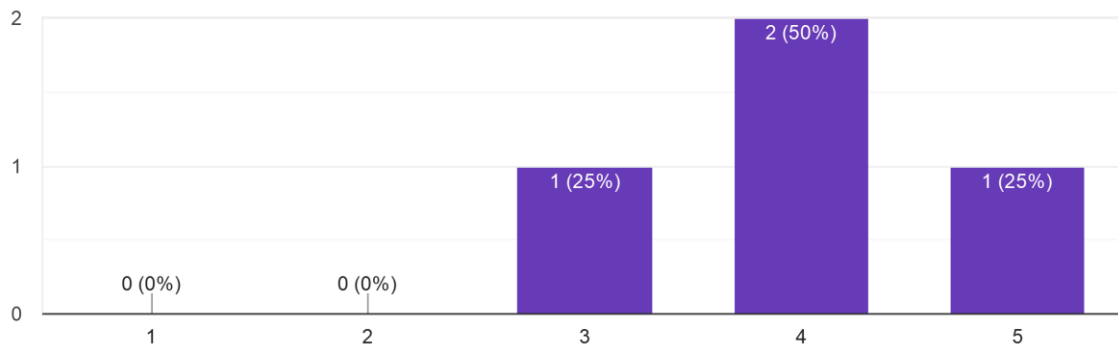
Achei que há demasiada inconsistência na plataforma.

4 respostas



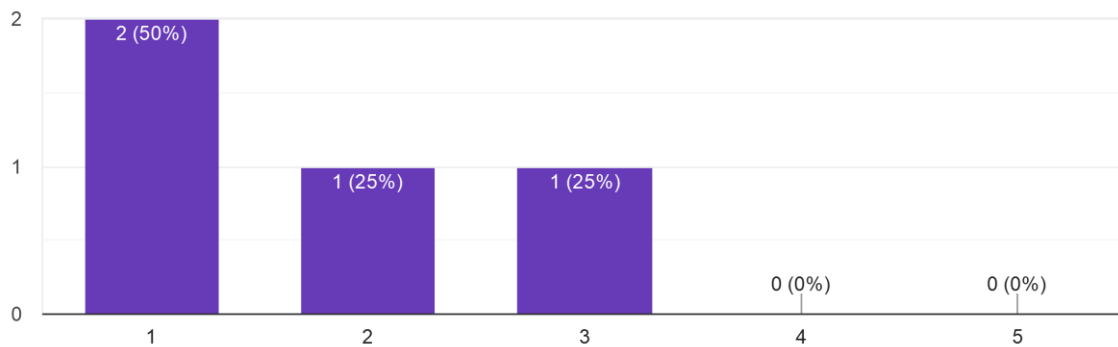
Acho que a maioria das pessoas aprenderia a utilizar esta plataforma rapidamente.

4 respostas



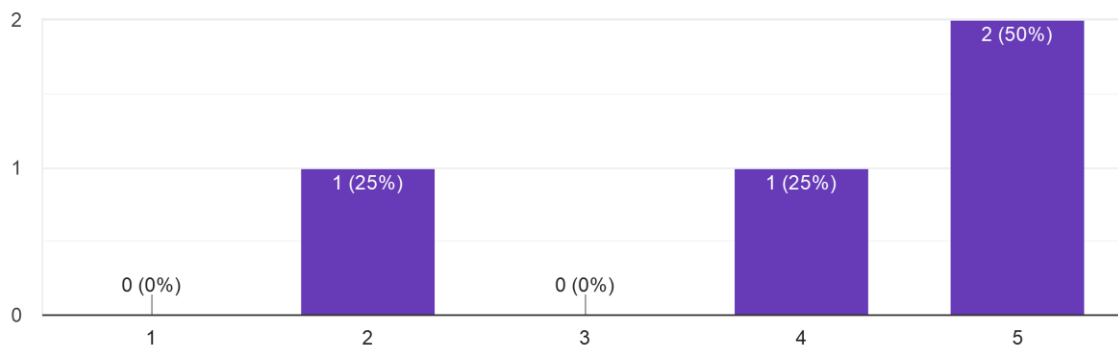
Achei a plataforma muito complicada de usar.

4 respostas



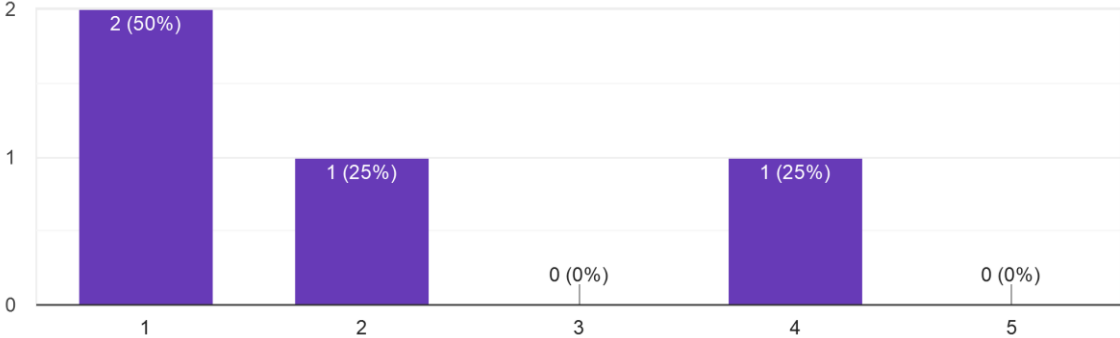
Senti-me muito confiante a utilizar a plataforma.

4 respostas



Precisei de aprender muito antes de conseguir utilizar a plataforma.

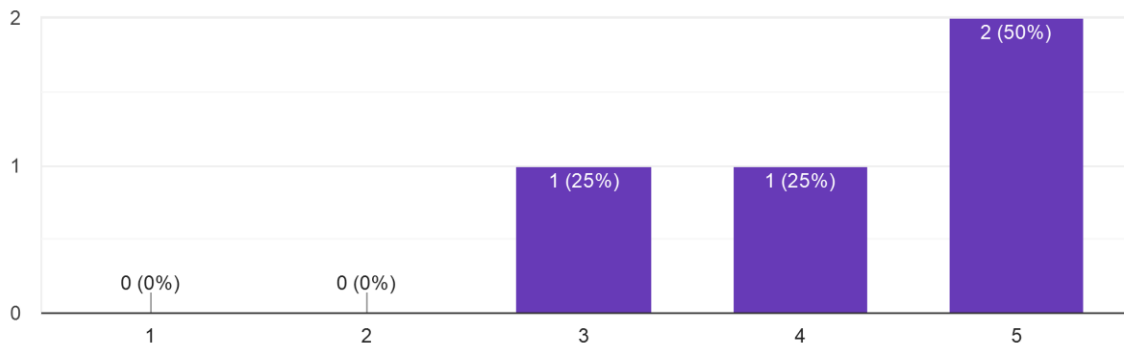
4 respostas



Terceira secção (third section)

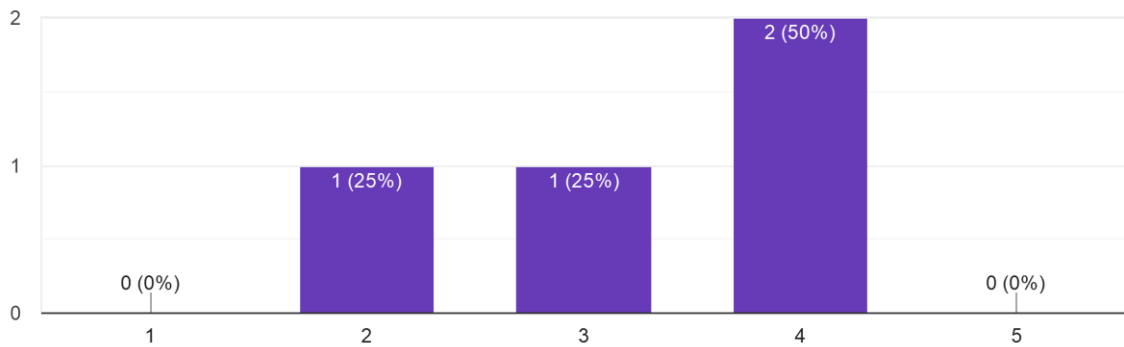
A barra de navegação é fácil de usar.

4 respostas



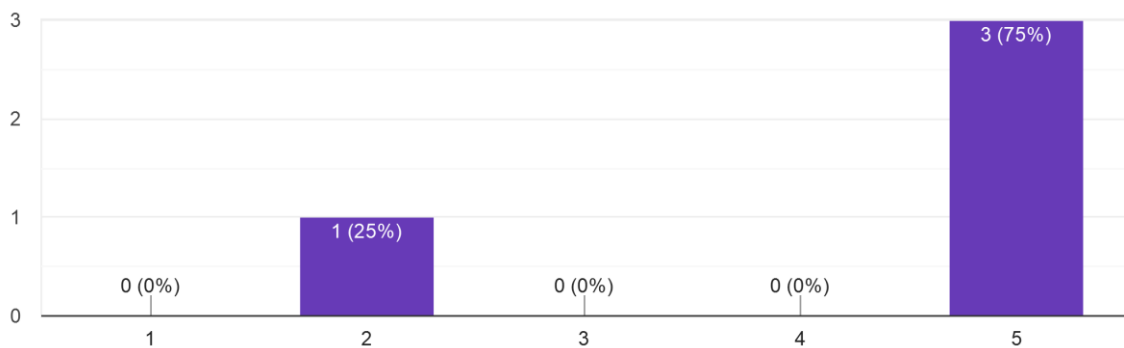
Acho interessante as opções de diferentes mapas base.

4 respostas



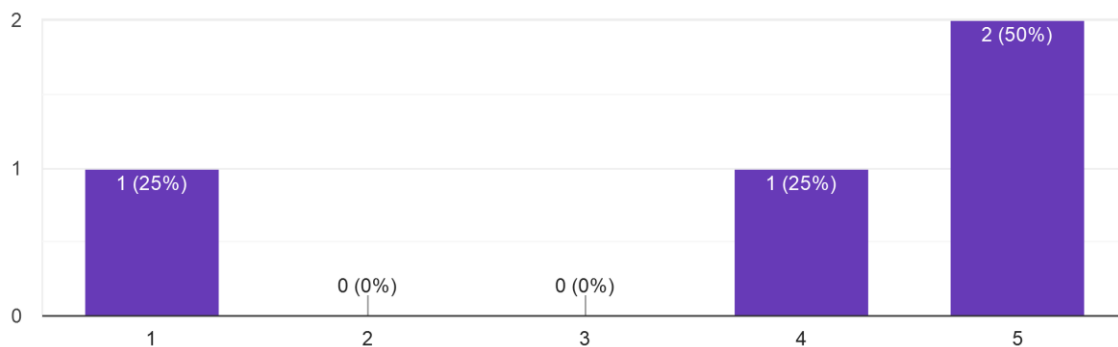
Acho interessante as opções de cartografia histórica.

4 respostas



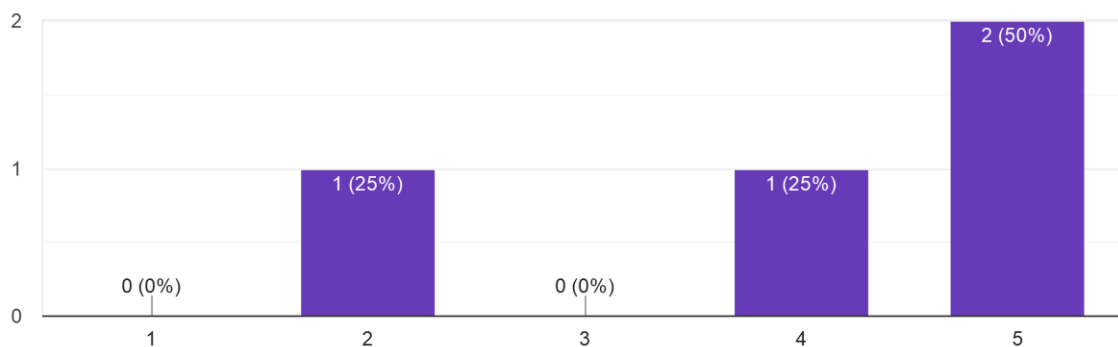
A submissão de imagens é fácil de efetuar.

4 respostas

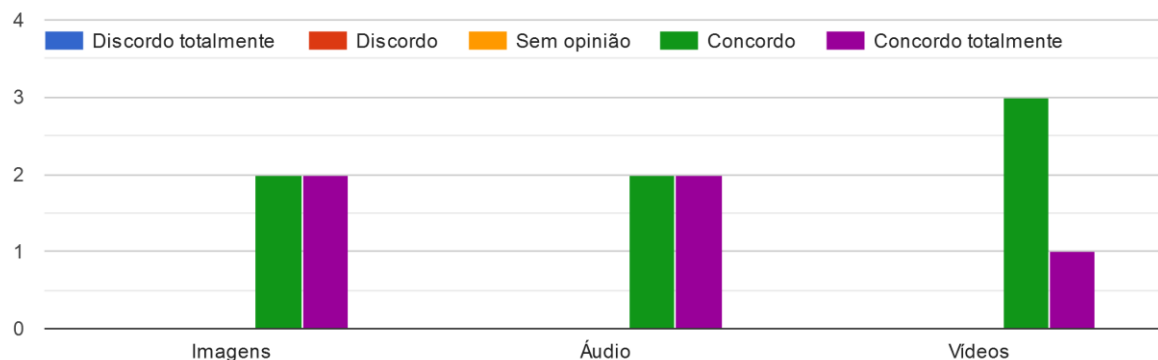


A submissão de áudio é fácil de efetuar.

4 respostas

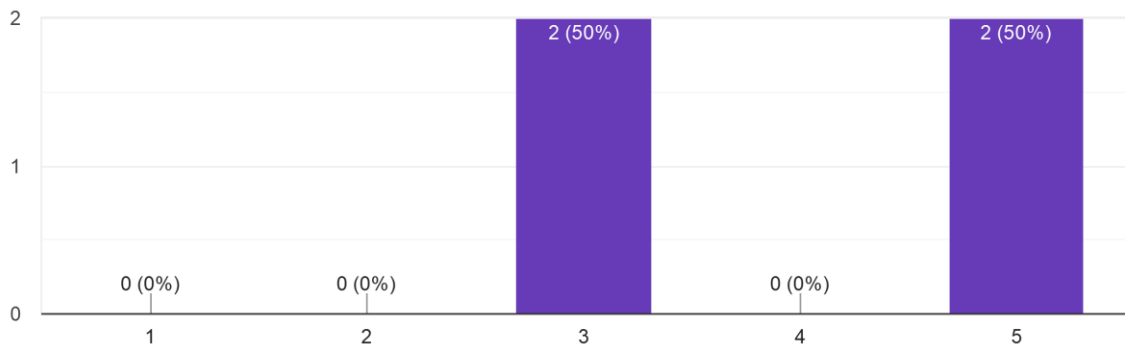


A submissão de conteúdo multimédia é interessante.



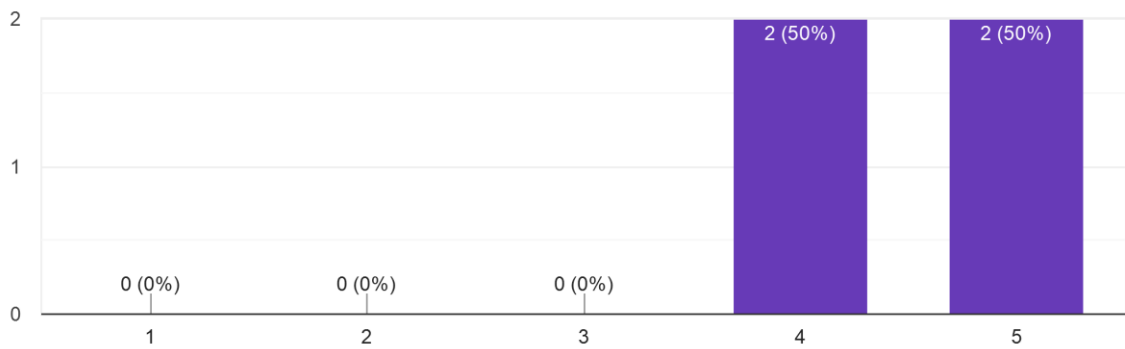
A interação com imagens 360° é interessante.

4 respostas



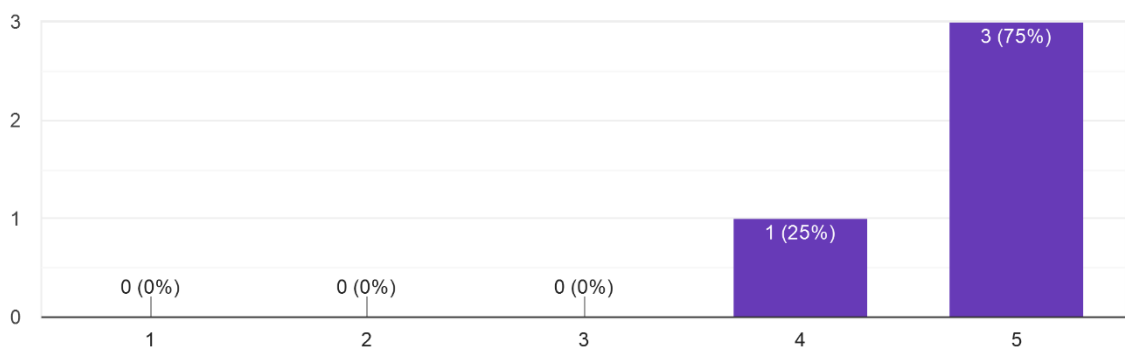
A interação com vídeos 360° com som espacial é interessante.

4 respostas



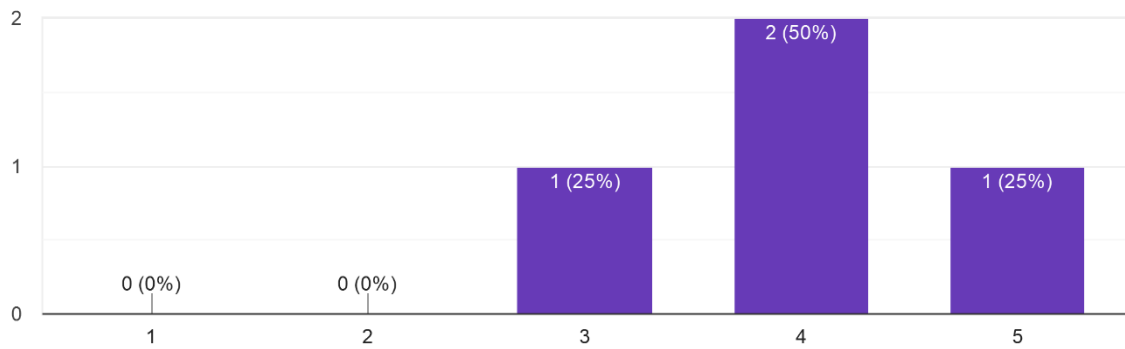
A timeline (linha temporal) é útil.

4 respostas



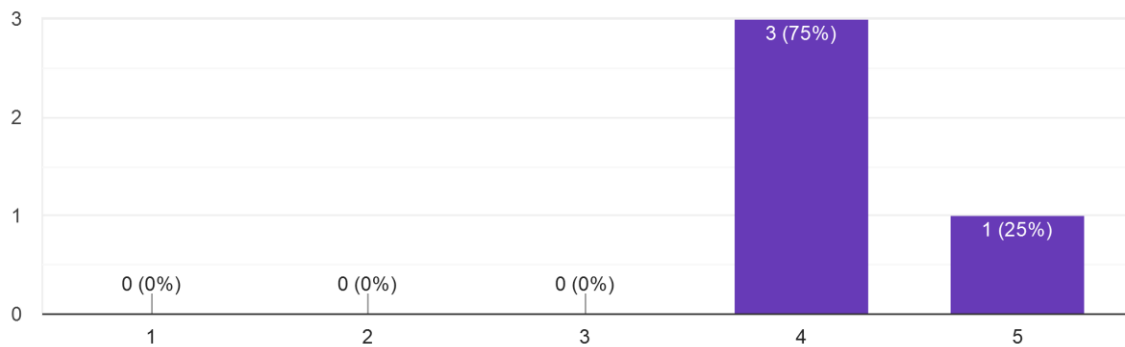
A timeline é fácil de usar.

4 respostas

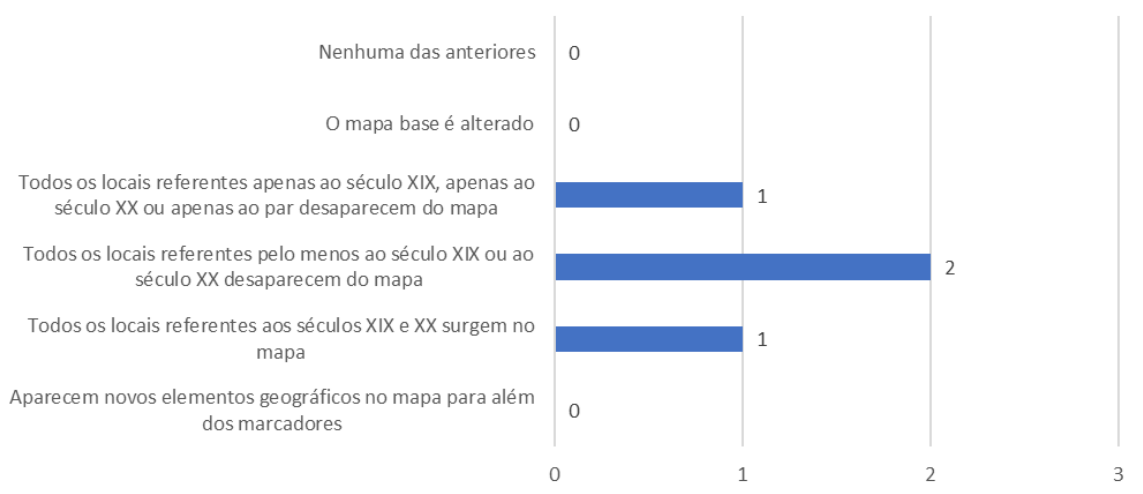


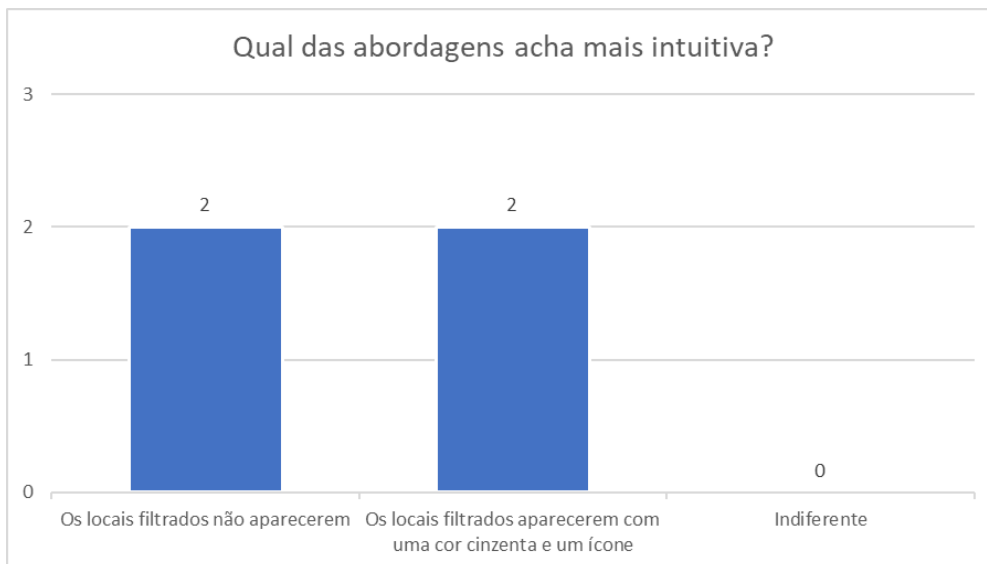
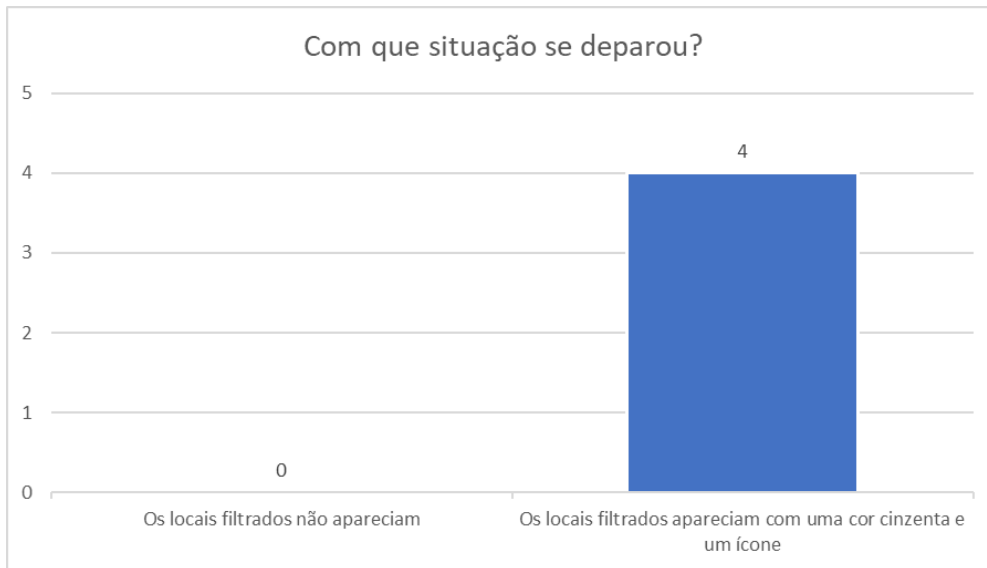
Compreendi como funciona a timeline.

4 respostas

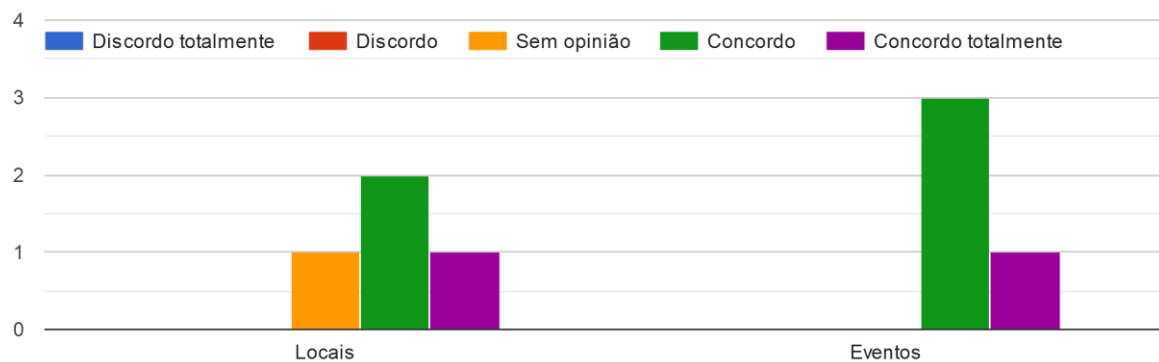


Em relação à timeline: um local pode estar associado a vários séculos. O que acontece quando os filtros do séc. XIX e XX se encontram ativos?



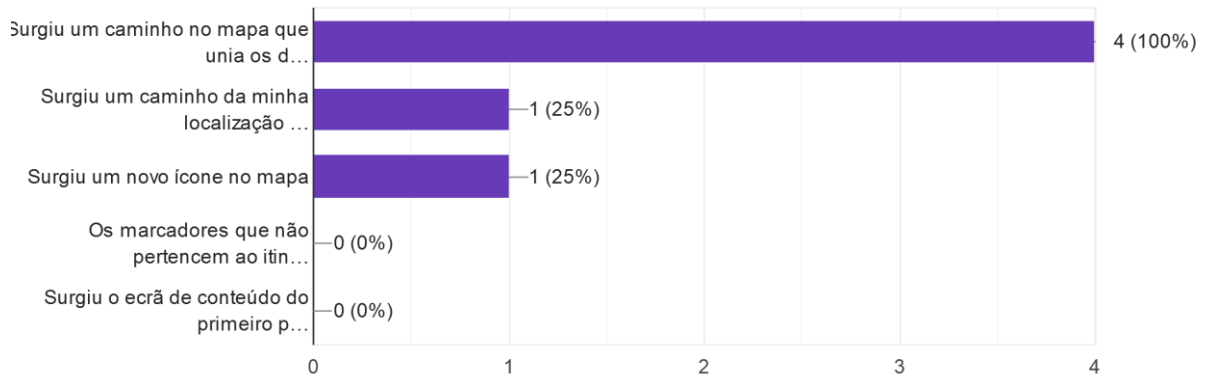


É fácil pesquisar:



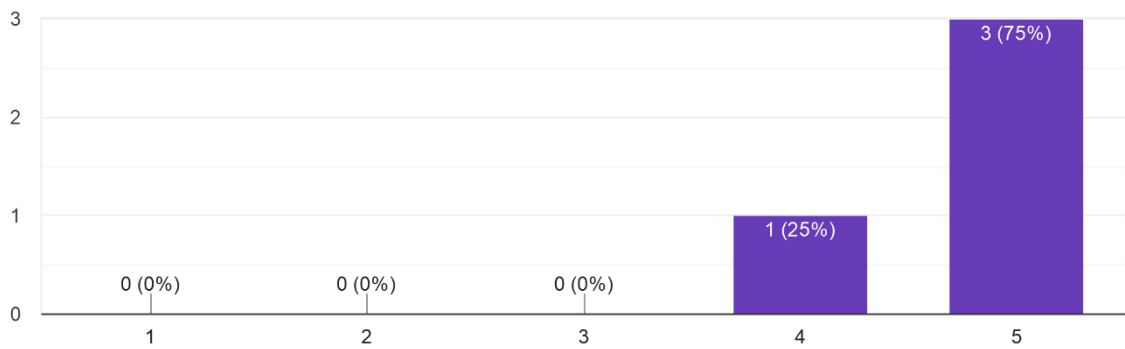
Depois de ativar um itinerário, quais das seguintes ações observou?

4 respostas



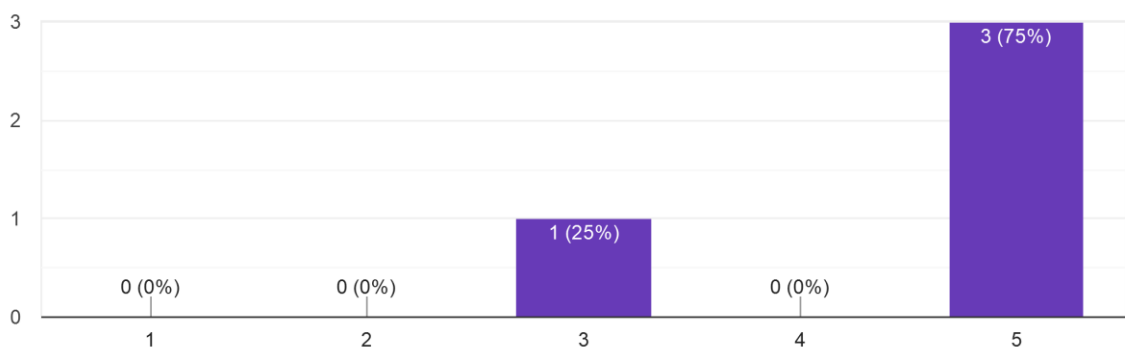
Achei o login fácil de efetuar.

4 respostas



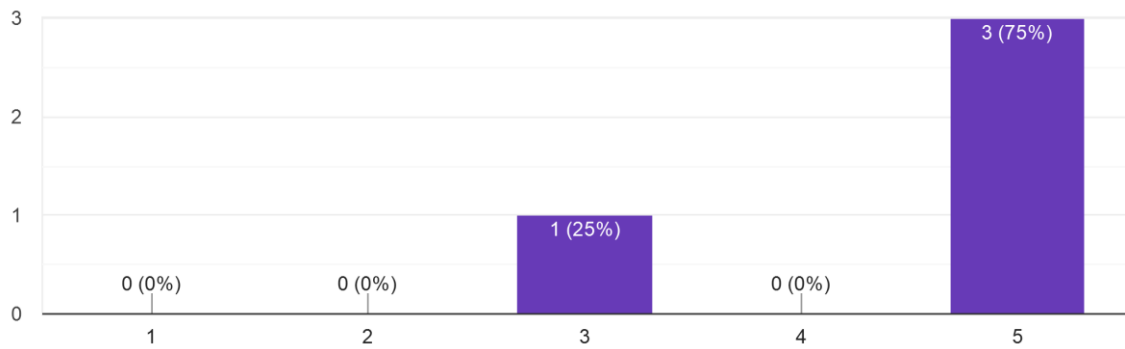
Acho interessante haverem dois tipos de itinerários diferentes.

4 respostas



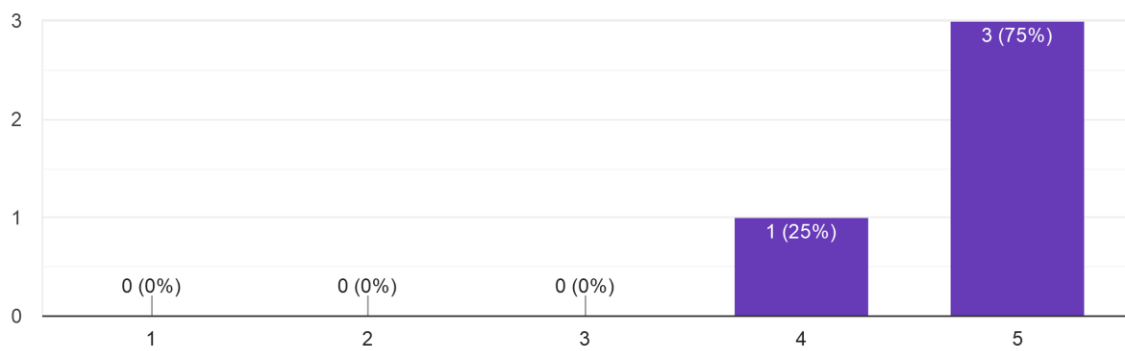
Acho importante poder gerir os elementos desta forma.

4 respostas



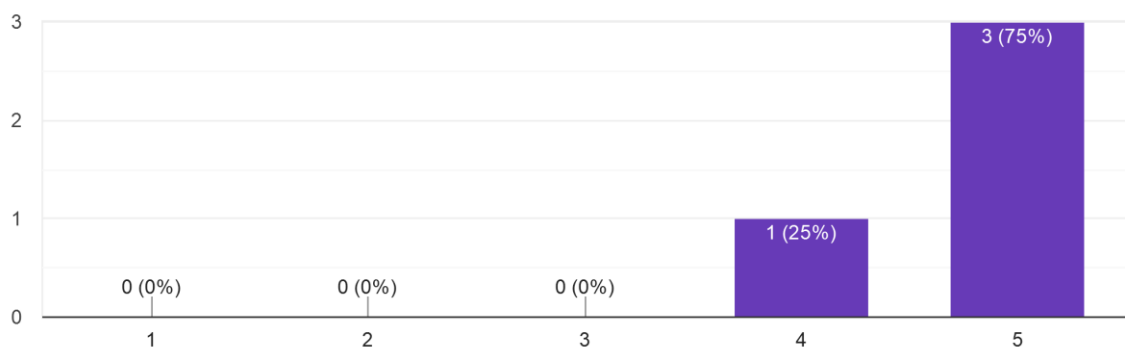
Acho importante gestão de conteúdo pendente antes deste ser disponibilizado publicamente.

4 respostas



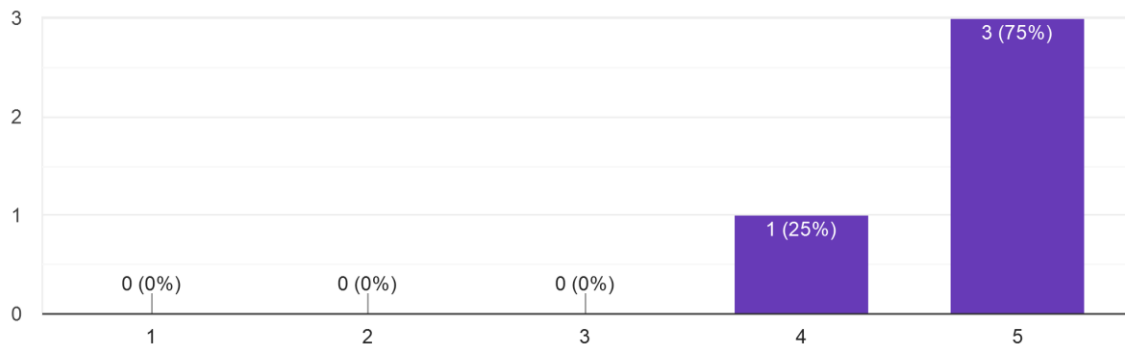
Compreendi como aceitar conteúdo pendente.

4 respostas



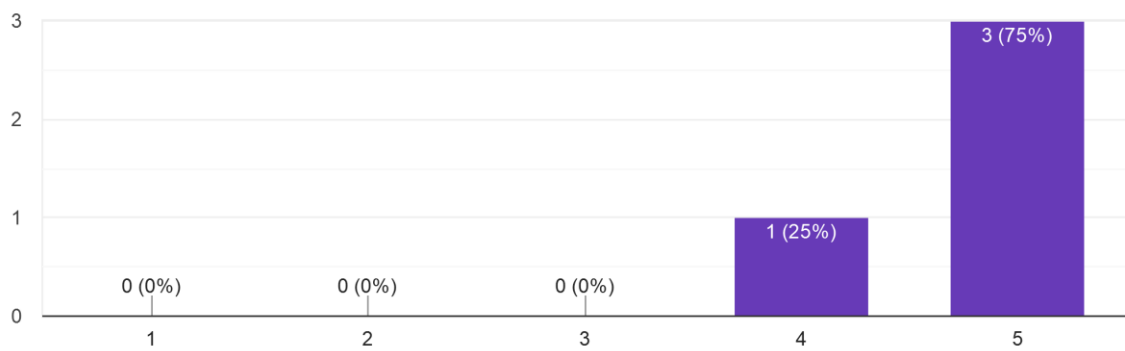
Compreendi como rejeitar conteúdo pendente.

4 respostas



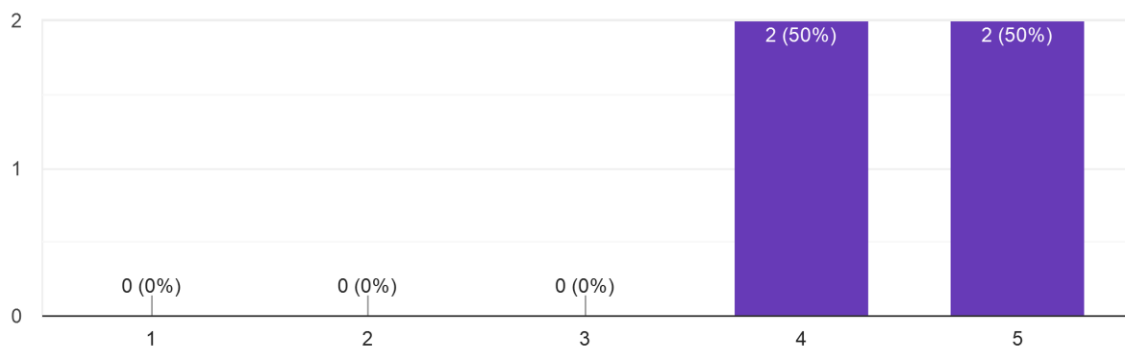
Compreendi como editar conteúdo pendente.

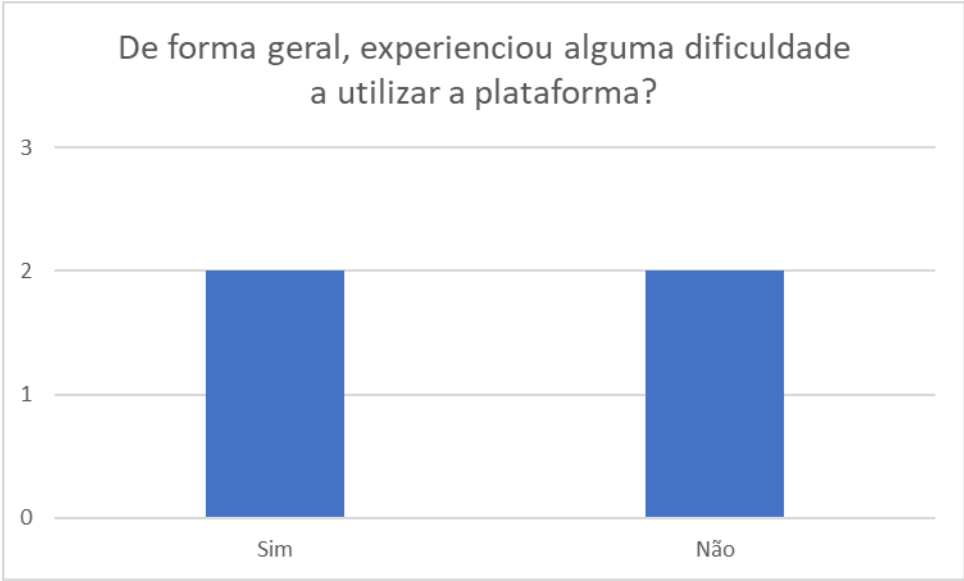
4 respostas



Acho importante poder selecionar vários conteúdos ao mesmo tempo e aceitar/rejeitar numa só ação.

4 respostas



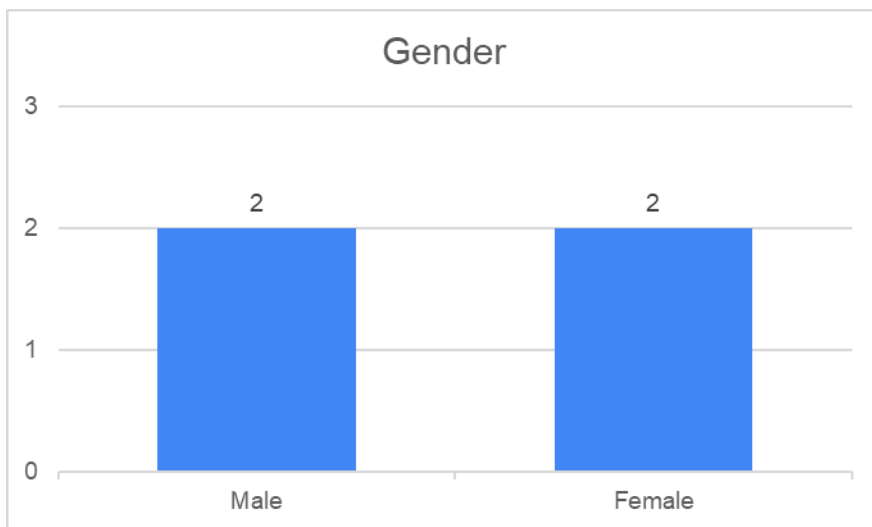
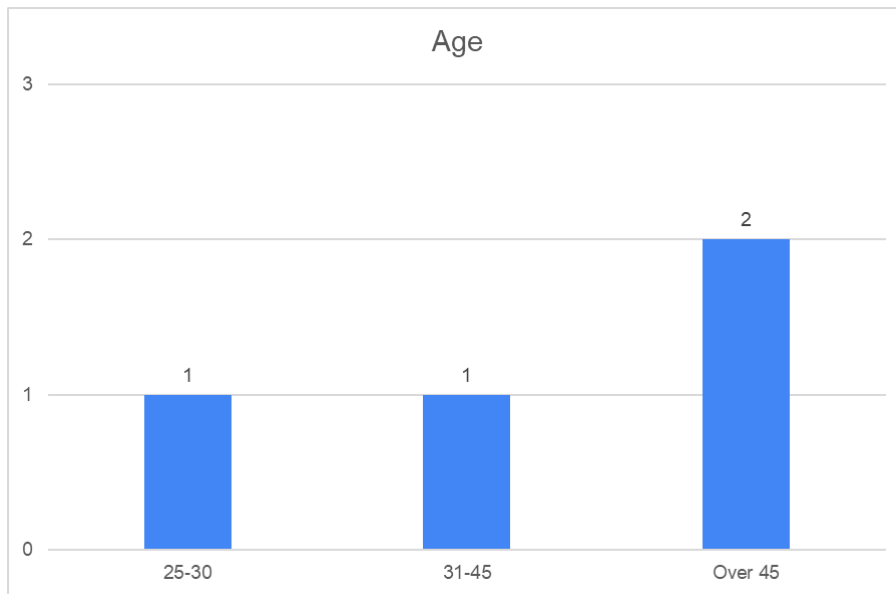


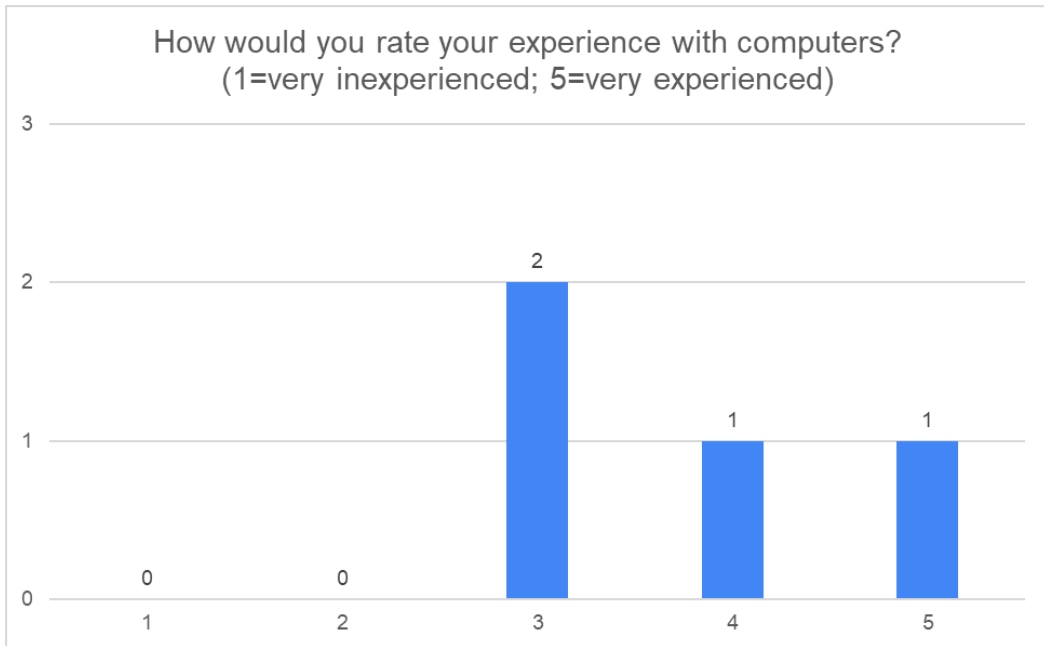
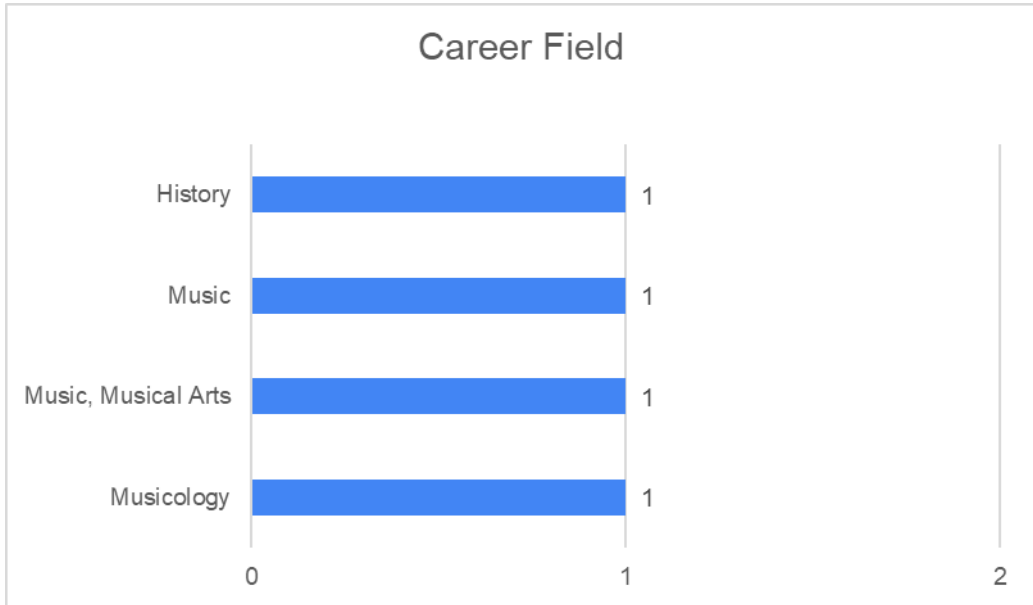
A P P E N D I X

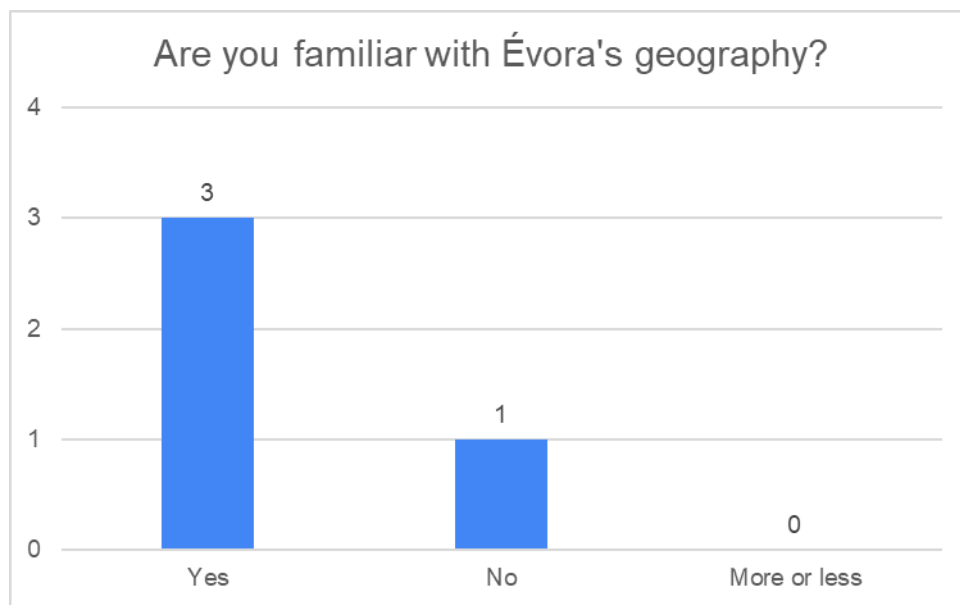
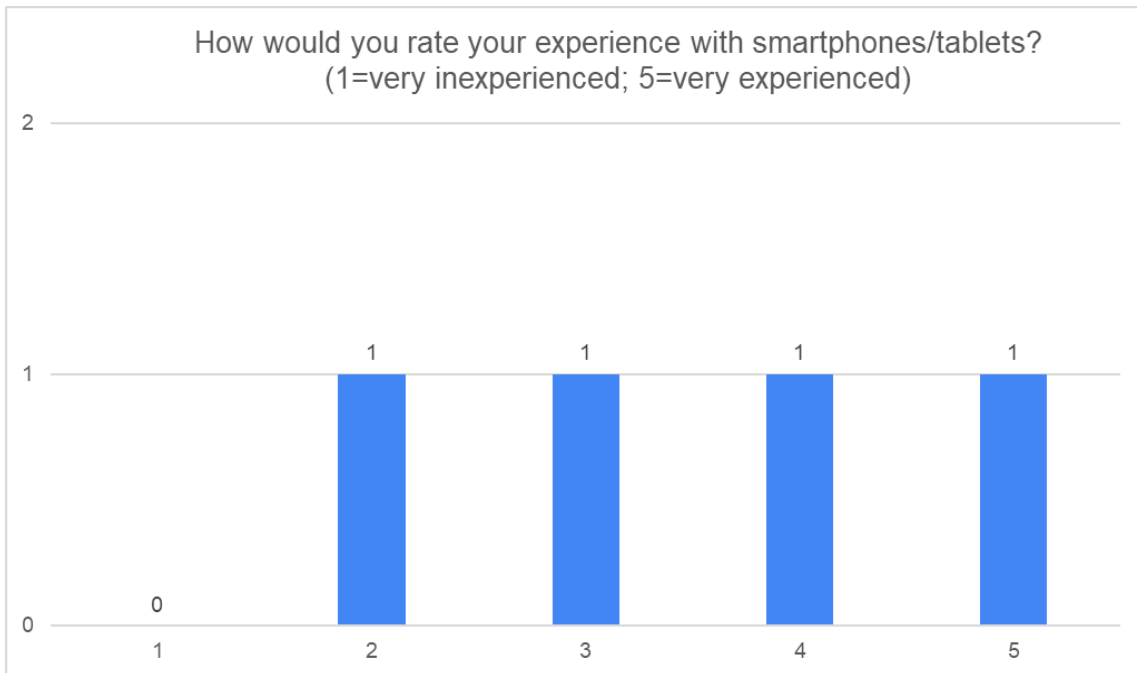


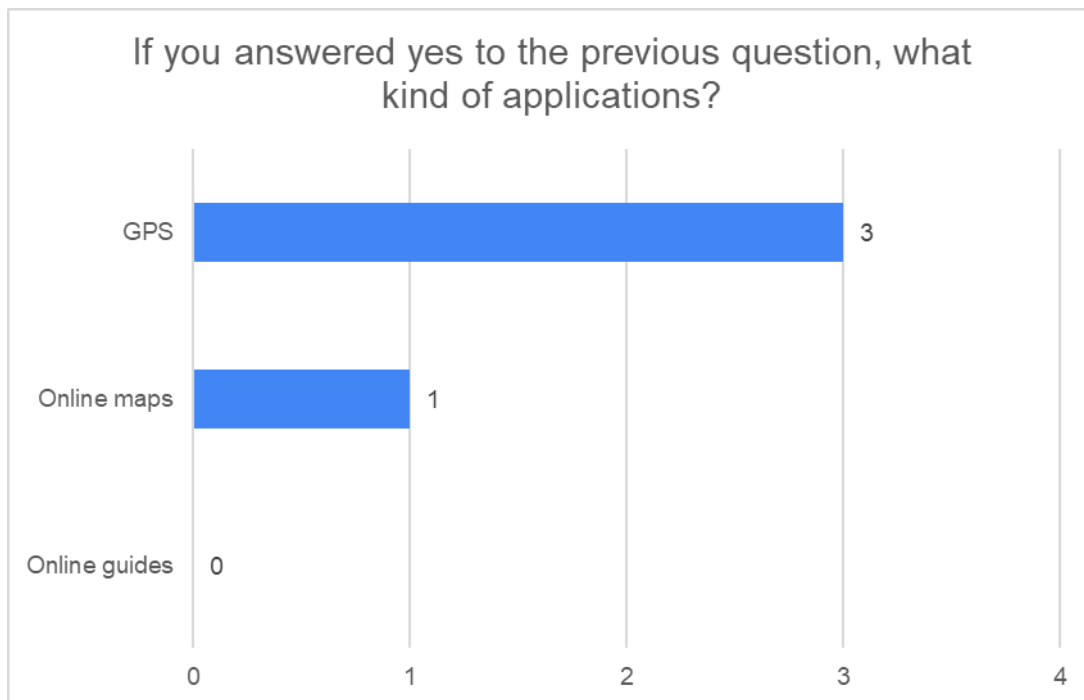
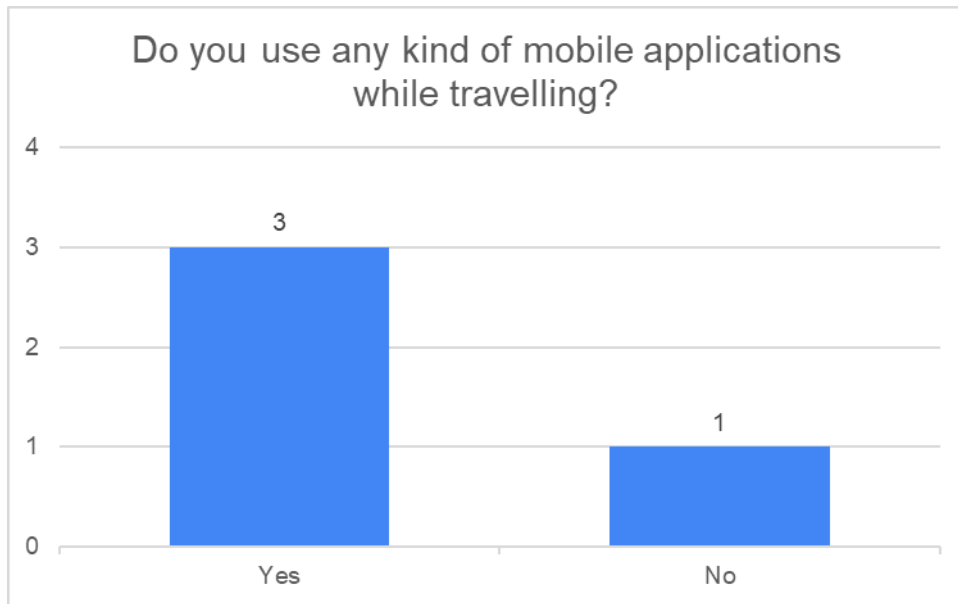
QUESTIONNAIRE GRAPHS - ADMINISTRATORS
(ENGLISH)

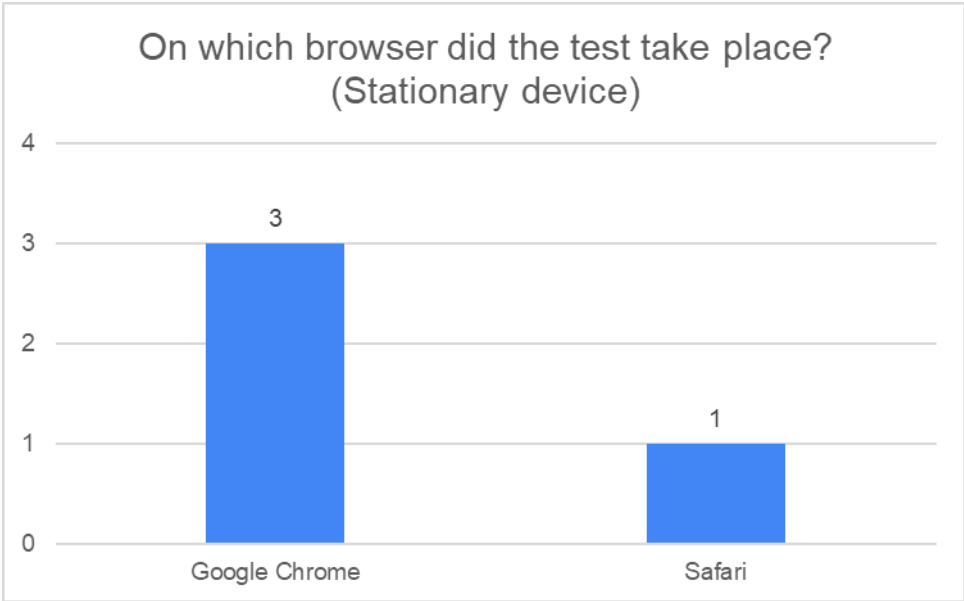
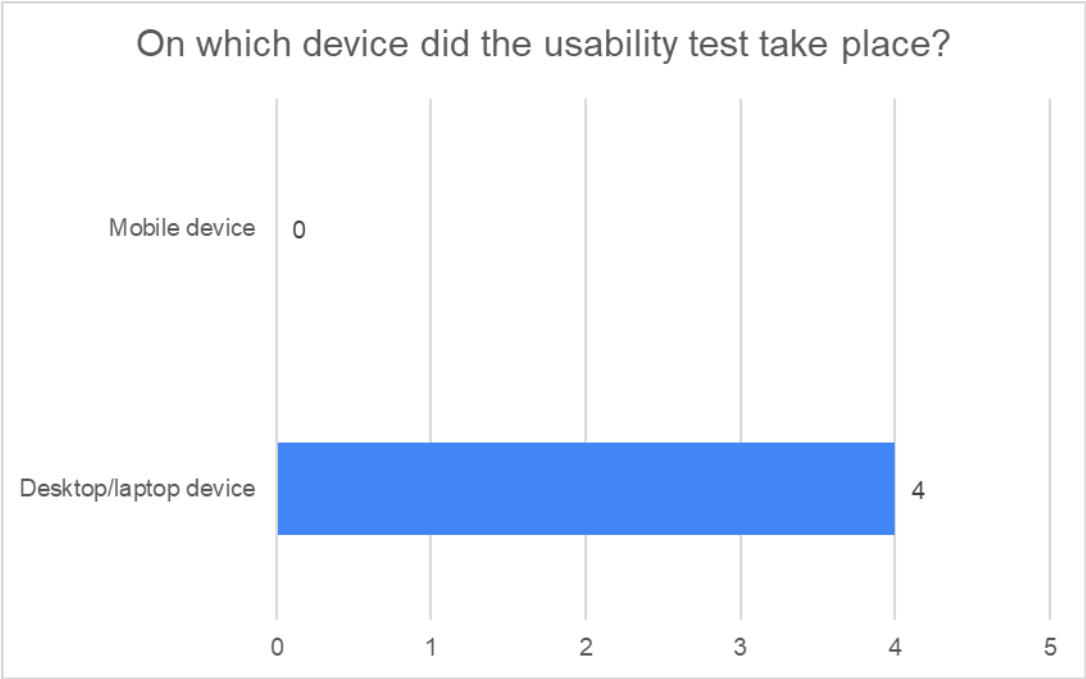
First section



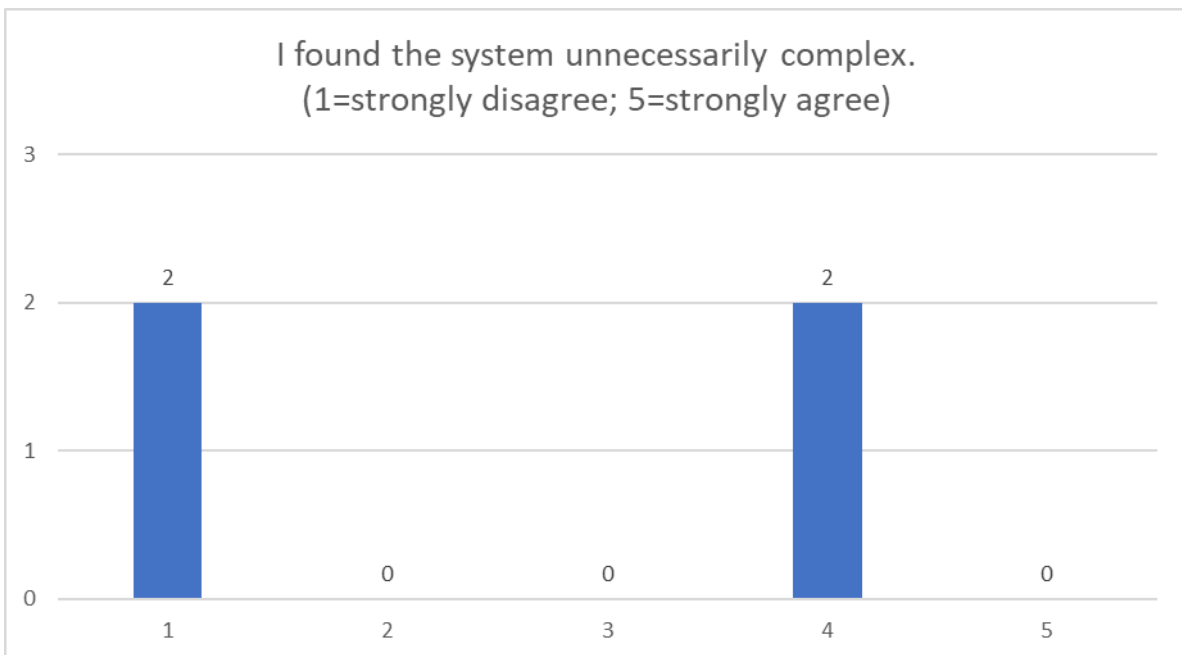
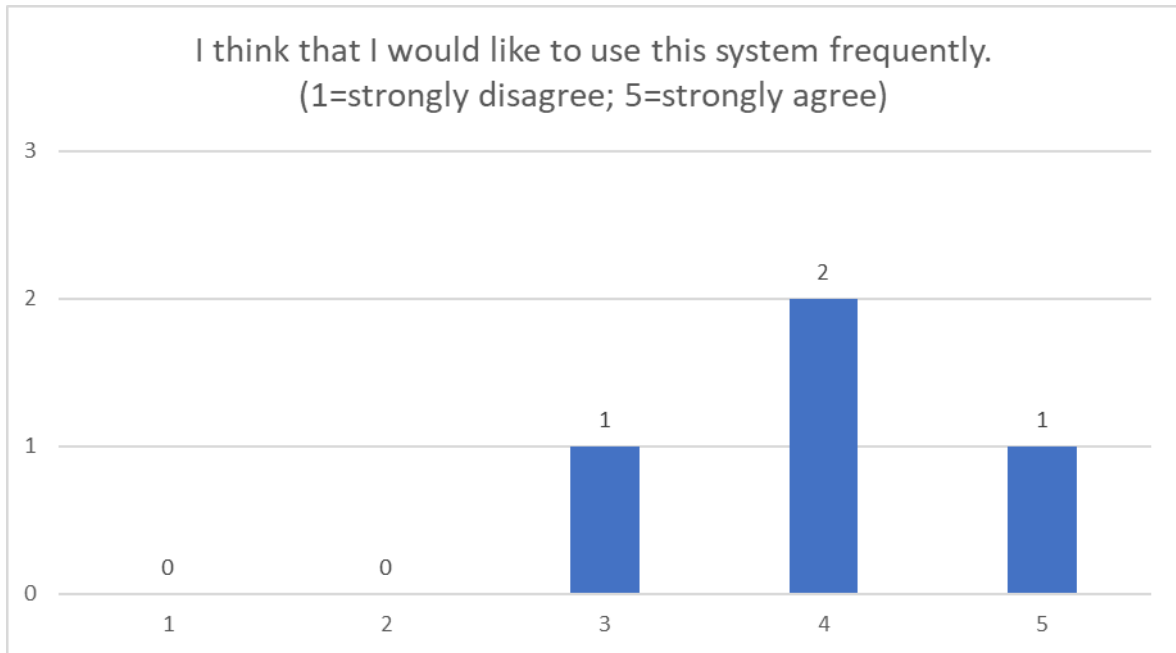


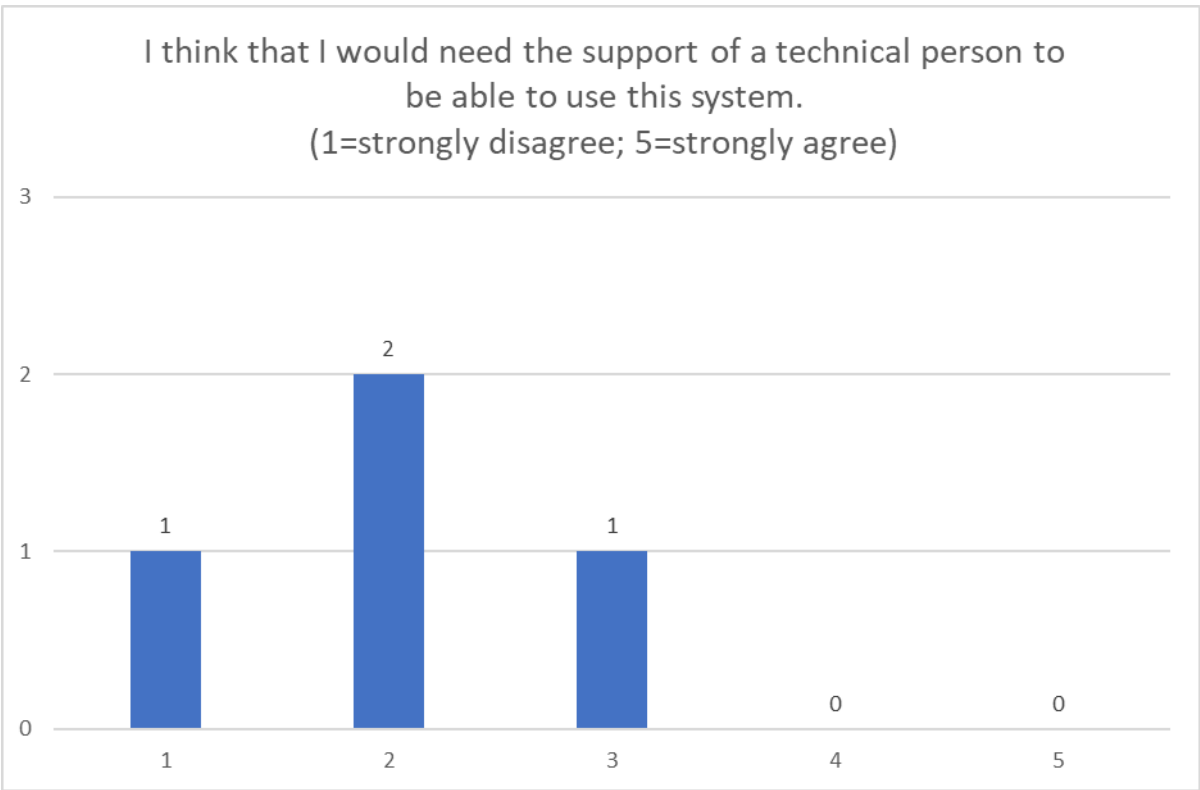
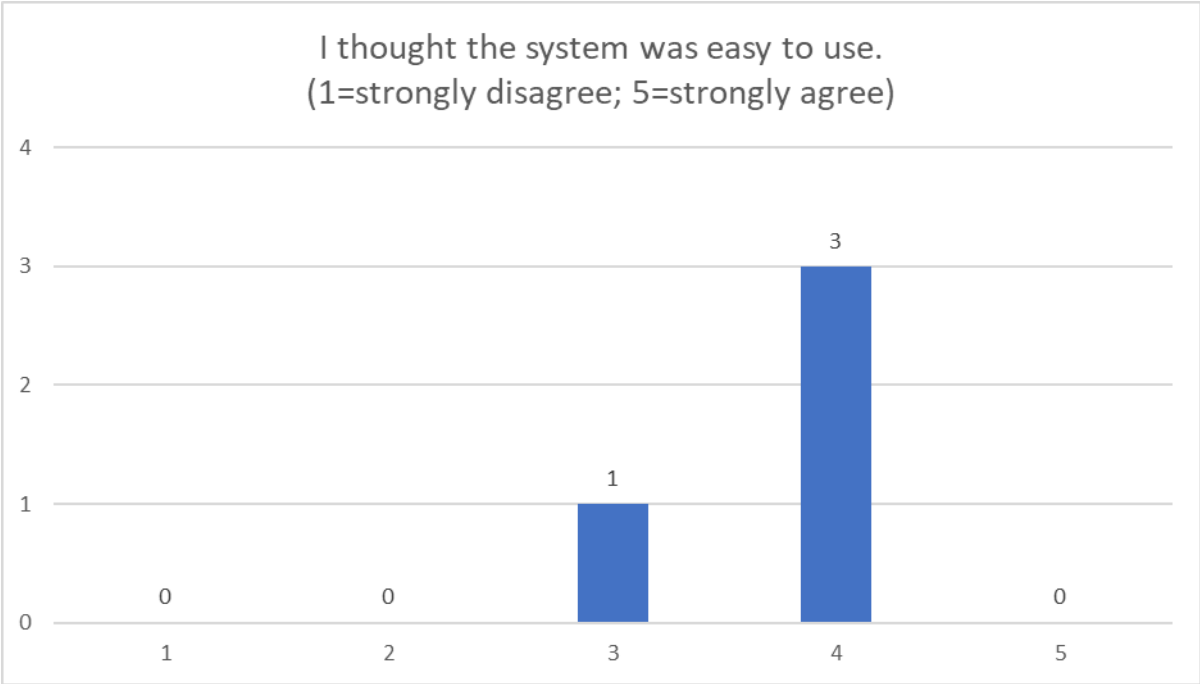






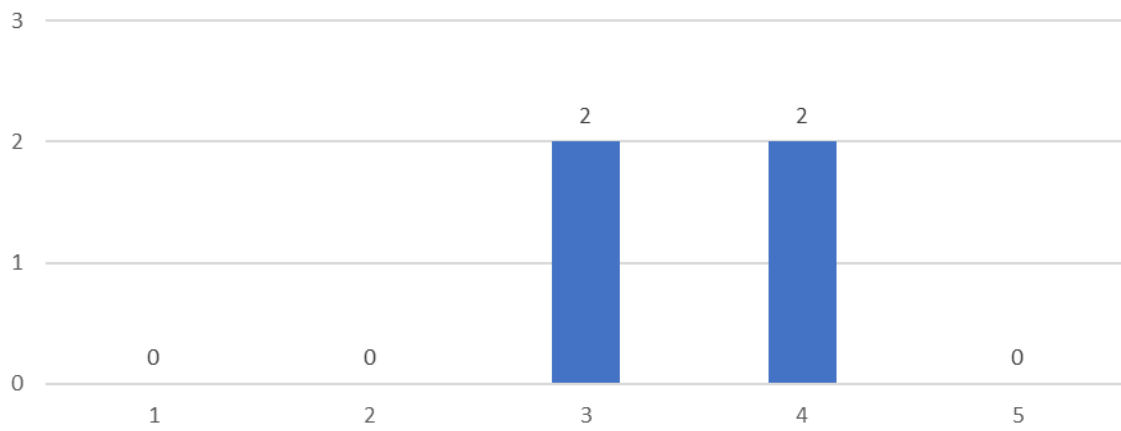
Second section





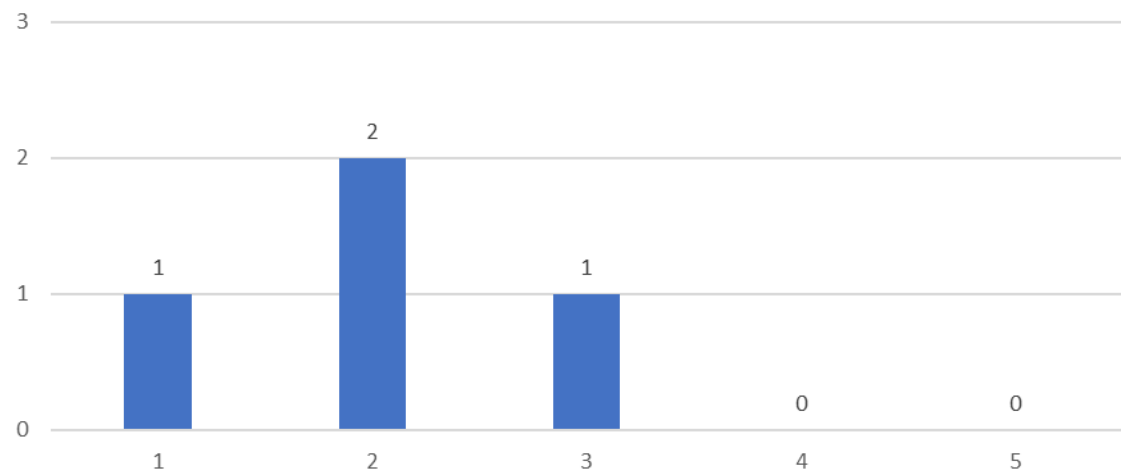
I found the various functions in this system were well integrated.

(1=strongly disagree; 5=strongly agree)

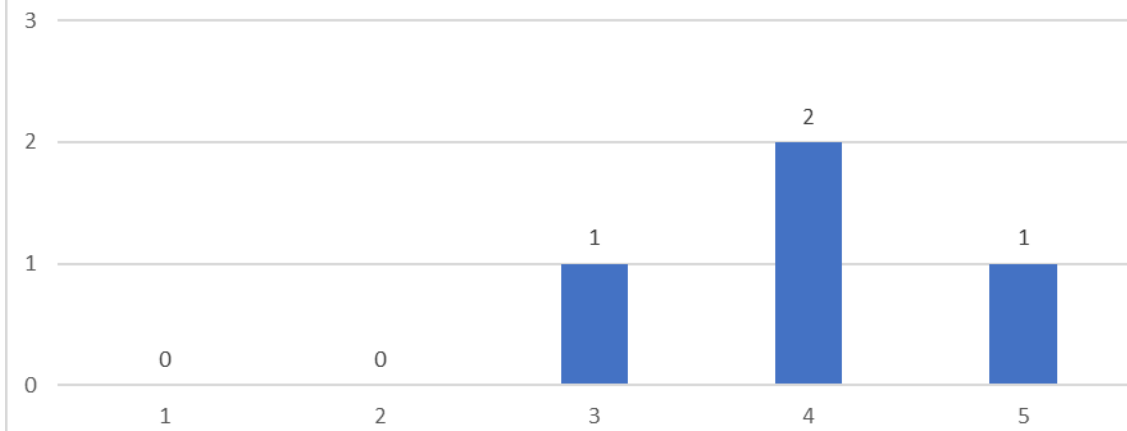


I thought there was too much inconsistency in this system.

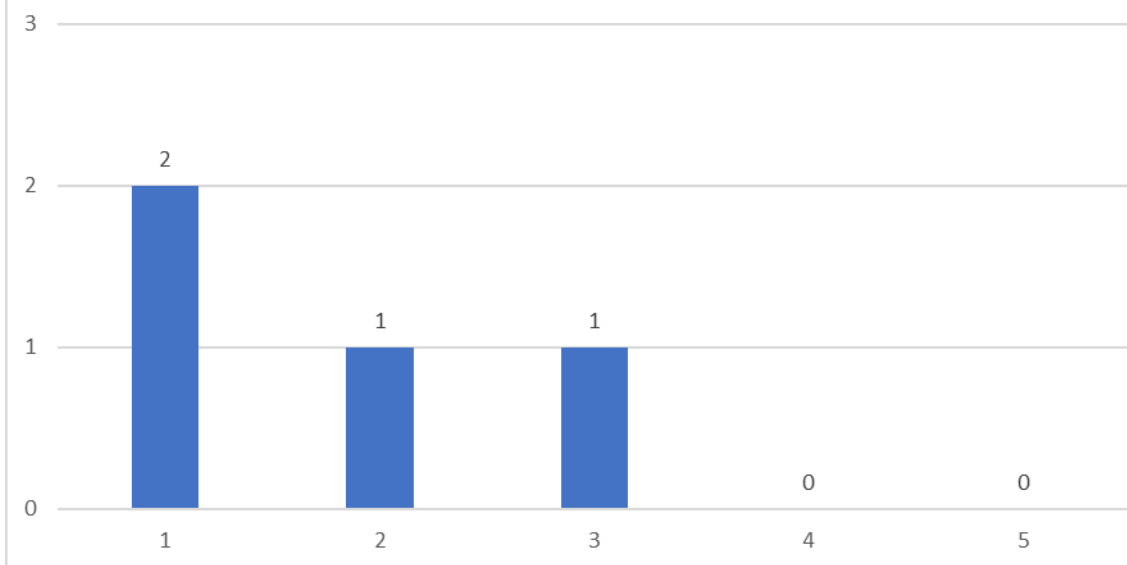
(1=strongly disagree; 5=strongly agree)

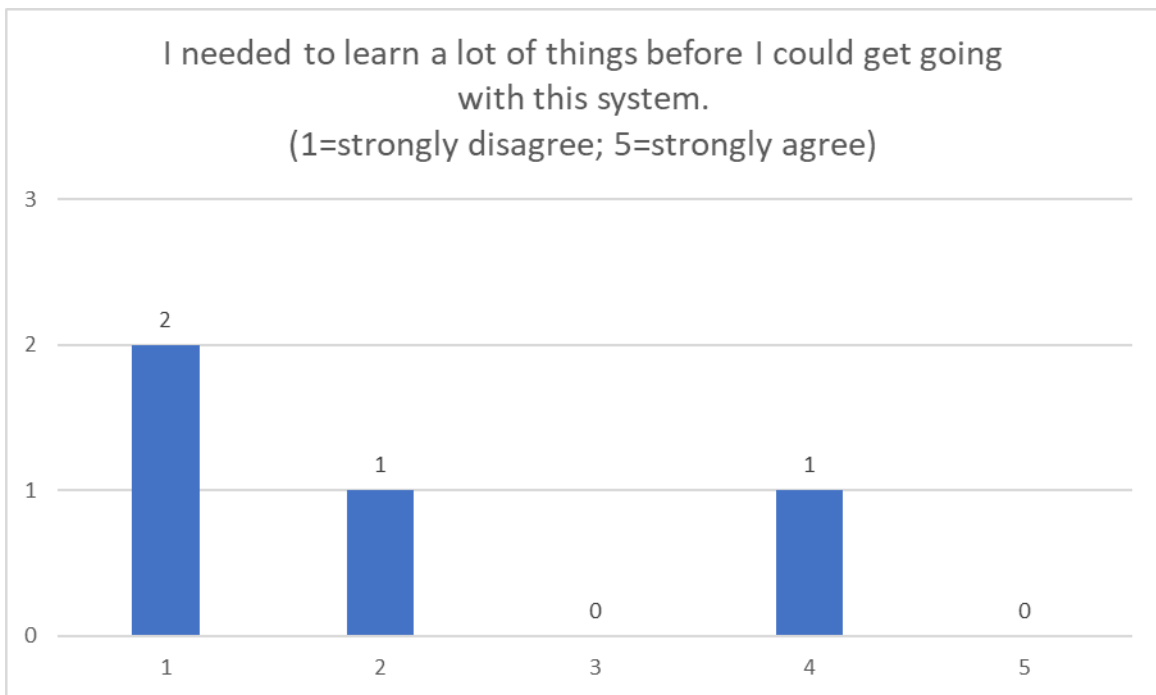
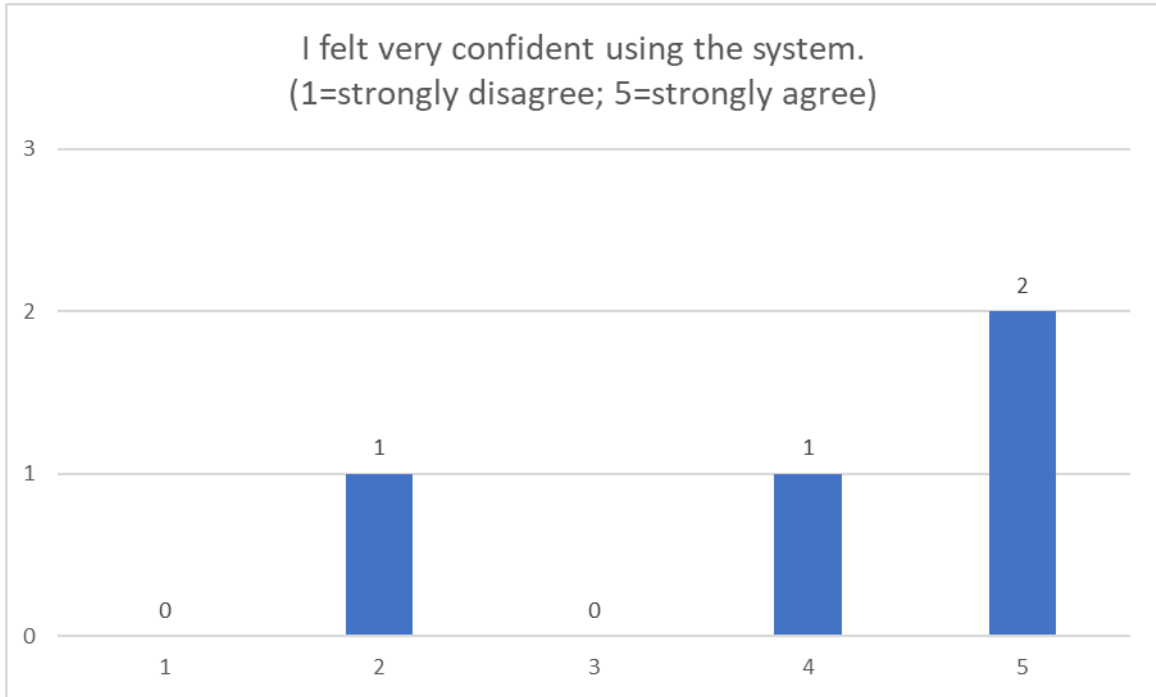


I would imagine that most people would learn to use this system very quickly.
(1=strongly disagree; 5=strongly agree)

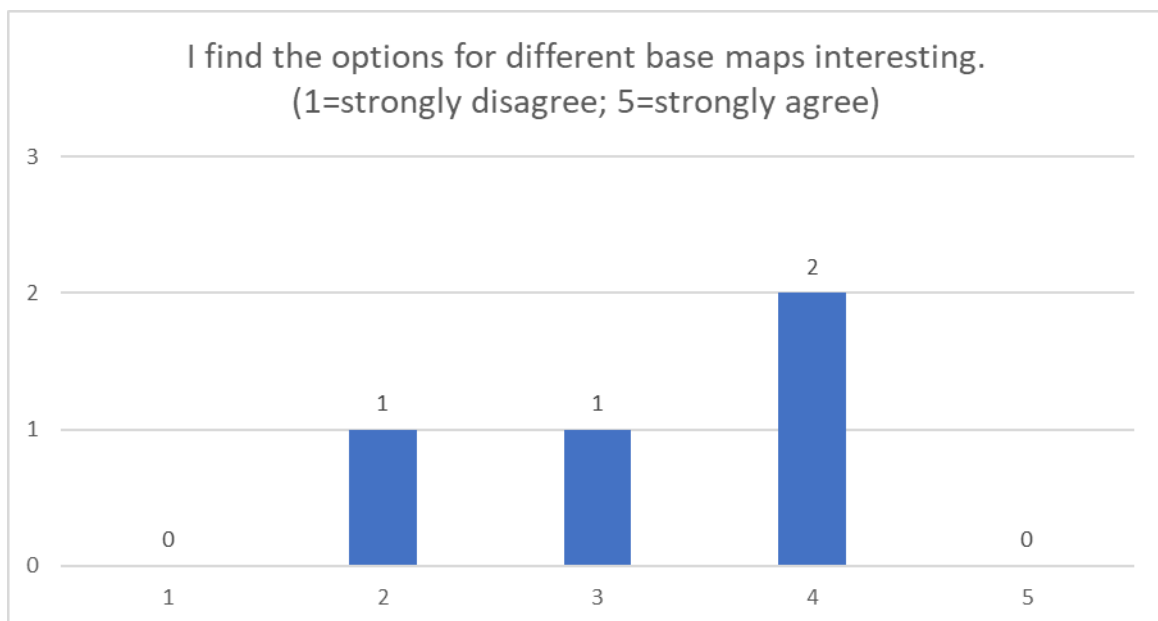
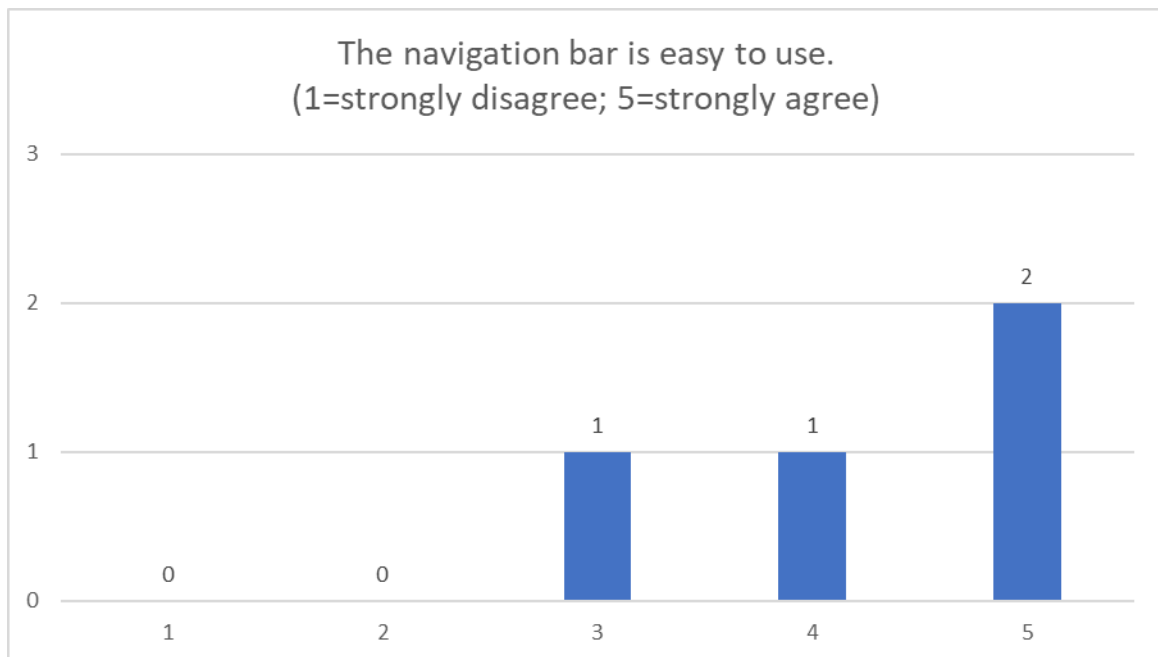


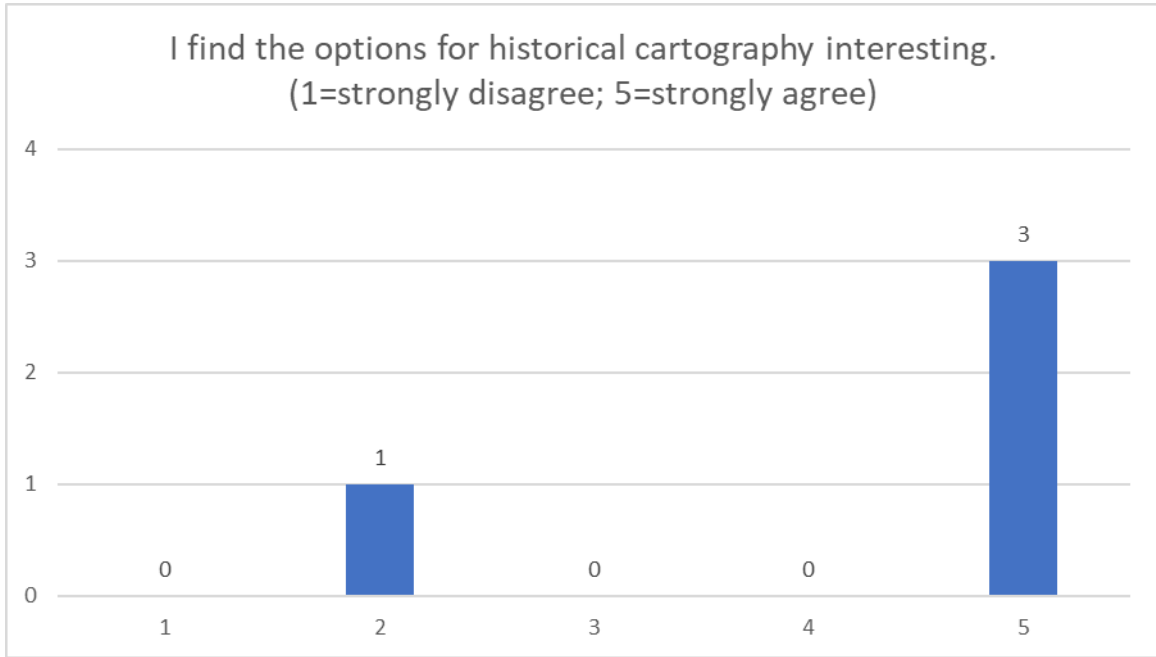
I found the system very cumbersome to use.
(1=strongly disagree; 5=strongly agree)

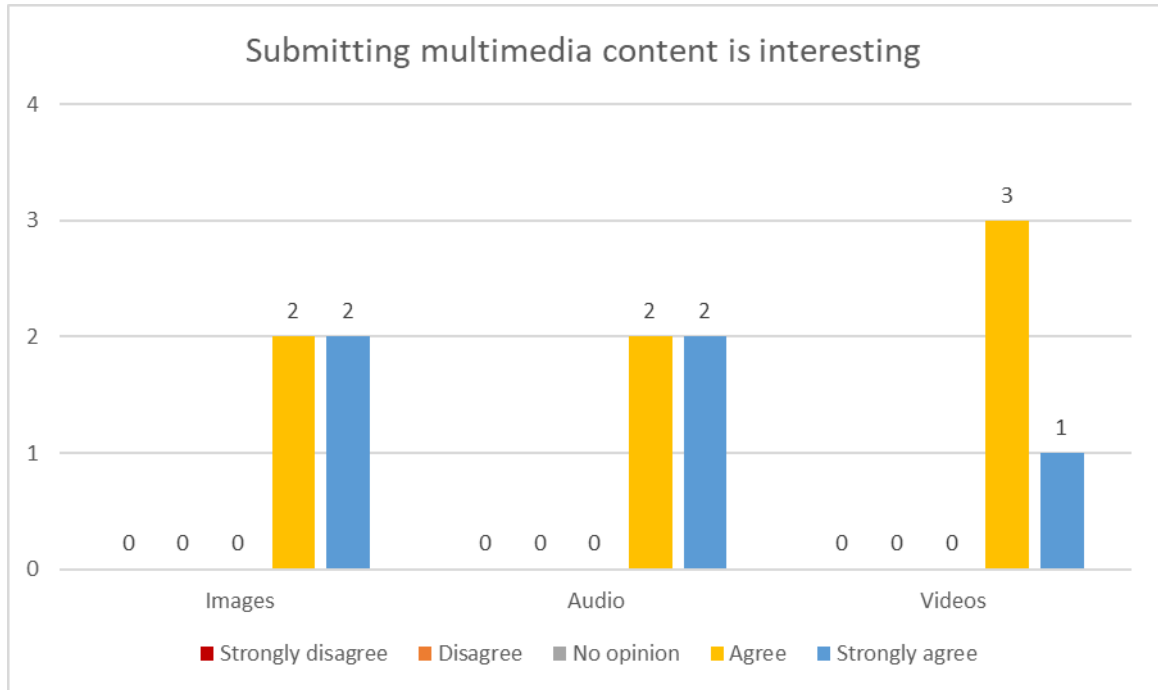
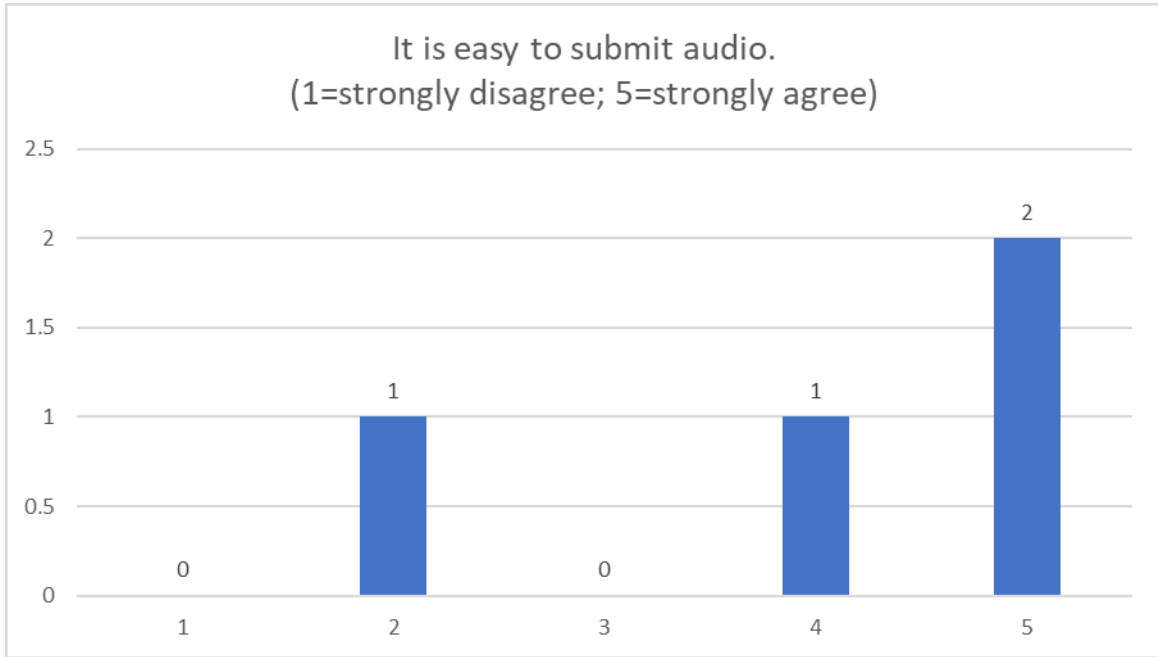


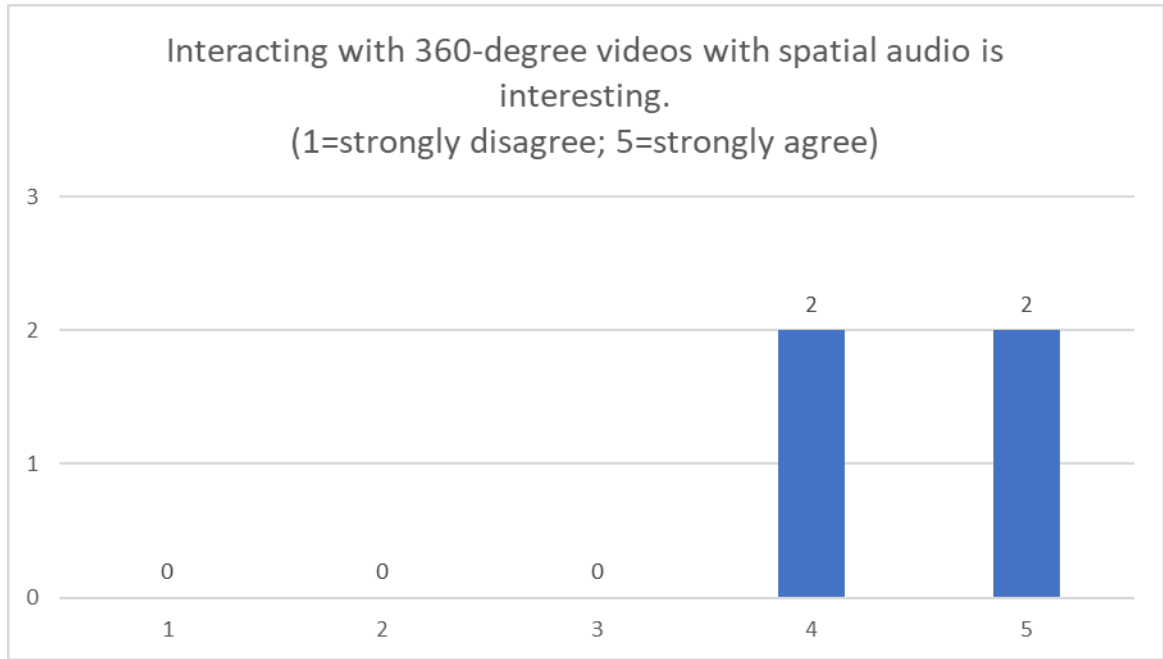
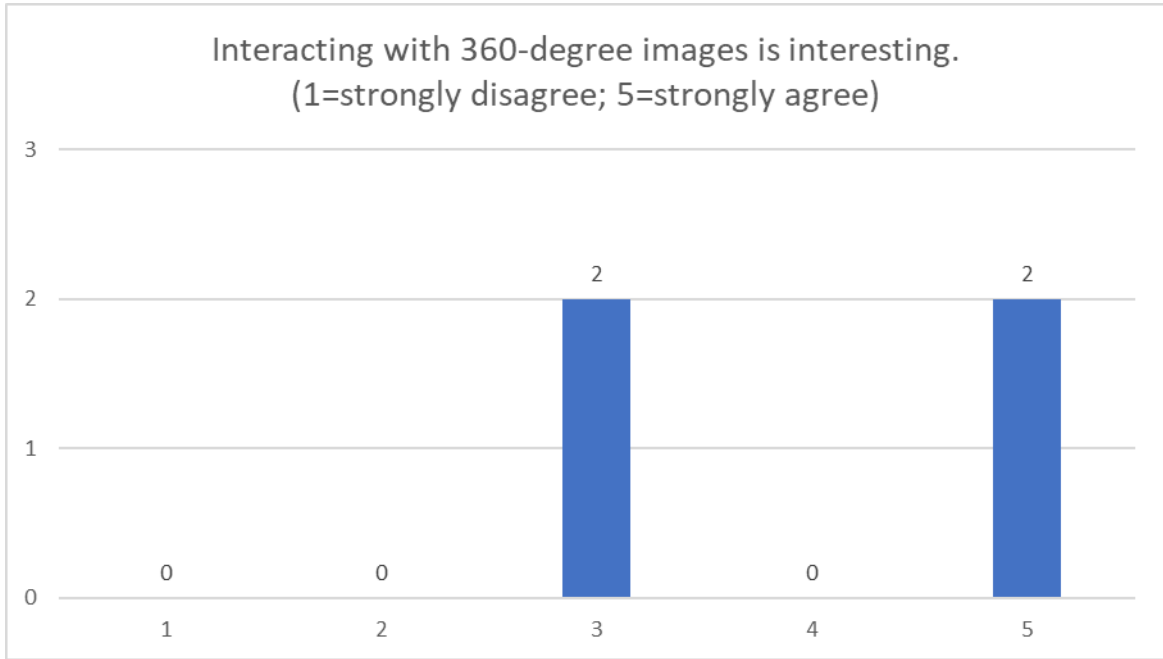


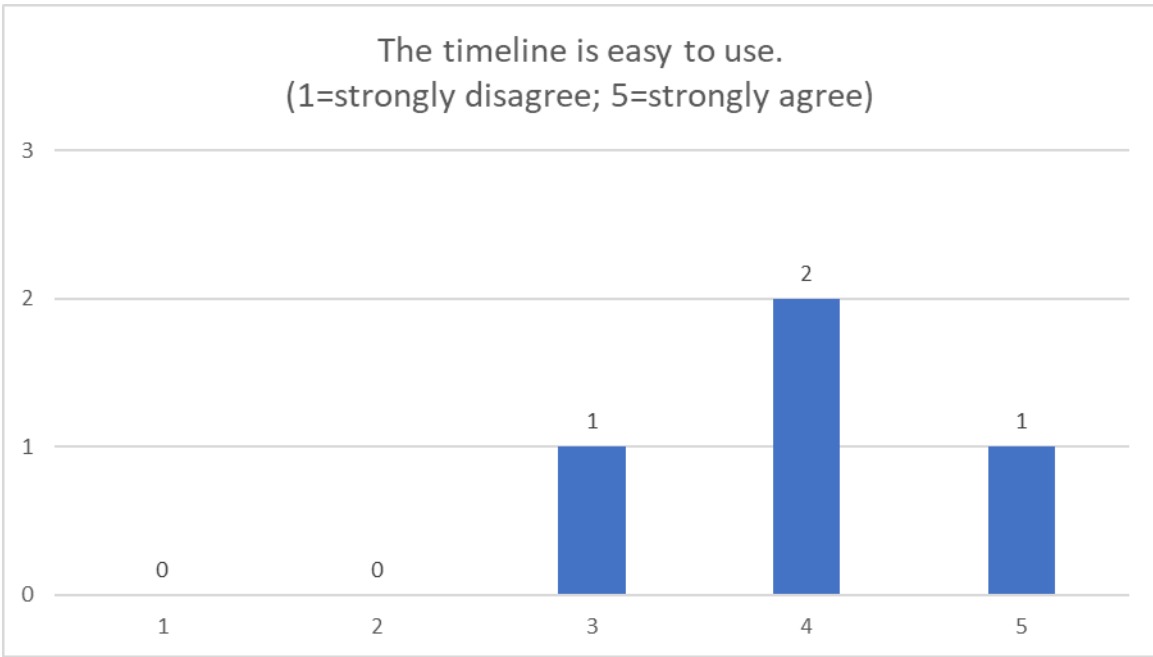
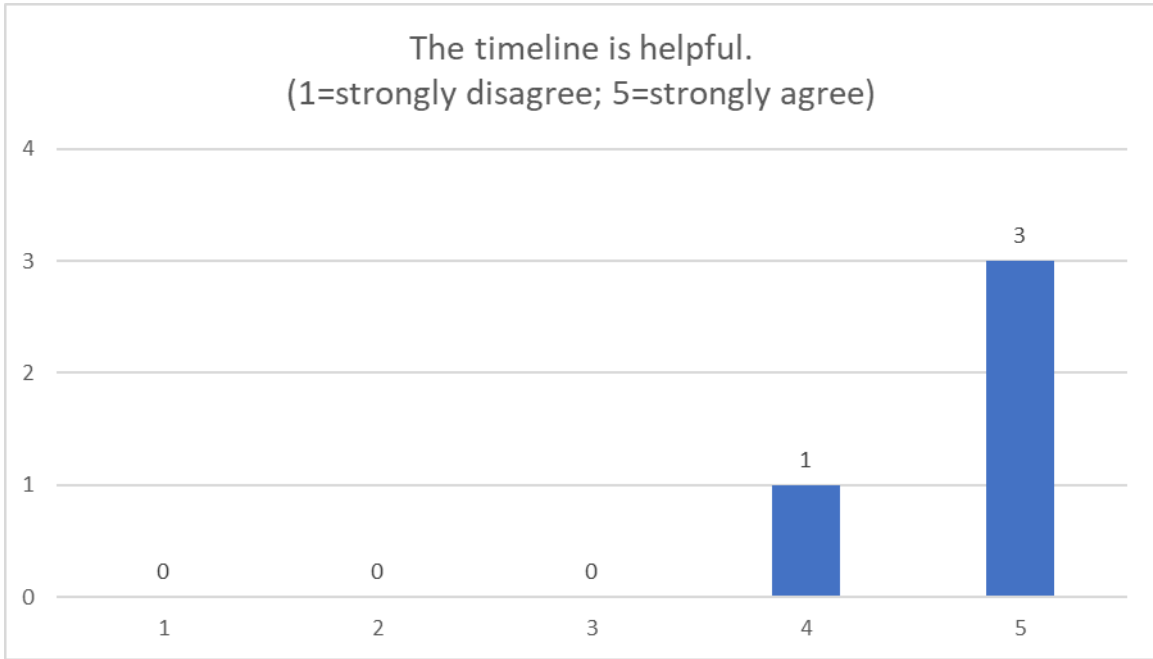
Third section

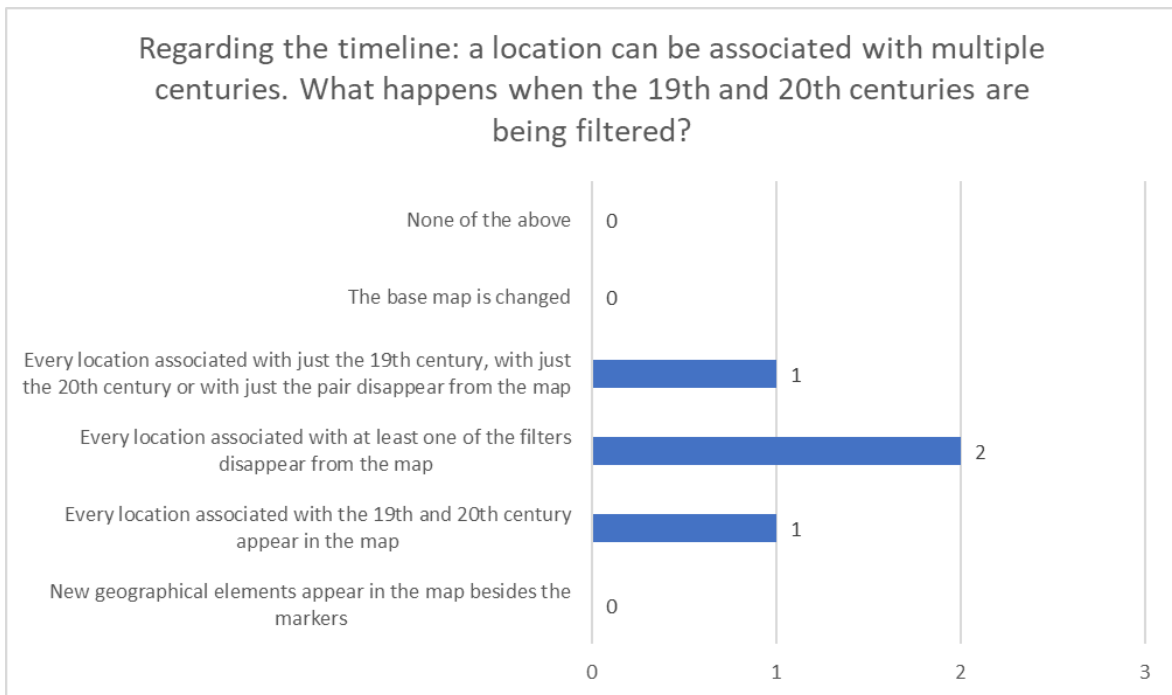
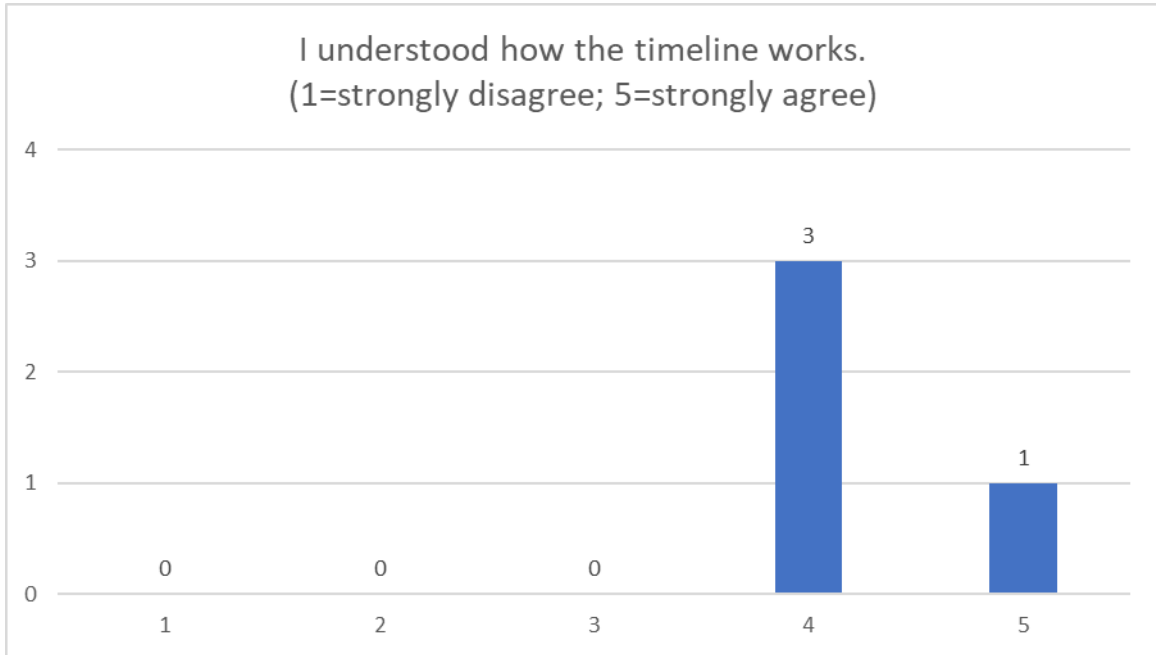


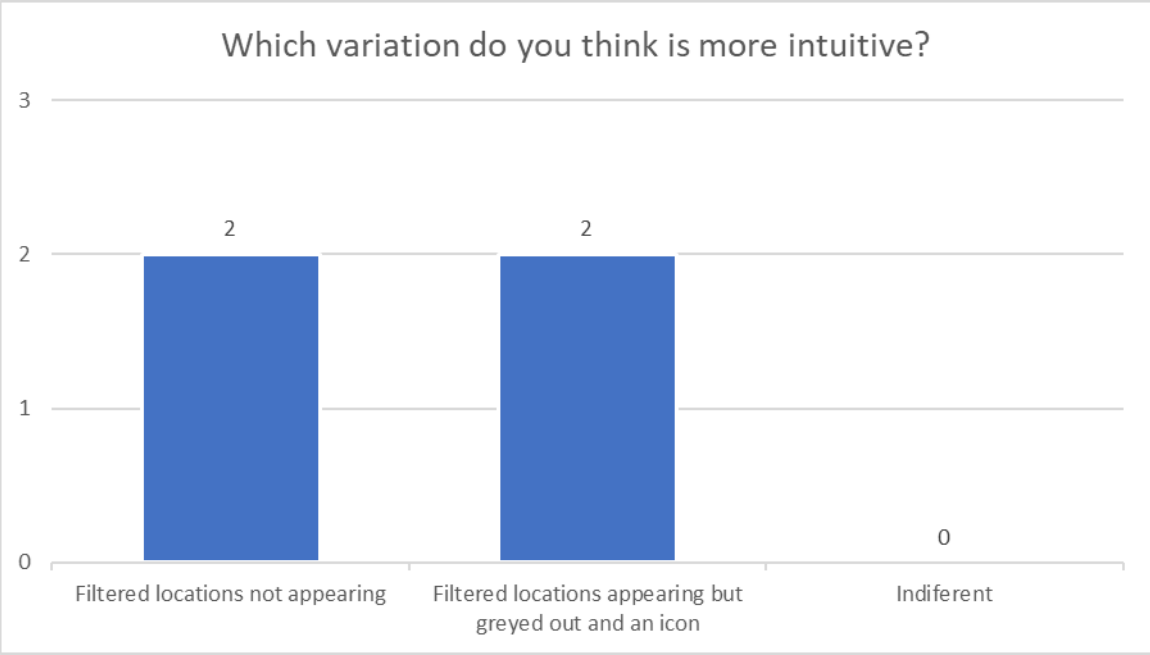
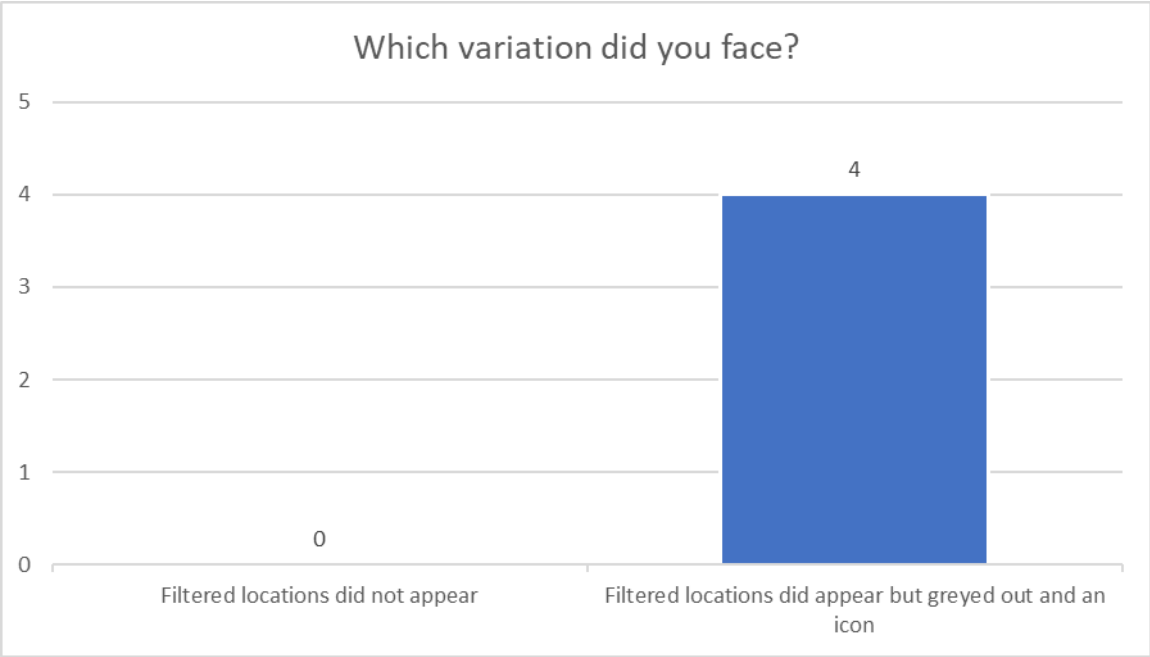


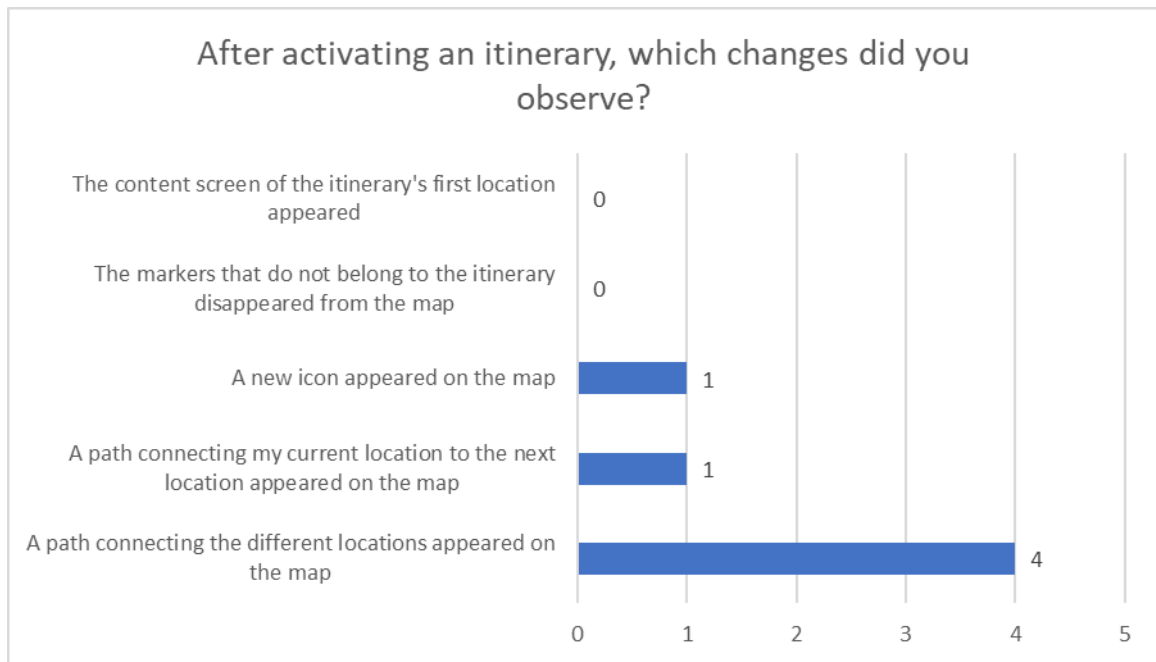
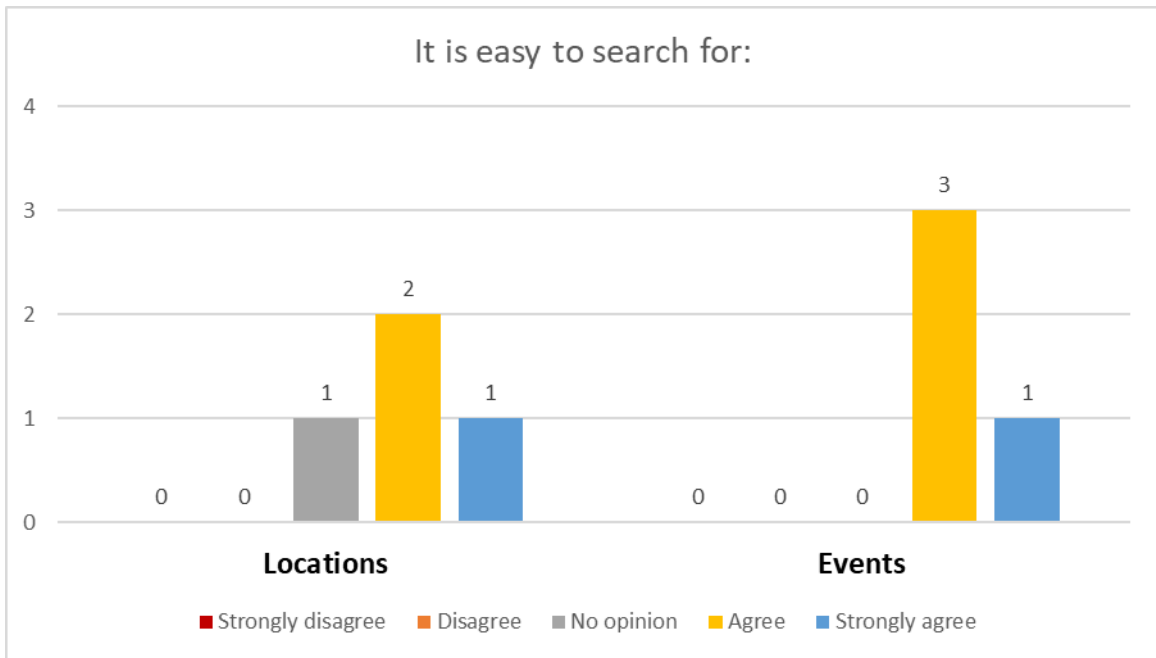


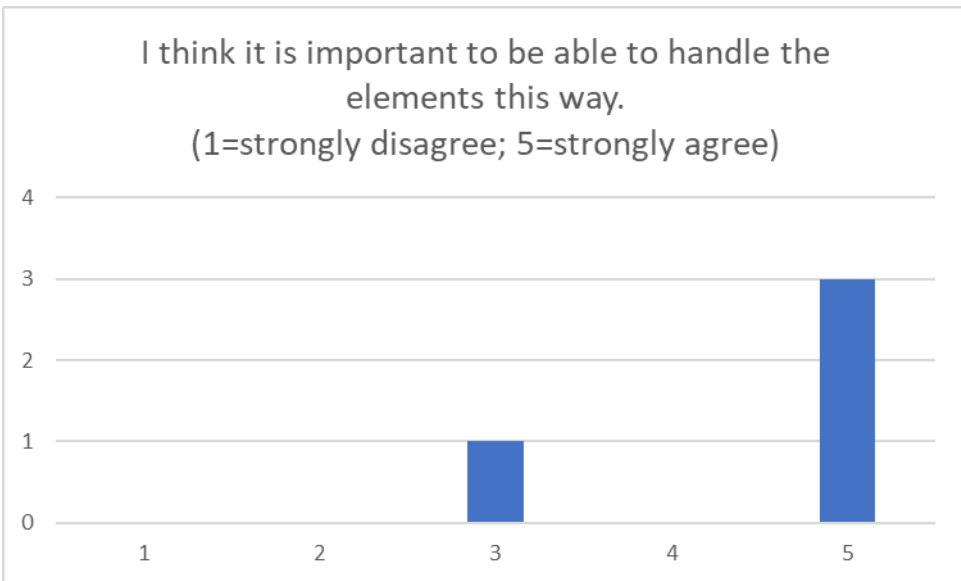
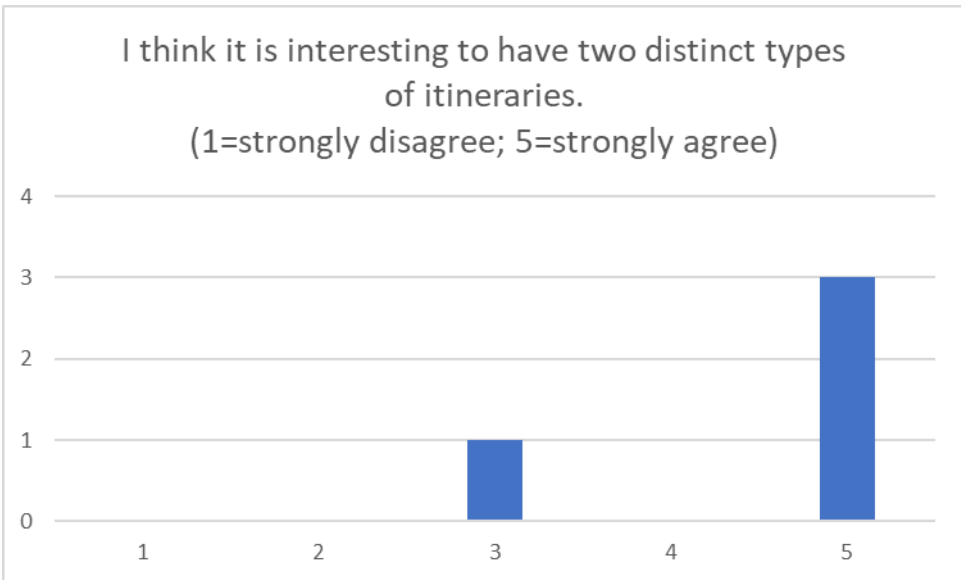
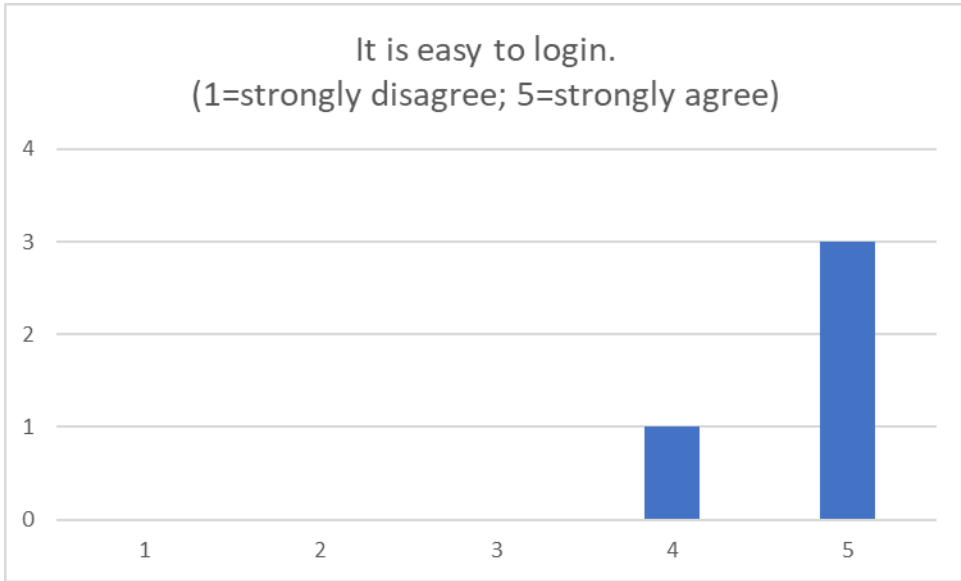


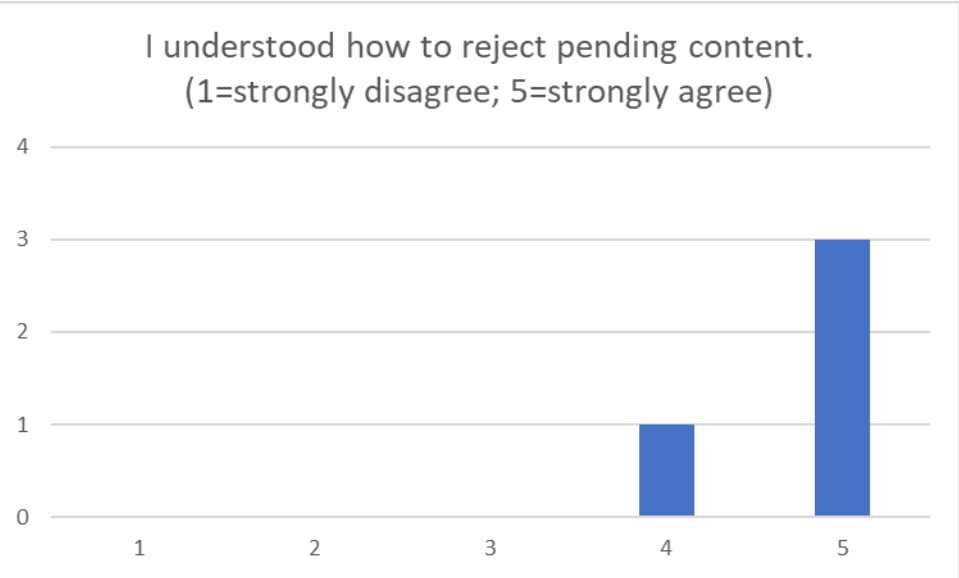
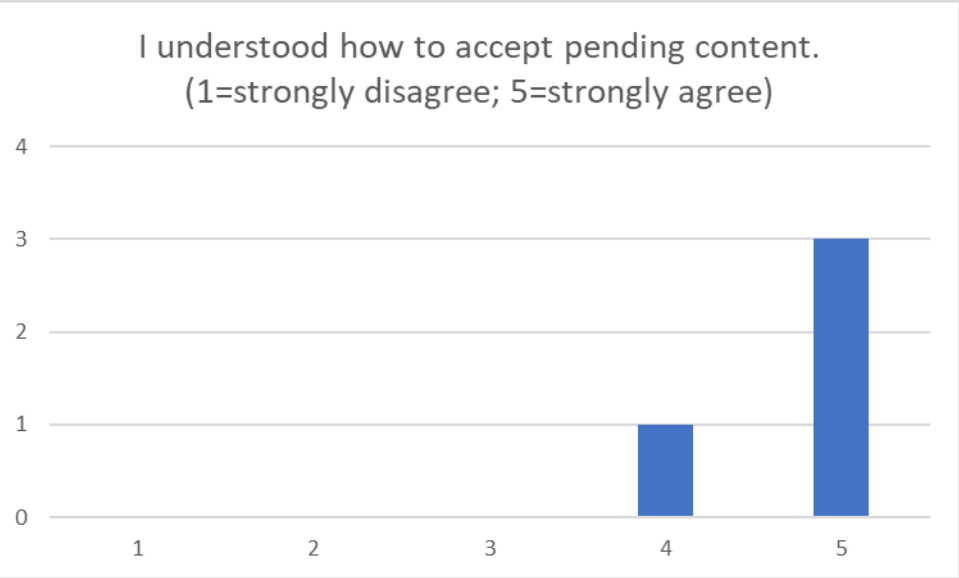
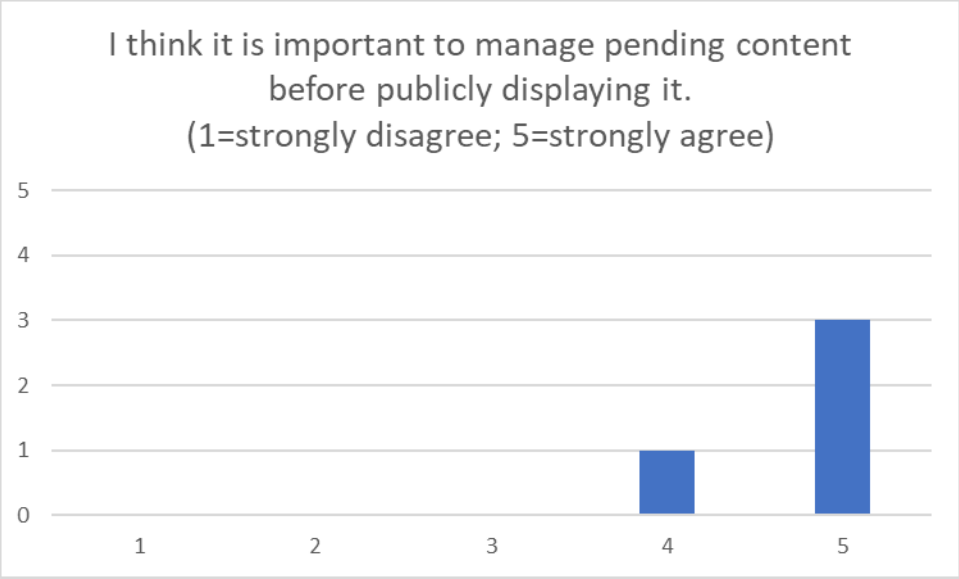


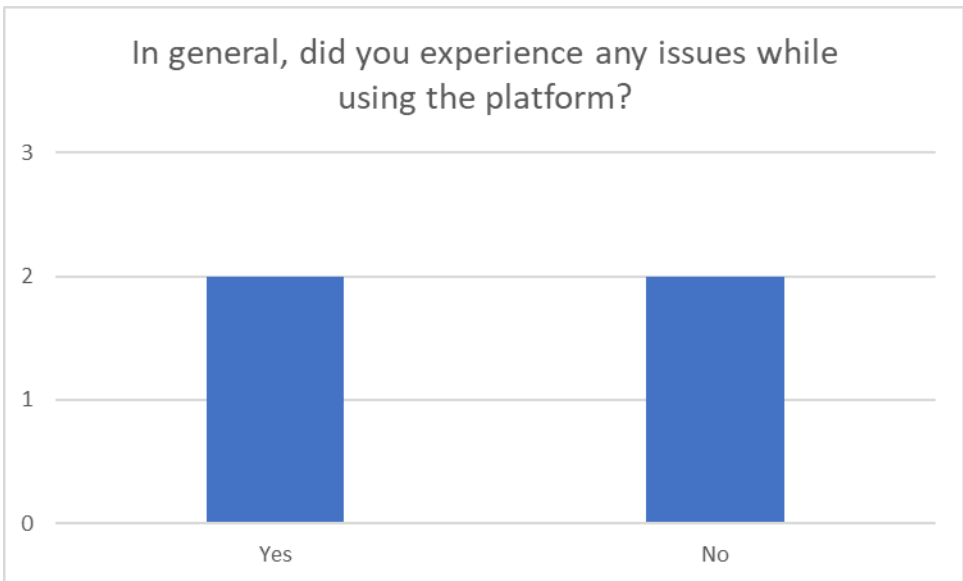
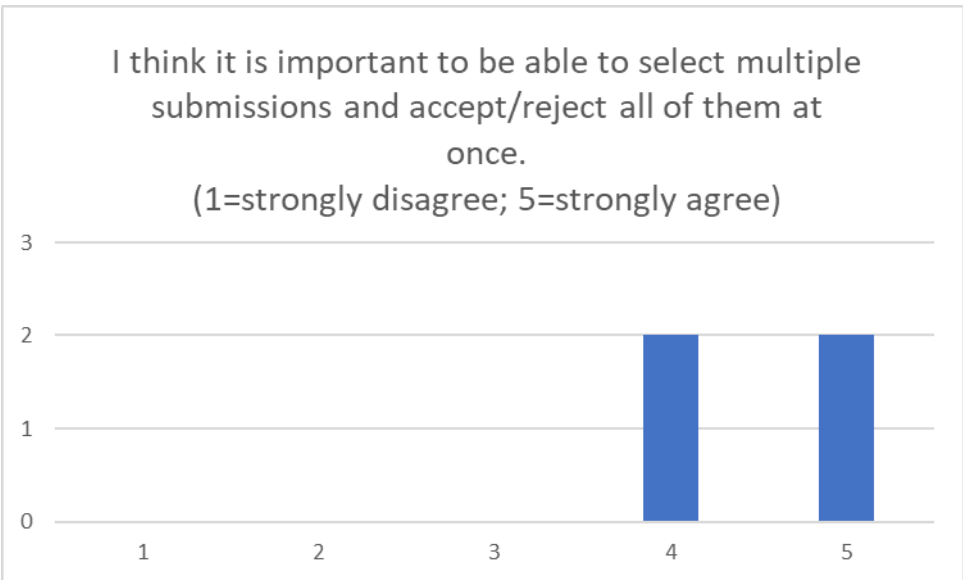
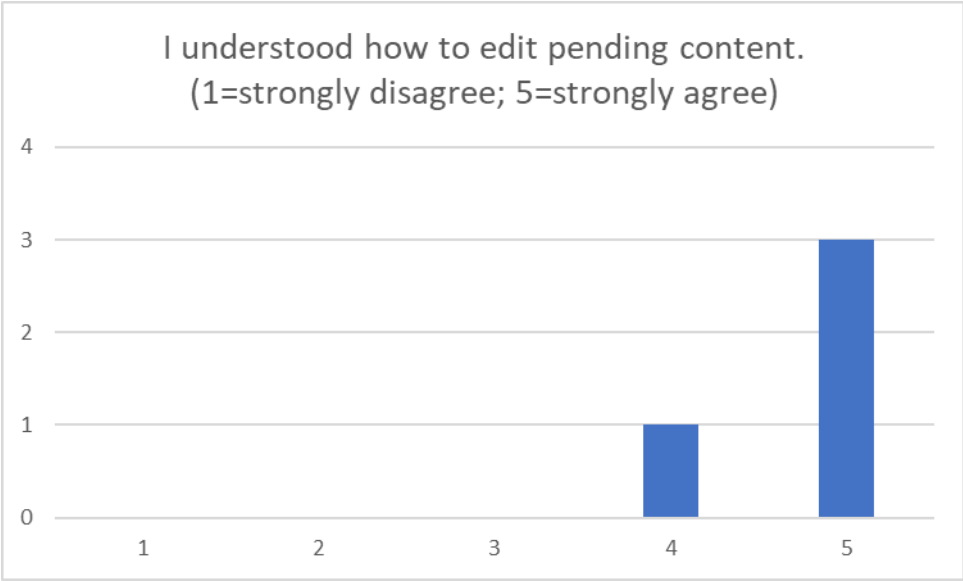












A P P E N D I X



EXPERT EVALUATION ON NEWEST VERSION

Occurrence	Usability Strength	Usability Problem Description	Usability Heuristic(s) Violated	Severity Rating Score
Can not go back to first time user screen	Very visible button	After clicking the button, the user accesses the map but can not go back to the first time user screen. It would be interesting if it was possible.	Visibility of System Status User control and freedom	2
Scrolling in map zooms in and out	Well established map	When attempting to scroll in the platform, if the mouse is over the map it will instead zoom in/out of the map, instead of scrolling the page.	User control and freedom	2
Category filter icons need labels	-	The icons for the different categories can cause confusion as user interpretation varies, they should be labelled.	Recognition rather than Recall	3
Timeline is unclear	-	The timeline's functionality is unclear, specially the circles at the start and end of it.	Visibility of System Status	3
Language only affects some elements	-	After changing the language, only some elements were affected.	Consistency and standards	1
Feedback after submission	-	After submitting content, instead of remaining in the same display, an option for "Would you like to submit another [photo]?" would be interesting.	Flexibility and efficiency of use	1
Confirmation for user submission	-	When submitting content, if the user has filled in fields, a confirmation dialog should be displayed when trying to go back or cancel the action.	Error Prevention	3