FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Development of a Virtual Tour Guide Mobile Application

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Abstract

The tourist industry has been significantly expanding in recent years, putting strain on cities all around the world. Smartphone usage increases daily, making them an object that people take with them everywhere they go. Consequently, a tourist's journey may be easily incorporated with their smartphone.

Searching and grouping destination relevant attractions and activities included in the travel and tour planning is part of the preparation process for a trip. Many mobile tourism applications have been developed for tour planning. Travellers' plans and tourism experiences are changing due to these mobile tourism applications.

This research aims to assist people who want to learn more about a city but cannot book a guided trip or who want to plan a journey ahead of time by using a previously virtual guided experience.

Due to the global pandemic situation it becomes mandatory to prioritise social distancing and taking a complete virtual tour is a safe and wondrous option as there is no contact and can be a cheaper alternative.

The work focuses on finding what is missing in the tourism applications market and developing a system that allows one type of user to create activities and another group to experience them asynchronously through interactive narratives.

This system consists of two interfaces with a set of guidelines to assist in the creation of a fun experience. The first interface is directed for tourist guides to create routes in a specific location so that others can visit using only this application. The second is for guided visits: viewing routes, unblocking points of interest using GPS, viewing content created by the Tourist Guide, and the ability to leave comments on the visit.

A set of tests were built to assess the prototype's functional requirements, notably the trip creation process.

The findings were favourable, and the target audience validated the solution's beneficial impact and their desire and enthusiasm to use it. We feel that our approach will aid cities in attracting tourists by improving their experience.

Keywords: Tourism, Smartphone, Mobile Application, Mobile Tour Guide

Resumo

A indústria do turismo tem vindo a expandir-se significativamente nos últimos anos, colocando tensão nas cidades de todo o mundo. A utilização de smartphones está a expandir-se diariamente, tornando-os num objecto que as pessoas levam consigo para onde quer que vão. Como consequência, a viagem de um turista pode ser facilmente incorporada com o seu smartphone.

A pesquisa e o agrupamento de atracções e actividades relevantes para o destino incluídas no planeamento da viagem e do tour faz parte do processo de preparação de uma viagem. Muitas aplicações de turismo móvel têm sido desenvolvidas para o planeamento de viagens. Os planos e experiências de turismo dos viajantes estão a mudar como resultado destas aplicações móveis de turismo.

Esta investigação visa ajudar as pessoas que querem aprender mais sobre uma cidade mas não podem reservar uma viagem guiada ou que querem planear uma viagem com antecedência, utilizando uma experiência guiada previamente virtual. Fazer uma viagem virtual completa é uma opção segura e maravilhosa, uma vez que não há contacto e pode ser uma alternativa mais barata.

O trabalho concentra-se em encontrar o que falta no mercado de aplicações turísticas e no desenvolvimento de um sistema que permita a um tipo de utilizador criar actividades e a outro grupo experimentá-las de forma assíncrona através de narrativas interactivas.

Este sistema consiste em duas interfaces com um conjunto de directrizes para ajudar na criação de uma experiência divertida. A primeira interface é dirigida a guias turísticos para criar percursos num local específico, de modo a que outros possam visitar utilizando apenas esta aplicação. A segunda é para visitas guiadas: visualização de rotas, desbloqueio de pontos de interesse utilizando GPS, visualização de conteúdos criados pelo Guia Turístico, e a capacidade de deixar comentários sobre a visita.

Foi construído um conjunto de testes para avaliar os requisitos do protótipo desenvolvido, nomeadamente o processo de criar uma visita guiada.

Os resultados foram favoráveis, e a validação com o público alvo validou o impacto benéfico da solução, bem como o seu desejo e entusiasmo em utilizá-la. Sentimos que a nossa abordagem ajudará as cidades a atrair turistas, melhorando a sua experiência.

Palavras-chave: Turismo, Smartphone, Aplicação Móvel, Guia Turístico Móvel

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My academic career comes to an end with this dissertation. These years have been full of learning opportunities and beautiful memories. Here are a few people I'm grateful to for supporting me in getting this far.

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Inês Marques

"I know I was born and I know that I'll die...
The in between is mine."

Eddie Vedder

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Abbreviations

API	Application Program Interface
POI	User Interface
SDK	Software Development Kit
APP	Application
GPS	Global Positioning System
UI	User Experience
UX	User Interface
SUS	System Usability Scale
UEQ	User Experience

Chapter 1

Introduction

Contents

This chapter introduces the dissertation's scope. The context around the issue of this dissertation, namely tourism and guided tours, is described in Section 1.1. Section 1.2 discusses the motivation for this project and the primary objectives that should be met are present in Section 1.3. Finally, the section 1.4 lays out the framework for the rest of the document.

1.1 Context

The tourism sector is critical to a country's economic development since tourist spending influences many areas, including housing, restaurants, culture, and retail. As a result, there is a need to nurture and promote inbound tourism. Porto is one of the most popular cities to visit in Europe. It is a fascinating city with an extensive history, a rich collection of cultural attractions and captivating tourist attractions. Tourist arrivals are increasing year after year. It is a requirement that a product's innovation and creativity be increased.

This study aims to help people who want to learn more about a city but can't afford to book a guided tour or who want to plan a trip by using a previously virtual guided experience. Because there is no physical contact and it can be a cheaper alternative, taking a complete virtual tour is a safe and fantastic option.

This project is relevant because it is an integral part of making guided tours secure to make everyone as safe as possible during the current pandemic. It becomes, therefore, essential to invest more and more in applications more focused on filling the gaps in the tourism area. Each tourist feels comfortable, motivated and has more support to visit the city.

1.2 Motivation

The tourism sector is one of the most critical sectors in Portugal. It is recognised as one of the top tourist destinations globally and has received accolades in a variety of areas. According to Portugal's Statistical Yearbook, in 2019, the tourist accommodation establishments registered 27.0 million guests. These visitors stayed in hotels for an average of 2.6 nights (for a total of 69.8 million overnight stays), generating 3.2 million euros in revenue. [7]

At the same time that tourism is reaching new heights, smartphones have become increasingly important in general and tourism in particular. [9] The various characteristics of smartphones, such as GPS and Bluetooth, have already enabled the development of some highly intriguing apps that assist tourists in tourism-related situations, such as museum visits or hiking. The tourism business is evolving at the same time as smartphone capabilities. New features can provide travellers with novel and fascinating ways to receive services.

One of the reasons why smartphones have become so popular in tourism is their capacity to assist travellers at every stage of their journey, particularly while on the road and within the destination, where other gadgets fall short. Given that mobile applications are becoming increasingly popular worldwide, particularly in the tourism industry, there is room for innovation and new ideas.

1.3 Objectives

The main objective of this dissertation is to create a tourist-oriented mobile application that functions as an anchor for travellers as they move around their destination, easing their overall visit. This concept can be transformed into a two-part aim. The first one is regarding creating touristic routes in a specific location so that other people can visit only using this app. The second portion is about touristy leisure while consuming the previously defined paths, emphasising the places they would see or experience, such as museums or landmarks.

The application aims to provide experiences centred on exploring touristic points of interest to its users.

Furthermore, it also aims to evaluate the developed application's usability and user experience and design guidelines for mobile applications that connect Tour Guides with visitors in Porto.

The primary goal of this thesis is to provide a user interface for the mentioned system while meeting the following steps:

- Designing a user interface for a mobile tour guide that meets the specifications.
- Develop a prototype for an Android mobile application that is functional, simple, useful, and enjoyable to use.
- Test the system and evaluate the results obtained.

1.4 Document Structure

This document has six further chapters in addition to the Introduction, Chapter 1, with the following structure:

The definition, explanation, and related works in the fields of the concepts on which the project is founded are presented in Chapter 2. It will also provide instances of various mobile applications that include touristic guides and are related to tourism.

Chapter 3 discusses the research design and methodology used in the study. The samples and their characterisation, the instruments and techniques used to acquire and acquire and analyse data.

Chapter 4, Requirements Elicitation, refers to the process of elicitation and the analysis and requirements that result from it.

Chapter 5, Application Development, shows the growth of each primary design concept of the application, from the earliest sketches to the implementation phase, the architecture of the application, and gives a solution aimed at solving the challenge outlined in this dissertation.

In Chapter 6, all of the tests that were conducted and the results that were obtained are reported. The validation procedure and analysis of the results are demonstrated in this chapter, Usability Testing.

The Chapter 7 concludes with a summary and evaluation of the work done thus far, as well as potential constraints and future work.

Chapter 2

State of the Art

Contents

This chapter discusses the current state of the project's areas. The context of this chapter is described in Section 2.1. In Section 2.2 a review of current studies and applications of this scope is shown. Section 2.3 offers comments on some mobile applications aspects. Finally, the Section 2.4 summarises the chapter.

2.1 Introduction

Leisure tourism can be focused on beaches and resorts, or, in the case of urban tourism, it can be more about experiencing the city and its attractions. The latter entails a significant increase in travel time between points of interest.

Cell phones have evolved from a simple communication device to an operational tool that, thanks to their functionality, has become the focus of many businesses. Users may enjoy a whole new and rich navigation experience thanks to advances in mobile technology, faster data access, and more interactive cell phone interfaces. For users, a fresh and rich navigation experience has been created. The rise of mobile applications, which have been developed in abundance in the recent decade for both IOS and Android systems, is one of the critical drivers of this phenomenon. [14]

Information systems have evolved to mimic the services provided by tourism agents, which include making vacation recommendations to travellers based on their budget and time constraints. [23]

This section will concentrate on tourist patterns and mobile tourist guides.

2.2 Mobile Tourist Guides

2.2.1 Studies

The tourism industry has always been one of the most adaptable sectors. The increased mobility of tourists, who use mobile devices, necessitated the adaptation of tourism product and service distribution and redirection to the mobile environment. Smartphone apps and other similar technologies now significantly impact supply and demand in the tourism industry. The Internet is heavily used before, during, and after the trip to connect and inform interested parties. Consumer behaviour has changed due to online reservations, payments, tourist information searches, and experience sharing. [16]

Some studies have been made in this scope.

The design, development, and feedback from the initial trial of the Taeneb City Guide project generating tourist information software were detailed in the paper "Design and development of Taeneb City Guide - From Paper Maps and Guidebooks to Electronic Guides", published in 2004. It attempts to build on the existing literature by concentrating on three primary features: (1) a queryable dynamic map interface, (2) dynamic information content, and (3) community review systems and users' forums.

One of the critical elements of this project is a review system that allows tourists to privately or publicly rate attractions. They might give attractions a rating on a scale and leave a comment. These ratings have been vetted to ensure that travellers only see reviews from other travellers who share similar demographic profiles.

The Taeneb City Guide's user interface was created with two primary views: a "Map View Display", figure 2.1, and a "List View Display", shown in figure 2.2. These two views depict maps and guidebooks, the two most common types of tourist literature. [8]

Figure 2.1: Map View Display

Figure 2.2: List View Display

The tourism industry's promising development prospects and mobile technologies' broad and profound impact on people make understanding consumer behaviour related to smartphone use for tourist information search more than justified. [20] The most common features of mobile tourism apps include:

- Live tracking, with the use of robust geographical location sensors such as:

  - the well-known GPS (Global Positioning System), which uses longitude, latitude, and altitude to calculate the receiver's position;
  - Accelerometer recognises the dimension and direction of a moving device;
  - The gyroscope provides the same information as the accelerometer but with more precision regarding the mobile's orientation and rotation.

- Destiny details: most tourism apps offer details of the tourist locations such as the weather and tourist attractions;

In 2013 an interactive mobile tour guide application with the intuitive idea of replacing the standard tour guide booklet was developed in Sri Lanka. Virtual tours of major locations, voice-based information provider, location identifier, and a map-based path selection function to identify the optimal path to a specified destination within the premises are among the app's main features. Creating a Location-Based Tourist Guide Application is a GPS-enabled travel app that allows users to take a self-guided tour of a given place. It also provides precise information on specific features associated with their current location. The mobile application and the webserver are the two primary components of this system. The mobile application receives the saved data from the webserver. The Global Positioning System (GPS) data is used to give the mobile device position information. When map-based services are necessary, "Google Maps" is used. [19]

An article about "Usability Guidelines for Designing Mobile Tourist Apps" recommends that tourist guide applications include at least the following features: listing POIs (Points of Interest), displaying POI information, picking a language, displaying a map, working offline, and displaying a visitor's current location. Other suggestions include showing relevant and complete information about POIs, such as opening hours and entrance rates; displaying many POIs on the map and their distance from the visitor; and avoiding displaying commercial and tourist information at the same time. [10]

iTravel is a mobile peer-to-peer recommendation system and virtual mobile guide prototype that uses other tourists' ratings and mobile peer-to-peer technology to recommend sites. Due to sporadic internet connections and costly roaming charges, mobile applications that communicate with a distant server might be difficult for visitors on the go. The proposed mobile tour guide intends to: "provide mobile users effortless and inexpensive means for exchanging ratings about attractions and makings effective attraction recommendation.". [21]

2.2.2 Mobile Applications

A tourist guide is the tour leader who assists tourists in planning routes and providing logistical support. As a result of technology evolution, self-guided tour apps are created.

Traditional paper-based tourist guides have the disadvantage of being difficult to navigate. The majority of today's mobile tourist guides are location-aware. [12] [17]

MTrip makes suggestions based on a user's travel choices, available time, and location. MTrip is a mobile travel app industry leader with a unique set of solutions for the travel and tourism sector,

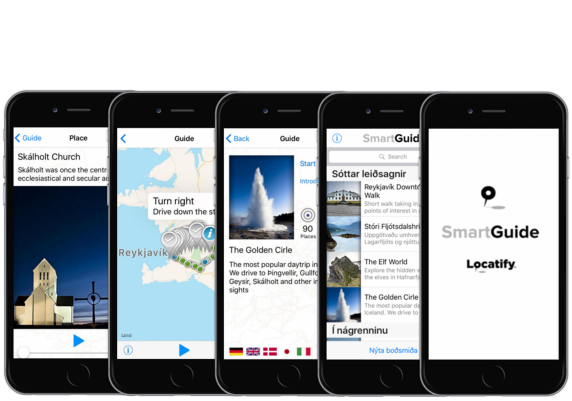
with a track record of assisting customers in protecting and sustaining higher income, customer happiness, and visibility. Customised solutions for tourist boards, DMOs, CVBs, hotels, tour operators, OTAs, travel agencies, and publishers are part of mTrip's varied portfolio. [3]

ReRex is a mobile trip planning tool that recommends points of interest (POIs) to users. To make its recommendations, it uses criteria impacting context-aware recommendations as defined by the user. Second, aid in the design of a thorough itinerary and its adjustment in response to situations and events that arise during the itinerary. The user might, for example, request recommendations for a specific situation. The program displays the predictive model's suggestions and justifies them with a clear and straightforward explanation of why an item is recommended in that particular scenario. [5]

Tripadvisor is one of the most popular tourist-related smartphone applications presently. It recommends hotels, restaurants, attractions, and activities based on various criteria (e.g., proximity and ratings). It also has certain trip-planning tools, such as bookmarking destinations in a designated trip folder. [22]

While these apps and other comparable options provide individualised recommendations, they are still significantly different from an in-person tour with a tour guide. Next, some mobile applications with more realistic tour guide features are presented.

Locatify SmartGuide is a software development company specialising in location-based mobile apps. Tourist offices, event planners, and educators can use Locatify to publish audio-guided tours, treasure hunt games, and itineraries to their own branded smartphone app. Location detection is possible in both outdoor and indoor environments.



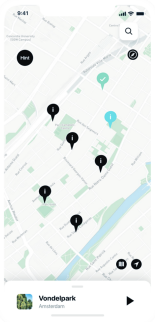


Figure 2.3: Locatify SmartGuide Screens

Locatify SmartGuide tours are created using the Creator CMS and then published to an app that uses maps and location-based technology to provide contextual information about users' surroundings.

The Locatify Creator CMS® is a simple content management system that allows you to create and publish location-based content to mobile apps. The system is a feature-rich cloud-based software tool that can be accessed via a browser. All Locatify apps are integrated with the Creator CMS®, allowing real-time app content updates. GPS, BLE Beacons, Ultra-wideband (UWB), Google Maps, Open StreetMaps, and Custom Maps are integrated into the Creator CMS. [2]

Tours can be downloaded to a mobile device and used at any time, either on-site or as virtual guides from the comfort of one's own home. Some features of this app are:

- Multimedia tours include audio, text, images, and video;
- Navigation supported by Google Maps and GPS;
- Audio narrations automatically play when the user reaches pre-defined locations;
- It can be enjoyed offline, after downloading a tour;
- Advertise local businesses or destinations;
- Social Media sharing integration;
- Custom Maps & Pins provide a unique user experience while also monetising the app by placing ads for cafes, shops, and other points of interest.

GyPSy Guide is an audio tour application for beautiful drives and road excursions. Thi app determines the user's location by using a free GPS signal provided by satellites and the GPS chip in the mobile device. Then the commentary begins to play automatically. The GPS will trigger audio points along the tour route, giving the feeling of being on a guided tour. [1]

- The app works Offline;
- History and Stories about the Destination;
- Multiple Tours;
- The freestyle nature of GyPSy Guide tours allows travellers to take the tours in different directions.

2.2.3 Features

This section represents the set of essential features gathered from the literature review.

FEATURES FOR TOURIST	FEATURES FOR TOUR GUIDE
Listing Points of Interest	Create multiple routes
Displaying Points of Interest information	Advertise local business
Save Point of Interest	Add Points of Interest information
Download Tours for offline use	Add audio guided tour
Change tour destination	

Table 2.1: Summary of features

2.3 Mobile Applications

A mobile app is a piece of software designed for use on small, wireless computing devices like smartphones and tablets rather than desktop or laptop computers.

2.3.1 Types of Mobile Application

If we categorise mobile apps based on the technologies used to create them, there are three primary types.

Web-based apps (responsive versions of web pages that function on any mobile device or OS because they're provided through a mobile browser) and native apps (made particularly for a specified platform) are the two types of mobile apps. Hybrid apps are the third type of software that incorporates native and web apps features.

2.3.2 Design

The interface design has gotten a lot of attention from user functional requirements to aesthetic criteria; the tourism and life service app gradually focuses on a more appealing user experience.

UX/UI design is a relatively new field that focuses on creating an aesthetically beautiful interface (UI) while also including the best possible user experience (UX), hence improving usefulness and simplicity of use. [11]

UX refers to all users' interactions with a product, whereas UI refers to the visually pleasant interface component. Because UI design is subject to changing trends and tastes, it's critical to develop foundational rules that stand the test of time. [13]

The design of an interface is an essential aspect of developing a product. People have proposed new standards for the interface design of Internet items as technology continues to expand and update. The strategy to achieve a good user experience for the self-guided tour app interface design is to match customer needs, emphasise the interactive interface, and boost user emotion. A product's design is created through the collaboration of numerous departments, including human-computer communication and the sensory experience of visual design. Material UI, Google's design language, was developed and made available to any designer.

2.3.3 Technology

Technologies designed for both platforms, e Android and iOS, are employed in cross-platform development. Two of the most promising may be identified: Facebook's React Native (based on js) and Google's Flutter (based on Dart). [18]

2.3.3.1 React Native

React Native is an open-source framework that uses React and the app platform's native features to create Android and iOS apps. We utilise JavaScript with React Native to access the platform's APIs and describe UI's appearance and behaviour using React components, which are reusable, nestable code bundles. React Native comes with a set of essential, ready-to-use Native Components. It is based on Facebook's React JS library for creating user interfaces.

Popular apps, like Facebook and Instagram, use ReactJS.

2.3.3.2 Flutter

Flutter is an open-source UI software development kit from Google that allows you to create attractively, natively built apps for Android, iOS, Linux, Mac, Windows, Google Fuchsia, and web embedded devices with a single codebase. Typically much faster than native development. The lack of platform constraints is Flutter's main advantage over React Native.

Reflectly [4] is an example of a React Native app that was built from the ground up. Using this technique, the team developed it for iOS. When they planned to launch the Android app, they ran into a difficulty. Because of the app's immense popularity, they decided to redesign it in 2018 entirely. They went with Flutter, which was ideal for the job. They rebuilt their app in two months and made it available on Android and iOS. In May of this year, a new version was released.

2.4 Summary

Mobile tour guides have evolved into more automated and tailored apps that adapt to the user's demands. They're all attempting to improve the travel experience by utilising the unique properties of mobile phones to meet passengers' expectations for immediate access to relevant and tailored information, anywhere and at any time.

When it comes to graphical interfaces and user experience, most of the apps generated in these studies are visibly older and have grown outdated.

Commercial successes like TripAdvisor have raised the bar for what may be expected from this sort of software. This prototype will give a new user interface and experience that can compete with commercial apps.

This dissertation stands out from these existing applications in the creation of tourist routes.

The interest in existing application features is evaluated in chapter 4.

Chapter 3

Methodology

Contents

This chapter formally describes the purpose of this work and the method used to arrive at the suggested solution. The overall overview of the proposed solution is described in Section 3.1. The development of the solution will be approached as described in Section 3.2. Finally, in Section 3.3, the themes discussed in this chapter are summarised.

3.1 Solution

This dissertation presents a prototype of a tourist-oriented mobile application. Users can have two roles: as a tourist or as tour guides.

The Porto district focuses on this project's efforts because of the enormous number of tourists it receives each year. Nonetheless, the project's ultimate purpose is to demonstrate that a system may be developed to help alleviate the unintended consequences of tourism in any given place.

The dissertation's planned outcomes include the creation of a usable and dependable app functional from mobile devices.

3.2 Methodology

To achieve the proposed solution, a user-centered methodology was followed. A thorough awareness of the user's needs and the task at hand. User feedback is used to determine needs.

3.2.1 Requirements Elicitation

After doing the initial study and reviewing the literature, a concept of functional and non-functional user needs is established. This analysis of the research on the advantages and disadvantages of mobile tour guides, as well as the selection of a sample of studies to study in greater depth, assisted in identifying any gaps in existing research and suggesting areas for future research.

An initial step should include a requirements elicitation assembling a focus group with potential application users. A questionnaire of Google Forms, with potential users, was created to understand tourists' issues and interests better. The questionnaire was distributed to the University of Porto community and friends via social media and dynamic email. A total of 118 people populated it.

3.2.2 Prototype

The design process begins after defining requirements, which consists of creating sketches. These sketches are more concerned with visual organising and content sharing than design aesthetics.

The second iteration began with creating high-fidelity prototypes, realistic representations of the final product. This stage entails creating a set of instructions for maintaining system uniformity, such as font and colour palette defining.

The final prototype is a working app created with Flutter; a user interface software development kit. User testing and evaluation were conducted on this last iteration.

3.2.3 Usability Testing

Usability tests evaluated the product and ensured that it met the users' needs and expectations. This type of test aims to determine how the user completes predefined tasks and to identify usability errors.

Usability tests are frequently conducted to assess and improve the usability of a project. A usability test is a valuable method for evaluating the usability of a user interface, in which the effectiveness of the user interface is assessed. Changes can be made to the interface and interaction of the project based on the findings of that evaluation. Usability testing is required for this project to include users in the evaluation process of the designed interface. Throughout the development period, these tests should be carried out to improve the proposed interface by observing and asking potential users.

3.3 Summary

The solution offered by this dissertation, a tourist-oriented mobile application, is shown in Section 3.1. This mobile application intends to address unresolved issues in tourist guided tours and serve as a lifeline for travellers visiting their desired destinations. In Section 3.2 methods used is described in detail. There were three stages to this process: requirements elicitation, prototype, and evaluation. The requirements were established based on a review of the literature and a survey

distributed to many potential consumers. The prototype was the suggested solution's minimum viable product version. The evaluation was based on usability tests.

Chapter 4

Requirements Elicitation

Contents

This chapter will discuss the initial elicitation of usability requirements, which is the first stage of the thesis development process. This stage consisted of a questionnaire, Section 4.1, where each section outlines the survey's goals, target demographic, number of participants, how these surveys were sent out to be completed, and provides an analysis of the responses given to each question, as well as an overall analysis with the survey's results, in Section 4.2.

4.1 Questionnaire

The primary goals of the questionnaire were to determine how satisfied users were with the present appearance and feel of various touristic platforms and evaluate the features and tools they would find helpful to be included in these platforms.

The survey was divided into five sections: Demographics, Overall Experience with Guided Tours, Experience with Guided Tours Applications, Features, and Final Feedback.

Each section outlines the survey's goals, target demographic, number of participants, how these surveys were sent out to be completed, and provides an analysis of the responses given to each question and an overall analysis of the survey's results. This survey was created with Google Forms and delivered to all student members of the Faculty of Engineering of the University of Porto by dynamic email and shared with friends on Facebook. One hundred eighteen persons responded. The following discusses some of the points addressed and analyses the findings produced with graphs and the conclusions drawn from the questions posed.

4.1.1 Demographics

The term "demographics" refers to a population's specific features or, in this case, a sample of the population. As shown in Figure 4.1, the questionnaire was answered by almost the same number

of men (50.8%) as women (49.2%), which is positive because it reflects the gender distribution of the population.

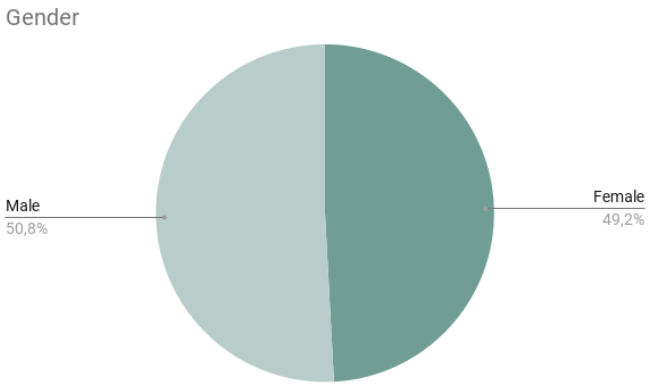


Figure 4.1: Gender of the participants

There is an imbalance in the age spectrum, as shown in Figure 4.2: the majority of the participants are between the ages of 18 and 23. This is because the survey was issued to everyone who works and studies at the Faculty of Engineering of the University of Porto; hence the majority of the respondents were students. Nonetheless, older participants' responses are still present (the oldest being 57).

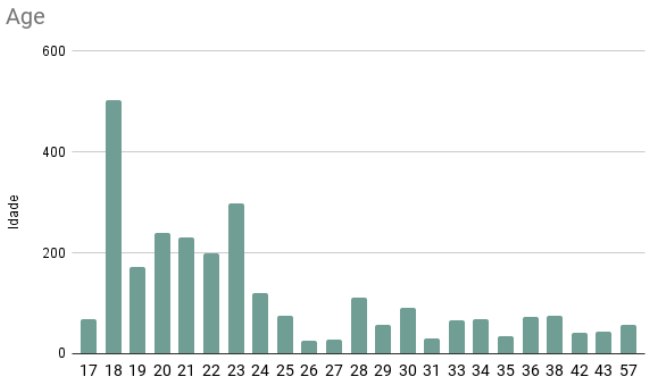


Figure 4.2: Age of the participants

The degree of education of the participants is indicated in Figure 4.3. As can be seen, nearly half of those (44.9%) have a bachelor's degree, while 33.1% have a high school diploma and 21.2% have a master's degree.

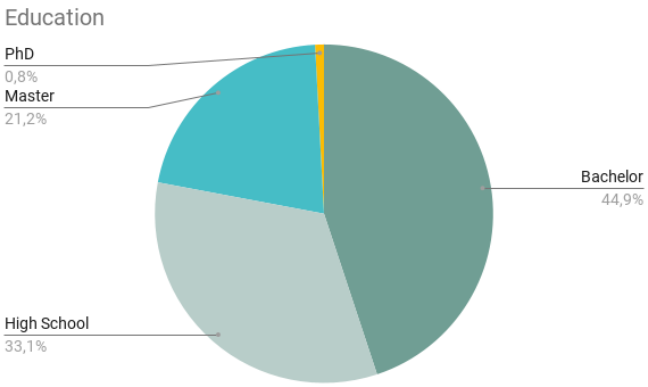


Figure 4.3: Degree of education of the participants

4.1.2 Overall Experience with Guided Tours

This section pertains to the general experience when making guided tours and focuses on the frequency of conducting in-person tours in the current pandemic situation.

The graph chart below 4.4 represents the participants' in-person guided tours frequency, where 1 represents null frequency and five very frequent. Analysing the Figure, most people, 45.8% to be exact, classified the frequency with 2, and 20.3% with 3. More frequent tourists, 5 participants, answered 4 and 1 participant 5.

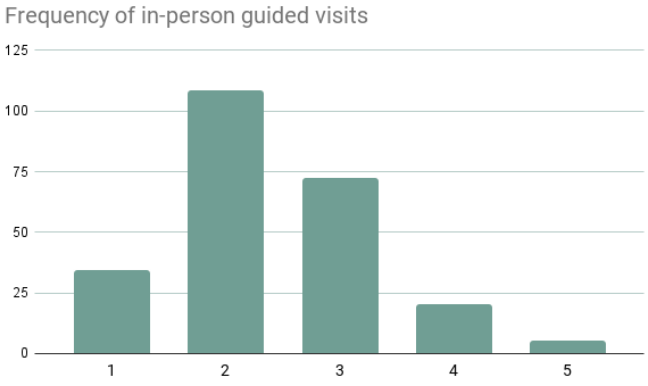


Figure 4.4: Participants frequency of in-person guided visits

The following graph chart 4.5 shows that With the current global pandemic state, most people in-person tours experiences has decreased. Approximately 91.5% of the participants state they don't conduct many guided tours, while only 8.5% affirm they disagree.

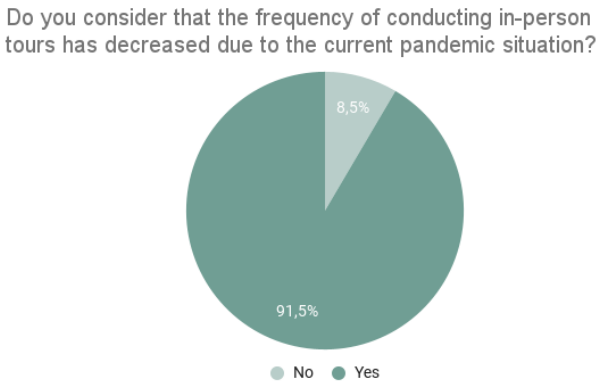


Figure 4.5: Decrease in frequency of tours due to the current pandemic situation

4.1.3 Experience with Guided Tours Applications

To understand if the participants have had any experience with virtual guided tours, the question "Do you know of any application that allows virtual tours?" seemed important, seeing as it would give an idea of the current market. As shown in graph 4.6 94.5% of the group does not know any application that allows virtual tours, and only 6 participants answered 'Yes'.

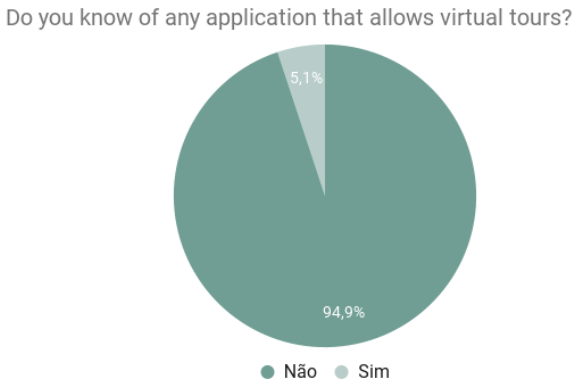


Figure 4.6: Do you know of any application that allows virtual tours?

Following the upper question, participants were asked to name the apps they knew. Only 4 participants answered, which is not surprising since only six know of any guided tours application. The answers were "Google maps", "Website used in the Alcazaba in Málaga; automatic Aúdioguia in Ghent Castle", Zoom and one participant couldn't remember the name but affirmed that they had used a platform in museums.

For the complete answers to this question, go to the B.1 subsection in the B Appendix section.

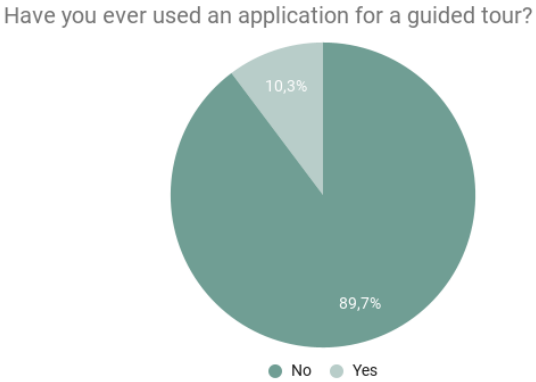


Figure 4.7: Have you ever used an application for a guided tour
?

The following graph, 4.8, demonstrates how the participants rated their interest in using an application with the goals discussed previously. The outcome was positive has 63.5% of the studied group showed interest (>3), 24.6% rated three on the scale given, 6.8% answered 2 and 5.1% had no interest and selected option 1.

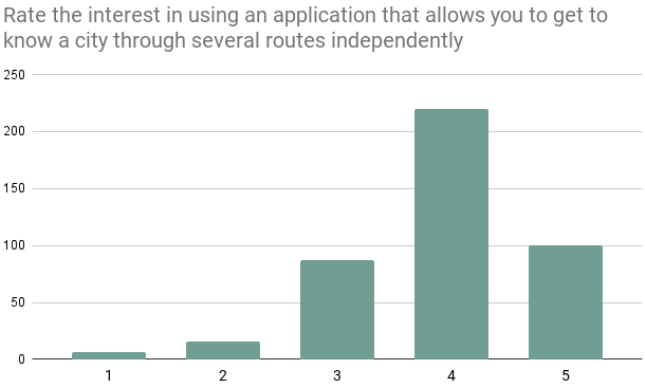


Figure 4.8: Interest in the application

4.1.4 Features

To understand which features would be essential and attractive to users, the participants were asked to choose from a list of options, gathered during the literature search, what feature(s) they would find helpful to be included in these platforms.

- Audio - **66.9%**
- Video - **55.9%**
- Offline Use - **55.9%**
- Navigation supported by Google Maps and GPS - **79.7%**

- Audio narrations automatically played when the user arrives at a location - **42.4%**
- Easy route change - **65.3%**
- Points of interest listing - **88.1%**
- Guided tour evaluation - **30.5%**

An open text box was also added for any additional features, and 4 participants gave the following answer, each:

- "Creating routes, points of interest, and even sharing of experiences along the lines of the physical activity app "Strava"
- "VR support"
- "Listing of transportation routes to the tourist destination"
- "Audio narrations available when the user arrives at a location"

One of the most questionable requirements in the app's future development was if the user interfaces with the consuming route role and the guide creator user interface would be connected or have altogether distinguished accounts. The following graph shows the participants' interest in taking on the role of a guide and creating tour routes in the application. Half of the participants didn't show interest in developing the routes, 38.8% were indecisive, and 11.2% answered 'Yes'.

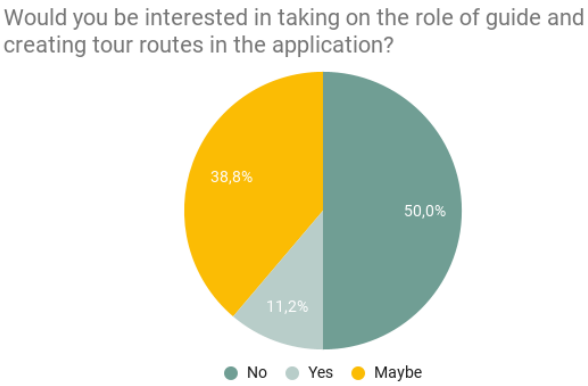


Figure 4.9: Interested in the guide role

The last question of this section was about monetary contribution. For this question, the income of questionnaire participants plays a big part, as most are students with no financial independence. When asked if the participant were willing to pay to enjoy a virtual tour, 54.2% answered positively, and 45.8% would not, as shown in the graph below.

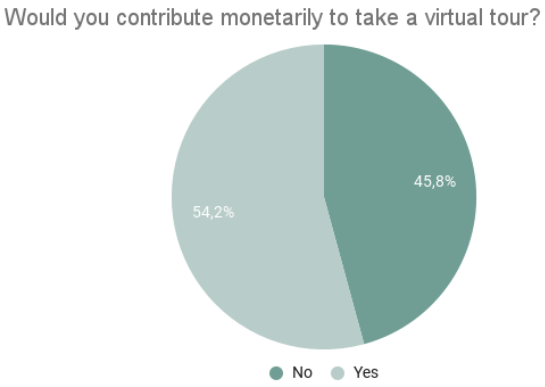


Figure 4.10: Monetary contribution

Looking at Figure 4.11 it's easy to deduce that most participants would pay less than 5€ to use the application, 32.8% answered they would give within 5€ to 10€, 1 participant answered the 10€ to 20€ range and one selected >20€.

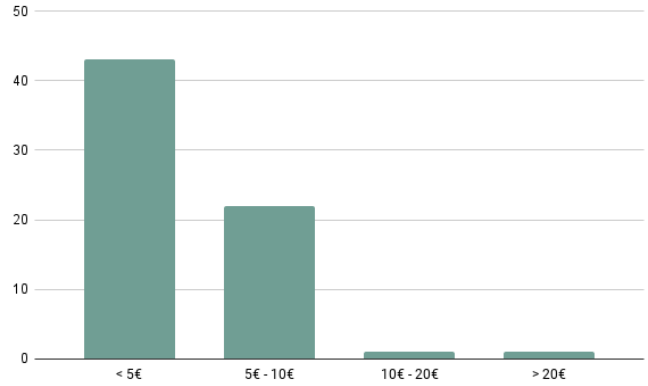


Figure 4.11: Monetary contribution values

4.1.5 Final Feedback

This section is for anyone to add any additional views, feelings, or suggestions that they did not express in the previous questions. Everything they saw, heard, and felt was significant and related to this research.

There were eight responses to this topic, representing various viewpoints and ideas. The majority of people favour the study's applicability being developed.

A few people point out the benefits of free and automatic audio guides, such as how to get to specific locations using public transportation and/or how to combine this with guided tours to examine apartments.

On the other hand, others stated that they don't understand the value of a paid digital tour app and that if it could be made free, they would reconsider their decision because an app allows

them to go at their own pace and not be bound by a schedule. Another disadvantage was that a participant found using such apps tedious and challenging at times.

For the complete answers to this question, go to the B.3 subsection in the B section of the Appendix.

4.2 Summary

This chapter discussed the requirements elicitation process used to define the proposed application's needs. A questionnaire was sent out with pre-established needs that users were asked to rate according to their preferences, based on the original ideas acquired from the literature review.

After analysing preferences and needs by potential users, a list of requirements for the application was defined. All of the aspects grabbed the participants' interest. However, to reduce the scope to the most requested features, it was decided to consider those scored more significant than 60%. The features were incorporated in the order of greatest interest to least interest when designing the app.

Despite the low percentage of participants who said "Yes" when asked whether they were interested in route creation, it was decided to combine the two responsibilities so that those who wish to create can. The app has two parts: a tourist guide and a tourist guide creator.

Chapter 5

Application Development

Contents

This chapter addresses the interfaces proposed for the previously stated solution. This chapter is introduced in Section 5.1, which sets the stage for the information offered in the following parts. The prototypes' major elements and design rules are presented in Section 5.2. The technology used to construct the interfaces are credited in Section 5.3. The developed interfaces are shown and described in Section 5.4. Finally, Section 5.5, the contents of this chapter are summarized.

5.1 Introduction

In the last chapter, we came to a conclusion about the mobile application's requirements that result in a list of features for the app. The prototyping process began with the design of sketches and the creation of high fidelity mockups that considered colour, typography, and aesthetics. The final application development step was actually bringing to life the app from the design and requirements that were created in earlier steps. The developed mobile application is a tourist-oriented GPS-based mobile application that allows travellers to easily find a guided virtual tour, check POI details, and receive directions to the POIs.

5.2 Interface

The functionality of the developed system is described in this section, later on Section 5.4 screenshots of the application to further explain how it works are included. All of the operating system's principles and guidelines were followed, which can be found on the website: https://material.io/design/.

Principles and guidelines for layout, colour, typography, and iconography, among other things, were followed.

5.2.1 Sketches and Mockups

The interface was designed, taking into account the potential users' goals, behaviours, and needs. The sketches and mockups were essential for developing the final prototype. In the first sketches, the goal was to show the idea and the general structure. The focus was on the most relevant functionalities, route creation, and visualisation. It was intended to have a simple and intuitive layout that would simplify the interaction processes with the system.

Following the initial designs, it was vital to consider other essential aspects of the project, such as naming the product, considering its identity, and exploring different chromatic alternatives. For the name, we wanted something simple that would be related to the type of application and the product concept. The name Guideo was selected while doing a wordplay with the word guide. This name was chosen since it may give the user an immediate impression of some of the application's features.

Figure 5.1: App Logo

The mockups were created through Adobe XD. Adobe XD is a vector-based experience design platform that is both powerful and simple to use.

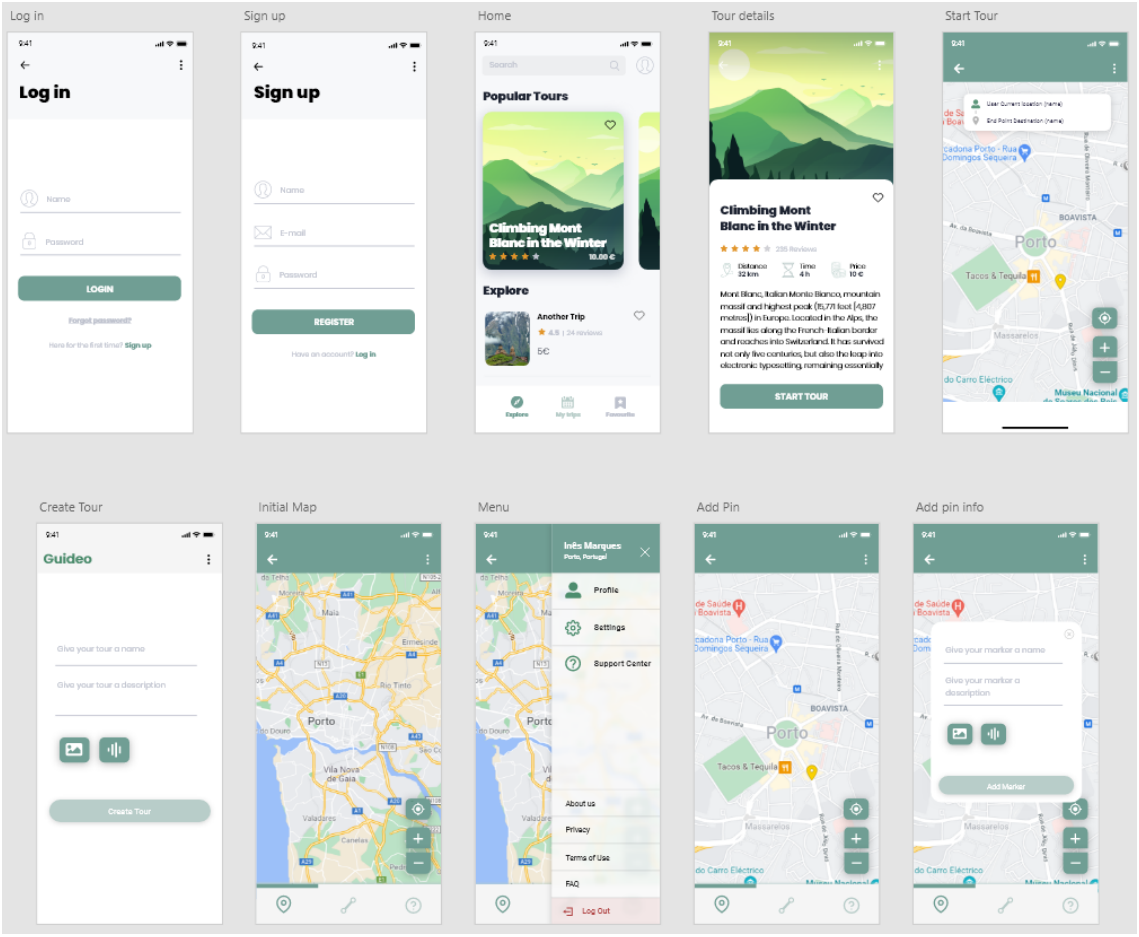


Figure 5.2: Mockups - Adobe XD

5.2.2 Colour Palette

The colour palette used throughout the product's identification can be seen in Figure 5.3. Green tones were always used in the prototype's interface, and the dark green of the logo was the most frequently used tone in the application's interface. The majority of screens have a white background. For the various screens, a consistent chromatic palette was desired, and the colour of the emblem was given additional significance.

Figure 5.3: Colour Palette

5.2.3 Font

In interface design, typography is extremely significant. It is feasible to make content accessible in a clear manner using it. The content of an interface must be easy to read in order for it to be simple to utilize. The Poppins font was utilized, which is a geometric sans serif typeface. With support for the Devanagari and Latin writing systems, it is an internationalist take on the genre. The Devanagari is designed by Ninad Kale. The Latin is by Jonny Pinhorn.

Figure 5.4: Poppins Font

5.3 Technology

Regarding the technology used, a hybrid-app approach was the right one for this project, where benefit from full device access with a lower development cost than native. In this category, the most appealing options were the React Native SDK and the Flutter SDK. Both were strong candidates that are perfectly able to meet our requirements and more, while still providing a good developer experience. The final decision was Flutter SDK, simply according to the desire to learn a new SDK.

5.3.1 Flutter

Flutter, a relatively new SDK from Google for generating cross-platform apps, was used to create the prototype mobile app. It's based on the Dart programming language, which was created by Google as well.

One of the goals for this project was to have access to an offline map. MapBox is a Flutter plugin for this. MapBox is a full-featured mapping SDK with a wide range of tools and features, including offline map compatibility.

5.3.1.1 Widgets

Widgets are the fundamental components of a Flutter user interface. In fact, in Flutter, practically everything is a widget. A widget is an immutable object that represents a specific aspect of the user interface. They're composable, which means you can mix and match existing widgets to create more complex widgets. The primary function of a widget is to implement a build function that explains the widget in terms of other, lower-level widgets.

Because everything in Flutter is a widget, and widgets are connected to form more complicated widgets/screens, some sort of framework is required to keep things organized. Widgets become "parents" and "children" to other widgets in Flutter's widget tree structure.

5.3.1.2 Asynchronous programming

Asynchronous operations allow the program to finish one operation while waiting for another to finish. Asynchronous operations allow your application to accomplish tasks while waiting for another to complete. Stream and Future are two types of streams in the dart:async library that is useful for many Dart APIs. A Stream is a collection of results, whereas a Future represents the result of a single computation.

"Futures," are one of Dart's most basic asynchronous programming APIs. The result of an asynchronous operation is represented by a future, which can be in one of three states: uncompleted, completed with a value, or completed with an error. FutureBuilder is a special widget for working with futures that takes a future and a builder method and rebuilds its children when the future completes.

"Streams" are similar to futures in that they can supply zero or more values and also errors over time. The listen method is used to subscribe to a stream. StreamBuilder is a dedicated widget for working with streams that takes a stream and a builder function. When the stream emits a new value, the child widget is automatically rebuilt.

Last but not least, there's the async/await API. This API is just a different way to use futures and streams that can help you write cleaner, more legible code. Async specifies that a method will be asynchronous, that is, it will not return anything right away, allowing the program to continue working on other tasks while the processing is being completed. Await tells the program that it needs to wait for a response from a function before continuing. This is critical because there are times when the output of one function is dependent on the output of another.

This project made significant use of asynchronous programming. Futures and async / await ensure that the app's speed is not harmed in the event of a thread being blocked, especially when the thread is dependent on hardware (e.g. GPS) or the network.

5.3.2 Firebase

Google Firebase is a Google-backed app development platform that lets you create apps for iOS, Android, and the web. Firebase delivers analytics tracking, reporting, and app issue fixes, as well as marketing and product experimentation capabilities.

The key feature used was the Firebase Realtime Database, which is a cloud-hosted NoSQL database that allows data to be stored and synced in real-time across users. The data is synced in real-time across all clients and is remains accessible when an app goes offline.

5.3.2.1 Cloud Firestore

Cloud Firestore is a versatile, scalable database from Firebase and Google Cloud for mobile, web, and server development. It, like Firebase Realtime Database, uses real-time listeners to keep data synchronized across client apps and provides offline support for mobile and web to allow developers to create responsive apps that run regardless of network delay or Internet access. Cloud Firestore also integrates with other Firebase and Google Cloud technologies, such as Cloud Functions, in a seamless manner.

Cloud Firestore was used to store the application media (images and audio).

5.4 Screens

This section shows the completed mobile app with the main features gathered implemented. The Guideo interfaces were designed to be simple and modern. The interfaces follow a rounded theme, with rounded images, input fields and buttons.

5.4.1 Login / Register

The user should always start by registering in the application. For the following uses of the application, it is only necessary to log in. The login and registration process is quite simple and straightforward, requiring the user to simply enter their credentials (email and password).

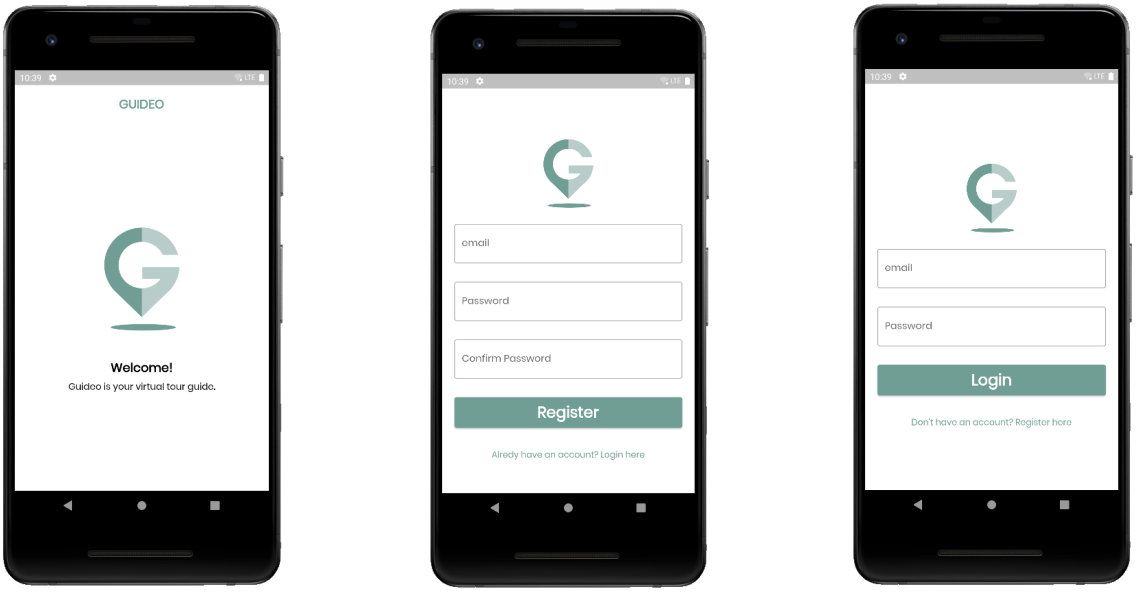


Figure 5.5: Register and Login

5.4.2 Home

The user is redirected to the Home screen after successfully logging in. This is the main screen, which is displayed by default when the app is launched. The user has access to the guided tours through browsing this page. This can be done by searching for tours using keywords in the search bar or selecting one from the popular tours area. This section of popular tours was created to showcase the most rated tours. The ranking system for tours was not implemented. The user can log out of the application by tapping the icon on the top-right corner of the screen.

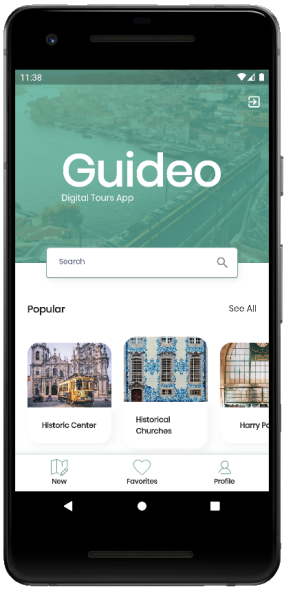


Figure 5.6: Home

5.4.2.1 Bottom Navigation Bar

The screen navigation flow of the application is placed in the bottom navigation bar,Figure 5.7 allowing access to the three screens: New Tour, Favorites, and Profile. In the subsequent sections, we'll go through these in more detail.

Figure 5.7: Bottom Navigation Bar

5.4.3 New Tour

The first stage in creating a tour is to determine what the user's first impression of the tour will be. This page is a form with the following inputs: a catchy title that describes the tour's major subject, a description that entices participants with a detailed explanation of the route and key learnings, and finally, an appealing image.

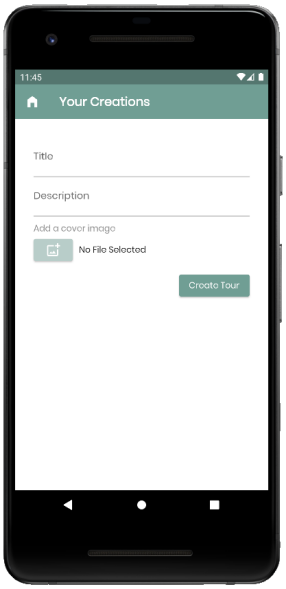


Figure 5.8: New Tour Form

5.4.4 Map

This is the main page of a tour creation. A map where all the points of interest can be added and in the end published using the top bar button "Publish".

The map page opens centred in Porto since this project was oriented around tourism in this city. Google Maps' zoom and current location buttons are available. The first time the map is open permission to make the current user location available is prompted.

Figure 5.9: Map

It was feasible to add maps based on Google Maps data to the application using the Google Maps Flutter plugin. The plugin takes care of accessing Google Maps servers, displaying maps, and responding to user actions like clicks and drags. Additional marks can be added to the map. These objects give the user more information about map places and allow them to interact with the map.

5.4.5 New POI

The points must be included in order to create the tour itinerary. This is done by tapping the screen on the point location and filling out the pin form with all of the required information.

It's recommended to have a complementary image of the recognizable location as well as detailed audio in addition to an identifiable title and description. Both the image and the audio files have their own upload buttons.

"Update" and "Delete" are the last two buttons on the form. The name "Update" was chosen because the form is the same for both creating and editing, and the latter can be accessed by touching the infobox at the top of the map pin. By visiting the edit form and tapping the "Delete" option, all points can be erased at any moment.

The position of a marker can be altered by dragging the pin on the map screen.

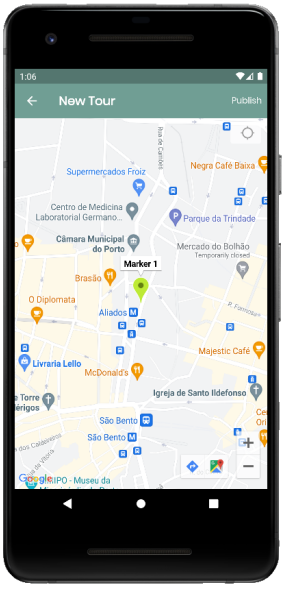


Figure 5.10: Add New Marker

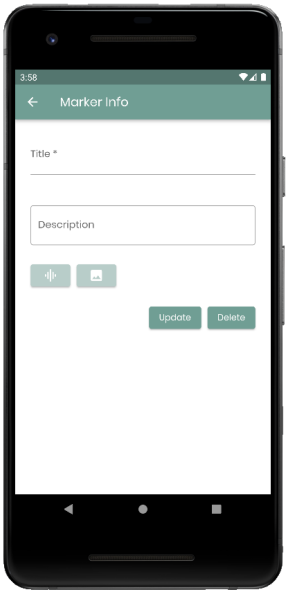


Figure 5.11: New Marker Form

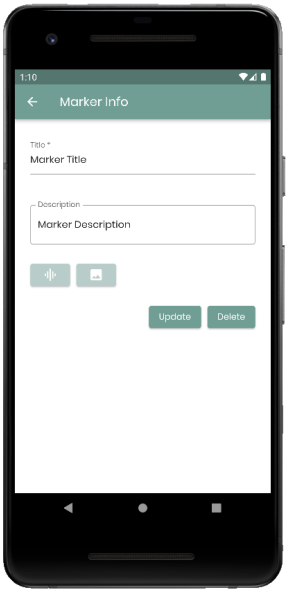


Figure 5.12: Edit Marker Form

5.4.6 Add Image Component

Both to the tour information and marker information can be added an image to identify and complement the information. This image can be accessed in the mobile images gallery or taken by the device camera. For both options, permission is needed on the first use.

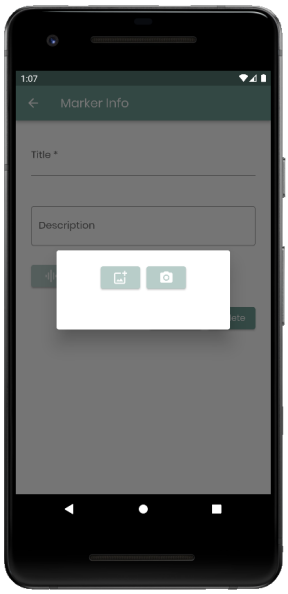


Figure 5.13: Add Image Options

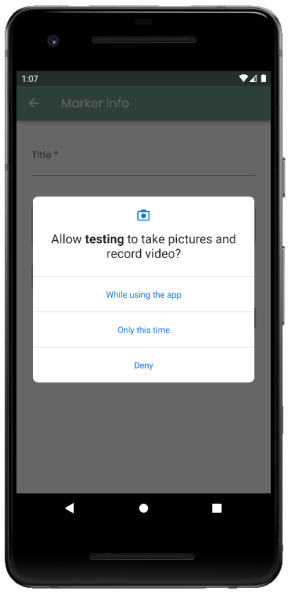


Figure 5.14: Camera Permission

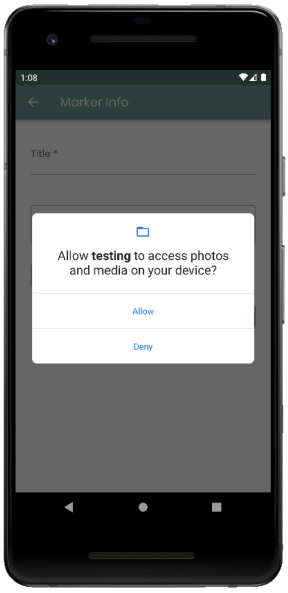


Figure 5.15: Photo Gallery Permission

5.4.7 Publish Tour

The tour is ready to be tested and published once the guide user is satisfied with all of the points. When the user presses the "Publish" button in the top bar, this page appears.

If the user is unhappy with the sequence of the points, he or she can reorder them by dragging the relevant point line to the desired position.

There are two choices: test or publish. To test the user's role will change from creator to consumer of the tour, and a preview of how the project developed will be visible to all app users is shown. If no testing is required, the tour can be made public right away by pressing the second button, "Publish."

Figure 5.16: Publish Page

5.4.8 Tour Details Page

This page is accessed throw the Home Page by selecting one tour. The tour selected can be viewed in full detail on this screen, which allows the user to decide its interest. The rating and price are not functional but were kept visually in order to get closer to the desired end product.

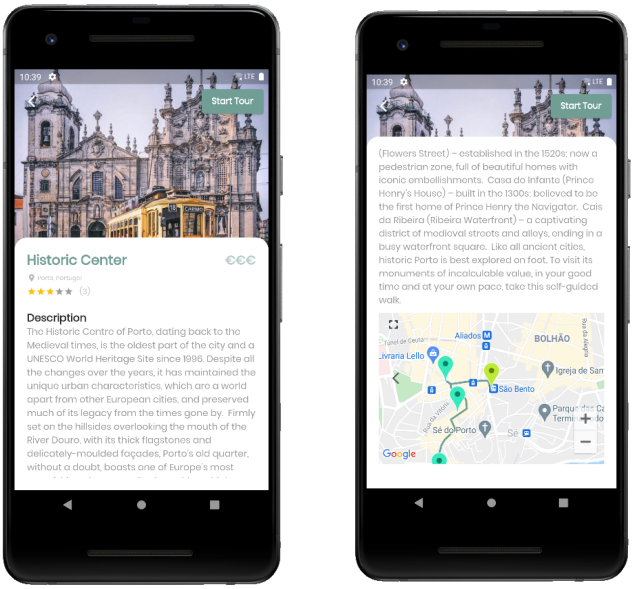


Figure 5.17: Tour Details Page

The user can begin the tour tapping the "Start Tour" button on the top-right corner.

5.4.9 Tour Map

This page is displayed when the user selects a tour and initializes it. A map with the tour stops is displayed, as well as, the line of the route. This route is calculated with google maps route calculator using polylines with the type walking and shortest path options active, The user can interact with the map and with the POIs. The user location is displayed by a blue point, equal to Google Maps app.

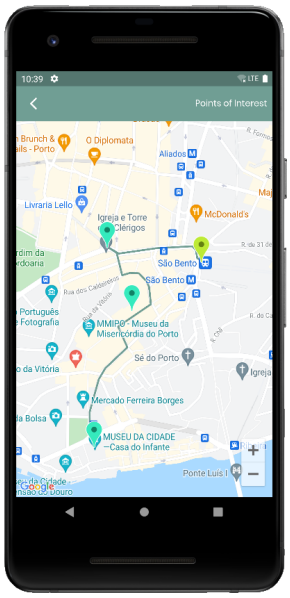


Figure 5.18: Initial Map Tour Page

5.4.10 POIs Interaction

The user has access to the points information by tapping on the top of each or by going to the "Points of Interest" section, clicking on the top nav button. This is a scrollable section that contains all the tour points. The POI page contains the point information, including the description, image and audio added by the tour creator.

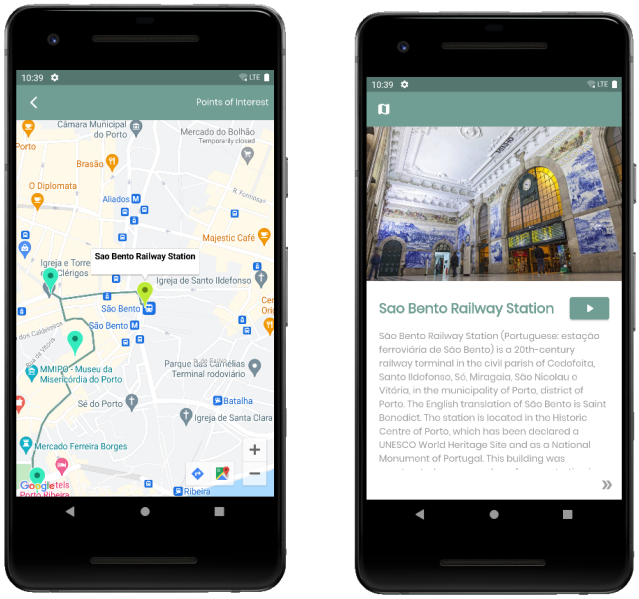


Figure 5.19: Point Information

5.5 Summary

This chapter introduces "Guideo", a tourist's go-to travel companion who serves as a guide. Home, Tour Creation, and Tour Guide are the four main screens of the app's UI. The user can navigate to the different pages from the Home screen. The user interfaces are clean and simple. The usability of the provided software is evaluated using feedback from potential users during usability tests, which are detailed in the following chapter.

Chapter 6

Usability Testing

Contents

The validation of this work is described in this chapter. Section 6.1 introduces the validation approach adopted and discussed throughout the chapter. Section 6.2 indicates the participants profiles that tested the application. The testing tasks are described in Section 6.3. The three steps of usability testing are presented in Section 6.5. Finally, Section 6.6 summarizes what was discussed in this chapter.

6.1 Introduction

Usability testing was used to measure the satisfaction of potential users in this research.

Background questions, the respective tests, System Usability Scale (SUS) and User Experience Questionnaire(UEQ), and interviews were conducted during the usability tests.

To begin, the participants' socio-demographic information was gathered.

The task assessment was the second stage, in which the participants were initially shown the prototype for evaluation. They were given a list of tasks to complete on the prototype.

In the third step, the participants considered the interaction and replied to statements based on the System Usability Scale and the User Experience Questionnaire. Finally, the participants were given a chance to provide some open feedback.

The usability tests were performed in person.

6.2 Participants Profile

The background surveys helped determine some of the characteristics of the test participants. There are 9 participants in the sample, 5 males (62.5%) and 3 females (37.5%). The competitors range from 20 to 25 years old in terms of age. All participants are members of the FEUP community and are highly comfortable using technology and mobile applications.

6.3 Tasks

The participants were asked to perform two sets of tasks on the developed app, the first one has a creator (Group A), and the second has a consumer of the routes created previously (Group B).

The following tasks were presented to **Group A**:

1. Register on the application for the first time
2. Create a new Tour
3. Add 4 Points Of Interest
4. Add an image to at least 3 of the points
5. Add audio to at least 2 of the points
6. Edit 1 POI
7. Delete 1 POI
8. Test the Tour
9. Publish Tour

The following tasks were presented to **Group B**:

1. Search a Tour
2. Select a Tour
3. Get directions and start a trip
4. Go thought the tour and see all the POIs

Figure 6.1: Participant performing the tasks

6.4 Evaluation

User effectiveness, happiness with the product, the number of errors made by the participants, and the amount of aid needed during the contact with the prototype were all noticed during the usability tests. In terms of task efficiency, the time spent by each user was recorded; however, this information is irrelevant because some users preferred to spend more time browsing the application rather than accomplishing the tasks.

Missclicks were only noticed on the task "Edit 1 POI", and help was needed in 50% of the cases.

6.4.1 System Usability Scale

The evaluation then was made with a form where, firstly, the users measured the app using the System Usability Scale (SUS). The System Usability Scale (SUS) is a popular self-administered tool for assessing the usability of a wide range of goods and user interfaces. The SUS's main benefit is providing a single reference score for participants' perceptions of a product's or service's usability.

Participants were asked to rate the following ten things on a scale ranging from Strongly Agree to Disagree Strongly, with five response options:

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 quickly.

8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn many things before I could get going with this system.

The following formula is used to compute SUS's total score:

- For odd items: subtract one from the user response.
- For even-numbered items: subtract the user responses from 5.
- Add up each user's converted responses and multiply the total by 2.5. Instead of 0 to 40, the range of potential values is converted to 0 to 100.

Even though a SUS score can range from 0 to 100, it isn't a percentage but a sum of these new numbers. [15]

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	SUS Score
u1	5	1	5	1	5	1	5	2	5	1	97,5
u2	4	2	5	1	5	3	4	1	5	1	87,5
u3	4	2	5	2	3	3	2	1	3	1	70
u4	4	2	5	1	5	2	3	2	3	1	80
u5	5	1	5	1	4	2	5	1	5	1	95
u6	4	1	5	1	5	1	5	2	5	1	95
u7	5	2	5	5	5	1	5	1	5	1	87,5
u8	4	1	5	1	2	2	4	1	5	1	85
u9	4	1	3	2	5	1	3	1	3	1	80

Figure 6.2: SUS's Results

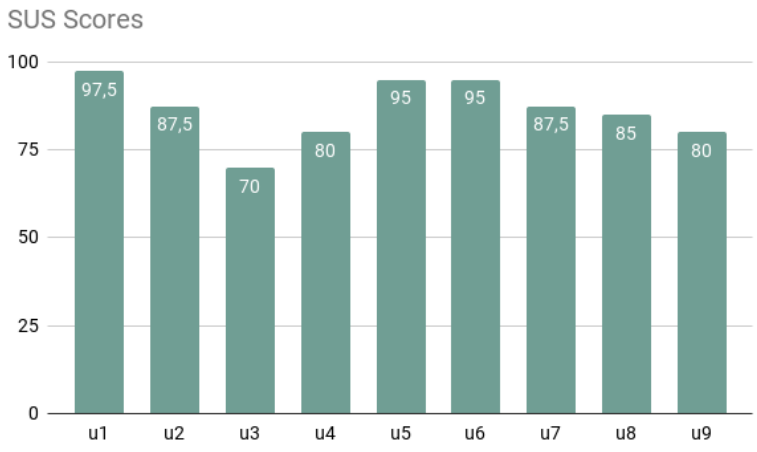


Figure 6.3: SUS's Score

	SUS Score
Max	97.5
Min	70
Mean	87,5

Figure 6.4: Maximum, minimum and mean score

The system was assessed using the criteria set out on the website www.usability.gov. According to the website, a system's usability is considered above average if the score is greater than 68 and below average if the score is less than 68.

All of the usability scores in the table and graph are over 68, indicating that the Guideo application is above average in terms of usability. The average score is 87.19, which means a high level of usability and satisfaction.

6.4.2 User Experience Questionnaire

The second section of the questionnaire evaluated usability through a scale from -3 to +3 was used. As a result, -3 denotes the most negative response, 0 represents a neutral response, and +3 indicates the most favourable response. [6]

This consists of 6 scales with 26 items in total:

- **Attractiveness**: In general, how does the user feel about the product? Is the product well-liked or despised by users?
  - annoying / enjoyable
  - good / bad
  - unlikable / pleasing
  - unpleasant / pleasant
  - attractive / unattractive
  - friendly / unfriendly
- **Perspicuity**: Is it easy to understand how to use the product? Is it easy to get familiar with the product?
  - not understandable / understandable
  - easy to learn / difficult to learn
  - complicated / easy
  - clear / confusing

- **Efficiency**: Is it possible to use the product fast and efficient? Does the user interface look organized?
  - fast / slow
  - inefficient / efficient
  - impractical / practical
  - organized / cluttered
- **Dependability**: Does the user feel in control of the interaction? Is the interaction with the product secure and predicable?
  - unpredictable / predictable
  - obstructive / supportive
  - secure / not secure
  - meets expectations / does not meet expectations
- **Stimulation**: Is it interesting and exciting to use the product? Does the user feel motivated for a further use of the product?
  - valuable / inferior
  - boring / exiting
  - not interesting / interesting
  - motivating / demotivating
- **Novelty**: Is the design of the product innovative and creative? Does the product grab the user's attention?
  - creative / dull
  - inventive / conventional
  - usual / leading edge
  - conservative / innovative

Attractiveness is purely a valence scale. Stimulation and Novelty are hedonic quality elements, while perspicuity, efficiency, and dependability are pragmatic (goal-directed) quality factors.

Users have a good impression if the scale has a value above +1 and a negative image if the scale has a value below -1. Because of well-known response effects such as avoiding extremes, observed scales mean values are typically in the -2 to +2 range. More extreme values are uncommon; a result approaching +2 denotes participants' favourable, near-optimal opinion.

	Scale means per person					
	Attractiveness	Perspicuity	Efficiency	Dependability	Stimulation	Novelty
u1	2,83	2,00	2,50	3,00	2,75	3,00
u2	1,67	2,00	1,50	1,00	1,25	1,00
u3	2,17	1,00	1,00	0,75	1,50	1,50
u4	1,83	0,75	2,50	1,75	1,25	0,25
u5	3,00	2,50	2,75	2,25	2,75	1,75
u6	2,33	3,00	2,75	2,00	1,50	1,75
u7	3,00	3,00	3,00	2,50	2,50	2,75
u8	2,17	2,50	1,50	1,50	1,75	1,00
u9	1,83	0,00	0,75	0,75	1,00	1,25

Figure 6.5: UEQ's Score

UEQ Scales	Mean	Variance
Attractiveness	2,315	0,27
Perspicuity	1,861	1,11
Efficiency	2,028	0,71
Dependability	1,722	0,63
Stimulation	1,806	0,47
Novelty	1,583	0,75

Figure 6.6: UEQ Mean and Variance

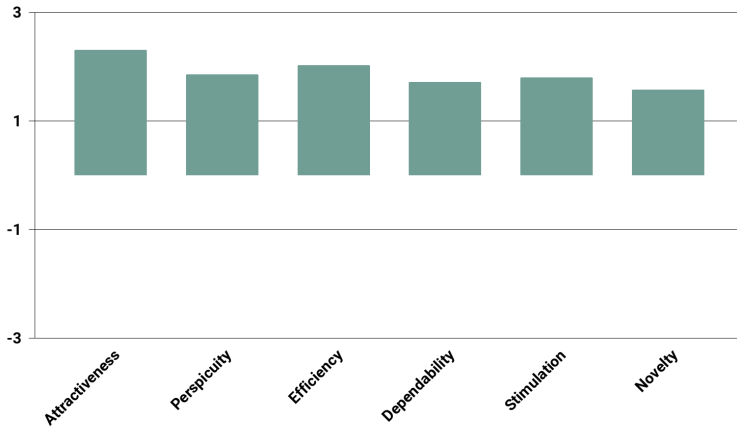


Figure 6.7: UEQ Scale Mean

All scales show a positive evaluation. To gain a better image of a product's quality, it's vital to compare the product's assessed user experience to the results of other well-known products. The UEQ provides a benchmark, which currently has data from 21175 people across 468 studies.

Comparisson to benchmark	Interpretation
Excellent	In the range of the 10% best results
Good	10% of results better, 75% of results worse
Excellent	In the range of the 10% best results
Excellent	In the range of the 10% best results
Excellent	In the range of the 10% best results
Good	10% of results better, 75% of results worse

Figure 6.8: Benchmark Interpretation

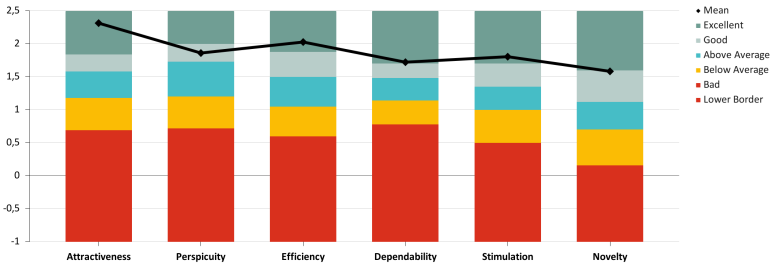


Figure 6.9: Benchmark graph

6.4.3 Interview

The usability of the prototype generated was quantitatively measured in the preceding parts. This section focused on a qualitative approach to evaluation. Three optional questions were asked to the users, allowing them to publicly express constructive critique.

1. **'What did you like the most?'**

   The most mentioned aspects were the design, ease of use and practical and dynamic aspects of use. The participants also enjoyed the integration of Google Maps, the autonomy that is gained by creating your own tourist routes and the versatility and flow aspects of creation. Some features mentioned were adding photos, adding audio, following other people's routes, being able to see the real-time updates of the map, be able to change points and their information.

2. **'What did you like the least?'**

   The most common concern expressed by the participants was how to edit a stop on the tour creation.

   The lack of information on some areas was also noted. Not having instructions on how to insert points on the map or change position and, when visualizing a tour, one participant considered there was little information on how to use and it was not intuitive in the information section.

3. **'What is missing or could be improved?'**

Two participants agreed that the app should offer more information or a small tutorial on how to use the app's interfaces. One participant proposed adding the possibility to freely design the itinerary so that the person can choose the recommended streets for the tour, passing through exciting points in the city, improving the route, and even improving the safety of the itinerary, avoiding darker or dangerous trails. Another common feature to add was searching on the map during the tour creation.

6.5 Results

Overall, the user response to the final prototype was generally positive. Good scores were obtained in the two questionnaires, and users expressed interest in using the created application in the last step. It is also important to mention that through the interviews, it was found that all users felt captivated by the application's design. The aspect that most needs revision is editing a point when creating a tour and an increase in usability hints.

Considering the results, it was possible to verify that the concept of the product pleases the participants as well as its respective functionalities. In terms of usability detected some flaws that were easy to rectify.

Even though the user review showed positive results, there is still room for improvement.

6.6 Summary

This chapter offered a summary of the test plan, the evaluation procedure, and the metrics employed. The participants' profiles and the most important outcomes of the corresponding usability tests, questionnaires, and interviews were summarized. The SUS and UEQ adaptations gathered qualitative feedback on the prototypes and converted them into numerical ratings. Both scales received high scores. Most respondents said they expect to use the app throughout the sessions and in the background questionnaires.

Chapter 7

Conclusions and Future Work

Contents

The dissertation comes to an end with this chapter. The findings of the research are presented in Section 7.1. The limits of this study, as well as future studies, are discussed in Section 7.2.

7.1 Conclusion

The goal of this dissertation was to create a mobile app for tourists that provides walking trip routes that avoid gatherings and target POIs in order to alleviate the problem of infection groups that is caused thought the current pandemic situation.

In this dissertation a prototype of a virtual guide application was developed. The goal has always been to develop something that would give the necessary support and tools to users who wish to get to know a city better, allowing them to learn about the city's history and significant landmarks via a mobile application.

These specifications were used to create the prototype. The prototype was created utilizing the Flutter SDK, which allowed us to target both Android and iOS with a single code base, despite the fact that iOS testing was not feasible. This drastically reduced development time and effort. A set of tests were used to assess the app prototype's functional elements.

Usability testing was used to evaluate the prototype, which included four steps: background questions, task assessment, SUS and UEQ modification, and open feedback. Quantitative and qualitative evaluations were conducted. This stage demonstrated that the mobile application proposed had a need and interest.

Overall, the findings of the surveys, interviews, and usability testing show that this prototype virtual guided tours application is worth considering and might be extremely valuable to users who wish to learn more about a place.

7.2 Future Work

Due to a lack of time, many improvements, testing, and research issues have been postponed. In this part, we give a few of those that we believe are the most important, as well as a proposal for how they may be accomplished.

7.2.1 Prototype enhancements

The prototype may be modified in a variety of ways, ranging from minor quality-of-life enhancements to more substantial additions. The process of guiding the user through the journey is one area where the app prototype might be enhanced. Currently, trip information follows a static path, which means it does not change throughout the journey. Having the opportunity to switch to another tour and modify the route theme, on the other hand, would boost the user's story-following options.

The user profiling is another feature of the app prototype that might be enhanced. The prototype currently lacks a profile or any linked statistics. For example, we might keep track of previously visited POIs and then filter them out. There's also the option to experiment with more complex profiling techniques, such as sentiment analysis depending on how the user selects tours, travels, or spends time on POIs. The ability to utilize the map and travel when offline has also been noted as a beneficial feature to have in the future.

7.2.2 Testing

Another area where the app's usability might be enhanced is validation. It was not possible to perform tests on iOS platforms, however, this possibility was taken into account during development process and the necessary steps for integration were followed. In addition to increasing the number of participants to improve statistical validity, it would be interesting to test these strategies with actual tourists to observe how the findings change.

7.2.3 Market opportunities

The next step would be to contact organizations that provide typical guided tours. Evaluating the interest in and possibilities for partnering and integrating with professional guides could change the concept of the app and allow for more detailed and accurate guided tours, as the introduction of incorrect information is a concern in this prototype, where any user can create their own tour.

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Appendix A

Requirements Questionnaire

08/02/22, 18:10 App para visitas guiadas virtuais

App para visitas guiadas virtuais

O seguinte questionário está a ser realizado no âmbito da dissertação "Walking Digital Tours" do Mestrado Integrado de Engenharia Informática e Computação da Faculdade de Engenharia da Universidade do Porto. O tema desta centra-se no desenvolvimento de uma aplicação móvel que junta guias turísticos a visitantes que querem conhecer uma cidade.

Para tal, este questionário tem como objetivo compreender o nível de interesse e procura, bem como o uso de aplicações já existentes.

As respostas são anónimas e confidenciais. Apenas serão divulgados os resultados do tratamento estatístico.

O preenchimento deste questionário demora aproximadamente 5 minutos. Caso tenha alguma questão, por favor, contactar up201605542@up.pt .

*Obrigatório

Dados demográficos

1. Género *

Marcar apenas uma oval.

- ◯ Feminino
- ◯ Masculino
- ◯ Outro

2. Idade *

3. Nível de escolaridade *

Marcar apenas uma oval.

- ◯ Ensino Básico
- ◯ Ensino Secundário
- ◯ Licenciatura
- ◯ Mestrado
- ◯ Doutoramento

Experiência geral com visitas guiadas

4. Frequência com que realiza visitas guiadas presenciais *

Marcar apenas uma oval.

	1	2	3	4	5	
Nunca	◯	◯	◯	◯	◯	Muito frequente

5. Considera que a frequência de realização de visitas guiadas presenciais diminuiu devido à situação pandémica atual? *

Marcar apenas uma oval.

- ◯ Sim
- ◯ Não

Experiência com aplicações para visitas guiadas

6. Conhece alguma aplicação que permite a realização de visitas guiadas virtuais? *

Marcar apenas uma oval.

- ◯ Sim
- ◯ Não

7. Se sim, qual (ou quais)?

_____

8. Já utilizou uma aplicação para a realização de uma visita guiada? *

Marcar apenas uma oval.

- ◯ Sim
- ◯ Não

9. Classifique o interesse no uso de uma aplicação que permita conhecer uma cidade através de várias rotas de forma independente *

Marcar apenas uma oval.

	1	2	3	4	5	
Nenhum	◯	◯	◯	◯	◯	Muito

Funcionalidades

10. Que funcionalidade(s) acharia útil ser(em) incluída(s) nestas plataformas? *

Marcar tudo o que for aplicável.

- ☐ Áudio
- ☐ Vídeo
- ☐ Uso offline
- ☐ Navegação apoiada por Google Maps e GPS
- ☐ Narrações áudio automaticamente reproduzidas quando o utilizador chega a um local
- ☐ Facilidade na mudança de trajeto
- ☐ Listagem de pontos de interesse
- ☐ Avaliação da visita guiada

Outra: ☐ _____

11. Estaria interessado/a em assuimir o papel de guia e criar rotas turísticas na aplicação? *

Marcar apenas uma oval.

- ◯ Sim
- ◯ Talvez
- ◯ Não

12. Contribuiria monetariamente para usufruir de uma visita guiada virtual? *

Marcar apenas uma oval.

- ◯ Sim
- ◯ Não

13. Se sim, quanto?

Marcar apenas uma oval.

- ◯ < 5€
- ◯ 5€ a 10€
- ◯ 10€ a 20€
- ◯ > 20€

Feedback final

14. Partilhe a sua experiência e tudo aquilo que ache relevante e importante que não tenha sido mencionado nas perguntas anteriores.

Appendix B

Full answers to all the open questions in the requirements questionnaire

B.1 Experience with guided tours applications

Do you know of any application that allows virtual tours?

Out of 118 participants, only **4** answered this question.

- *"Zoom"*
- *"Website usado na Alcazaba em Málaga; Aúdioguia automático no castelo de Ghent"*
- *"Google maps"*
- *"não sei o nome, usei em museus e na pandemia"*

B.2 Features

What feature(s) would you find useful to be included in these platforms? Open answer

Out of 118 participants, only **4** answered this question.

- *"Criação de rotas, pontos de interesse e até mesmo partilha de experiências do género da aplicação de atividade física "Strava""*
- *"suporte VR"*
- *"Listagem de rotas de transporte para o destino turístico"*
- *"Narrações áudio disponíveis quando o utilizador chega a um local"*

B.3 Final Feedback

Share your experience and anything else that you think is relevant and important that was not mentioned in the previous questions.

Out of 118 participants, only **8** answered this question.

- *"Enquanto existirem free walking tours, pessoalmente, não vejo interesse numa app digital de tours paga. Se houvesse possibilidade de ser grátis reconsiderava a minha preferência já que com uma aplicação consigo realizar a tour ao meu próprio ritmo e não fico restrita a um horário. Boa sorte com a dissertação, é pro 20 :)"*
- *Não tenho mais feedback"*
- *"Acho chato e às vezes difícil de usar aplicações dessas (falo da minha experiência de audioguia em museus, que não é a mesma coisa mas tem algumas similaridades suponho). Sempre procuro walking tours pelas cidade porque são mais descontraídos, algo que acho que uma aplicação não consegue."*
- *"Excelente ideia!"*
- *"Acho que visitas guiadas virtuais para cidades em geral não fazem muito sentido nem são muito apetecíveis. Faz bastante sentido para museus, casas de arte, atrações culturais, igrejas históricas, etc."*
- *"Uma pequena sugestão. Alguns passos poderiam ser mostrados. Por exemplo, como chegar a certos locais usando os transportes públicos"*
- *"Pode ser uma boa ideia, juntar isto de visitas guiadas orientado para visualizar apartamentos e os seus detalhes, envés de ir fisicamente. Isto seria viável também para pós pandemia"*
- *"Audioguias grátis e automáticos são incríveis. Experiência ainda melhor quando se junta algum humor ao guia. AR seria uma boa adição, por exemplo ver personagens históricas num local como se fosse Pokemon Go"*

Appendix C

Usability Testing Scales Questionnaire

Usability Testing - Digital Tours App

Grupo A - utilizador como criador de histórias
Grupo B - utilizador como consumidor de histórias

*Obrigatório

System Usability Scale

1. Avalia as seguintes afirmações numa escala de Strongly Agree (1) a Strongly Disagree (5). *

Marcar tudo o que for aplicável.

	1	2	3	4	5
Acho que gostaria de utilizar este produto com frequência.	☐	☐	☐	☐	☐
Considerei o produto mais complexo do que necessário.	☐	☐	☐	☐	☐
Achei o produto fácil de utilizar.	☐	☐	☐	☐	☐
Acho que necessitaria de ajuda de um técnico para conseguir utilizar este produto.	☐	☐	☐	☐	☐
Considerei que as várias funcionalidades deste produto estavam bem integradas.	☐	☐	☐	☐	☐
Achei que este produto tinha muitas inconsistências.	☐	☐	☐	☐	☐
Suponho que a maioria das pessoas aprenderia a utilizar rapidamente este	☐	☐	☐	☐	☐

2. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Desagradável	◯	◯	◯	◯	◯	◯	◯	Agradável

3. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Incompreensível	◯	◯	◯	◯	◯	◯	◯	Compreensível

4. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Criativo	◯	◯	◯	◯	◯	◯	◯	Sem Creatividade

5. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
De fácil aprendizagem	◯	◯	◯	◯	◯	◯	◯	De difícil aprendizagem

6. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Valioso	◯	◯	◯	◯	◯	◯	◯	Sem valor

7. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Aborrecido	◯	◯	◯	◯	◯	◯	◯	Excitante

8. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Desinteressante	◯	◯	◯	◯	◯	◯	◯	Interessante

9. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Imprevísivel	◯	◯	◯	◯	◯	◯	◯	Previsível

10. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Rápido	◯	◯	◯	◯	◯	◯	◯	Lento

11. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Original	◯	◯	◯	◯	◯	◯	◯	Convencional

12. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Obstrutivo	◯	◯	◯	◯	◯	◯	◯	Condutor

13. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Bom	◯	◯	◯	◯	◯	◯	◯	Mau

14. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Complicado	◯	◯	◯	◯	◯	◯	◯	Fácil

15. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Desinteressante	◯	◯	◯	◯	◯	◯	◯	Atrativo

16. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Comum	◯	◯	◯	◯	◯	◯	◯	Vanguardista

17. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Incómodo	◯	◯	◯	◯	◯	◯	◯	Cómodo

18. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Seguro	◯	◯	◯	◯	◯	◯	◯	Inseguro

19. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Motivante	◯	◯	◯	◯	◯	◯	◯	Desmotivante

20. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Atende às expectativas	◯	◯	◯	◯	◯	◯	◯	Não atende às expectativas

21. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Ineficiente	◯	◯	◯	◯	◯	◯	◯	Eficiente

22. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Evidente	◯	◯	◯	◯	◯	◯	◯	Confuso

23. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Imprático	◯	◯	◯	◯	◯	◯	◯	Prático

24. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Organizado	◯	◯	◯	◯	◯	◯	◯	Desorganizado

25. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Atraente	◯	◯	◯	◯	◯	◯	◯	Feio

26. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Simpático	◯	◯	◯	◯	◯	◯	◯	Antipático

27. *

Marcar apenas uma oval.

	1	2	3	4	5	6	7	
Conservador	◯	◯	◯	◯	◯	◯	◯	Inovador

Entrevista

Grupo A - utilizador como criador de histórias

28. 3 aspetos que mais gostaram

29. 3 aspetos que menos gostaram

30. 3 aspetos a melhorar

Entrevista

Grupo B - utilizador como consumidor de histórias

31. 3 aspetos que mais gostaram

32. 3 aspetos que menos gostaram

33. 3 aspetos a melhorar

Appendix D

Full answers to all the open questions in the usability testing interviews

D.1 Group A

'What did you like the most?'

- *"-Criar as próprias rotas turísticas; -Facilidade de utilização; -Aplicação pprática e dinâmica."*
- *"Interface limpa, criação facil e rápida dos pontos, opção para adicionar fotos a cada um."*
- *"o aspeto, conseguir ver o mapa atualizado, poder alterar os pontos e a sua informação"*
- *"O aspeto geral, a capacidade de adicionar foto, a ideia da app em si :)"*
- *"Adicionar fotos, adicionar áudio e seguir as rotas de outras pessoas"*
- *"Autonomia que se ganha, conhecimento de fácil acesso, tentador"*
- *"Facilidade utilização Versatilidade de criação Diversidade"*
- *"Design Possibilidade de adicionar áudio ao criar tour"*
- *"Google maps Integrado. Design Flow de criação"*

'What did you like the least?'

- *"nao era muito claro como editar uma paragem da visita, nao havia uma linha que unisse todas as paragens de uma visita"*
- *"As pessoas podem fazer uma rota fraca e para apagar tem de se clicar no nome"*
- *"não ter instruções de como inserir pontos no mapa ou alterar os pontos"*
- *"Aparecer editar após editar posição do marker"*
- *"Ter de procurar os locais manualmente"*

'What is missing or could be improved?'

- *"-Criação de conteúdo apropriado em diversos idiomas; -Opção de existir um vídeo para cada ponto escolhido; -Adptação do conteúdo para pessoas com deficiência visual; -Classificação ponto a ponto e utilizar a média ponderada para avaliar o percurso na globalidade; -Incorporar as condições metereológicas (temperatura e estado do tempo); -Incluir uma versão GPS que permita efetuar a rota e alertar caso o utilizar se engane no percurso definido; -Proposta de desafios em cada local para o utilizador conhecer melhor o sítio a visitar; -Apresentação de um tutorial para ajudar os utilizadores a usarem a App; -Apresentação de informação mais detalhada do local a visitar a partir de pesquisa direcionada para o Google; -Possibilidade de a aplicação reconhecer o meio de transporte efetuado na deslocação (a pé, bicicleta, trotinete elétrica ou outro) e contribuir para a avaliação ecológica do percurso; -Nos roteiros que envolvam a aquisição de bens ou serviços ter a opção de existir uma forma direta de conseguir os mesmos, horários de funcionamento, etc..."*
- *"Possibilitar a pesquisa de locais, para facilitar organização. Fazer ordenação dos pontos, adicionando dicas do que consumir em cada ponto melhorando assim a experiencia. Desenhar o itenerario, podendo assim a pessoa escolher as ruas aconselhadas para o tour, podendo fazendo passar por pontos interessantes da cidade, melhorando o percurso e até melhorar a segurança do itenerario evitando pontos mais escuros ou perigosos."*
- *"Compra de tour e bilhetes Preços de entradas em espaços Parcerias com fotógrafos e outras pacotes extra"*
- *"Opção de pesquisa no mapa, mostrar rota final, indicar o tempo previsto entre cada viagem"*
- *"os aspetos que menos gostei, seriam aqueles a ser melhorados"*
- *"ser mais intuitivo, ter mais instruções"*

D.2 Group B

'What did you like the most?'

- *"conseguir ver todos os pontos no mapa, ver toda a informação na janela de informação, ter um aspeto clean"*
- *"Fluidez na visualização dos pontos, home page atrativa, facilidade em encontrar / visualizar os pontos."*
- *"-Facilidade na utilização da App; -App dinâmica e apelativa"*
- *"Design; Aparecimento de rota de imediato."*

'What did you like the least?'

- *"ter pouca informação de como utilizar e ser pouco intuitivo na secção de informação"*

'What is missing or could be improved?'

- *"adicionar informação de como fluir melhor na app"*