Design for Outdoor Mobile Multimedia: representation, content and interactivity for mobile tourist guides

Heloisa Caroline de Souza Pereira Candello

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Abstract

The research reported in this thesis explores issues of information design for mobile devices, in particular those relating to selection and presentation of on-screen information and interactive functionality for users of mobile phones. The example domain is that of mobile tour guides for tourists, local people, students and families. Central to the research is the issue of multimodality, particularly the graphic and interaction design issues involved in viewing video, in combination with other media, on a mobile device, in an outdoor context. The study produced three main results:

1. An analytical framework for user-experience concerns in cultural heritage settings,

2. Design recommendations for outdoor mobile multimedia guides and

3. Refinements in methods for collecting and analysing data from fieldwork with visitors in cultural heritage settings.

Those results were formulated for the use of mobile guide designers.

The methodology used to inform and structure the work was Design Research, involving literature review and empirical work, including user trials of a prototype tourist guide developed in the project. The literature review covered areas of tourism, multimedia design, mobile HCI and existing mobile guides. Outdoor fieldwork exercises were carried out with three different cultural information sources – human tour guide, paper based guide and mobile guide app – in order to identify any problems that visitors might have and to gather requirements for the development of a mobile cultural guide. Qualitative analysis was applied to analyse the video observations and questionnaires completed during the tours. Requirements were grouped and analysed to give substantial information for a conceptual design. Personas and scenarios were created based on real participants and situations that occurred on the tours. A mobile guide prototype was developed and evaluated in the field with visitors. Qualitative analysis and descriptive statistics were used to analyse the data. Visitors were asked about their preferences among various multimedia design elements and answered a questionnaire on their experience.

The elements that affect the user experience with outdoor mobile guides were categorised and organised into a framework. It became apparent that users' experience of technology (in this case the mobile tourist guide) and environment are affected by context, content and look and feel elements. This framework of user experience generated a design toolkit with a collection of recommendations for designers of such systems. The recommendations are described in context of usage and have a rating system with strength of evidence and confidence based on how often they appeared in the field works and solutions tested.

Table of Contents

List of Tables

List of Figures

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Dedication

I dedicate this thesis to my lovely husband, for his comprehension, support and patience during this period.

Declaration

I declare that the research contained in this thesis, unless otherwise formally indicated within the text, is the original work of the author. The thesis has not been previously submitted to this or any other university for a degree, and does not incorporate any material already submitted for a degree.

Signed

Dated

1 Introduction

The work described in this thesis is a contribution to the research field of mobile human interaction (Mobile HCI) and interaction design for cultural heritage visitors in outdoor settings. This chapter gives an overview of the motivation for this research, together with its context and content. It describes both my personal motivation to start this work as well as the value of the research to its target communities. The aims, research questions and scope of the research are highlighted, and a summary is given of the methodological approach taken. Finally, we provide an outline of the organisation of chapters.

1.1 Personal Motivation

In my Masters degree I explored online digital magazines through the Semiotic perspective of Charles Sanders Pierce. This was a reflection on the overall levels that users can be involved in when using digital magazines. It made me aware of the extent to which the syntactic, semantic and pragmatic elements might have an effect on a user's experience. The presentation of information is considered to relate to the syntactic view, the meanings of the elements on the layout to the semantic view and how effectively users interact with the interface to the pragmatic view. I suggested that these elements work together and that their conjunction makes for a rich or poor user experience. From this study, I began to think about how those elements might make a difference for users of diverse platforms, and additionally, how designers could take advantage of multimedia resources to deliver content in an understandable way.

As I had the opportunity to work with online resources before, I decided to examine how multimedia elements should be delivered on mobile phones. The constraints of the device and environment issues attracted my attention. In addition, I was teaching a course in Information Design for Design undergraduate students in Brazil and we were developing paper-based touristic guides as an assignment. Once more, these circumstances made me think about the constraints of platforms to deliver content. I am very keen on travelling and testing new technologies in museums and outdoor urban settings. I tested several audio and video guides in a number of cities and was impressed by the ways historical and cultural content were

delivered in those contexts. In order to illustrate my interest in multimedia guides and the situations in which visitors might experience them, one occurrence is worth mentioning. In 2008 I struggled to use a video guide in the Coliseum, Rome. With a choice between a video or audio guide, my chosen option was the video guide. Unfortunately, it was almost impossible to see the videos in the setting of the Coliseum. It was hot, (40 degrees C) and no shade was available. Additionally, although the content was very interesting I found myself unwilling to look at the screen instead of appreciating the Coliseum. I wondered how other tourists would behave in the same situation.

These experiences led me to search for any published research on designing multimedia to deliver cultural information on mobile devices in outdoor settings. I found several approaches and applications, most of them involving audio and text. A few studies had investigated user behaviour as requirements for such applications. There was very little investigation of the use of multimedia elements, and little reflection on the constraints of outdoor use and the visitor's experience. The potential value of stabilising recommendations for designers to improve users' experience with mobile cultural guides in outdoor settings, by examining visitors' behaviour and context, was clear.

1.2 Why this research is needed

There are currently a large number of initiatives in mobile technology related to culture and tourism (Cheverst et al 2000; Krosche et al 2004), which have become understandably popular domains for handheld information devices. Some mobile guides are designed for use in museums and indoor settings, and others are for use in restricted outdoor settings. For this work, we concentrate on outdoor mobile guides.

Much recent research on mobile city guides has been focused on the kind of technology applied to supply historical and cultural information. Location-based technologies help visitors and also residents to localise themselves and receive historical, cultural and entertainment information at a particular point of interest. Location-based games are another means of presenting the history of a city in an entertaining way. Cell ID and Wi-Fi help to identify user location and enable context-sensitive information access. Sensors are employed to enhance the

use of maps and the interaction of visitors with systems. Moreover, the use of augmented reality in the cultural heritage field allows users to find out what certain locations and monuments were like in the past. Overall, the application of technologies has to make sense and involve visitors culturally and historically. In this way, visitors and residents alike might have new experiences, be entertained and learn more about historical cultural sites.

Not only must appropriate technology be chosen for handheld mobile cultural guides, but also interfaces need to be well designed to provide information to visitors. Hence, principles for developing these mobile interfaces are essential to guide both designers and cultural heritage professionals. A number of projects have concentrated on guidelines to develop mobile systems. For instance, a framework to support different application scenarios for map-based city routing was developed by Grun (2005). Additionally Savio and Braiterman (2007) present ten heuristics for mobile interactions considering the limitations on both human users and devices arising from the context of use. Likewise Paay and Kjeldskov (2007) created a method for providing mobile system designers with knowledge about elements in the user's physical context, so that information that already exists in the user's environment can be indexed into the mobile interface. Applied to mobile learning settings Grasso and Roselli (2005) developed guidelines for designing contents and courses on mobile devices. Similarly, Damala (2007) brings the new perspective of designing mobile guides based on museum learning theories and object oriented learning in museum settings. All of these perspectives are of major importance: however, there is a lack of studies on how people interact with representations of content on the mobile screen, in different contexts.

In addition to guidelines delivered by the scientific community, design guidelines and style guides are available from mobile device manufactures. For instance, Apple iOs usage guidelines are sometimes very general, e.g., "Analyze what's needed on each screen" or very specific, e.g. "Use system-provided buttons according to their documented meaning" (Apple, 2010). These are very specific to platform or manufacture technical constraints and were not specific for presenting multimedia content in cultural heritage settings (see 3.4.2 for more details). Some writers claim that design patterns are a better way to deliver recommendations (Van Duyne et al 2003; Tidwell 2006) but only a few patterns are available for developing mobile design

applications (Roth 2002; Nilsson 2009). There has been only limited activity in studying visitors' behaviour in order to generate patterns of behaviour (Kim 2007; Oliver 2004) and also for designing mobile applications (Brown 2003). More studies highlighting the lexico-visual, audio-visual and multi-visual representation in location-based systems are required to help designers to design and develop multimedia apps with user needs in mind. Additionally, the research in mobile multimodal interfaces in cultural heritage settings is still weak in understanding how people perceive, handle and interact with mobile systems in outdoor location-based contexts.

Research in this area is particularly needed at this point as the number of mobile applications is increasing substantially. In three years (from 2007 to 2010) over 300,000 mobile apps have been developed. In 2010 these applications were downloaded 10.9 billion times (Ellison 2010). On the other hand, one in four mobile application downloaded is never used again (Localytics 2011). It may be that users abandon an app because of usability problems, because it did not meet their expectation or because it lacked engaging content and interactivity. Travel services were identified as being among the top ten mobile consumer services in 2010 (comScore MobiLens 2011) and kept their place on the prediction list for 2012 (Gartner 2009). Location-based services and mobile search are also on the list. More apps available in the market increase competition and boost development of better mobile interfaces designed with focus on user experience.

Furthermore, mobile apps are a relative new technology; consequently mobile cultural guides are even newer. The popularity of mobile apps started with the launch of the various app stores (Apple AppStore and Android Market, both 2008). When this research began, very few mobile cultural apps were available: this number is now greater (see Chapter 3.5.2 – Background). Design recommendations for developing mobile cultural apps are scarce. Therefore, this thesis is intended to contribute to filling this gap in the field.

1.3 Research questions and objectives

Two main questions permeated the process of this thesis.

1. How do visitors perceive, handle and interact with graphic representations and multimedia resources on location-aware mobile cultural guides in outdoor settings?
2. How should cultural and tourist guides present information and provide interaction for tourists and city residents in outdoor settings?

The two questions were answered in the process of this thesis research and findings were integrated into a design toolkit, illustrated in Chapter 7 – Results. Those were also described at Chapter 8 – Conclusions, reflections and further work. Both perspectives were examined in the research process – users' interaction with multimedia presentation, studied with regard to user characteristics, and ways to present multimedia content in mobile devices. These questions were investigated applying and refining Mobile HCI methods and structured in a design process guided by the Design Research methodology (Chapter 2).

These research questions emerged from current open issues in the design of outdoor mobile cultural guides. Unlike designing for well-understood genres such as ecommerce sites, this raises questions to which there are no accepted answers, since the combination of mobile device, multimedia materials, outdoor use and cultural heritage application domain is a new one. Examples of the sorts of questions to which designers might seek answers could include:

- Should photographs of the POI (sculptures, monuments) be displayed on the app interface even though users will be able to see it for themselves?
- What is the maximum length of video people can watch in outdoor settings?
- Should users be able to interact with other parts of the system while listening to any audio that's included?
- Are dialogues an appropriate style to deliver audio content?

The broad research questions and specific issues identified during the research process contributed to achieving the aims of this thesis. The major focus of the research is to provide direction and insights for designing mobile cultural guides to be accessed in outdoor settings. To achieve this goal, investigations were carried out into users' explorations of cultural heritage

sites, their behaviour and their wayfinding strategies. Fieldwork studies assisted in answering the *first* broad research question. Literature Review and Competitor analyses offered background and contributed to answering this research question as well.

Data collection, design and evaluation activities were planned to uncover and understand the way users interact with diverse information sources in outdoor settings. Therefore, those activities offered answers to the *second* high level research question about multimedia content presentation. Several factors were identified as influential to the activity and were modelled in the design frameworks available in Chapter 7 - Results. The integration of these frameworks resulted in a design toolkit. This aims to assist designers identify essential influential factors and access design recommendations for developing outdoor mobile cultural guides accompanied by a rating scale based on evidence and confidence.

More specifically, the objectives of the thesis are to:

- Identify the influences involved in being guided in outdoor settings, specifically with the use of mobile multimedia devices, in order to help designers understand and develop mobile guides with the visitor's experience in mind.
- Investigate users' interaction with multimedia features in outdoor settings.
- Provide design recommendations for designing outdoor mobile guides for use in cultural heritage settings
- Provide straightforward ways for designers to consult the design recommendations.
- Examine and refine data collection and evaluation methods and techniques undertaken in real situations, in order to add knowledge to the field of Mobile HCI and improve interaction design technologies in cultural heritage settings.

1.4 Research method

The methodology applied in this work is Design Research (Bayazit 2004; Broadbent 1981; Collins et al 2004; Friedman 2003; Lawson 2006; Plomp 2007;). This involved a range of methods and techniques, some desk based, others involving empirical work in cultural settings. We used a user centred design approach throughout, with users identified as informants to aid in the design decisions. Mixed methods were applied to collect data and analyse data collected.

Design requirements to develop a mobile guide prototype were gathered from design activities. The prototype was evaluated with experts and typical end users. These activities resulted in a design toolkit to aid designers to identify factors influential in the activity of being guided by mobile devices in cultural heritage settings and to have access to design recommendations relevant to the genre of mobile tour guides.

1.5 Scope of this research

This thesis is situated in the field of Mobile HCI and interaction design applications for cultural heritage visitors in outdoor settings. The scope of this research is restricted to the activity of using a touch screen mobile phone to access multimedia content at real points of interest and provide design recommendations to develop such systems. The major interest is in delivering multimedia content on mobile phone screens and not on wayfinding strategies or programming. Other areas that lie outside the scope of the thesis are theoretical and economic approaches to tourism. Mobile technology was used to identify its potential to deliver multimedia content and users' expectations of using it in outdoor settings.

1.5.1 Setting for the research activities

The city of Brighton & Hove, on the South Coast of England, was chosen to be the setting of the study. Brighton, the larger part of Brighton & Hove, is a lively city and welcomes a diverse visitor population throughout the year. A survey sponsored by Tourism South East (2009), found that:

- 41% of people surveyed were day visitors made up of visitors on day trips from their homes;
- 19 % were visitors on holiday travelling to visit Brighton;
- The majority of visitors were domestic (83%) and the overseas visitors (17 %) were from more than ten different countries.

Brighton also hosts music festivals and cultural festivals. The Fringe[1] and Brighton Festivals occur in May, with numerous attractions. They have a program with numerous walking tours. Many tours are related to history and ancient monuments. The first fieldwork activity, designed

[1] Brighton Fringe festival. http://www.brightonfestivalfringe.org.uk/ticketing/index.aspx?et=1

to obtain an overview of guided visits to cultural heritage sites, unmediated by technology, was made on such tours during the Brighton Fringe Festival 2008 (see section 4.2.1.). Most of the people who attended the tours were from Brighton & Hove or places nearby. This was the motivation for expanding the study to include local people and residents of Brighton as well as tourists as the term is generally understood.

Brighton & Hove has two universities with a large number of international students. This facilitated the recruitment of participants for the studies. The public for cultural heritage settings and tourist attractions is diverse in age, background and time available to visit places (Chapter 2 - Background). Hence, diverse nationalities, age and interests were an interesting sample to study. This was attested, as well, with the responses to requests for participation in the studies. Although most of the invitations were disseminated through university e-mail groups, it was not only students who showed their interest in being involved in activities. Experts in cultural heritage, employees and acquaintances/friends or family of people who received the invitations also participated in the studies.

Competitor analysis was used to make decisions about the exact focus of the study. Applications researched presented content about the main landmarks and services in Brighton, but content related to the public sculptures of Brighton was not available for access via mobile devices, with no apps including the outdoor monuments in the centre of the city. Information on these sculptures was, however, available from publications of the Public Sculptures of Sussex[2] project, in the form of a web site and a small booklet. The booklet was developed by University of Brighton students under the supervision of Anthony McIntosh, who was responsible for the Public Sculptures of Sussex database. He kindly allowed us to use the booklet and information available in the website to conduct this study. We see the ability to make use of this pre-existing content as a strength of the project, enabling us to work from a realistic base.

The advantages of researching mobile guides in Brighton were clear. The city is a tourist destination. Researching an eclectic public would result in interesting and diverse design

[2] http://www.publicsculpturesofsussex.co.uk/

requirements. The centre of Brighton is small and the university, a rich source of participants, was located nearby the centre of Brighton, which would facilitate transportation. Opportunities to use content available in a paper based guide and on-line database would avoid the need for developing cultural heritage content.

1.6 Outline of the thesis

The thesis is organised according to bottom-up principles for selecting and presenting on-screen information and interactive functionality for users of mobile guides. The first chapters provide a foundation of knowledge on which the later chapters are built.

This Introduction has provided the main themes of the thesis and given an overview of contents. It describes the motivation, aims, objectives, scope, methodology and the structure of the work. Chapter 2 Methodology discusses issues related to the choice of methodology and research methods used in this work. Chapter 3 Background describes the existing work in relevant areas, together with an analysis of competitor applications. Chapter 4 Design Research Activities addresses the requirements gathered from user studies. Three fieldwork phases are described, resulting in the identification of factors influential in the design process. The results of this chapter supported the design of a mobile guide prototype, described in Chapter 5 Design, Prototype and Construction. Chapter 6 Prototype Evaluation describes the results of the evaluations with the prototype guide in Brighton. Chapter 7 Results underlines the main results of the prototype evaluation and frameworks of influence factors. Chapter 8 Conclusions, reflections and further work summarises the contributions of the thesis and suggests avenues for further development.

2 Methodology

2.1 Introduction

The present chapter describes the methodology and methods applied in this research. It sets out how these methods aid in answering the research questions and objectives of the research (1.3), as well giving details of each method applied. Design Research methodology was followed with the aim of understanding visitors' perceptions and their attitudes towards outdoor mobile guides. Additionally, the outcomes of using this approach identified ways to improve multimedia presentation and interaction with mobile cultural guides. Design research is also a methodology that focuses on the improvement of the design process (2.2) and not only on the results of the research. Therefore, its adoption helped to improve mobile Human Computer Interaction methods applied in the research process. As a framework, this methodology also opened up space to take a user centred design approach.

The first part of this chapter describes approaches and methods applied in designing mobile guide systems. Priority was given to qualitative methods employed in this research, but basic quantitative approaches were also described. These techniques were used to improve the design process and gain a better understand of potential users.

2.2 Design Research

Design research aims to improve the design process of manmade artefacts and extend the knowledge acquired to projects with a similar approach. Several authors contribute with definitions of Design Research (Bayazit 2004; Plomp 2007; Broadbent 1981; Collins at al 2004; Friedman 2003; Lawson 2006). Some of them explore design research applied to the Human Computer Interaction field (Gould and Lewis 1985; Zimmerman 2007; Stolterman 2008). Not many apply this approach to the design of mobile systems (Nokia 2011; Xu 2008). Most writers emphasise the lessons learned in the design process as a contribution to knowledge. Methods, theories and better development of certain artificial products are carefully studied to improve the design process, solve problems and extend the knowledge generated to other similar artefacts. Additionally, in their opinion, previous research is necessary to boost new achievements in developing objects. In Collins at al. (2004), Design Research (also referred to as

the design experiments approach) was developed as a way to carry out formative research to test and refine educational designs based on theoretical principles derived from prior research. In general design research, authors agree that the design research process consists of three main stages: Preliminary Research, Prototyping phase and Assessment phase (Plomp 2007). Reeves (2006) and Nieveen (2006) add one more stage: reflection and documentation. (Figure 1).

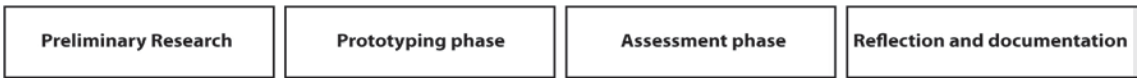

Figure 1: Design research stages

The prior research phase (Collins at al. 2004), also known as preliminary research (Nieveen et al 2006) and predictive research (Reeves 2006), may be an investigation of literature and main principles existent in the field; similar products that are already in the market and/or field studies to understand better the target users. Broadbent (1981) suggests the designer has to start by analysing human behaviour, from which he could derive "quantities, qualities, and relationships". Empirical research is essential to this first stage.

The stage of refinement is also called the prototyping phase. Elements identified in the preliminary research are implemented in the prototype in order to test their validity and improve the artefact. Some elements are implemented as intended by the designers, some are adapted to circumstances and others will not be implemented due to their lack of relevance in the context. Collins at al. (2004) describe this approach as progressive refinement. This implies bringing the first version of a design into the world to see how it works. Therefore, the design is constantly revised based on experience to solve possible problems. Expert evaluations or user evaluation with early prototypes might be applied. From these studies, design principles are indicated. Prototype designs represent a specific framing of the problem, and are compared to other research artefacts that emphasise the same problem. They provoke a discussion in the community of methods and approaches employed to solve common problems (Cross 2007). Those artefacts produced in this type of research become design exemplars, providing an appropriate conduit for research findings to easily transfer to the HCI research and practice communities (Zimmerman 2007). Design research prototypes have a different purpose from commercial products:

> … the intent going into the research is to produce knowledge for the research and practice communities, not to make a commercially viable product. To this end, we expect research projects that take this research through design approach will ignore or deemphasise perspectives in framing the problem, such as detailed economics associated with manufacturability and distribution, the integration of the product into a product line, the effect of the product on a company's identity, etc. (Zimmerman 2007:7).

Research prototypes are made to intensify innovations looking at the problems with a holistic perspective.

> …contributions should be artefacts that demonstrate significant invention. The contributions should be novel integrations of the theory, technology, user need, and context; not just a refinement of products that already exists in the literature or commercial markets. (Zimmerman 2007:7).

Van der Akker et al. (2006:5) agree, suggesting that while design researchers do focus on specific objects and process in specific contexts, they try to study these as integral and meaningful phenomena. Hence, the whole community extracts lessons and benefits from the research experiment.

The last stage, the assessment phase, is more usually named the evaluation phase. The outcomes of this stage are: identification of main problems occurring; confirming design issues and principles emerging in the experimental phase with the prototype; and recommendations for artefact and design process improvements (Plomp 2007). The result of the whole process, after a systematic reflection and documentation of each phase, will be the production of theories or/and validated design principles (Nieveen et al 2006).

According to Friedman (2003) a theory is a model that shows how something works and the relationship of elements in the same model. With a model it is possible to generate knowledge based on experience. Actions are interpreted and understood to lead from existing situations to preferred ones. With a model, it is possible to generalise the findings and apply them in future situations.

Models, and/or theories generated in design research are outcomes; likewise design recommendations for improvements. They might be labelled as design principles (Reeves 2006); heuristic statements (Van den Akker 1999; McKenney 2006; Shneiderman 2010; Nielsen, 1994) and design patterns (Alexander 1977; Van Duyne et al, 2003; Chung at al., 2004; Landay & Borrielo, 2003). Design heuristics/guidelines/principles are very specific and sometimes hard to follow (Shneiderman 2010; Nielsen, 1994; Van den Akker 1999). Design Patterns on the other hand, may offer a better language to show the recommendations. (Van Duyne et al. 2003; Chung at al 2004; Landay & Borrielo 2003): see Chapter 3 - Background.

Nieveen et al. (2006) point to the derivation of design principles as the fundamental aim of development studies. In their opinion, the practical contribution is a secondary benefit. Friedman (2003) adds the ability to theorise design results in a broad explanatory set of principles to help solve diverse problems. It focuses on an integrated perspective instead of unique case studies. Those principles are not intended as recipes for success; however, they serve as the basis and guidance for similar research approaches in their own settings (McKenney 2006). Besides, they have limitations, as they are based on contextual studies (Collins et al 2004), so that certain adjustments are necessary for application in diverse scenarios. In Lawson's (2006:122) opinion, there are no optimal solutions to design problems but rather a whole range of acceptable solutions. One of the aims of design research is to unveil those acceptable solutions to be reused in development of similar artefacts.

2.2.1 Evaluating and reporting design research

Criteria for evaluating educational design research and interaction design research within HCI are found in the literature. From the educational perspective the quality and contribution of a design research intervention is based on: relevance, consistency, practicality and effectiveness. (Nieveen 1999). With the focus on interaction design research, criteria are evaluated via four lenses: process, invention, relevance and extensibility. (Zimmerman et al. 2007).

Process, Practicability and Extensibility – The design process should be well documented with details of design process, rationale and choice of methods. In the educational and HCI fields reproduction and employment of the research process are relevant.

Relevance – Design research should be based on state-of-art knowledge (Nieveen 1999). As a result, a contribution to knowledge upon content validity will be built. Zimmerman et al (2007) emphasises that relevance should be in the preferred state in the real world for design product work. In his words "design researchers must articulate the preferred state their design attempts to achieve and provide support for why the community should consider this state to be preferred" (2007).

Invention – Educational design research emphasises the importance of literature review to start the first intervention based on concrete guidelines. Interactive design research uses the literature also to identify gaps and to gauge how the contribution advances the current state of art in the research community. Additionally, prediction of how technology will advance and how the intervention will work in the future is part of a designer's responsibility. Therefore, guidance will be provided on what to build.

Consistency – All components should be consistently linked to each other: for example, fieldwork leading to prototypes, evaluated by experts, applying modifications to early prototypes and evaluation with users.

Effectiveness – The intervention is effective if the objectives were achieved using the design research methodology applied.

The last two criteria belong to the educational field for evaluating design research interventions. The HCI community should embrace those criteria to develop more coherent and effective interaction designs. The description of the methods applied should also be clear to facilitate use.

After identifying the contributions of design research, it is important to know how to present the findings uncovered through the design research process. In the opinion of Collins et al. (2004), design research is an experimental process that needs a different structure for reporting. Five sections are proposed: goals and elements of the design; settings where implemented; description of each phase; outcomes found; and lessons learned.

2.3 User-centred Design

The purpose of the design field is to benefit users by the end of the process. That is why it is essential to involve users during the design process. Designing a system centred on the user is widely believed to increase the chances of user satisfaction with products. How users perceive, learn and use the system affects their experience (Norman 1999). A positive experience with products might be the result of usability and sensory research with users, placing them as the focus of the design process.

Certain approaches started paying attention to users after the Second World War. The products before the WWII were more technical and did not always involve users in the process (Bayazit 2004). Combat-driven requirements for new products based on observation of users using certain products arose. Design was introduced to the process and other concerns were gaining strength, such as cultural and aesthetic desires (Harper et al 2008). In the late eighties, the term "user centred design" (UCD) was introduced by Norman and Draper (1986). Nowadays, User Centred Design is an interdisciplinary field and has several research niches such as user modelling (Francesca 2008; Goren Bar 2006; Petrelli 1999), evaluation (Aleksi 2008; Sauer 2009; Grun 2008) and design (Ginsburg 2011; Shneiderman 2010; Jones & Marsden 2006).

Following the same development process, the introduction of new technologies such as mobile devices brought new practices and methods to the UCD field. Having mobility at its centre brings an extra set of constraints for the designer to deal with. Dunlop & Brewester (2001) highlight challenges designers should be aware of when designing mobile systems, such as: environment and context change; straightforward systems needed for a broad population; multitasking users and input and output facilities. Additionally, Cheverst et al (2000) identified certain characteristics of tourists using a mobile phone based guide. Some of the issues raised by them were: ability to stop the system any time during the tour; personal and environment context should be the base for tailored information; dynamic information should be present to advise visitors about possible changes in the content; and interactive services should be available in case they need to book services. Therefore, context plays an important role in experimentation with mobile devices and its impact is easier to recognise when observing users

in situ. Many variables might change the nature of interaction with these devices, suggesting that user centred research might clarify them and point to directions for designing systems for specific situations.

Diverse levels of collaboration with users are identified in the literature. In certain cases, users are design partners and act as co-authors throughout the design process. In this situation, named Participatory Design, usually the same group of potential users participates in all the design process phases and work as equals in the development process (Jones & Marsden 2006; Preece et al 2007). Participatory Design approaches are cyclical, informal, holistic, cooperative and evolutionary (Axup 2006). In other cases users are only involved during the requirements phase and usability testing (Abras 2005).

Independent of user involvement, it is cheaper to make changes early in the process than later when the software is ready (Shneiderman 2010). A recent example illustrates this perspective. The company Expedia travel[3] had problems with their online shop system. In their website the field "address" came after the name of the bank, which confused users, leading them to type the bank's address instead of their home address. Therefore, the company website did not complete the transaction because the address of the credit card did not match with the one filled in. It is clear that having users involved in the design process works as a preventive measure to avoid severe problems (Heath 2010).

The process of user centred design is based on the International Organisation for Standardisation – ISO 13407/9241-210, 2010[4]. It comprises three stages (Figure 2):

1. specify the context of use;
2. specify the user and organisational requirements;
3. produce design solutions and evaluate designs against project requirements.

[3] Expedia – extra field in the form http://bit.ly/9VkVfr
[4] http://www.iso.org/iso/catalogue_detail.htm?csnumber=52075

Figure 2: The human centred design model (from O'Grady 2008)

The same line of thought is employed in the model for successful user interfaces proposed by Shneiderman (2010) (see Fig. 3 below). The four pillars of design model do not promise a process without flaws, but it can seep up the process and generate new ideas.

User-interface requirements are well known as an essential way to research users and to gather indications for development of new systems. User requirements are a way to establish which user interface and system type is more suitable for a niche set of people. One way to retrieve this information from users is to use ethnographic observation methods, monitoring the context, behaviour and environment of real users. (Preece 2007, Shneiderman 2010).

Figure 3: The human centred design model (Shneiderman 2010)

Guidelines documents and process are employed to conduct the design process. Some of them are very general and delivered in form of heuristics (Nielsen 1994; Shneiderman 2010). Others are focused on specific subjects such as data display (Tufte 2008; Tullis & Albert 2008; Harris 2000) and device constraints and specifications (Nokia[5], Serco[6], Windows Mobile[7], and Apple[8]).

User interface software tools help to visualise the user interface before complete implementation. Interactive prototypes give users the real sensation of how the system works and are more useful in this sense than paper prototypes (Jones & Marsden 2006; Preece et al 2007). Paper prototypes are more suitable for the beginning of the process, when design concepts are discussed. With interactive prototypes is possible to identify errors in the system architecture and navigation. Numerous tools may serve the purpose of showing how a system works and interacts. Simple PowerPoint presentations and Adobe Flash files to more sophisticated tools such as Sun's Java as well as specific development kits are among the choices. For high fidelity mobile app prototypes, diverse platforms are used according to type of device. In a project for developing a web app for the BBC, eight platforms were considered (Figure 4).

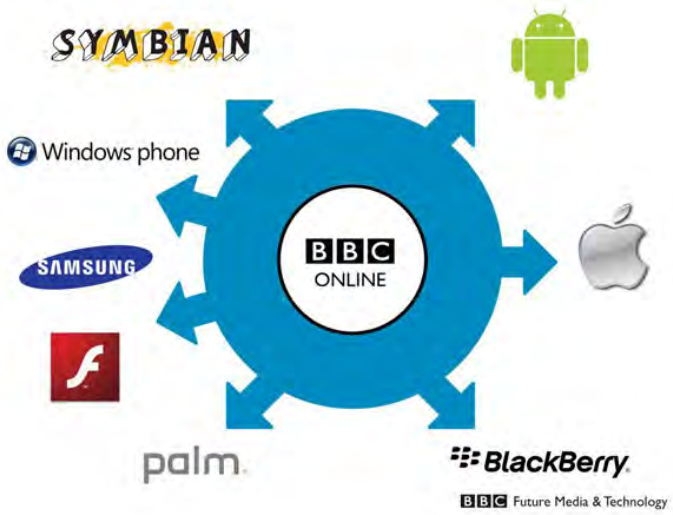

Figure 4: Mobile device platforms

[5] http://wiki.forum.nokia.com/index.php/Category:Mobile_Design
[6] http://www.serco.com/Images/Mobile%20TV%20guidelines_tcm3-13804.pdf
[7] http://msdn.microsoft.com/en-us/library/aa286514.aspx
[8] http://developer.apple.com/iPhone/library/documentation/UserExperience/Conceptual/MobileHIG/PartII/PartII.html#//apple_ref/doc/uid/TP40006556-CH9-SW1

Other alternatives, for developing mobile apps that not require programming expertise, are Apple's Rome project[9]; IWebkit[10] and mobile phone tailored websites added to the home screen as widgets (Figure 5).

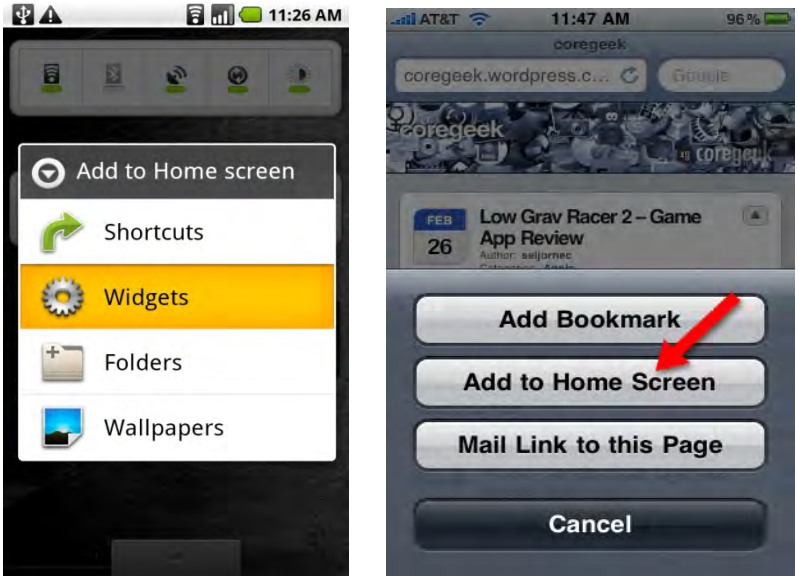

Figure 5: Home screen widgets

Wiketude.me[11] might be a good alternative for map-based content. Technologies used in this project are covered in Chapter 5 - Prototype Development

The last of Shneiderman's pillars concerns refinement through expert reviews and usability testing with users to reach an acceptable product. Expert reviews are necessary to identify severe errors in the systems before user's interaction with it. Sometimes the focus of the research is not only on usability issues but also on content issues. Therefore, it is beneficial to identify usability issues before testing with users. In this way users will not focus on, and be distracted by, usability problems, interacting in a more natural way with the product.

According to Nielsen (2011) a single expert can find 35% of usability problems. This percentage increases when more evaluators are recruited. He recommends the use of about five

[9] http://rome.adobe.com/trailer.html

[10] http://iwebkit.net/

[11] http://wikitude.me/

evaluators, but certainly at least three. Expert evaluation methods are discussed in the next section.

Even though experts may identify major problems with new products, minor problems and problems related to the context are more susceptible to appear in tests with real users. Duh et al (2006) investigated the differences found in usability tests with mobile phones between conventional laboratory tests and real life situations. Overall, 171 problems were identified in the fieldwork and 92 in the lab with the same prototype and similar group of users. Users also reflected more negative behaviour and feelings in the real life settings. Other comparison research with mobile systems by Nielsen et al (2006) identified more usability problems in the field as well, mainly the ones related to cognitive load and interaction styles. Roger et al (2007) agreed that the context plays an important role when evaluating mobile learning systems. In his opinion, even after expert evaluation of the tested system, several usability and user experience issues come to light. Roger et al's (2007) research identified the value of fieldwork research in response to Kjeldskov's (2004) research paper. In Kjeldskov's paper, an experiment with a mobile application was tested by six people in the field and six people in the lab. As a conclusion four key findings were identified:

- Little was added to take the test in field conditions
- The only problem identified in the field and not in the lab was one related to real context of use.
- There was a challenge to evaluate and lack of control in field conditions.
- Both lab and field studies revealed context-aware related problems and high quality of data collection.

Still, this research was not extensive and did not have a large number of subjects. Kallio et al (2005) did a similar study and identified the same usability problems in both settings, although they state that in the field tests users commented more spontaneously about the application than in the laboratory settings. In their opinion, when the objective of the test is the user interface of a mobile application, field tests may not be necessary due to time consuming and higher effort.

Evaluation methods and techniques are explained in the next section and the application of those in this work is available in Evaluation Chapter (6).

2.3.1 Mixed methods and techniques applied in Mobile HCI

It is important to distinguish between the nature of qualitative and quantitative research. It could be suggested that this distinction is not clear. Bryman (2008) supports this notion stating that the status of the distinction is ambiguous and further suggests that the difference is deeper than the superficial issue of the presence or absence of quantification. Blaxter et al. (2006: 64) concur:

> ... the use of questionnaires as a research technique might be seen as a quantitative strategy, whereas interviews and observations might be thought of as qualitative techniques. In practice, however, it is often more complicated than that. Thus, interviews may be structured and analysed in a quantitative manner, as when numeric data is collected or when non-numeric answers are categorised and coded in numeric form. Similarly, surveys may allow for open-ended responses and lead to the in-depth study of individual cases.

Hence, it could be summarised that qualitative is more suitable for observing individual behaviours whereas quantitative is better for broader research.

Human-Computer Interaction (HCI) lies at the intersection between the social and behavioural sciences on the one hand, and computer and information technology on the other hand. It is concerned with understanding how people make use of devices and systems that incorporate or embed computation, and how such devices and systems can be more useful and more usable. (Carroll 2003). Therefore, the use of mixed methods is essential to understand how people interact with computer-based systems. The use of quantitative research shows, for example, the numbers of minutes it takes to perform a task or the number of errors made by users. On the other hand, qualitative research focuses on the nature of something and can be represented by themes, patterns, and stories. (Preece et al, 2007:356). Additionally, the use of qualitative methods is motivated by the need to understand user work before design begins, the inadequacy of many traditional forms of data and requirements gathering when applied to interface design problems, the need to involve users in the design process and data analysis

(Wixon 1995). Qualitative strategies were formerly investigated in the field of mobile services and tourism, including Grounded Theory (Daengbuppha et al 2006), Phenomenological research (Iacucci et al 2000), case studies (Kramer et al 2007) and ethnography (Brown & Chalmers 2003).

The use of mixed methods provides freedom to apply different approaches in the HCI field. Creswell (2009:14) classifies this approach into three general strategies:

- Sequential mixed methods procedures are those in which the researcher seeks to elaborate on or expand on the findings of one method with another method.
- Concurrent mixed methods procedures are those in which the researcher merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem.
- Transformative mixed methods procedures are those in which the researcher uses a theoretical lens as an overarching perspective within a design that contains both quantitative and qualitative data.

Bryman (2008) also highlights some approaches to combining qualitative and quantitative research in mixed methods research:

- Triangulation: when the researcher uses more than one method or source of data in the study of social phenomena.
- Context: The application of this approach was for a qualitative study to provide the context for understanding broad-brush quantitative findings.
- Confirm and discover: The inferences that are derived from a qualitative study are then subsequently tested with quantitative research.

We consider that the strategies presented by Creswell (2009) and the approaches to combining qualitative and quantitative research highlighted by Bryman (2008) are in concordance. For instance, triangulation is present in both sequential and concurrent mixed methods.

Techniques and methods are employed in the design process to facilitate collection, development, evaluation and analysis of data. The choice of a method is related to the purpose

of the activity and what is to be achieved using certain techniques. Additionally, cost and time are variables that have an impact on this selection.

Data gathering methods aim to collect data to understand the nature of potential users and context to serve the base for development. Information collected not only comes from user studies, but also other sources such as research literature, competitor analysis and background experience of designers. Design methods are ways to refine, interpret and envision ideas from data collected in the previous phase, in order to create a product. Information is transformed into a concrete object tailored to potential users. Evaluation methods elucidate certain issues that were not clear in the previous phases and aim to discover how users will use the system and what can be improved before the final system is fully deployed.

In this section priority is given to methods and techniques employed in the process of the thesis.

2.3.1.1 Data Gathering Methods

In order to create a picture of the potential users' behaviour with a mobile cultural guide, in this research study fieldwork observations were the main means of data collection and evaluation. For this reason, observational approaches are described in detail. Self-reporting methods, including questionnaires and semi-structured interviews, were applied in order to support the observations, to provide an overview of design preferences for the interface and to compare answers from participants with diverse profiles (e.g. visitor, resident, international, local).

Field observations

Observational techniques aim to investigate behaviours, interactions and practices in everyday environments. Dezin (1994) describes observation as a technique that seeks to examine the world through relevant human faculties. He emphasises that observers make use not only of their visual faculties, but also other senses, from smell to hearing. In addition, Manson (2002) mentions some of the observational activities and social interactions that an observer will

perform, such as: observing; participating; interrogating; listening and communicating, with a range of other forms of being, doing and thinking. Furthermore, Marshall and Rossman (2006) highlight the importance of observational studies as a method for use in investigations of complex interactions in natural social settings.

Observation is one of the key techniques employed in the human-computer interaction (HCI) field. Early in the design process, observation helps designers to understand the user context, task and goals. Observation conducted later in the development process may be used to investigate how well the developing prototype supports these tasks and goals (Preece et al 2007). This method can reinforce findings and is sometimes combined with other methods in order to gather more accurate and rigorous information (Dezin 1994; Marshall & Rossman 2006; Preece et al 2007).

There are different kinds of observational studies, one of which is known by the term participant observation. According to Bryman (2008), ethnography and participant observation are very difficult to define. In his opinion, participant observation is frequently used as a term to describe observation alone. However, ethnography denotes both the observation and the written outcome of the research. Marshall and Rossman (2006) state that participant observation researchers immerse themselves in the social setting and also observe everything that they can about it. According to Preece et al (2007), where a particular study falls along this spectrum depends on its goal and on the practical and ethical issues that constrain and shape it. In HCI, the role of the researcher differs from that of traditional ethnographers.

> ... in addition to seeking understanding of their subjects, user-interface designers focus on the interfaces for the purpose of changing and improving those interfaces. Also, whereas traditional ethnographers immerse themselves in culture for weeks or months, user-interface designers usually need to limit the process to a period of days or even hours to obtain the relevant data needed to influence the redesign (Shneiderman & Plaisant 2010: 130).

Usually, interactive systems ethnographers use observational studies with a range of other methods such as interviews and focus groups in order to identify the main characteristics of a certain group of people. Jones and Marsden (2006: 98) suggest that it is immensely rewarding to make use of ethnographic methods in mobile design projects. They affirm that after a period of observation, the researcher should have a range of sketches, which can be used to create an overview of the field setting. In their words, "the ethnographer's job is to portray the action in a vividly colourful way both in responding to design team questions and by providing an account resulting from careful reflection" (Jones & Marsden 2006: 98).

The observer may participate in the activities through which s/he seeks to observe the user's behaviours/tasks either directly or indirectly through records. Overt observation occurs when participants are informed about the objectives of the research and are aware of the researcher's presence. In covert observation, observers infiltrate themselves into the activity and do not inform other participants of their presence. According to Bryman (2008), most research projects use overt observation, but both perspectives are adopted sporadically. In the field, in some cases, it is difficult to avoid coming into contact with people who are unaware of the ethnographer's status as a researcher, even though s/he is carrying out overt observation. In addition, it is cumbersome to perform covert observation, as it is difficult to take notes without being noticed by the participants. The researcher cannot take advantage of other methods like interviews, and ethical issues like privacy can arise (Denzin & Lincoln 1994; Bryman 2008).

There are many issues in the literature regarding covert observation and ethical issues (Bryman 2008; Manson 2002; Preece 2007). Among them are issues relating to privacy, deception and the lack of informed consent. In the case of overt observation, the description of what is going to be analysed has to be clear for the participant. In field work, as well as in the evaluation of systems in laboratories, it is important to clarify the purpose of the study, the kind of information that will be collected, who has the rights to the data and analysis, and how this information will be used. Participants must not only be allowed to withdraw from the study at any time, but must also be permitted to ask questions at any time (Marsden & Jones 2006). It is important to give some kind of payment such as vouchers or a certain amount of money in

exchange for the participant's views. This should be communicated verbally, or described in a consent form which users are requested to sign before starting the study.

Sometimes is not easy to classify the role that the researcher will play. A number of authors use the classification of participant and observer roles proposed by Gold (1958), which is based on the level of involvement with the research, such as: complete observer, observer as a participant, participant as an observer and complete participant (Denzin & Lincoln 1994; Bryman 2008). For instance, as a complete observer, a researcher must not be noticed. In this case, video and/or audio recording or photography may help in the task. An observer as participant carries out short periods of observation and conducts semi-structured interviews. The overt stance is applied. The third role is participant as observer, in which the researcher is a complete participant but the participants know their status. The fourth role is the complete participant; the researcher acts as a covert observer, undertaking the same role as an ordinary participant. The decision about which approach to undertake is affected by the kind of research questions that the study aims to answer.

A broad range of studies in the literature has set the stage and structure of observation studies (e.g. Denzin 1994; Bryman 2008; Manson 2002; Marhall & Rossman 1999, 2006, 2011; Shneiderman & Plaisant 2010: 130). Below is a discussion of the most important issues to be addressed when carrying out observation studies.

Select the setting – Researchers should select a setting that contains everything in which they are interested (or as much of the desired material as possible). It is also important to check the availability of the participants and the venue.
Research teams members – The researchers may have to train members in what to observe and how to take notes.
Sampling – According to Bryman (2008), there are certain types of sampling that are more likely to be used in observational studies, such as:

Convenience sampling: This is a sample that is available to the researcher due to its accessibility;

Snowball sampling: The researcher contacts a small group of people who are relevant to the research and then use these to initiate contact with others;

Theoretical sampling: This is the process of data collection in order to generate theory whereby the analyst jointly collects, codes and analyses the data and decides which data to collect next and where to find them, in order to develop the theory as it emerges (Glaser & Strauss 1967: 45);

Representative sampling: Jones and Marsden (2006) give advice on selecting a representative sample to observe in the context of mobile design. For instance, a group that characterises the entire population or a broad section of it should include a diverse range of people;

Defining a broad research question: Normally, the study is guided by a broad research question. After familiarisation with the field, new findings will guide the research.

Data analysis: This is covered in Section 2.3.1.4.

Overall, during the early stages of research, the investigator typically enters the setting with broad areas of interest but without predetermined categories. The value of this is that the researcher is able to discover recurring patterns of behaviours and relationships. After this stage, some patterns are identified and described for an early analysis of fieldwork and records.

There is a broad range of techniques for registering the information identified during observational studies. In the case of direct observation, field notes are the typical choice. The literature provides some general principles on how to take notes (Bryman 2008; Manson 2002; Preece et al 2007). The focus and the type of notes that should be taken are related to the research questions of the study. It is important to be aware that sometimes, the participants may act differently or be self-conscious while the researcher is taking notes. Therefore, most authors suggest carrying out the observations only over short periods of time. Notes should also be clear and legible. Marshall and Rossman (2006) also focus on the recording data perspective, saying that detailed, non-judgmental and concrete descriptions of what has been observed should be included in the field notes. After a long day of experiments, researchers should review and reflect on their notes, adding observations where necessary.

Think aloud technique

In interaction design studies, several techniques are applied in order to capture user data, including think aloud protocols, video and audio recording and photography. The think aloud technique, developed by Erikson and Simon (1985), requires subjects to verbalise their every action or thought during the study. According to Jones and Marsden (2006), this technique has some drawbacks, e.g. it is embarrassing and people forget to speak after a while. A more satisfactory technique may be the constructive interaction technique suggested by Nielsen and Mack (1994), in which two participants exchange their opinions with each other, resulting in a more natural task.

Multimedia documentation

Video and audio recordings are employed at the beginning of the project in order to collect information for the development process and at the end of the project in order to evaluate the prototype design. Video recordings have the advantage of capturing both visual and audio data, but can be intrusive. However, after a while, participants concentrate on the tasks and forget that they are being filmed. Other positive aspects of video recording are that it allows us to capture what users are doing on the system screen, to go back and analyse what happened after or before a specific event and to zoom in on the scene in order to analyse the user's face to give some indication of his/her emotional state (Jones and Marsden 2006). Preece et al (2007) mention that is easy to miss things that are outside of the camera's view, which is why the use of more than one camera is an advantage. In addition, the use of more cameras provides a second opportunity to understand data recorded in noisy and windy urban environments.

Photographs also provide contextual information and are an excellent method in addition of gathering audio data and notes (Preece et al 2007). Similarly, sketches of the site, maps, pictures and documents are other resources that can be analysed (Jones and Marsden 2006). Alternatively, indirect observations can be made when direct observation would be intrusive or participants cannot be present on the day of the study (Preece et al 2007). Diaries and interaction logs are examples of this type of data.

Diaries and interaction logs

Diaries are suitable for when the researcher cannot be with the participant when interesting things might happen. With this technique, participants are asked to enter their thoughts about a subject in a diary, through a phone call or on a website (Jones & Marsden 2006).

Interaction logs involve the use of software to track and record the user's activities in a log that can be analysed later (Preece 2007; Jones & Marsden 2006). In this way, researchers can analyse different aspects of the usability of the activity.

Questionnaires and semi-structured interviews

Questionnaires are usually applied in order to request demographic information and to elicit a participant's views of a certain system. The questions should be designed to extract the participant's opinion efficiently and should also be easy to analyse. Tullis and Albert (2008) suggest the use of rating scales such as Likert scales and semantic differential scales for this purpose.

Typical Likert scales consist of positive and negative statements with which participants rate their agreement. Normally, these scales have a five-point scale of agreement, e.g. strongly disagree, disagree, neither agree nor disagree, agree and strongly agree. For instance, in a study integrating fitness and a mobile map-based guide, Buttussi et al (2006) invited 12 participants to test the new system (MOPET). They followed the trails encouraged by an avatar on the mobile guide that reported on their performance as they went. After the test, participants answered a questionnaire rating their motivation and the support offered by the guide in performing the exercises via a Likert scale. As a result, users agreed that MOPET guided them in how to perform the exercises correctly.

On the other hand, semantic differential scales involve the presentation of antithetical words at the extreme points of the scale. As with Likert scales, a five to seven-point scale is normally used. The challenge is to choose suitable and clear opposites so as not to confuse respondents and to obtain dependable data. For instance, Tonder and Wesson (2010) used semantic scales to identify users' overall impressions of using tilt and keypad interaction in a mobile map-based

application (app). The findings indicated that keypad interaction was preferred for tasks requiring precise selection, while tilt interaction offered controllability, efficiency and ease of use for navigation tasks.

Another popular questionnaire is the System Usability Scale (SUS), which was developed by John Brooke (1996). The SUS consists of 10 statements with which users rate their agreement. Half of the questions are positively worded and the other half negatively worded. Bangor et al (2009) found that the SUS was highly reliable and useful over a wide range of types of interface. In the same study, they substituted the scores for adjectives and compared them to the school grading scale and acceptability ranges. The scores are classified according to their acceptability. If the mean score is less than 50, the system does not have an acceptable level of usability. A score between 50 and 70 is classified as indicative of marginal acceptability, while a score higher than 70 is acceptable (Figure 6). The same model was adopted in our mobile phone study (Section 4.2.3). More information on sample questionnaires for usability metrics can be found in Shneiderman (2010), Preece (2007) and Tullis and Albert (2008).

Figure 6: SUS scale (from Bangor et al 2009)

Open-ended questions and interviews are used for qualitative and exploratory research. These may be hard to analyse (Tullis & Albert 2008; Jones & Marsden 2006) but lead to interesting findings, as the answers are not predetermined. In a study using a mobile system to track the behaviour of young people, this is clear. Reid et al (2008) claim that certain results would not have been available if closed-ended questions were present in their research. In their opinion, when participants are asked to answer closed-ended questions, they have to reframe their

thoughts and behaviour into the options given, while this does not occur when open-ended questions are used.

Open-ended questions are hard to analyse because the answers may be long and very diverse. The researcher needs to interpret the answers and to find patterns in order to analyse the data. According to Babbie (2009) this opens the possibilities of misunderstanding and researcher bias. Therefore, the researcher should use a set of codes emerging from the first analysis and try to apply it to the subsequent analyses, with the flexibility to add new codes. It is important to test this method with other researchers, as well as testing questionnaires in pilot studies before using them with a large number of subjects in order to correct possible mistakes and check the time taken to answer the questions (Walliman 2006).

Semi-structured interviews

Occasionally, the time available to carry out experiments is not enough for users to write long answers. At other times, users do not feel encouraged to write their own opinions. An alternative is to use semi-structured interviews. Semi-structured interviews are employed in order to support users in answering questionnaires and to give users opportunities to share their experience in a more natural way. According to Bernard (2000), this is the best type of interview for questioning someone who will only be interviewed once. It has the freedom of an unstructured interview, but is based on a questionnaire guide. Audio recordings might be used to register the findings, or the researcher might take notes, and therefore users do not have to write their own answers as they would in a questionnaire. For instance, semi-structured interviewing was the method chosen to collect requirements in a project to develop accessible mobile phones for individuals with cognitive disabilities. This method was suitable for interviewing people with disabilities and for developing a contextual and detailed understanding of the role that mobile phones can play in the lives of individuals with cognitive disabilities (Dawe 2007). As a result, it was found that the mobile phone should be rugged and

durable, and should have a simplified menu system, charger input, voicemail access and features targeted at specific remote communication tasks (e.g. sharing one's location).

2.3.1.2 Design methods

Design activities aim to employ the knowledge acquired in the data collection process in designing a product. The main trends that have been identified in the universe in question should be extracted and interpreted in order to give shape to the product and specify requirements. These are applied to the conceptual design, and later to the prototype. Personas and scenarios are inspired by the preliminary research in the field, and used to identify functionality, content and appearance of a prototype.

Requirements elicitation

Requirements are statements that define which functional and quality characteristics the system should have. Requirements usually emerge from necessities identified in fieldwork and competitor analysis. Researchers may review the literature in the field and find certain requirements that have already been collected by others to apply to a new product. There are different kinds of requirements: functional and quality requirements. According to the template proposed by Robertson et al (2010), eight types of quality requirements can be identified: look and feel requirements; usability and humanity requirements; performance requirements; operational requirements; maintainability and support requirements; security requirements; cultural and political requirements; and legal requirements. The use of this classification helps to identify diverse requirements and to focus not only on functional requirements. As regards guided tours of monuments and sculptures, a location-based multimedia information system of monuments in Germany (2004) is worth mentioning. The system, called MobiDENK, was tested by archaeologists and monument conservationists. As a result, the users envisioned the system as a great opportunity to integrate mobile technology into their profession. Conversely, some technical requirements were pointed out as drawbacks in the fieldwork, such as the restricted battery life, the PDA's screen visibility in sunny weather and the app speed.

Conceptual design

It is not only user requirements, but also factors involved in the activity that emerge from the fieldwork. The environmental context, communication and personal behaviour might influence how tasks will be performed with the envisioned product. In addition to a list of requirements, ideas and concepts are put forward about what a system should do and how it should be presented on the interface (Preece 2007). Messeter and Johansson (2008) explored the design ideas and concepts of place-specific computing based on fieldwork carried out in four countries. The study resulted in 36 concepts, which are available for consultation on their website.[12] In this phase, general specifications of the interface design were developed, and only the main ideas were illustrated by a prototype. From the ubiquitous learning perspective, Chen et al (2008) described an experiment conducted with 54 college students using a cross-platform learning website. The conceptual design of their system covered device-adaptive and user model-adaptive components in detail. Three models of information awareness were developed in order to scaffold students according to their learning status, schedule reminders and mentor arrangement. After testing the system, it was possible to affirm that the task accomplishment rate and the learning goal achievement rate could be improved with the support of the ubiquitous learning website.

Personas and scenarios

Personas are characters who embody certain characteristics of a niche user group. They might be inspired by source documents from field studies. As designs are proposed, they can be checked against personas (Jones & Marsden 2006). The use of personas avoids elastic users facilitating the communication in the development group. Hence, it is the persona who would behave in a certain manner in a specific situation, and not the designer. Personas are actors in scenarios who illustrate interaction with products. According to Carroll (2000), every scenario involves at least one agent (persona) and one goal, and if the agent is different, the goal may change. Scenarios are the setting. Design cycles are contemplated in scenarios in order to illustrate interaction and user reactions in a real-life situation. Storyboards are one way to illustrate scenarios and to clarify interaction. From scenarios, it is possible to extract the main necessary elements of the system. De Sá and Carriço (2008) provide a set of guidelines for

[12] http://do-fi.com/REcult/index.php?option=com_content&task=blogsection&id=8&Itemid=33

developing scenarios for designing mobile devices. The pervasive nature of the mobile context is affected by several factors that might interfere in the activity. Therefore, the authors suggest a framework with three types of modular concept that should be considered by designers: contextual scenarios (composed of a set of variables), scenario transitions (moving from one context to another while using the system) and scenario variables (details that make up each contextual scenario). The latter covers the location and setting, movement and posture, workloads, distractions and activities, devices and usages, and users and personas.

Prototyping

In this stage, system features are specified and transferred to a physical design. Low-tech and high-tech prototypes are normally employed to verify modes of interaction and interface design. Low-tech prototypes are relevant to the resolution of navigational problems and errors that would be complicated to solve after coding. Paper-based prototypes and PowerPoint presentations may serve this purpose. High-tech prototypes are more similar to the final product and are usually ready to be tested by experts and users.

Carter and Mankoff (2005) decided to test a paper-based prototype of their ubiquitous system for supporting office workers because of the need to install a technical infrastructure in many locations. Pen, papers and Post-it notes were used by potential users to write notes and make requests on the paper prototype, e.g. to request paper for a printer. Some facilitators were responsible for answering these requests using the same method. The facilitators and users were interviewed about their experience and possible changes. Remote access activity was highlighted by participants, e.g. reserve a meeting room from the prototype. In their opinion, it was advantageous to use the paper prototype, as it generated requirements for new services that the system should support and identified points at which computational support was needed in the workplace.

The question of how close the prototype should be to the final product was investigated by Sauer and Sonderegger (2009). Six experiments were carried out in order to study prototype fidelity. Participants were assigned to diverse user groups such as: paper prototype; computer-based prototype; fully operational appliance, highly appealing and moderately appealing

prototype. The task completion time was higher for the computer-based simulation than for the fully operational appliance. On the other hand, the results suggested that perceived usability may be more strongly associated with attractiveness ratings than objectively measured usability parameters. Therefore, aesthetics is as relevant as efficiency and effectiveness for user satisfaction.

2.3.1.3 Evaluation methods

Evaluation can be informal or formal. The first case includes techniques such as self-generated evaluation, peer reviews and casual user testing, which can provide insight into what should be improved in the final product. In the latter, expert evaluations and user testing are applied. Evaluation might occur during the design process (formative evaluation) or in the final stage (summative evaluation) (Preece 2007). As Duh et al (2006) and Jeffries et al (1991) both suggest, methods of usability evaluation can be categorised into four main areas: heuristic evaluation, cognitive walkthroughs, usability testing and software guidelines. The latter area is frequently employed as a guide for heuristic evaluators.

Some techniques that are employed in the early stages of development with users may also be applied in the evaluation phase. These include observation of users interacting with the product in the field and/or laboratory settings, questionnaires and interviews. These methods are specified in **Section 2.3.1.1.** In addition, cognitive walkthroughs and heuristic evaluation are the main techniques used by experts.

Usability testing

When people first hear about usability testing, they sometimes assume that it is the same as a focus group. Tullis and Albert (2008: 58) clarify the term according to their experience:

> … the similarity between the two methods begins and ends with the fact that they both involve representative participants. In a focus group, the participants commonly watch someone demonstrate or describe a potential product, and then react to it. In a usability test, the participants actually try to use some version of the product

themselves. We've seen many cases where a prototype got rave reviews from focus groups and then failed miserably in a usability test.

Giving users a version of the product to test can highlight more interesting issues than demonstrating it and asking for opinions. The same might occur according to the choice of setting (laboratory or field test). Field tests provide a real context for the user's experience, despite being more time-consuming and expensive (**Section 2.3.1.1**).

Similar approaches for collecting data are also effective during evaluation procedures. Feedback achieved through questionnaires, interviews and thinkaloud techniques allows designers to improve the products based on users' opinions. In addition, the use of observational studies helps to clarify the user's interaction with the product and the influence of contextual factors on his/her experience (**Section 2.2.1.1**).

Heuristic evaluation

Heuristics evaluation is an expert method of examining system usability. Authors have different opinions of the essence of this technique. Jeffries et al (1991) consider this type of evaluation to be based upon the expertise and experience of the evaluator and that it is not necessary to follow pre-determined design and usability guidelines (Nielsen 1994; Preece 2007). The use of a set of heuristics and guidelines is valued by Jones and Marsden (2006: 208) – "… as someone who has received these reports on their cherished designs, we appreciate it when the evaluator lists which particular heuristic is being violated, to show that the assessment is based on rational evaluation and not personal opinion." This method is considered as an alternative to formal usability tests with users. It generally requires fewer resources and less time than testing with users (Jones & Marsden 2006; de Kock et al 2009).

After comparing the results of a heuristic evaluation study and a formal usability evaluation by eye tracking, de Kock et al (2009) identified several differences. First, the purpose of a heuristic evaluation differs from that of usability tests. The former aims to identify usability errors while the second focuses on effectiveness, efficiency and user satisfaction. Second, the resultant data from a heuristic evaluation are highly influenced by the expert's experience. In a usability evaluation, it is possible to triangulate results due to a diverse range of methods applied in the

same test – observation, questionnaires and usability measures. Third, a heuristic evaluation tends to answer questions such as *why* and *when*, while usability tests consider *what* and *how* information is acquired.

Cognitive walkthrough

Cognitive walkthrough is an expert evaluation method that focuses on the steps and goals taken by users in order to predict and solve problems with a future system. It was created by Poulsen et al (1992) to examine users' cognitive activities. Knowledgeable experts are necessary for this method, and sometimes the process is somewhat tedious (Jeffries et al 1991). The goals and steps taken by users should be well planned in order to facilitate experts' reviews and to ensure that they are representative of major interactions (Mowat 2002). The strengths of this technique are the focus on detailed problems experienced by users and that users do not need to be present; not even a functional prototype is necessary. However, this technique is highly time-consuming. Preece et al (2007) presents a model (p. 703) of how to conduct a cognitive walkthrough. For every task to be accomplished, evaluators should answer "yes" or "no" to four questions –

Will the action be sufficiently evident to the user?

Will users know what to do?

Will users understand how to do it?

Will users understand from feedback whether or not the action was correct?

– and add their comments. Positive responses to the individual questions support the inference that the interface will be easily learnt. Negative responses highlight those steps in an operating procedure that may be difficult to learn (Lewis et al 1990; Mowat 2002).

Cognitive walkthrough was the method chosen in two projects involved with outdoor mobile guides. In the first project, six experts applied this method, combined with the think aloud technique, in order to gather requirements for the development of a mobile guide for City University, London, in the UK (Liarokapis & Montain 2007). Experts answered two questionnaires, one relating to general issues about human navigation and another testing four hypotheses for virtual navigation. The qualitative evaluation resulted in insights about navigator speed, destination view and search enquires for the future multimodal guide. The

second project – a mobile tourist guide for Paris that allowed two simultaneous input modalities (speech and a pen) – was evaluated by 12 Portuguese and Norwegian experts (Almeida et al 2002). This study consisted of sequential steps, such as: introduction to the project; exploration of the system and comments about any apparent issues; explanation of the cognitive walkthrough method and clarification of questions to be answered; and cognitive walkthrough evaluation and discussion of the main issues identified. This process took approximately two hours. Overall, the findings were that neither the use of multimodal inputs nor the possibility of using them simultaneously was intuitive. Experts suggested the addition of an introduction explaining the service, e.g. a video. They also offered recommendations for improving the graphical interface and the design of the buttons.

More explanations about expert reviews and a list of methods can be found in Shneiderman (2010: 152). These methods were not covered here because they are not common practice in the mobile computing field and were not applied in the present research.

2.3.1.4 Data analysis methods

As previously affirmed, this research has two strands, in order to conduct and analyse the data gathered. Qualitative approaches permeate most of the research process, but quantitative approaches are also present. Therefore, mixed methods were applied in order to uncover relevant issues for designing outdoor mobile guides.

Qualitative analysis

The value of this method is that the researcher is able to discover recurring patterns of behaviour and relationship issues in the target group. The study continues until the findings starting to repeat consistently. Different approaches can be applied for data analysis according to the nature of the research. Creswell (2009), Marshall and Rossman (2006) and Bryman (2008) offer an overview of typical procedures in qualitative data analysis: (a) organising the data; (b) immersion in the data – reading through all data; (c) generating codes by theme and/or description; (d) finding relations among themes/description; (e) interpreting the meaning of themes/descriptions; and (f) validating the accuracy of the information.

It is advisable to carry out the first step (Bryman 2008) while the data are being collected. In this phase, data from interviews and video observations are transcribed, field notes are typed up and data are organised according to the source of information. The following step involves creating an overview of the issues which have emerged or been examined in the study. With the highlighted issues organised into chunks, codes are generated. Coding is the process of organising the material into chunks or segments of text before studying the meaning of the information (Rossman & Rallis, 1998: 171) and labelling it with terms (Creswell 2009). There are certain tools that can make this stage faster, easier and more accurate, such as: software for analysing videos (NVivo) and spreadsheet applications and tools that support the organisation, coding and manipulation of data. After finding the mainstream categories (terms), the researcher looks for relationships, and new categories may emerge during this process. Findings are described through the interpretation of categories, which could be the researcher's personal interpretation or/and the meaning derived from a comparison with the literature or theories. Therefore, information could be validated through a comparison to previous research and new questions may emerge (Creswell 2009: 188), (Figure 7).

The findings are described as contextual trends, and the use of quotations from participants affirms the truthfulness of the research. In addition, initial hypotheses are tested according to the results, and some questions will not have answers (Creswell 2009), perhaps because of the sample size, and therefore more attention should be given to this issue in future research. The use of questions and hypotheses in the initial phase of the study helps the researcher to understand the events, participants and setting (Goetz & LeCompte 1984).

Not only do the recognised patterns, categorisations and hypotheses provide options for analysing the data, but also the recognition of critical incidents. In interaction design, critical incident analysis has been used in a variety of ways, but the main focus is to identify specific incidents that are significant, and then to focus on these incidents and analyse them in detail, using the rest of the data collected as a context to inform the interpretation (Preece et al 2007: 384).

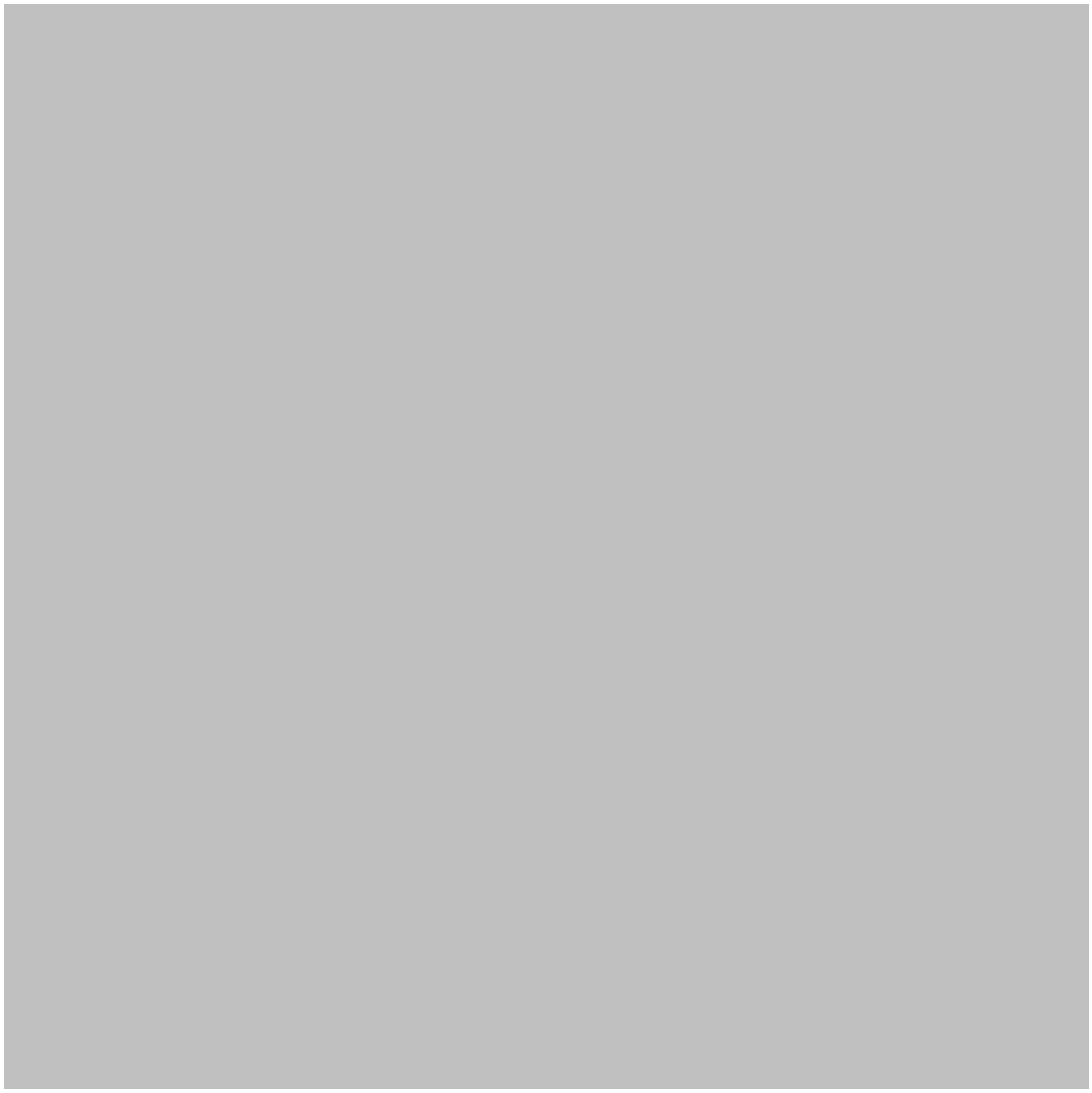

Figure 7: Validation of data (Creswell 2009: 185)

Mixed methods analysis

Similar incidents/categories may be seen as emphasising the strength of issues in the data. Therefore, mixed methods might be applied. Data transformation and content analysis are examples of this approach.

Data transformation is a quantification of qualitative data. This involves creating qualitative codes and themes, and then counting the number of times they occur in the textual data. This enables researchers to compare quantitative results with qualitative data (Creswell 2009: 218).

A more structured and well-known methodology in this line is content analysis. This is considered to be a quantitative approach, despite the fact that in the first steps of the analysis,

categories and codes are not always pre-defined. Patterns emerge from the data, key aspects are identified and their frequency is counted. Hence, content analysis reduces qualitative data to a quantified form (Love 2005). It is a flexible, objective and unobtrusive method (Bryman 2008: 289). It is easy to identify the steps of the content analysis approach in Bryman's study aimed at analysing the combined use of qualitative and quantitative research in 232 articles.

First, the rationale given by the authors for combining the two approaches to data collection and/or analysis is coded. For this exercise, the reasons that were given before the findings were presented are typically examined. Then, the ways in which quantitative and qualitative research were actually combined are coded. This coding presents the authors' reflections on what they feel has been gleaned from combining quantitative and qualitative research, and any ways in which the two were combined which were not reflected in the authors' accounts. The purpose of discriminating between these two ways of thinking about the justification for multi-strategy research was that authors' accounts of why they intended to combine quantitative and qualitative research might differ from how they actually combined the methods in practice (Bryman 2006).

Paay et al (2009) describe how content analysis was undertaken in order to analyse and represent people's understanding of the physical and social aspects of urban settings in order to develop a digital environment. Elements of the physical environment were recorded in the form of photographs and field notes. These elements were coded according to five categories proposed by Lynch (1960) – landmarks, districts, nodes, edges and paths – based on the focal element in each image. Elements were also coded based on 253 patterns, which were investigated by Alexander et al (1977). Later, maps of the setting – Federation Square, Melbourne, Australia – were created featuring the same elements. The social context was analysed using rapid ethnographic methods and contextual interviews. In the opinion of the researchers (Paay et al 2009), social and physical elements in the space would not be noticed if the researcher merely examined the original data or visited the space. The results were applied in a pervasive prototype to enrich people's experiences of Federation Square. For example, the new system identifies people's previous interactions in the same place, and so it is possible to

access information about familiar paths and places that have been visited, the estimated waiting time for a friend, and navigation based on known landmarks.

Quantitative analysis

Interaction design data are typically analysed using simple statistics (Preece 2007). The issues that are relevant in the context of the study are denominated as variables. Variables are classified as nominal, ordinal, interval, ratio, dependent and independent. Nominal variables can be defined using categories that are qualitative in nature (e.g. gender). Ordinal ones vary according to degrees (e.g. satisfaction). Interval variables are when the difference between two values is meaningful (e.g. temperature). Ratio variables have the same characteristics as interval variables, but a zero value exists (Rees 2001; Rubin 2010). Dependent variables record the effect provoked by the independent variable, and this is what is measured (Babbie 2010; Rubin 2010; Thomas 2011). For instance, an experimental evaluation of a mobile guide in the field used age as the independent variable and usability measures as dependent variables. The authors (Goodman et al 2004) suggest a summary of usability measures they found relevant and recommended methods to be employed for evaluating mobile guides based on the study. These included timings, errors, perceived workload, distance travelled and route taken, walking speed and comfort.

The data may be described as descriptive, without saying anything about the large population size. Another type of classification is inferential, from which conclusions can be drawn about a large population (Tullis & Albert 2008). Descriptive statistics covers the measures relating to central tendency, tables and cross-tabulation, which are other ways of investigating data (Bryman 2008; Love 2005; Tullis & Albert 2008). In this work, the explanation will be limited to measures of central tendency, tables and cross-tabulation. More information on how to use statistics in mobile HCI research is available from Love (2005) and Tullis and Albert (2008).

Measures of central tendency are denominated as the mean, median and mode. The mean is the average score of the dataset, in the everyday sense of the term. The median is the central value of the distribution (half of the values are smaller than or equal to this value). The mode is the value that occurs most frequently within the dataset (Rees 2001; Rubin 2010; Love 2005).

When the data have a more limited set of values (such as subjective rating scales), the mode is more useful than when the data are continuous (e.g. completion times) (Tullis & Albert 2008).

Tables are used to display counts and percentages for individual variables or to compare one or more variables (cross tabulation). Cross tabulation tables show whether and to what extent two or more nominal-level variables are related. They display the frequency and/or percentage of the categories of one variable cross-tabulated with the frequency and/or percentage of another variable or variables (Rubin 2010: 188).

Quantitative data analysis might be assisted by a statistics software package, such as Minitab or Microsoft Excel.

2.4 The process of this research

A description of each phase is available in the next section (2.4.1), and the outcomes and lessons learnt are reported in the Results chapter. This research is reported according to the model proposed by Collins et al (2004). The goals and elements of the design and the research setting are covered in the Introduction (1.3).

2.4.1 Description of each phase

Design research guided the activities of the study. Design research is supported by a user-centred design approach and mixed methods. The main sections of a design research study are: (a) preliminary research; (b) prototyping phase; (c) assessment phase; and (d) reflection and documentation (Plomp 2007). All of the sections are related, and it would not be possible to produce results without any one of them. A description of each phase is given here, and is also illustrated by Figure 8.

Preliminary research was carried out through deskwork and fieldwork. It concerned three main goals. First, in the literature review, competitor analyses and field studies were used as sources to generate requirements for the following stages. Second, the preliminary investigation provided the base from which to develop a theory, illustrated by a framework of mobile guide

user experience in outdoor settings. Third, the information acquired was used to validate the findings at the end of the process.

The literature review (Section 5.2.2) and competitor analysis (Section 5.2.1) served to indicate the way in which the research should be constructed, the constraints involved in developing apps for mobile devices and to provide an understanding of the state and nature of the field. The literature review assisted in validating the findings and served to verify the shortage of user research in displaying content on mobile devices. The competitor analysis was relevant for identifying main features of competitor applications, technical issues and the way in which commercial apps display cultural information on screens on mobile device. Certain apps had high-level features; it was not possible to follow the same technological level in this research (see Chapter 3 – Background).

Mixed methods were employed in order to collect and analyse field data. Field studies were chosen as the main way to collect data in order to inform the development phase and evaluate the prototype. Users were considered to be informants in the design process, and not co-authors. Different groups of potential users were researched. In addition, not all of the phases of the design process were based on user research. Participatory techniques were applied, but this study cannot be considered to have a participatory design. The process applied in this work followed established phases such as: design activities with potential users; generate requirements; prototype design and evaluation. In this chapter, a summary of the methods employed to collect data is given. More details of these studies are available in Chapter Four.

The first fieldwork aimed to produce an overview of the cultural heritage context. Participant observation was applied in order to identify how tourist guides lead groups of people in cultural heritage settings and how mobile technologies could fit into that reality. Audio transcriptions and field notes were acquired. The field notes guided the analysis and offered guidelines for the main categories to look for in the audio transcriptions. No formal requirements were produced by this study. It guided the subsequent studies to focus on visitors, short-term residents and long-term residents. Moreover, this study highlighted some behaviours of visitors

and tour guides that were then investigated in subsequent studies. The process and results of this study are available in Chapter Four, Section 4.2.1.

The second field study centred on the perspective of being guided by a paper-based guide. Convenience and snowball sampling were used to recruit participants. The participants could follow the guide as they wished while applying the think aloud technique. The sessions were video and audio recorded. Two video cameras were used in this study; one to capture the interaction between the participants and the environment and the other to capture the material in their hands. A pilot study was conducted with one participant to check the tour length and to identify possible improvements to the questionnaire. When the participants were accompanied by someone on the tour, they preferred to do the study without the researcher. Formal payment was not a part of this study. In exchange for their participation, the participants enjoyed a cream tea after the tour. At this stage, the participants also answered a questionnaire and a semi-structure interview.

The participants were questioned about demographic information and rated their satisfaction with the presentation of the booklet through Likert scales, as well as the influence of the environment on the activity (e.g. noise, weather, density of people). The semi-structured interview covered open-ended questions about the participants' comprehension of the content and the possibility of having the information in the booklet on mobile phones. An exploratory and qualitative approach was undertaken in order to conduct the data analysis. The data were coded after typing out all of the questionnaires, semi-structured interviews and video transcriptions. Categories emerged from the data and pre-determinate hypotheses helped to find relationships between the categories. This process was facilitated by the use of NVivo software. The main categories that emerged were: navigation; presentation; content; interaction and internal factors. In addition, 33 requirements accompanied by issues that occurred in the tours were gathered and classified according the strength of evidence. See Chapter 4, Section 4.2.2 for details and the findings of this fieldwork.

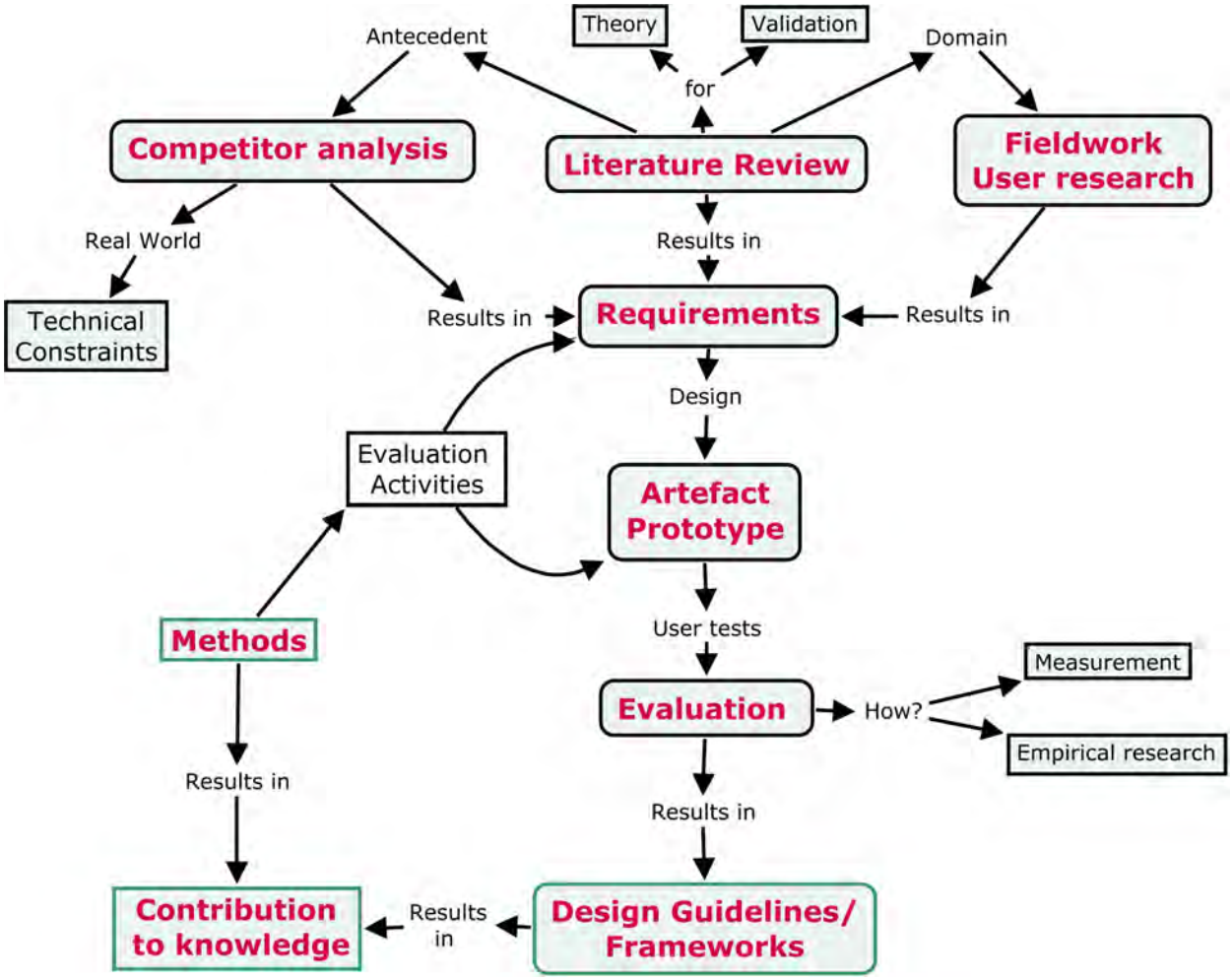

Figure 8: Research methodology

The third field study was intended to clarify whether the requirements acquired in the previous study would be repeated in a study with the same information displayed on mobile phones. There was also a possibility that new requirements would emerge by changing the support. An app called Wikitude and the HTC Magic touch screen mobile device displayed the content. The Wikitude app displayed POI (Points of Interest, in this case monuments and sculptures) in three views: a map, a camera view and a list. According to the results of the previous study, the participants were curious to know about the monuments on their way, which is why historical monuments were included in this tour along with sculptures. Instructions for using the app and the phone were given to participants at the beginning of the tour. They were also advised to employ the think aloud technique and encouraged to express their thoughts, not simply to

describe their interaction with the device. The participants wore a head camera in order to film their interactions with the screen and to record their voice. This study was more focused on the support, and so only one camera was necessary. Again, when the participants were accompanied by someone on the tour, they preferred to do the study without the researcher. Usually, the participants following the tour alone were shy about using the equipment and employing the think aloud technique. In such cases, the researcher accompanied them. Following the tour, the participants answered a questionnaire and a semi-structure interview. This time, Likert scales, semantic differential scales and system usability scales, as well as demographic questions, were answered by the participants. The objective was to rate the participants' experience, environmental influences on the activity, the graphic interface and satisfaction with and preference for interactive elements. Four questions were asked in order to validate the content, the use of multimedia in the tour and the participants' expectations of the new features. The participants were free to add any comments to the questionnaire forms. The location in which the questionnaires were answered was chosen by the participants; the researcher indicated the public library as an option but some participants preferred open-air settings. They were rewarded with a £12 food voucher. The data analysis was guided by, but not restricted to, the main categories that emerged in the previous field study. As expected, interaction issues appeared more frequently than in the previous studies. Therefore, new issues came to light. In addition, three experts participated in a data analysis meeting and uncovered some relevant issues to be considered as well, which are exemplified in Section 4.2.3.2.1. The analysis was assisted by the Nvivo software, in which video transcriptions, questionnaires and semi-structured interviews were typed out. Presentation, content and context were analysed through the interaction perspective. "Look and feel" was identified as a better label for "presentation" because more senses were involved in interaction with touch screen mobile phones, such as sight, hearing and touch. A combination of similar issues resulted in the creation of new sub-categories. Ultimately, 57 requirements accompanied by issues were acquired. As in the previous study, issues were rated based on their occurrence resulting in requirements of different strengths. More information about this study can be found in Chapter Four, Section 4.2.3.

Prototyping phase – requirements are offered as a base for the prototype design. They were the result of three data sources: the literature review (Section 5.2.1), competitor analysis (Section 5.2.2) and fieldwork (Section 5.2.3). Requirements from the fieldwork were compared using a whiteboard. Some of them were discarded because of duplication, technical constraints or for being outside of the scope of this work. Discarded issues and requirements were kept to see whether they would be repeated in the evaluation phase, which would provide stronger evidence. A list of 50 requirements resulting from the fieldwork was applied to the prototype design (Annex G and Section 5.2.3).

The conceptual design (sect. 5.3) was created and illustrated by the low-tech prototype (Section 5.3.1). Four scenarios (5.3.3) with six fictitious personas (5.3.1) inspired by real participants in the fieldwork covered the main interaction cycles with the future mobile guide. A product definition statement was created, as follows: an app to help visitors and residents to comprehend history through outdoor monuments in Brighton, UK (sect. 5.3.4). The physical design (Section 5.4) was adapted to the interaction cycles of the scenarios, following the interface and content design (Sections 5.4.1 and 5.4.2). The interface design was created based on requirements established using Adobe Illustrator software. The content was modified according to requirements suggested by participants in the fieldwork. In addition, a conceptual map tool (Cmap Tools) was used to organise the content clusters. The steps covered in the scenarios were demonstrated with the user interface design (Section 5.4.3). Therefore, the specifications were ready for developing the mobile app. The mobile app was developed in Adobe Flash Lite 2.2 and tailored to the HTC Hero device (Section5.5).

Assessment phase – Two expert evaluations and one usability evaluation with users were necessary in order to assess the prototype app.

The expert evaluations were divided into content and user-experience evaluations. The aim of the expert evaluations was to identify any inconsistencies before user testing. Two cultural heritage experts reviewed the content of the app (Section 6.2). Text, links and media files were sent by e-mail and received back with suggestions and corrections to be applied in the prototype. During this phase, the experts did not see the content as part of the final design,

and therefore the focus was on the content itself. These suggestions were applied to the high-tech prototype and the app was tested in sequence by six experts in the mobile interface design field (Section 6.3). Cognitive walkthrough (Section 3.2.3.3c) was the method chosen to identify any drawbacks before user testing. This was a laboratory-based activity and took approximately 20-30 minutes. The experts were asked to follow 20 steps and to answer contextual questions for every step. They could add suggestions for improvements to the form or verbalise their concerns. The researcher accompanied them, making it possible to identify critical parts of their experience and to take notes. They made 31 recommendations. Twenty were applied to the prototype app, and 11 were left to test with users. Some of the recommendations were not applied due to technical constraints. The relevance of those 11 recommendations was also analysed with users (Section 6.4.5). Experts tested the session of the prototype app with the overall multimedia content available (the presence of hyperlinks, additional information to be accessed from pictures, audio and video). This version attended to the requirements phase, but did not allow room for users to give their opinions about the presentation of the multimedia content. In order to test the users' preference in terms of content presentation as well, another version of the content was added to the high-tech prototype. One version had a more complete set of multimedia features – tested by experts – and another had fewer multimedia features (Section 6.4).

The final stage of user testing was to obtain feedback on usability issues and to understand user preferences in terms of the multimedia presentation of outdoor mobile guides (Section 6.4). In this stage, diverse user profiles were important, not only to reflect a more precise visitor experience of mobile guides, but also to have enough data to compare design preferences based on user characteristics (Section 6.4.1). With this in mind, the task of recruiting users was focused more on finding a group of participants who had resided in Brighton for different lengths of time, and of different nationalities and levels of familiarity with technology and mobile guides. Questionnaires were distributed on a university campus in order to refine the choice of participants. In addition, invitations were sent by e-mail to target users and advertised on websites. The participants did not receive any form of payment for this study. Overall, 32 users evaluated the prototype. The participants were asked to apply the think aloud technique and wore a head camera. The participants were asked to follow the map and

to visit two sculptures (Section 6.4.2). Half of the participants were asked to visit Queen Victoria first, and the other half to see George IV first in order to counterbalance the access order and avoid order effects. In the first part of the tour, the participants were free to choose any feature they were interested in seeing. The researcher took notes about features by order of access. In the second part of the study, the participants were invited to interact more with the system, guided by the researcher. Field notes and video files comprised the resultant observational data. In addition, two questionnaires and a consent form were filled out by participants. Before the tour, demographic information was requested and after the tour, Likert and semantic differential scales were the mode used to judge the users' satisfaction, opinions and preference for multimedia design.

The analysis of video data and questionnaires was guided by the notes taken by the researcher and established the research questions. Data transformation was applied in order to count the frequency of the categories that emerged in the data. NVivo software was used to organise the more qualitative data. Quantitative data were analysed through descriptive statistics. In particular, measures of central tendency, tables and cross tabulation were calculated. The resultant data from user evaluations were abnormally distributed and the sample size was not substantial. Basic statistics were used to support the qualitative research and to understand the main differences between the users' profiles using nominal data. The software Minitab facilitated this task (Section 6.4.3). The findings (Section 6.4.4) are described according to the frequency of access during the tours. Primary multimedia features (more frequently accessed) and secondary multimedia features (less frequently accessed) were described, accompanied by issues to be improved upon based on the strength of evidence and suggestions based on the strength of confidence. The strength of confidence was based on the number of times different participants repeated an interaction on the screen in order to resolve an issue, and the number of times they verbalised certain suggestions. Moreover, suggestions were given according to user profiles (Section 6.4.4.3). Furthermore, issues recommended by experts and not applied to the prototype were identified in the user tests (Section 6.4.5), highlighting the strength of evidence. Overall, 68 issues were extracted from the user evaluation. It was not possible to give a confidence score to them all. More tests are necessary in order to be certain of these recommendations (Section 6.4.5.2).

Discussions and reflections can be found at the end of every chapter. These sections concern the methods applied and the main lessons learnt during each research phase. The overall results of the discussions and reflections upon the data collected and analysed consist of a framework of user experience with outdoor mobile guides and a list of recommendations for developing outdoor mobile guides (Chapter 7 – Results). Design recommendations were chosen to reflect the empirical study instead of patterns, due to time constraints preventing the same issue being tested several times (Saffer, 2007**;** Landay & Borrielo, 2003)**.** Issues and recommendations collected during the evaluation phase were grouped according to issues and requirements that were not selected in previous phases of this work. The result was a list of issues and design recommendations for developing outdoor mobile cultural guides rated by the strength of evidence and confidence, organised by: major recommendations; medium recommendations and recommendations to be tested. This rating scale was inspired by the scale applied in Leavitt and Shneiderman's (2006) work.

In addition, factors that affected user experience during the fieldwork were grouped and classified in a framework. Look and feel, content and context are the main classifications in this framework. These factors may help designers to identify the main issues and constraints involved in the activity of being guided by an outdoor mobile guide to unveil cultural information.

2.5 Conclusion

This chapter has described the methodology followed in this thesis: design research. This thesis was also supported by user-centred design approaches and conducted using mixed methods. Qualitative and quantitative approaches were used to collect and analyse the data. Design research procedures from the fields of education and interaction design were identified and discussed. The specific methods and tools used in this research were detailed and organised according to the main stages of the design research methodology (namely preliminary research, the prototyping phase, the assessment phase and reflection and documentation).

The previous chapter covered the aims and objectives of this research. The next chapter discusses the background and competitor analysis in order give a clearer picture of the context of this thesis. The following three chapters describe the data-gathering field studies, design activities and evaluation stages in detail. Chapter 7 describes the main results of this research and Chapter 8 presents the final conclusion and areas for further research.

3 Background

3.1 Introduction

This chapter covers the influence of the literature review and competitor analysis on the research, and provides a first set of requirements for developing a prototype mobile guide (Chapter Five – Prototype Design). The development of mobile cultural guides is an interdisciplinary task. For this reason, a literature review was undertaken in order to understand different types of visitor, to identify current technology and to study the main findings of mobile guide projects and guidelines, patterns and principles for developing mobile guides in cultural heritage settings. In addition, a review of similar apps helped to discover the main features available in mobile tourist guides and the state of the marketplace.

3.2 Consumption of cultural heritage and tourism

3.2.1 Tourist characteristics

Knowledge of the characteristics of tourists in cultural and heritage sites is fundamental in developing mobile cultural guides. Socioeconomic, demographic and behavioural characteristics, and also motivation and satisfaction, are central concepts to our understanding of sightseeing tourists.

In general, the typical visitor to heritage and cultural sites is likely to be female, mature, highly educated and well off (Urry 1990). In a recent study, Kim et al (2007) emphasised these characteristics while examining different kinds of cultural attraction in the US through a telephone and post-back survey. First, they identified four clusters of activities labelled as festival and musical attractions; commercial recreation parks; local festivals and fairs; and aesthetic/ knowledge-seeking. Subsequently, they estimated the effects of income, education and age on participation in these clusters of cultural attractions. As a result, the study suggested that the high- and middle-income groups were more likely to participate in festivals and musical attractions than the low-income group. Moreover, individuals younger than 30 and females had a significant tendency to participate in the same activities. In the case of commercial recreation parks, individuals with a graduate degree were less likely to play a part

in this kind of programme than individuals in the middle- and low-education groups. Surprisingly, as regards local festivals and fairs, gender had a substantial effect. Females were more likely to take part in local festivals and fairs. In addition, middle-aged people were the most frequent participants in these activities. Finally, the middle- and high-education and income groups and females were the most likely to participate in aesthetic/knowledge-seeking activities. Kerstetter et al (2001), in a study that aimed to identify types of heritage tourists, agreed that highly specialised individuals are more motivated to learn about an historical period or event, and also to experience authentic elements in a historic destination. It could be said that people with a high level of education are more interested and motivated to visit cultural heritage sites, because to some extent, they already have knowledge of the subject. Rojas and Camarero (2008) confirmed this theory in their study, stating that more highly educated tourists do not choose to visit heritage sites because of a superficial interest, but because they are familiar with the exhibition's theme.

Another relevant topic, addressed by McGuiggan (2001), is personality. He investigated the extent to which personality variables determine the choice of leisure activity. He found that leisure planning, the variety of activities, competition and the desire to engage in activities with others are highly correlated to personality type (2001: 201). Beerli (2004) agreed, saying that personality factors, such as psychological aspects (motivations, personality, emotions and experience of previous trips), influence perceptions of the environment and the resulting image. He also commented that this is why people go to the same place for different reasons, if their perceptions of the location satisfy their needs.

3.2.2 Destination image

Destination image can be defined as impressions, beliefs, ideas and expectations about tourist areas. According to Govers et al (2007), this mental construct is based on a flood of information such as: promotions (advertising and brochures); the opinions of others (family/friends, travel agents); media reports (newspapers, magazines, television news reports and documentaries) and popular culture (films, literature). In their view, the promotion of tourism does not have a significant impact upon the perceptions of travellers as a source of information. They investigated the destination images of seven places in a survey of 1,100 online respondents

around the globe. According to the results, the media (television, newspapers and documentaries) have a primary impact on destination image formation. On the other hand, the Internet had a smaller effect than expected, considering the population that was sampled. Shaw and Williams (2004) agree on the strength of the media, and particularly television:

> The distinction between the ordinary and extraordinary has been undermined by what can be termed "television culture". Such representational codes of tourist sights have, in part, reduced the aura of tourism places, in that they can be viewed repeatedly in a range of contexts in the media. Television has also played another role in that, within strongly televisual cultures, the TV culture itself will increasingly be a tourist attraction. For example, many tourists are interested in visiting the locations of their favourite soap operas (p. 167).

Another survey in Switzerland investigated the role of information in tourism through written interviews performed with 1970 households on the basis of a structured questionnaire. This study highlights that brochures (local and hotel brochures) are the most widespread source of information, while travel guides, books and journals are the main source of information for long-distance trips. Electronic media (television programmes, videotapes, CDs and the Internet) are the most commonly consulted sources for long-distance trips with a comparatively high degree of individual organisation. A special role, according to Bieger and Laesser (2000), is played by information given by friends and relatives. Two reasons are given for this phenomenon. First, travel is connected to identity and people's beliefs, and therefore individuals prefer to develop their identity through social interaction rather than through relationships with machines. Second, travel requires trust, and so family and friends are the best source of such information, as they normally provide trustworthy information and know the person who is asking for indications. Therefore, it can be said that destination image is heavily affected by both the media and the suggestions of relatives and friends. Consequently, the impression that the visitor has of the destination may be artificial. Tourists arrive in the destination with beliefs and knowledge about the place acquired from other tourists and the media. A destination bubble is established, and the tourists create their own reality by being physically in foreign place but socially outside the culture (Oliver 2001). For instance, package

tours and organised tours often trigger social isolation from the local community (Shaw & Williams 2004).

In order to understand cultural tour participants' experiences and the extent to which their destination image changes after their visit, Oliver (2004) conducted a research-based questionnaire in Ireland. First-time visitors answered a pre-tour questionnaire distributed in Dublin Airport and a post-tour questionnaire, which was sent by post to each participant's home. Each type of questionnaire consisted of two parts: a qualitative map element and a quantitative attitude measurement. As a result, it was identified that the tour experience enforced predefined images, rather than generating new ones. In addition, the pre-tour route images were fairly well advanced, showing that knowledge about the tour was acquired during the purchasing and planning stages of the trip. Oliver (2004) also recognised two main drawbacks of organised tours: first, the fast pace of the tour compared to the number of attractions included in the itinerary. Second, there was a lack of ideas provided by tour guides or the tour company that would encourage visitors to return. As expected, the isolation of the tour members was highlighted by the same study. Visitors, in this study, did not have free time to interact, participate and engage with the local people. Therefore, the destination bubble was represented, and it was not only the responsibility of the visitors, but also of the intermediaries and tourism policy-makers.

3.2.3 Tourist satisfaction

Based on destination image studies, we may affirm that satisfaction is achieved when the visitor's expectations are met. If the pre-visit destination image is the same or better than the post-visit image, tourists are satisfied. Regardless of what affects visitor satisfaction in heritage and culture exhibitions, it can be said that expectations, the quality of service and cost are the main factors that change the post destination image. In a study comparing cognition (perceived quality) and emotions (pleasure) as a way of measuring satisfaction with cultural exhibitions, De Rojas and Camarero (2008) stated that these paths are complementary and constitute the basis for satisfaction. They found that the quality of the exhibition (location, internal distribution, walkways, lighting and information panels) influences the visitor's satisfaction, and that mood plays an important role in satisfaction. For instance, visitors in a positive mood

might not perceive the quality of the exhibition in the same way as other visitors. According to these researchers (2008: 533), a positive mood reduces the effect of perceived quality on satisfaction. Another perspective is given by Neal and Gursoy (2008), who highlighted the notion that satisfaction is reached during the various stages of the tourism experience. This study was based in Southwest Virginia in the US, and the data were collected via questionnaires posted to people who had travelled for leisure purposes in 2007. Service quality, overall efficiency and the overall cost of pre-trip services, services at the destination and transit route services were identified as the main factors determining global satisfaction with trips. It could be said that tourist satisfaction is a hybrid experience and cannot be evaluated for one phase of the tourist experience.

3.2.4 Residents' perceptions of tourism

There are a great number of positive and negative variables that influence the local communities of tourist and heritage sites. Social, economic and environmental factors are emphasised in the literature. Regardless of the economic perspective, cultural tourism brings benefits to residents. As cultural tourists tend to have higher incomes and education levels than other visitors, this results in more money being spent per visit and in longer stays (Fu et al 2007). Furthermore, cultural tourism provides jobs for residents, and helps them to learn about their own city. In a study conducted in order to examine the perceptions of cultural tourism of Hispanic and non-Hispanic citizens in Colorado in the US, Besculides et al (2002) observed that tourism helps residents to learn about, share and preserve their culture. For example, Hispanic residents preserve their traditional folklore and learn more about the Hispanic culture.

It is also true to say that host communities support the development of tourism when they are aware of, understand and participate in tourism and the city's cultural activities (Fu et al 2007; Andereck et al 2005; Besculides et al 2002). Although local communities can improve their financial status and receive cultural benefits from tourism, there are negative attributes such as crowding, congestion, traffic, litter and crime (Andereck et al 2005). Van der Borgn et al (1996) agree that certain aspects have a negative effect on tourism, such as: pollution, traffic in historic centres, vandalism and crime, parking problems, crowding, litter and a lack of a tourism development strategy. However, in the same study, which aimed to develop guidelines to help

artistic European cities to manage their tourism, inhabitants of four European cities (Oxford, Salzburg, Bruges and Venice) felt that the overall consequence of tourism was positive or at least neutral rather than negative (Van der Borgn et al 1996: 316). Overall, it is important to involve residents in tourism, so they can advertise and also preserve the city.

3.2.5 Discussion

After this review, it is clear that most visitors to cultural places are adults who are highly educated and well off. In addition, satisfaction can be achieved when their expectations are met. On the other hand, this satisfaction is not always completely real and related to the history of the city. Normally, tourists visit a city with package tours, and reality is veiled by the destination bubble. In addition, residents and locals sometimes do not support tourism, because they are threatened by the drawbacks that the tourism industry can have, such as violence, the density of people and waste. Overall, it is important to engage residents in tourism and cultural activities, as they are the main promoters of the city.

3.3 ICT in cultural heritage and tourism

The use of ICT in tourism, and particularly in the cultural heritage field, is enhancing the experience of visitors and providing opportunities for residents to share their business and culture. ICT is present in many stages of the operations of the heritage industry and acts as a modifier within cultural heritage organisations. Heritage organisations can recognise how change occurs and where it is possible to influence its outcomes (Peacock 2007). ICT also improves content creation and communication, value enhancement and market strategy (Go et al 2003). Residents and visitors are the main agents who boost the tourism industry through information technologies.

3.3.1 Locals' interaction with ICT

Residents and local businesses (small and large businesses and operators) are responsible for maintaining the image of the city, and they are the main creators and communicators of public information about the city. As previously pointed out, residents preserve and share knowledge of their location when they become involved in tourism. Information technologies might be the

canal through which it is possible to communicate about the city and engage residents in tourism. The most common and promising technologies are web pages and mobile devices.

Web pages are consulted in order to get information about points of interest, restaurants, accommodation and the history of a destination. Residents and visitors share their tastes, add reviews and also meet people with the same interests.[13] For instance, a project called "the urbanista diaries,"[14] sponsored by Nokia, aimed to investigate the use of a mobile multimedia computer by four bloggers. The initiative consisted of a trip by bloggers around the world with a mobile phone recording their journey and the stories of people whom they met on the way. From the same perspective, the project called Point-to-GeoBlog (Robinson et al 2008) is a mobile approach to supporting the creation of a record of journeys made and places encountered. By pointing and tilting a mobile device, users indicate their interest in a location. During the journey, users do not receive any information; however, later, they can consult the online materials placed automatically on an interactive map. They conducted two experiments to explore lightweight approaches to gathering location-oriented material while mobile. The first aimed to explore pointing gestures with visual feedback. In the second, only the gestures as feedback were taken into account. As result, most of the participants found it easier to mark points of interest while mobile and found unexpected information, even about familiar areas. The main results rely on the type of landmark (public and historical buildings and landscape features); features (the aerial view and zooming functions were not often used); time (the time taken to mark each location was 4.5 seconds); system demand (overwhelmingly positive) and confidence in performing marking tasks (low) (Robinson et al 2008).

Micro blogs and blogs are significant communicators of tourist information, and also provide a space for social interaction. Reported research on the analysis of blog entries relating to trips to Austria highlights that the characteristics of bloggers and the trips they take influence the destination image, and such information can be drawn from the blog content (Wenger 2008). Micro blogs[15] have provided an emergent way to post on the Web. Users can update their status and enter blog posts at any time, anywhere. Therefore, websites and particularly blogs

[13] http://trustedplaces.com/; http://www.tripadvisor.com/

[14] http://www.nseries.com/index.html?l=campaigns,n82,urbanistadiaries#l=campaigns,n82,urbanistadiaries,about

[15] http://twitter.com/

can boost local tourism and help tourists to find the main points of interest in a city before, during and after travelling.

Mobile devices have been used in tourism to consult maps, directions and information about landmarks. In addition, they are utilised in order to add information about collaborative tasks. Urban Tapestries and Our City, Our Music[16] are examples of collaborative projects involving residents using ICT.

Urban Tapestries explores a mobile, location-based platform used to connect people with the place in which they live through their memories – historical information, experiences, observations, pictures, short films and sounds (Lane 2003; Silverstone et al 2005). In an ethnographical study investigating the use of Urban Tapestries, Silverstone et al (2005) classified their findings into four categories: technological identity; issues of place; social knowledge and social costs and opportunities. In order to unveil these results, they adopted methods such as questionnaires, interviews and an Urban Tapestries walking tour in Bloomsbury, in the UK. The results defining the relationship between their respondents and ICT rely on the importance of control (or lack therefore), socio-cultural contexts, expectations, management, an external or internal locus of control and personal aesthetics. In addition, respondents who were excited about the possibilities provided by technology were likely to feel the same about Urban Tapestries. Respondents used the system not only to "aesthetically embellish their spaces, but also to place themselves in their localities" (Silverstone et al 2005: 20). Hence, the sensation of ownership was intensified through the system. Questions of public authorship, aesthetics and the customisation of space were also highlighted in the same work.

Our City, Our Music is a project that encourages local artists to collaborate with a multimedia platform, creating a location-based album. Our City, Our Music"[17] uses PDAs to access music videos filmed on location, re-experienced in situ using a handheld device. It uses Mscape[18] software developed by Hewlett-Packard, which uses audio and media files with GPS in one platform (Smith 2008).

[16] http://urbantapestries.net/ http://www.ourcityourmusic.com
[17] http://www.ourcityourmusic.com/
[18] http://www.mscapers.com/

Being able to contribute to the interactive system design engages users in the experience and creates a sense of belonging and attachment to the cultural heritage spot (Ciolfi et al 2007). It can be said that ICT can help residents to spread and share their culture in a meaningful way, as long as the use of multimedia technology allows users to choose from a wide range of media in order to represent their content. Therefore, it is relevant that host communities and businesses have knowledge of how to manage information technologies. Go et al (2003: 63) suggest that specific e-learning content may be made available in order to educate enterprises about the way to provide culture-related products and services while maintaining their cultural identity.

3.3.2 Visitors' interaction with ICT

ICT allows visitors to access, consult and collaborate with exhibitions. The process of designing information for these technologies and offering it to the visitors is called heritage interpretation. Reino et al (2007) emphasises that heritage interpretation is considered to be an indispensable element of the visitor's experience, due to the relevance that heritage has acquired as part of the tourist destination and the need to increase museum competitiveness. Learning, entertainment and experience are considered to be the main outcomes of heritage interpretation that affect visitor satisfaction (Reino et al 2007). Owen et al (2006) agree, and add that it is important for cultural heritage professionals to be aware of the latest interpretation design techniques available.

Reported research on visitors' evaluations of advanced technologies in cultural heritage sites has demonstrated that when visitors notice the importance of using technology to help them to understand the exhibition, they are very supportive of it (Owen et al 2006). Therefore, the use of technologies and its main objectives needs to be clear for visitors. Moreover, Collins et al (2009) highlight the resources which also play an important role in visitors' experience and which should be presented in ways that will help visitors to engage with them. For instance, some mobile guides use visitors' own phones or other mobile phones, while others are dedicated PDAs and audio guides that provide location-aware services. When travellers do not use their own phones or devices, they need to learn how to interact with the dedicated device. According to Tjostheim and Fesenmaier (2008), it might take some time for travellers to start using apps that are available to them on their mobile devices. However, they appear to

understand the potential of this kind of media for travellers. The next section provides a description of projects that use mobile technologies to enhance visitors' experience.

3.3.3 Mobility in cultural settings

There are a large number of projects that are applying mobile technology to informal and formal environments. Schools, universities, museums and also workplace settings take advantage of the mobility approach to enhance the quality of learning. Some mobile apps for tourism are designed for use in museums and indoor settings, while others are made for use in outdoor settings. For the scope of this review, initiatives in museums and cultural heritage settings are taken into consideration.

3.3.3.1 Considerations of mobility

The notion of mobility encompasses many aspects, regardless of context and social interaction. As shown in Table 1, the main dimensions of mobility are constituted by certain characteristics such as: spatiality; contextual mobility; conceptuality; temporality and also the mobility of technology (Kakihara & Sorensen 2002; Kukulsa-Hulme et al 2009).

Dimensions	**Characteristics**
Spatial mobility	Where - Geographical movement of not just human but objects, symbols, images, voice, etc.
Contextual mobility	In what way In what circumstance; Towards which actor(s); Multi modality of interaction; Unobtrusive vs. Obtrusive; Ephemeral vs. Persistent; Weakly & strongly tied social networks
Conceptual mobility	Attention moves from one conceptual topic to another driven by personal interest, curiosity or commitment.
Temporal mobility	When - Clock time vs. Social time Cumulative process
Mobility of technology	Mobile devices

Table 1: Dimensions of mobility

It could be said that most of the dimensions described above fit into the study of mobile cultural guides. Students or visitors to museums or outdoor settings improve their spatial experience by following the trails that are pre-loaded onto the device, or received in certain locations. From a contextual perspective, they gather information relating to the historical/cultural object in certain locations. In a conceptual mode, the representation of the information plays an important role in the recognition of the objects, and also in retrieving information, e.g. how this information will draw the attention of formal or informal learners. From a temporal perspective, pre-existing knowledge of the concepts and also the social aspect of the interaction should be considered. This can boost curiosity and the interest in interacting with the system. Finally, the mobility and characteristics of the device (size of the screen, connectivity and usability) are paramount in developing these systems.

The dimensions of mobility provide a way to identify important considerations for engaging users in mobile learning projects. Therefore, it is cumbersome to follow this classification, as not all of these perspectives can be isolated. Consequently, the review of projects that follows highlights these dimensions all together, by describing findings and drawbacks that assisted in developing the prototype mobile guides (Chapter 5).

3.3.3.2 Visitors' engagement with cultural heritage and museum settings

Visitors might be interested in the content of the exhibition, if they have a keen interest in the subject, as well as sharing experiences with others. They may also be motivated by the use of diverse technologies. Kukulsa-Hulme et al (2009) recognised the same factors after an overview of European mobile learning projects. Personal interest, social approach and cross-platform projects are the main characteristics of current initiatives.

While researching visitors' interest in museum environments, Benta (2005) examined three types of engagement. As she describes them:

> The first one corresponds to the case in which someone behaves like he is not interested in art, but interested in saying that he did visit that famous art gallery. The engage-able one is the one who is interested to summarise the content of the gallery,

> he is behaving more like an accountant than like an art lover. [...] The highest level is the engagement with the artistic part that demands more time to observe: having a close look at the brush strokes, colours, gradients, etc. (Benta 2005: 54).

After an experiment that involved sending recommendations for paintings to see from time to time to a visitor through a mobile device, the engagement level was measured. As a result, Benta (2005) attested that engaged visitors learn better in exhibitions. The measure of engagement was based on how long each visitor remained in front of a particular painting. Therefore, it could be said that is very difficult to confirm whether the visitor was examining the characteristics of the painting, chatting with a colleague or waiting for someone. In this project, it is clear to see that different dimensions of mobility work together. Not only can the temporal aspect of mobility be recognised, but also the museum space, the visitor's context and the content of the exhibition.

In order to engage teenagers in informal science learning, Liberty Science Center in the US started a project called Science Now, Science Everywhere. It was based on a study into how teenagers handle mobile phones and features in everyday life (Bressler 2006). One activity that formed part of this project was a camera phone challenge that the user could complete during or after the visit. Challenges were created to remind players to look at specific objects and to take pictures in the museum. After the tour, they could continue playing reminders of the challenge received on their mobile phones. The research showed that the teenagers used their mobile phones as a way to share experiences with friends more than adults, and especially to send pictures that they took with their camera phones. They prefer to communicate with friends through written communication. In addition, teenagers like to create and save ringtones, video clips and animations. It is interesting to note that the choice of mobile phones instead of PDAs in this project makes sense, as the use of simple features (MMS, SMS and audio) is something that users do with their mobile phones. Hence, there was no need to learn to interact with a new device.

3.3.3.3 Visitors' interest in cultural heritage and museum settings

An interest in the subject of the museum's exhibitions is one of the main characteristics that grasp visitors' attention. In informal spaces in particular, learning is predominantly voluntary. It depends on the visitor's motivation and interest in learning (Wessel et al 2007). Interest is defined as the feeling of having one's attention held by something, or of wanting to be involved with and learn more about something (Cambridge 2008). During exhibitions, a high number of objects are available to view, and sometimes visitors hurry in order to see everything. This makes situational interest influential during visits.

According to a study conducted by Wessel et al (2007), overall, visitors are not interested and motivated throughout their entire visit. Hence, their interest is situational, and specific situations and objects draw their attention. In order to identify whether the immediate satisfaction of situational interest leads to increased engagement with the exhibition and learning during the museum visit, Wessel et al (2007) employed a research design with two groups of students. They received a questionnaire before and after the visit. In addition, an interview was realised three weeks after the visit. Some participants received additional information (SMS/MMS) during the visit through a PDA screen or simply a bookmark. In addition, a link to the exhibition on Wikipedia was available. Those who received additional information thought that the exhibition included more remarkable objects and information. On the other hand, those who did not receive additional information found more relationships and connections between the exhibits. They also wanted to receive more information during and after their visit. It can be said that situational interest seems to appear in the first case, while compensation behaviours are manifest in the second one. This behavioural pattern can be exploited by designers and museum staff in order to develop more interesting systems to deliver information in a timely manner.

Another initiative that makes use of text messages appears in Bletchley Park, in which visitors are sent keywords about a specific exhibit of interest using their own mobile phone. Afterwards, visitors could go to the museum's website and find out more about what they had identified in the text message and explore the archives. They could modify and create relations between the keywords in order to access stories from the archive. In order to evaluate the

system, Mulholland et al (2005) invited 35 students from a secondary school to use it. Overall, 20 students accessed the museum website in their free time; a group of six pupils used the Bletchley Park text to help them in an essay and two requested books relating to the essay topic to read in their free time. Situational interest made them learn more about the subject in which they were interested.

In a mobile learning service for school museum trips, myartspace, not only the museum visit itself and the period afterwards were taken into consideration. Students also had a preparatory class before exploring the museum, in which teachers discussed the purpose of the visit and set questions and goals to guide the visit. During the visit, they selected an exhibit, typed the relevant code into the system and, consequently, the system started a multimedia presentation on the phone. They also could access background information. Furthermore, they typed in their reasons for choosing that object. The information was then transmitted to the myartspace website through a GSM phone connection. In the classroom or at home, they could organise what they had collected during the visit, add new objects and make a multimedia presentation that could be included on the student's gallery website. In the evaluation tests (Sharples et al 2007), it was detected that the students engaged with the experience and that it encouraged teachers to do pre- and post-visit lessons. However, there were some usability and technical issues such as connection, cost, deficient student orientation, the lack of a quick reference guide and the use of different buttons for certain actions. It could be said that it can be more engaging for students to play the role of explorers. In spite of having a goal or questions to answer about the collection, they could choose their trail and decide which objects are important for their purpose.

3.3.3.4 Content and choice in cultural heritage and museum settings

Content must be designed according to users' preferences to avoid redundancy. For instance, the work conducted by Pieri et al (2008) can be quoted. They researched how students interacted with a mobile guide (the Art Mobile) to Saint Ambrogio's Church in Italy. Overall, the mobile guide was easy to use, but it lacked original content and interactivity with the user.

Another example can be seen in the Victoria and Albert Museum in London. Design students explored the museum's collections via PDAs. The "iGuides from Streetaccess" consist of Web-based trails designed to be accessed on PDAs inside the museum. In the evaluation tests, the response to the content was positive (Reynolds & Speight 2008). In this case, students could choose which trail they wanted to follow. Consequently, students were more interested and motivated to do the activity.

The Royal Commission on the Ancient and Historical Monuments of Wales developed a system for delivering cultural information on mobile phones. According to Pert (2008), the system highlights the importance of clear descriptions of the monuments and a hierarchical method of providing information, so that if visitors want basic information it is immediately available, and if they want more detailed information, it is possible to dig a little deeper.

3.3.4 Mobile devices for enhancing tourism and cultural settings

There are currently a large number of initiatives in the field of mobile technology relating to culture and tourism (Millis 2007; Anon 2007; Agamemnon 2006; Cheverst et al 2000; Sharp et al 2008), which has become an understandably popular domain for handheld information devices. It is in people's nature to be mobile, as "people are tourists most of the time whether they are literally mobile or only experience simulated mobility through the incredible fluidity of multiple signs and electronic images" (Urry 1995: 148). Some mobile guides are designed for use in museums and indoor settings, and others are for use in restricted outdoor settings. For this work, both perspectives are reviewed, but the relevance relies on outdoor mobile guides.

3.3.4.1 Projects that intensify the social perspective

The social approach promoted by mobile systems can be exemplified by games and collaborative activities in cultural heritage settings. Kruger et al (2007) predicted that more socially aware systems would appear, taking into account more than one user, and also that more guides will be used on mobile phones as the current platform for most systems is still the PDA**.** Brown and Chalmers (2003) also noted the importance of the social aspect of leisure in a study concerning how people interact with guidebooks and maps in Edinburgh and Glasgow. In

addition, Grün (2005), having evaluated eight electronic mobile tourist guides, identified the lack of social factors in these systems:

> Social factors are important in tourism since people tend to go sightseeing in groups. Some systems provide limited support by offering so called "friend-finders" or the possibility to add personal information to POIs and share this with other people. However, social activities comprise more functionalities than just displaying positions of personal information. Future systems should consider communication technologies, e.g. the integration of instant messaging services (Grün 2005: 49).

A museum visitor's guide called PII (PEACH Israel project) is a system that was developed to facilitate communication among visitors in groups and to support the overall visit. The system contains a user-modelling component that keeps track of visitors' preferences based on their behaviour. A group of three to four visitors attends an exhibition, and sees and listens to presentations. The system detects the location of each visitor and provides relevant presentations. Visitors and the system can communicate by suggesting information or posing questions to other visitors in the group. Therefore, every group member receives different information according to their behaviour, so that they can discuss what they saw and learnt in the museum after their visit (Kuflik et al 2007). It is interesting to note that visitors are not together in the visit, as they make their own paths.

Most of the games on mobile systems focus on treasure-hunting activities in order to draw the attention of students and visitors. One of them is "Mystery in the Museum," developed by Cabrera et al (2005). It consists of two parts: a text game and a picture game. The game was tested by groups of students with an average size of two. Before the visit, teachers gave the students background information relating to what they were learning in class. In the evaluation tests, it was identified that they took more time to do the text game than the picture game. The first one required the students to join together fragments of well-known poems in order to receive a clue. In the second one, the students received a set of pieces of different images. In the games, they must exchange the pieces between them in order to achieve a complete image. The interface of the system on the PDA was very intuitive and the image game was

easier to solve. One important fact is that the solution to the image game was presented in the museum environment (in an exposed exhibit), but the same did not occur with the text game. In terms of collaboration, most of the groups stayed together, and sometimes moved around in order to find the relevant picture on the walls of the museum (Cabrera et al 2005). This initiative allowed the students to discuss the theme of the exhibition while they were looking for the solution to the game.

The social characteristic of leisure in a location-based system can be seen in the work of Walz and Ballagas (2007). They developed a location-based game named REXplorer in Regensburg, Germany. The aim of the game was to explore historical information about the city using a device composed of a mobile phone and a GPS receiver in a custom-designed shell. Players interact with the system using gestures, receiving and resolving questions that lead them to the next touristic point in the city in a non-linear way. The system provides verbal and visual feedback. The playability tests showed that it was useful to indicate which situations occurred during the game. It maintained a sense of immersion and persuaded players to continue playing.

A similar approach is addressed by Kim et al (2007). They developed a mobile walking tour in combination with a historical story and a role-playing game in Korea. The system was designed to include location-based services; however, in the first user test it was not possible to include maps and textual instructions that were provided in every location by Wi-Fi. The prototype was tested at the Pusan International Film Festival 2005 with 34 people. A tour mode or a game mode could be selected depending on the user's preference. Most people chose the game mode. Users gave positive answers about the content, the interface and the use of a game element (story) to finish the tour. For instance, images of the past reinforced the theme of the game, mainly when they were rare or unknown. On the other hand, the tour was identified as being too long and linear (it prevented visitors from choosing what they wanted to access in a different order). In addition, the texts were identified as overly long and difficult to read.

3.3.4.2 Projects that use contextual information

Certain mobile guides in informal learning identify what users need in different locations. This shows that not only situational interest is relevant, but also what users' physical context suggests to them during the visit. As can be seen in Paay and Kjeldskov (2005), who created a method for providing mobile system designers with knowledge about different elements of the user's physical context, information that already exists in the user's environment can be indexed into the mobile interface.

Those mobile guide apps might use technologies such as geographic information systems (GIS), including location-based services that utilise the geographical position (GPS) of the mobile device to push contextual information towards visitors. The use of sensors is also common practice, such as image recognition and 2D bar codes (QR codes), radio-frequency identification (RFID), near field communication (NFC) and the use of Cell ID in the mobile network and Wi-Fi location detection. One of the advantages of using location-based services is that they save time because the user does not have to enter his/her current location.

3.3.4.2.1 Geographic information systems

One of the pioneering city guides, "The Guide," was developed in order to provide city visitors with up-to-date and context-aware hypermedia information while they explore a city in England (Cheverst 2002). When evaluating the system, the researchers found that human factors were extremely relevant whilst people were using their guides. Some visitors became frustrated because they were interested in visiting attractions, regardless of whether they were open or closed, in order to see the architecture of the building from the outside, but the system showed only the open ones.

Tjostheim and Fesenmaier (2008), after a field study, found that GPS is an important issue for helping tourists to navigate a city. However, some visitors take a while to understand how to use GPS on their phones. Moreover, some visitors substituted traditional information sources (street signs, posters and printed maps) with new information sources available on mobile phones (GPS, guides on mobile phones and maps).

In addition, Schmandt and Marmasse (2004) believe that geographical information can be further personalised based on its relevance to the user, with suitable descriptions used to deliver valuable location-aware services. Some examples of this perspective can be seen in the work of Baus et al (2005), who reviewed maps on mobile guides designed to provide certain services. They highlighted some questions that should be considered in the development of these systems, such as: How should the information contained in the system be represented? How would it be best presented to the user? How can we facilitate interaction between various services?

As regards tour guides of monuments and sculptures, two works are highlighted. First, a location-based multimedia information system for monuments in Germany (Krosche et al 2004), called MobiDENK, was tested by archaeologists and monument conservationists. As a result, users envisioned the system to be a great opportunity to integrate mobile technology into their profession. In addition, they recognised that the system gave them the chance to discover and explore sites that they had never noticed before. Conversely, some technical issues were appointed as drawbacks in the fieldwork, such as the restricted battery life, the visibility of the PDA screen in sunny weather and the app speed. Second, Van Aart et al (2010) developed a mobile app that uses GPS to identify the user's location in Amsterdam in the Netherlands. It provides historic information based on the user's context, such as events that have taken place there and artwork that was created at or inspired by the location and artists who have lived or worked there. The information available to visitors is based on a combination of linked open data sources. Consequently, a rich source of semantic information makes visitors aware of history, which would not be possible through consulting open sources (e.g. Wikipedia) in isolation.

3.3.4.2.2 Sensors

Some technologies are used in addition to or as a replacement for geo-information technology. The use of sensors introduces the ability to employ one device to deliver multimedia, location-specific interpretations in both indoor and outdoor spaces, and this device will handle the transition between these spaces without the need for user input (Hull & Melamed 2007). Some

initiatives with tourist maps can be seen in Hardy and Rukzio (2008) and Kruger and Jiang (2007).

Hardy and Rukzio (2008) describe an interaction technique called Touch & Interact, which combines mobile phones and public displays through NFC technology. In a touristic app designed to build an itinerary for the day, it was possible to see the strengths of both technologies. A large display is used to overcome the output limitations of the phone, and mobile phones are used to show private data and enhance user interaction (input modalities, additional feedback and display and storage capabilities). In addition, pick-and-drop techniques can be explored with both technologies.

The other proposal employs embedded cameras that function as sensors for implicit user interaction. TIMMI, a mobile map interaction system, provides users with the ability to request and receive specific information about points of interest on their mobile devices. The interaction occurs by sweeping the mobile camera device over a paper map. Users see, through the mobile device, a digital map and can request information about areas of interest. Kruger and Jiang (2007: 688) summarise the findings of this experiment by saying that static maps provide high-resolution, large-scale information with zero power consumption while, on the other hand, digital maps enable personalised and dynamic information on request.

In addition, a mobile camera may be the way to recognise 2D codes (QR codes) and to gather information about sculptures, as illustrated in an open-air museum in Taiwan. The URL (uniform resource locator) of each sculpture was stored in a remote database that could be accessed through the camera using the decoding program installed on the phone. A field trial in the open-air museum of the National Koahsiung Hospitality College was conducted in order to understand user acceptance of the mobile guiding system. Users underwent a short tour to test the system and answered a questionnaire with Likert scales and demographic information. There was no substantial difference according to the age and gender of the 131 users. Trust was an important variable, and the researchers discovered that this was related to trialability. The more people tried, the more likely they were to trust and recommend the app to others (Shih 2010).

In the educational field, a project called mi-Guide and mi-Guide@school developed by the University of Salford (Linge et al 2008) follows the use of sensors to acquire content. The system delivers information to museum visitors through a multimedia handheld system. It provides context-specific information on selected exhibits through images and audio and video information for visitors through RFID tags. Currently, the system is being extended to schools. Teachers can access content relevant to the National Curriculum to explore in the classroom, and later on students can receive tailored learning activities through the mi-Guide handheld device in specific museum locations.

Lonsdale et al (2007) described a study held at Nottingham Castle Museum, which is part of Project MOBILearn. They developed a system that identifies contextual information in order to determine what content should be displayed on the screen of handheld devices by sensors or/and user input. The system was designed based on three principles: What painting is the user currently closest to? How long has the user been in his/her current position? Has the user been in this position before? For every principle, the system behaves differently. In the first case, the system identifies and shows the main contents of the closest painting. In the following case, the system identifies how long the visitor has spent in front of the painting in question and provides information accordingly, as people who remain longer in front of one painting are more interested in it. For the last principle, the system identifies the level of content to display when it is not the user's first time in that location. In order to identify what the context affords, designers can use this kind of system to make useful information available to visitors.

3.3.4.2.3 Cell ID and Wi-Fi

The location of the mobile device might be determined by other technologies, such as Cell ID in the mobile network or with Wi-Fi location detection. One of the projects that illustrate this approach is Culture Around the Corner in the Netherlands (Arts & Schoonhoven 2005). The researchers developed a system that sends a text message about the nearest cultural site to users who receive it through their mobile phone, PDA or laptop. On the mobile phone, the visitor's location is detected by GSM antennas. PDAs and laptops have a Wi-Fi card that detects

signals from wireless access points. Therefore, users can access the Internet and their location will then be recognised in a public database.

3.3.4.2.4 Augmented reality

In addition, new approaches such as augmented reality are being applied in the field. A review of the results, solutions and components of augmented reality systems in cultural heritage can be found by Demiris et al (2006). They concluded that if augmented reality is to be a part of the dissemination of cultural heritage, then technological infrastructure, visitors' needs and experience on the sites and valuable information about the curators of these sites all need to be taken into account. The Archeoguide project illustrates some difficulties, regardless of infrastructure and the implementation of a mobile outdoor augmented reality system. After some tests on Olympia in Greece under different weather conditions, Dahane and Karigiannis (2002) attested that augmentations provide added value to the visitors of an historical site. On the other hand, some drawbacks were addressed as regards the device, a laptop, which is uncomfortable to wear, too expensive to use commercially in historical sites and too fragile for rough outdoor conditions. In addition, the display and the camera were unsuitable for outdoor applications (in direct sunlight it is difficult to see the augmentations).

3.3.4.3 Projects that intensify cross-platform initiatives

Some of the projects described above are built in cross-platform environments (Wessel et al 2007; Sharples et al 2007; Robinson et al 2008; Smith 2008). Websites and mobile phones are the main platforms explored in cultural heritage environments. Cross-platform environments also support users before, during and after their visit. The use of more than one platform may promote social interaction and access to information between on-site and online visitors.

Galani and Chalmers (2003) describe the "city system" in which trails were followed at the same time by users with different platforms. A virtual museum environment, mobile information system and hypermedia were explored in this task. Visitors could communicate with each other during the visit, share experiences and take advantage of other information resources, such as websites (virtual environments), booklets and touch screens (for visitors in the museum). In the opinion of the city system developers, the use of mixed reality systems can

support social interaction and make the experience of the exhibition richer and more pleasurable.

3.3.5 Discussion

It could be said that most of the mobile technology approaches used in cultural heritage settings take into consideration visitors' and students' engagement. In order to provide such engagement, educators and museum specialists employ diverse technologies in the same project, involve groups of students and families in the mobile system activity and consider the user's personal interests and context.

It is also true that ICT enhances the experience of tourists in cultural heritage sites. As Modsching et al (2007) exemplifies, in the case of mobile devices, mobile guides help tourists to see four times more attractions in about one and a half hours than they would be able to enjoy in four hours without such an app. Different kinds of technologies might be used according to the content and context of the users.

Location-based technologies provide information relating to the user's location and help visitors and also residents to localise themselves and receive historical, cultural and entertaining information about a particular point of interest. In addition, location-based games show the history of a city in an entertaining manner. Cell ID and Wi-Fi help to identify the user's location and access information on the way. Sensors are employed in order to enhance the use of maps and interaction between visitors and systems. Moreover, the use of augmented reality in the cultural heritage field allows users to find out the history of certain locations and monuments. In general, the application of technology has to make sense and must involve visitors culturally and historically. As a result, visitors and residents can experience, be entertained by and learn more about historical and cultural places.

The next section covers issues of mobile interface design and the existing guidelines for developing cultural apps. In sequence, a section listing commercial apps and the main competitors within the scope of this work are described.

3.4 Mobile interface design

Designing mobile cultural systems is not a trivial task. This task becomes even more difficult when outdoor settings are taken into consideration. There is a great deal of guidance on mobile information systems, but very little that covers how to develop systems for outdoor mobile multimedia guides. In this section, a review of the principles, guidelines and patterns that are relevant to the development of mobile touch screen interfaces is covered. In this work, principles and patterns had a major influence and helped to develop the mobile guide interface prototype. Guidelines were used when they fit specific situations. The application of these guidelines is available in Chapter Five.

3.4.1 Principles

Design principles are general concepts that come from a variety of design disciplines. In general, they define ways to arrange the visual elements of a design, such as line, shape, space, direction, texture, typography colour and value. In interaction design, authors (Ballard 2007; Fling 2009; Shneiderman 2010) consider not only the visual elements but also other elements that emerge from the nature of a user's performance with mobile devices, such as feedback, context, message and touch (haptics). A broad view of design principles is given by Lidwell et al (2003). They offer a collection of 100 universal design principles to help designers to influence the way in which a design is perceived, learnt, enhanced by usability, and to increase the appeal of a design in order to make better decisions. In this work, Gestalt principles, interface design principles and experience design principles are considered.

3.4.1.2 Experience design principles

Users experience design in numerous ways. However, there are some basic needs that are shared by everyone and that should be met first. According to Maslow (1943), needs motivate people to act. He presents a model with five kinds of need. The essential needs at the bottom of the pyramid (Fig. 9) should be fulfilled first. Therefore, for example, people would not be fully confident if they were not in a healthy condition. Maslow's pyramid was recently used to guide a study of mobile learning initiatives around the world (Waisman et al 2008). The researchers applied the same levels of the pyramid to the search for mobile learning projects, but the level of "esteem" was substituted for "joy." In their opinion, mobile devices serve the

purpose of motivating and engaging students to see learning as a pleasurable, personally meaningful and uncomplicated activity.

Figure 9: Pyramid of needs (Maslow 1943)

A version of this hierarchy was adapted to product design (Lidwell et al 2003; Bradley 2010). In this version, from the bottom to the top, functionality, reliability, usability, proficiency and creativity are covered (Figure 10). Poor designs fail to meet the low-level needs. The most basic design requirements should be met first, e.g. the function should answer to the user's input. The system should perform consistently and be stable, e.g. the same actions should lead to the same results. The system should be easy to use and offer easy recover if errors occur. If these conditions are met, the system should allow users to do more than they expected, e.g. to share pictures with audio commentary with their social network. After all of these needs are met, creativity is the last level, allowing users to give the design new uses and extend the system in innovative ways, e.g. personalisation and aesthetics.

The levels of the hierarchy are connected to phases of design history. From the 1950s to today, society has changed, as well as the values of each period. Until the 1950s, society was focused on functionality. From the 1950s to the 1980s, design was consumer-focused; approaches to human-centred thinking came to life during this period. From the 1990s to today, design turned

its attention to humans, not only as consumers, but also by focusing on users' experience (Zhang et al 2009). Experience is of great value in our age.

Ultimately, we are deluding ourselves if we think that the products that we design are the "things" that we sell, rather than the individual, social and cultural experience that they engender, and their value and impact. Design that ignores this fact is not worthy of the name (Buxton 2007).

Figure 10: Design hierarchy of needs (Bradley 2010)

Based on an influential model of needs – Maslow's hierarchy of needs – Jordan (2002) proposes a hierarchy to help designers to better understand their users. Functionality forms the base, followed by usability and pleasure. The pleasure level is at the top and is divided into four types: physio (body and senses); psycho (emotions and thoughts); socio (relationships) and ideo (values). For Norman (2004), a mix of the four kinds of pleasure results in fun. Fun is a consequence of excitement and surprise during users' experience, and it is associated with context.

Karapanos (2010) emphasises the concept of diversity in user experience. Not all individuals perceive or/and evaluate products in the same way. Therefore, a rigid hierarchy is not always appropriate for understanding users. Four sources of diversity are recognised in Karapanos' research. First, individual differences dictate the value given to certain products. Second, different qualities are important in different types of product. Third, the situation in which users interact with the product can change their view of it. Finally, people's experience of a product changes over time. Therefore, studies that privilege user experience of products result in indications for future research based on diverse aspects.

As a consequence of diversity, it is important to identify why people choose or prefer to experience certain technologies. According to Hassenzahl (2010), there is a subjective level in the interaction process. The majority of projects in the HCI field consider instrumental goals – what and how people interact with products. The subjective level (why people choose to use a specific) technology is sometimes forgotten. An example described by Hassenzahl (2010) is the importance of a reference point in user tests. A reference point is relevant for comparisons in user tests. If no reference is given, people can use anything they like as a reference point, and judge the design as they wish; without comparison, it is impossible to judge. Therefore, with various versions of the product, the difference is more likely to be experienced. Moreover, different objective situations may lead to different experiences. Another example, provided by the same author, to illustrate why a situation can be experienced in different ways is the difference in gratification between silver and bronze medallists. Bronze medallists are always more satisfied than silver medallists. The latter, because they almost won the gold medal, feel more frustrated. A near miss changes one's experience of certain situations, resulting in the subjective nature of experience. Furthermore, people have needs to meet, and they use technology as an instrument with which to achieve this goal. Apps are used to supply subjective expectations and needs, such as "being informed" or "not being lost." This subjective perspective of interaction should receive the attention of new product designers. Designers should design in such a way that users will be attracted by the product and want to use it.

3.4.1.2 User interface design principles

The best-known principles for user interface design are provided by Shneiderman et al (2010) and Nielsen (1994). In the table below, they are combined and grouped in one list:

Shneiderman*/ Nielsen**	
Strive for consistency */Consistency and standards**	Similar actions should be requested in similar situations avoiding misunderstandings and doubts. Shapes, colours, fonts, menus and so on should be consistent throughout the layout. It is also in accordance of the Gestalt principle of continuity. Mainly in the mobile field is suggested to follow platform conventions, as users are accustomed with certain interaction actions.
Match between system and the real world**	Use real world conventions making information appear in natural and logical order.
Carter to universal usability*/ Flexibility and efficiency of use**	Design for plasticity, recognising different user profiles (novice and experts; internationals and nationals; disabilities). Add possibilities of content change.
Offer informative feedback* /Visibility of system status**	Keep users informed of what is happening during the interaction by feedback. Visual presentation is a way to show changes explicitly.
Design dialogs to yield closure*	Sequences of actions should be organised with beginning, middle and end. It is also in accordance of the Gestalt principle of continuity and closure.
Prevent errors*/ Error prevention**	Design the system to prevent errors in the interaction cycle.
Permit easy reversal of actions*/ Help users recognise, diagnose, and recover from errors**	Minimise actions to recover errors and show errors messages in a plain language.
Support internal locus of control*/ User control and freedom**	Experienced users appreciate to be in control of actions. Support undo and redo in case users want to go back to previous state of the system.
Reduce short-term memory load*/ Recognition rather than recall** .	Humans have limited capacity of information processing in short-term memory – seven plus or minus two chunks. Avoid making users to remember information/action from one screen to be used in another screen. The interaction should be clear for users. Training should be provided for complex sequence of actions.
Aesthetic and minimalist design**-	Important actions should be privileged. Irrelevant information should not be part of the visual interface.
Help and documentation**	Provide a source of information for users to easily look for actions that they are not sure about or do not know how to proceed

Table 2: User interface design principles

The principles above fit the purpose of designing interfaces for mobile cultural guides. They are very general, but offer direction for designing and evaluating interfaces for mobile devices. Love (2005) recognises consistency, learnability, flexibility, feedback and support as the fundamental principles to apply when designing mobile user interfaces. In the author's opinion, consistent and easy-to-learn apps meet users' expectations, usually because users have

previous experience with similar systems. Users do not want to spend time learning new ways to interact, unless these ways are faster than previous methods. The public that uses mobile devices is very diverse, and so devices should accommodate different users' needs. In addition, flexibility should be provided in sharing/downloading information through different platforms and supports. The elements of mobile interfaces should be organised clearly on the screen and the interfaces should be supportive when certain tasks cannot be completed, such as adding data when disconnected. The same author adds the context of use as a design principle.

The mobile context, according to Ballard (2007), is a result of the carry principle. People carry mobile devices, particularly mobile phones, all the time and everywhere. The carry principle adds some restrictions for accessing information on mobile devices, due to their small screen size, multipurpose functions, battery life, wireless connection and because they are personal. Not only restrictions connected to the device pose a challenge to mobile app design. Savio and Braiterman (2007), Grun (2005) and Parsons et al (2007) identify in their studies other elements that are involved in the context of use. Savio and Braiterman (2007) affirm that many mobile apps are designed as desktop or Web apps. Therefore, they are not always designed with the peculiarities of the mobile context in mind (Fig. 11). Users are involved in the activity while surrounded by their environment and cultural issues. They have goals and a task to accomplish on the mobile device interface, which in turn is restricted by the device, connection and carrier charges. In addition, users' attention to the task might be interrupted. It is not a simple scenario, and it can change if any of the parts changes. For example, different users will have different goals; diverse devices have fewer or more restrictions; different countries and nationalities present various values, and so on. More specifically, Grun (2005) developed a framework to support different application scenarios, such as presenting map-based city routing. He displays a framework that focuses on the location, as this, according to Grun, is the most important contextual factor. This framework also integrates Web technologies, interfaces for exchanging geographical information and existing data sources. As the content is retrieved from Web pages, the layout is sometimes not designed for mobile device screens. Another point is that the user has to have a Web connection in order to access the system (see Table 3).

Framework - Grun 2005	Mobile Learning Framework - Parsons et al 2007
Support for LBS. The framework supports the creation of LBS tailored to the user's position and references for arbitrary application domains	Generic mobile environment - User role and profile, mobility, mobile interface design, Media types, communication support.
Integration of external data-sources. Integration of existing external data sources is enabled by incorporating existing GIS servers as well as by augmenting the POIs with existing Web content.	Learning contexts – Identity, learner, activity, spatial-temporal, facility, collaboration.
Exploitation of GIS standards. The framework uses the open OGC WMS[19] standard for retrieving geospatial information in form of maps.	Learning experiences - Organised content, outcome and feedback, goals and objective, representation or story, conflict, competition, challenge, opposition, social interaction
Configuration of external GIS inclusion. The WMS request to the external GIS server can be configured again through a Web-based interface.	Learning objectives Individual learning – improved skills and new skills. Collective learning – social skills and team skills
Configuration of external content inclusion. The framework offers the possibility of configuring the inclusion of external Web content through a Web-based interface	
Application of a thin client approach. A thin client approach is employed allowing running the application out-of-the-box.	

Table 3: Frameworks

Equally important is the framework developed by Parsons et al (2007), which is based on a combination of a game metaphor and several studies of mobile learning contexts. The model is supported by four m-learning perspectives: generic mobile environment; learning contexts; learning experiences and learning objectives. Like the other models described previously, it takes into account the user's context. It is important to notice that this framework covers the main issues which will help designers to gather requirements in order to develop mobile information systems (see Table 3).

Ballard (2007) points out threats and recommendations for handling elements of the mobile context (Table 4). Following this thought, Savio and Braiterman (2007) display 10 principles for mobile interactions, considering the limitations of humans and devices that arise from the context of use (see Fig. 11 and Table 4). An outline of the main issues involved in mobile cultural heritage apps can be seen in the work of Colazzo et al (2005). They highlight the

[19] The OpenGIS® Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. http://www.opengeospatial.org/standards/wms#overview

limitations and opportunities of using mobile devices to unfold indoor and outdoor exhibits. They also consider disabled users, addressing questions of accessibility (see Table 4).

Figure 11: Context of mobile interaction (Savio & Braiterman 2007)

Ten principles for location-based systems. Savio & Braiterman (2007)	**Carry principal implications. Ballard (2007)**	**Design issues in mobile applications in cultural heritage sites. Colazzo et al (2005)**
1. All mobile interactions are user-driven. Content and activities must be desired and requested. 2. New mobile experiences compete with legacy user models. 3. Ease of use is paramount. 4. Calm technology will be valued over constant disruptions. 5. The device as continuous companion opens the realm for mobile experiences of different intensities and durations. 6. Mobile interactions can extend beyond the device. Web / sensors 7. Mobile interactions are often small steps in part of larger user goals. Many interactions must be intuitive and rapid. 8. Peer-to-peer is the most trusted form of mobile marketing. *9.* With GPS on the near horizon, the mobile phone will be able to provide services that redefine our social networks and the places we inhabit. 10. Mobile phones will not be limited to the processing capabilities of the device. It can work as personal identity, wallet, ticket, entrance key, activator and personal display.	1. Small devices afford displaying one app at time due to small screen size. 2. One handed operation is preferential and thumb-operated. 3. Specialised multi-purpose devices with diverse range of features are currently requested by users. 4. They do not want to carry several devices one for each purpose. 5. Personal device implies security in data entered and stored. 6. Customised device with themes and flexibility of changing the settings according to user's personality. 7. Nowadays people are always on and always connected with mobile devices, especially phones. 9. Battery-powered life should be taken in consideration. 10. User access apps, sometimes in places with inconsistent connectivity. Design of apps should consider it.	1. Hardware characteristics 2. User interaction should be simplified, minimising the interaction elements displayed on the screen and avoiding visually demanding navigation. 3. Considerate the duration of the user experience with the device (batteries). 4. Considerate the requirement of the task to choose the hardware and technology (GPS- enabled systems provide accuracies on the 0.5 to 10 m level. *5.* Communication infrastructure *6.* Take into account which kind of communication the system will utilise (GPRS, UMTS, WLAN, Bluetooth). 7. Designers should take in consideration what happens to the user if he gets disconnected. *8.* Software capabilities 9. Limited processing power (usually 400MHz) and memory spaces imposes on developers some restrictions (presentation logic - user interaction and data display; business logic – server). 10. Interaction Design 11. Scenarios – the same content can be used for different purposes and for different contexts of use. 12. It is useful to maximise the use of content in different media (coherence). 13. Long text is not appropriate on the screen; it requires scrolling to be read. Substitute an audio file for a long text. Visitors want to look at the exhibits and not to read long texts. A text to be read is different from a text conceived to be heard. 14. Large images are not indicated. 15. Time-based media should be carefully considerate. They are technically demanding. The utility is the key to justify a temporary distraction from viewing the painting. 16. Each different context may need specific pieces of content only relevant to it. 17. The navigation and structure of the content should be designed for mobile applications (content, visit duration. 18. Supporting cross-channel workflows can help in understanding the

		exhibition. 19. Location awareness 20. The use of location awareness systems should take into account: 21. Location accuracy 22. Location-mediated control and, or user control 23. Localisation and time-based media (updates according to location) 24. Accessibility 25. Consider different disabilities and sets of requirements for them.

Table 4: Mobile design principles

3.4.1.1 Gestalt principles

With the aim of organising a visual layout, several principles may be applied. The best-known principles are those derived from Gestalt theory, created by Kurt Koffka, Wolfgang Kohler and Max Werthemeimer in 1912. This set of principles is very useful for organising information logically so that users can understand content quickly and clearly (Zwick et al 2005). We will now follow the gestalt principles defined by Lidwell et al (2003) and their application to small screens (Zwick et al 2005; Lidwell et al 2003).

Chang et al (2007) undertook a study in order to confirm whether the gestalt principles of similarity and proximity could be applied to haptic perception as they are applied to visual perception. Most participants used similarity to group the elements, through the senses of touch and sight, when the space between them was the same. When it was not, proximity was used with both senses. This study was useful to help designers to predict how users would group elements in touch screen surfaces. Another study using the gestalt approach contributed to the mobile design field. Paay at al (2007) applied the gestalt principles as a theoretical framework in order to understand the relation between a location-based system and the context in which users were visiting. They aimed to understand how users joined together small pieces of information provided by the system and compared them to the environment in order to acquire information. Users looked for information about their current location on the screen according to proximity. Closure explains how people put together fragmented information provided by the system, and how they added parts of themselves in order to comprehend it. Symmetry was employed in order to align representations on the screen to the real world in

order to obtain more accurate information. Continuity was used as a way to show the users' interest in certain locations, if they looked for locations with which they were familiar or from previous recommendations. Similarity was used as a way to match the real environment to the screen representation by colour, shape and text on the screen. (Table 5).

Gestalt Principles	
Proximity	Elements close together are perceived as a single group.
Similarity -	Elements that are similar are perceived to be more related than elements that are dissimilar.
Closure	A tendency to perceive a set of individual elements as a single pattern rather than multiple individual elements.
Figure-ground	Elements are perceived as either figures (objects of focus) or ground (the rest of the perceptual field). This distinction should be clear to facilitate interpretation.
Symmetry	The tendency of human perception to search for regular formed. Symmetric designs are evaluated as harmonious and balanced.
Good form / Pragnanz –	A tendency to interpret ambiguous images as simple and complete, versus complex and incomplete
Continuity –	Elements arranged in a straight line or smooth curve are perceived as a group, and are interpreted as being more related than elements on the line or curve. People perceive elements based on previous experience, on what it has already seen.

Table 5: Gestalt principles

In the next section, principles focused on HCI and mobile HCI for developing user interface designs will be covered.

3.4.2 Guidelines

Guidelines are specific recommendations for designing apps. Each manufacturer has its own set of guidelines to help its designers to develop products for a specific device size and platform.

This maintains the identity of the company and assists users to navigate apps in the same platform. Therefore, users do not need to learn new modes of interaction every time they use an app on their phone.

Each mobile device has its own characteristics, screen size, resolution and memory. Therefore, guidelines are adapted for presenting information in diverse situations. The most popular size for touch screen devices is 320 x 480 pixels, which was introduced by Sony with the Sony Cliè in 2002 and followed later on by Apple with the release of the iPhone in January 2007 and by Google with the HTC Dream in 2008. Nowadays, over 40 models of mobile phones have this screen size.

Not only the screen size affects the presentation of information, but also the characteristics of the operating system. The most popular operating systems for smartphones are Google Android, Symbian (available for Nokia devices) and Apple's mobile operating system (iOS) (see Fig. 12).

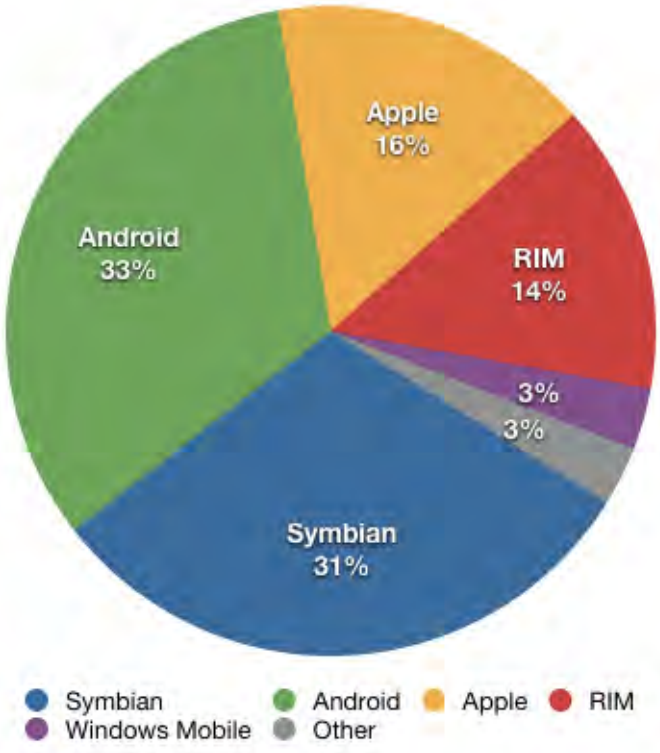

Figure 12: Smartphone sales to end-users by operating system – 01/2011

(Data sourced from http://www.canalys.com/pr/2011/r2011013.html)

The market is also shared with other companies that have their own operating systems, such as RIM (which is responsible for Blackberry OS) and Windows Mobile by Microsoft. Guidelines are provided to supply and fulfil the needs of each platform/operating system, and in some cases to guide the design of a specific device. Below is a table with popular sources of guidelines. (Table 6).

Platform	Source
Symbian	http://bit.ly/9Kw9sw
Android	http://bit.ly/hVO32
Apple	http://bit.ly/bhfeej
RIM	http://bit.ly/eKUdXN
Microsoft	http://bit.ly/BNACI

Table 6: Platform guidelines

The guidelines are organised by topics of importance, and sometimes they are accompanied by illustrative examples. Some of them cover best practice guidelines and the design principles mentioned previously, while others are platform- or device-specific. Overall, guidelines describe platform characteristics and restrictions, user interfaces and experience guidelines, methods for developing and evaluating apps, technology usage performance aims and code samples.

The best practice guidelines from different manufacturers can mostly be applied to the majority of devices that have the same configuration and screen size. For this reason, it would be exhausting to review a great number of guidelines from diverse manufactures, as they would repeat themselves. The Apple iPhone and Android are the main platforms for the most popular size of touch screen mobile phones, and therefore their guidelines are reviewed here.

Ginsburg (2011) suggests six design practices that are also applicable to other platforms: be welcoming; let the content shine; know the user; make selections fast and error-free; provide appropriate feedback and minimise the pain.

Apps should welcome users by guiding them through the system. For example, they should provide introductory information, present annotations for first-time users such as “tap here,” and offer an optional video demonstration.

The content is the reason why users want to use an app, and this is why it should shine. Therefore, the way to access and hide controls in order to interact with the app should be clear. Users may tap on the screen to hide or reveal controls, tap on a button/zone to show only some user interface controls and hide others, or view a list and hide the controls while scrolling.

On the Apple platform, it is possible to retrieve the user’s name, add favourites and find user behaviour. Apps may welcome users with greetings, sync favourites pages added by cross-platform apps or search the user’s history in order to identify his/her behaviour. User information from these sources might be used to personalise actions, but privacy issues may arise. Another way to personalise an app is to offer settings, through which users can suit their preferences for font size, sound, screen orientation and so on.

Errors can be avoided to make users more efficient. Hence, smart defaults are required in order to avoid users typing information that can be filled in automatically, such as the current location identified by GPS features. When using a search engine, the system should include predefined lists and possible results that match the user’s search terms. Storing recent activity, completing certain fields based on previous entries and the use of voice recognition may minimise user effort.

Feedback is given through animations, sounds, visual transitions and text alerts. When downloading information, animations and progress bar displays makes users aware of what is happening in the app. Sounds should be the second option for feedback, because they may disturb users, and sometimes users may mute their phones or may be unable to listen because of environmental noise. Visual transitions may be used to maximise the selected item, providing visual feedback. Text alerts can be used when visual feedback is not enough.

It is impossible to be sure that the entire experience will be error free. On some occasions, network connection problems or limited bandwidth might disrupt the user's experience. Therefore, when this happens, alerts explaining the problem should be displayed and the app should cache information to maintain its current state. In addition, the app should save work in progress, for example saving drafts.

Ginsburg (2011) describes these practice guidelines and illustrates them using examples from the iPhone device. Most of these examples could be adapted to other mobile phone devices that use different platforms. Beyond these six practices guidelines, Apple offers a set of iPhone human interface guidelines. These are organised by user experience guidelines and element usage guidelines.

Similar information is found in the Android best practice guidelines. The Android is an open source platform, meaning that the guidelines are updated and added by Android developers. They are not easily transferable to other platforms, and focus more on the developer than the user. Android best practices are not aimed at specific devices, as they are on the Apple platform, in which the mobile guidelines are focused specifically on iPhone and iPad devices. Hence, the guidelines support a range of screen sizes. Moreover, guidelines for increasing performance, responsiveness and the seamlessness of an app through coding are displayed with sample packs and codes to write in the system development kit. Furthermore, Android user interface guidelines are displayed and focus on the construction and usage of elements.

Android and Apple devices differ in their modes of interaction. Android devices usually have six hard keys, such as "menu," "back" and "zoom in/out," that maintain consistent interaction across different apps on the same device. Users are able to interact with the screen through direct manipulation, while some functions can only be accessed using the hard keys. iPhone devices have only one hard key for exiting from apps or for shortcuts (expert users). Interactions occur almost exclusively through users' gestures on the screen of Apple devices. For this reason, Android guidelines are more difficult to use with other platforms, because they are focused on the hardware as well, and not only on the screen design.

A list of reviewed guidelines from the Apple and Android platforms is available in Appendix A. In Appendix A, preference was given to the presentation and user experience guidelines applied later in this work (Chapter Five: Prototype Design).

3.4.2.2 Guidelines for cultural heritage and tourism apps

There is a great array of guidelines for helping heritage professionals to organise exhibitions. One of the most frequently mentioned guidelines is the aim of using applications and the purpose of using ICT in heritage settings. A range of authors have affirmed that ICT should be used when conventional media are not sufficient to deliver the intended information or when ICT can provide a better understanding of the subject before, during or after the visit (Carter 2006; Silberman 2006; Mitsche 2008). In Black's (2005), words visitors want to learn with exhibitions. For this reason, the approach taken to engage them should be imaginative, interesting and enjoyable.

The content is also of paramount importance in developing cultural information systems. Most projects in museums should design the content according to user preferences, and based on user research (Silberman 2006). ICT media must relate clearly to the places, objects or events in the real world that form the subject matter (Carter 2006). Tilden (1957) affirms that information, as such, is not interpretation. Interpretation is revelation based upon information. However, they are entirely different things. Nevertheless, all interpretation includes information, and the chief aim of interpretation is not instruction, but provocation. Therefore, the content should be presented in a lively, interesting and accessible way.

Sustainability and the environmental impact of ICT should be considered during planning in order to avoid unrealistic expectations or unexpected side effects of tourist development (Silberman 2006; Carter 2006).

There are some specific design and usability guidelines for application in museums and exhibitions. Silberman (2006) and Carter (2006) have pointed out that the design should be evaluated during the development of the project. Carter (2006) states that it would usually be beneficial for users to be able to stop, replay and rewind content, especially if the system is to

be used outdoors or on the move. Silberman (2006) adds the provision that multilingual programmes are a good alternative for considering users' needs where appropriate and necessary.

In addition, hardware and equipment can improve or lose a visitor's attention. The impact on visitors who use or do not use the technology, whether it is easy to use and the impact on the environment should be considered (Carter 2006; Silberman 2006; Ludwick 2003).

Similarly, Grasso and Roselli (2005) have developed guidelines for designing mlearning content. They recommend a number of guidelines for usable interface design and also suggest interface design from a pedagogical perspective. The proposed guidelines were applied to create a course on the work of Caravaggio (see Table 7).

Designing M-learning contents. Grasso & Roselli 2005
Technical guidelines The interface must be suited to the mobile device and its functions but not depend strictly on them; The contents should be significantly reduces in conformity with the limited capacity of the device and to ensure rapid access; Mobile devices must be easy to handle and allow easy interaction by any user type; Mobile devices need to be resistant to damage and adaptable to different visual and acoustic conditions, so that the users attention can be focused on the learning content rather than on how to use the device itself.
For the menus User disorientation must be avoided and the total number of interactions with the system required must be kept low; The user must not get trapped in links to the various sections, which could be activated in few steps; Each display must be presented in the same way and the form and function should call to mind the menus of traditional computers;
For links and navigation objects When the user activates a link the presentation of the resulting interface must correspond to his/her expectations; Each link must be associated with a given task. Each display must be filled with useful objects to avoid the need for frequent scrolling of the page;
For the help, feedback and cancel functions Give clear, simple suggestions for the main objects, allowing the user to turn them on and off; Provide visual and sound feedback allowing the user to turn them on and off; Allow the user to cancel and correct mistakes made during navigation; Provide user help for all applications both online and offline;
For personalising the user environment Allow user to personalise and creatively organise his/her work area;
For the interaction modes The contents must be adaptable and independent of various interaction modes: user must be free of how they want to interact with the application;

For the contents and multimedia objects
The meaning, communicative power and role of each multimedia object must be enhanced within its usage context;
The user must not be distracted by lack or excessive use of sensory channel;
The multimedia objects used to present information must be derived from the usage context;
The previously learned domain contents must be suitable integrated into the new contents;
The developer should bear in mind that not all types of media can be displayed on palmtop devices;
The varieties of colours, bold type and italics must not cause confusion between links and static contents;
The contents and image resolution must be reduced, but not so much as to make them incomprehensible;
Use images of appropriate quality rather than filling the screen with tiny icons.

Table 7: Guidelines (Grasso & Roseli, 2005)

A list of guidelines derived from the literature review (in the Prototype Design chapter) is available in Appendix A.

3.4.3 Design patterns

Design patterns are solutions to a problem in context. The term "design pattern" was introduced by Christopher Alexander in 1977. According to the author, patterns are elements of a language that describes frequently occurring problems and solutions in context. Landay and Barrielo (2003: 93) complete the definition by focusing on interaction design and saying that patterns are written to be flexible enough for reuse in many situations, and that designers can use them to identify and propose solutions to recurring problems.

Pauwels et al (2010) highlight that Alexander's patterns differ from software patterns: the former were given to non-professionals to help them to develop good designs, whereas the latter were made by and for professionals. The interest in patterns shown by interaction designers began in programming conferences and HCI workshops (Bayle et al. 1998; Griffiths et al 2000). Attention was given to user interfaces and the use of patterns. Books such as *Designing Interfaces* (Tidwell 2006) and *The Design of Sites: Patterns, Principles, and Processes for Crafting a Customer-Centered Web Experience* (Van Duyne et al 2003) popularised the theme. In the mobile design field, papers have been published in journals such as *Personal Ubiquitous Computing* (Roth 2002) and conferences such as "Designing Interactive Systems: Processes, Practices, Methods, and Techniques" have been held in the interaction design field

(Chung et al 2004). None of the above has resulted in clear patterns focused on the development of mobile cultural heritage systems. Research in the field has provided patterns of visitors' behaviour at cultural attractions (Kim 2007) and when exploring the city surroundings (Brown 2003; Oliver 2004). Although there is a lack of patterns for guiding the development of cultural heritage systems in open-air settings, much can be learnt from general patterns that have been researched in the past.

According to Roth (2002), patterns acquired from successful software design can be utilised to build new designs. He proposes a group of mobility patterns based on mobility constraints. Six pattern classes were created: security; streaming; mobile code; user interface; mobile data; and mobile service (Fig. 13). Patterns are presented according to the established descriptions format: pattern name; synopsis; context; forces; solutions; consequences; examples; related patterns and classes. The benefits of the use of mobility patterns are described below. First, designers will be aware of specific aspects of design. Second, as patterns and their implications are described, designers will come to know the pros and cons of specific patterns. Third, designers can reuse successful designs.

Figure 13: The pattern hierarchy (from Roth 2002)

Nilsson (2009) identified those benefits that validate a group of mobile design patterns. This group of mobile design patterns is divided into three main user interface problems: utilising screenspace; interaction mechanisms and the design at large. They concern screen size constraints, entering information into the system and the use of mobile equipment. Every pattern has a description, followed by when, how and why it should be used. The collection of patterns was validated by 48 experts in HCI during HCI conferences. They answered a questionnaire about the patterns and assigned a score to each one. Relevance, usefulness and future use were scored on a scale from 1 to 6, where 1 = Not relevant at all/Not useful at all and 6 = Highly relevant/Very useful. As a result, the average score was 5.0 for utilising screen space, 5.2 for interaction mechanisms and 4.7 for the design at large. This shows a high score approval rating for the collection. The collection has 26 problems, and some of them are also adapted to touch screen use. More details of the collection can be found in Nilsson (2009: 1317).

It is always difficult to identify when suggestions are patterns. In addition to presenting implications, solutions and examples in context, there is the frequency with which the situation in question occurred and can be considered authoritative. Some authors (Saffer 2007; Landay & Borrielo 2003) affirm that patterns can only be declared as design patterns when they are used at least three times successfully in real products or systems. In the project described above (Nilsson 2009), the validity of a pattern collection was scored. Instead of asking experts, Leavitt and Shneiderman (2006) undertook fieldwork in order to rate their design recommendations. They classified their design recommendations as providing strong (4-5), moderate (3) or weak (1-2) support for research. In their research, the strength of evidence was rated as being between 1 and 5, depending on how frequently this issue appeared during the fieldwork experiments. Strength of confidence is related to the extent to which we can trust this solution. The scale varies between 0 and 5. The solutions rated as zero were not tested, and only the evidence of the problem exists and offers possibilities for further research.

Certain mobile companies also provide lists of patterns to help designers to develop for their platforms. For example, Apple has a set of design patterns for the Cocoa environment.[20] Other recommendations are provided and shared by communities and are not specific to a certain platform. The World Wide Web Consortium (W3C) is an international community that aims to develop Web standards. They offer recommendations named "Mobile web best practices."[21] Some recommendations are accompanied by definitions of what the practice is, how to do it, what to test and references. Certain manufactures such as Nokia have a variety of platforms running on their devices, whether software platforms (e.g. Symbian), development platforms (e.g. Java ME) and diverse Web technologies (e.g. Flash Lite). Therefore, Nokia design patterns[22] are more general and may fit the majority of devices. The list of patterns provided by Nokia covers most of the user interface patterns indicated by others (Nilsson 2009; Apple 2010; Roth 2002). It contains a description of the pattern, its advantages and disadvantages and when to use it. In this work, Nokia patterns were followed because of their clarity and ease to follow during the development process. The list of design patterns that supported the mobile guide prototype design is available in Appendix A.

3.4.4 Discussion

This literature review of principles, guidelines and patterns has pointed to a direction for the work described in this thesis. Firstly, experience design principles, user interface design principles and gestalt principles indicated parameters within which to reflect on needs and to understand what was relevant in order to demonstrate an interface design for a mobile guide. Secondly, guidelines provided by mobile device manufacturers and cultural heritage research led us to think of operational and technical issues, with some relevant considerations of visitors' needs in cultural settings. Finally the literature in the field described the process of creating a pattern together with the relevance of showing problems in context and offering tested solutions: Nokia design patterns were recognised to be clear and easy to follow in developing mobile apps.

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[20] http://developer.apple.com/library/mac/#documentation/Cocoa/Conceptual/CocoaFundamentals/WhatIsCocoa/WhatIsCocoa.html#//apple_ref/doc/uid/TP40002974-CH3-SW16

[21] http://www.w3.org/TR/mobile-bp/#ca

[22] http://wiki.forum.nokia.com/index.php/Mobile_Design_Patterns:_Interaction_Models

The majority of the recommendations shown above were very general, emphasising operational and technical issues and were not specific about presenting multimedia content in cultural heritage settings. More studies highlighting lexico-visual, audio-visual and multi-visual representations in location-based systems are required in order to help designers to develop their thinking about users' needs for multimedia apps. In addition, research into mobile multimodal interfaces in cultural heritage settings is still weak in terms of understanding how people perceive, handle and interact with mobile systems in outdoor location-based contexts.

3.5 Competitor analysis

The aim of this review is to identify the main functionalities and content of commercial apps. This review is restricted to apps that contain cultural heritage information or have the potential to store such knowledge. Priority was given to travel guide apps that focus on the city of Brighton and those that stand out in the marketplace. In addition, websites that host specific content about monuments and sculptures in Brighton were selected. The analysis of these apps indicated the characteristics of mobile guides in the marketplace and served as a visual reference guide for the development of a mobile guide prototype later in this work (in Chapter Five).

3.5.1 Brighton city-based mobile apps

In 2008, when this research started there, there was not a single mobile app focusing on the city of Brighton. The Apple iTunes App Store opened in July 2008. In early 2009, two apps with text-based information were available for visitors wishing to explore Brighton – the Brighton app and the Brighton England app. Later in the same year, a map-based guide was released which helped visitors to locate themselves in the city – the Walk Brighton app. In 2010, most of the Brighton mobile apps that are currently available were launched. Nowadays (2011), there are eight location-based apps available for users to find their way around Brighton. These apps are focused on ways for pedestrians to find landmark locations, street names and other points of interest (restaurants, hotels, museums, etc.). Cultural attractions may also be found in three other apps dedicated to cultural events and attractions in the city – the Brighton What's On app, Brighton Artists Open Houses and Culture Sussex. In addition, there are ten travel guide

apps available, highlighting POI located on the map or listed alphabetically with content about the city. Overall, 23 apps serve the purpose of giving information relating to Brighton to locals and visitors. Some of these apps are reviewed here (see Appendix B – Alignment chart of Brighton city-based apps; sect. 2.5.1.2).

Android Market, the Blackberry App Store and the Ovi Nokia App Store were consulted in order to check for available Brighton apps. Only one app which displayed information through text was available in the Android store, released in 2011 – the Travel Guide UK Brighton app. Therefore, the review focused on apps available in the Apple store.

3.5.1.2 Alignment chart – Brighton city-based apps

An alignment chart was made in order to focus on the main characteristics of Brighton-based apps. Nine apps were chosen for comparison according to their content, features, multimedia usage and available interactive elements. In addition, they were classified into four categories: POI guide, guide plus advertisement, user-generated content guide and location-based guide. Four were free, and the others ranged in price from £0.59 to £2.59. Some highlights are also described.

POI guides were characterised by the function of guiding visitors towards the main attractions in the city. Only two apps had authored content, while the others pulled in content from the Wiki travel and Wikipedia Web pages. Rarely did they mention cultural heritage outdoor monuments, with the exception of landmarks such as the Palace Pier and the Royal Pavilion. The Brighton England guide displayed two public sculptures, but they were not labelled correctly. The guide was mainly text-based, filling the whole screen. No effort was made in terms of text presentation, except for two guides (Brighton Cool Places and the Brick guide). Not all of them showed a map with POI. The ones that had a map usually showed the user's current location. However, none of them provided directions from the visitor's current location to a specific point of interest. The back icon was present in all of them and eased the navigation flow. In addition, a list of POI was part of all guides of this type. The most attractive content was written by a local (Emma Gregg), in the Brighton Cool Places travel guide. This guide also stood out by adding interaction styles – wheel spinning – in which users could sort the main

attractions to see by chance. In addition, activities to do on rainy days and with children were available.

Guide plus advertisement was a category created in order to show how commercial places can benefit from publishing mobile guides. My Holiday Let has authored content, with text and pictures of the main landmarks in Brighton. It is very well structured and easy to use. In addition, users can send a postcard via e-mail with pictures provided by the app or using their own pictures.

User-generated content guides were available to download from the App store. They are labelled as Brighton guides and serve more as a platform for adding content. Users have to pay to download them. In the future, when more users load content onto these guides, they may become good reference guides, but for now they are weak. Yescitiz Brighton has two modes to chose from: tourism and daily life. Different functions appear on the screen according to the mode. The tourism mode offers the opportunity to select places, hotels and bar & cafés. The daily life mode provides an opportunity to add and see places and events on a Google earth map (satellite mode). These categories are currently empty. There is also an option to share places with social networks. It is interesting to have these distinct modes, as information added by residents is trusted, and the app does not show content which is irrelevant to residents (e.g. hotels). Users can only see the content after creating an account. An advantage is the possibility of entering text in four different languages. The other user-generated content that was analysed was the AHI's Offline Brighton, which, like the tourism mode on the previous app, shows a map to which users may add pins (POI) with descriptions and pictures. This serves the purpose of a travel diary more than a travel guide. In both cases, the user's current location is identified.

Location-based guides have a map of Brighton as the main background. No information is given about any POI, only directions. The Genius app is a library of roads and streets in Brighton that users can search or pin to an interactive map. The advantage is that users can send the address pinned to an e-mail to others and add it as a bookmark. The visual layout is very attractive and clean. The second app chosen for this category is Walk Brighton. It shows a map that one can

move around by sliding the screen with one's fingers. It is not possible to add any information to the map; however, the map displays the main areas of Brighton with POI. Gardens and parks are displayed in green, which helps to find one's way. Points of interest are displayed as 3D drawings that help visitors to recognise the main attractions. In the corner of the screen, arrows pointing to the station and the main regions are displayed, allowing visitors to see the direction in which they are going.

This group of Brighton apps has very little cultural heritage information and does not focus on content as the primary user task. Few have authored content that can illustrate the history of Brighton through public monuments and attractions. Map-based apps were the most common layout found in this selection. The most popular functions are interactive maps with POI, current location identification, lists, search and share. Screenshots of these apps can be seen in Appendix C.

3.5.2 Popular travel and tourism mobile apps

To the same extent as the user-generated content guides presented above, other apps are available on the marketplace. They are not exclusively for the city of Brighton, but one can add content for any point of interest available on the world map. These apps employ Google maps as the main background in order to add and share locations. They may also be supported by content available on the Web, like Wikipedia and other related websites. Some of them are called compass guides, such as Layar and Wikitude. Users may see annotations on the top of the visual screen through the camera lens from the real world. These layers of content are developed using a developer kit, or in the case of Wikitude, content can be added on a website and requested from mobile devices. The camera view is useful for seeing POIs around the user's location, but GPS technology is sometimes fairly imprecise and does not always identify the user's correct location (Sung 2011). An application of these can be seen in Chapter Four: Design Activities.

In addition, it is worth mentioning the apps made by travel guide companies that lead the marketplace for paper-based guides. Lonely Planet and Frommer's are good examples. The

former has the same kind of content as is published in their paper-based guides, and a great deal of text. The layout is organised by colour and intuitive icons that lead to categories. Users can refine their search results by category and see them placed on the map. They can also choose from a list to view a POI and see detailed and operational information. Frommer's is a similar kind of digital guide and stands out for making available three views of POIs in the "sights" category: rating; alphabetically and nearest to the visitor.

Two other world travel guides have served as references for this research. Schmap, which is derived from guides available on the Web, and Sprice, a multimedia travel guide that was the only guide analysed which presented multimedia content (audio and video) in the same guide. Schmap retrieves content from their website and works only with an Internet connection. An interesting way to change the view mode in this app is to turn the screen. Users can change from the content/list mode to the map mode by turning the screen to landscape. Sprice has an audio guide for visitors to listen to while walking through the city. The audio guide is accompanied by a map on the screen showing the points of interest mentioned in the audio guide. The audio files last for around two hours. The content of each POI is displayed with a short description and pictures or videos. The main landmarks are displayed with pictures and videos, which last for around one minute, while the other POIs feature pictures only. In this guide, users can refine the results alphabetically, or by distance or rating, like Frommer's guide.

Screenshots of the analysed travel guides are available in Appendix C. The layout, icons, structure and modes of interaction of these guides have an influence on the design of the prototype guide described in the Prototype Development chapter.

3.5.3 Web-based cultural heritage information available about Brighton

Nowadays, websites can be accessed anywhere that has an Internet connection. Three websites covering cultural heritage content are highlighted here.

VisitBrighton.com[23] offers important information to help tourists. It has PDF guides, podcasts and audio walking guided tours about Brighton's history. Of particular interest to this work is a podcast named "Brighton Arts & Sculpture Trail." The podcast has a PDF map that users can download in order to follow the trail. The podcast is a recording of a conversation between two people: an interviewer (Simon Fanshawe) and an expert in the field (Peter Seddon), following the trail in its true setting. Six sculptures were chosen to be part of the trail explored in the present research.

The "Brighton Arts & Sculpture Trail" podcast had the support of the National Recording Project of Sussex.[24] They have an online database[25] under the coordination of Anthony McIntosh. This online database offers detailed information about the monuments and sculptures of Sussex, including GPS locations. A paper guide is also part of their material. This paper guide was used in the design activities in the present research (Chapter Four: Design Activities).

Another relevant source of cultural heritage content on the Web is the "My Brighton and Hove"[26] website. This is a community website that aims to preserve and share the memories of the city through photos, knowledge and the opinions of citizens. There is information available about monuments and sculptures all over the website, but not categorised in one section.

These websites also serve as a reference for content design in Chapter Five.

3.5.4 Discussion

The competitor analysis aimed to understand the marketplace of mobile guide apps, especially those regarding the city of Brighton and those that present cultural heritage content. Websites also indicated what kind of information is displayed via digital media and how, and showed opportunities for improvement.

[23] http://www.visitbrighton.com/site/maps-guides-and-interactive/podcasts
[24] http://artsresearch.brighton.ac.uk/research/projects/nrp-sussex/national-recording-project-for-sussex-online-database
[25] http://artsresearch.brighton.ac.uk/research/projects/nrp-sussex/national-recording-project-for-sussex-online-database
[26] http://www.mybrightonandhove.org.uk/

The alignment chart of Brighton apps and the analysis of popular mobile guide apps showed the main features, interaction modes and methods of content presentation that are currently used in this context. It was recognised that there are opportunities to improve these guides. Cultural heritage content is rarely a part of these guides. Only a few guides take advantage of multimedia functions, such as audio and video, in order to enhance their content. Pictures designed to illustrate the content are not always available; usually, there is one picture of the POI or more pictures from different angles. Therefore, they do not provide new information to the user. Blocks of text are usually dense and are not always original or formatted to be displayed on the mobile device screen. On the other hand, great technology is being employed to help in navigation. Most of the guides analysed have a GPS function and can recognise the user's current location. Google maps technology is used in numerous apps as the background on which to display POI icons. Even though Google maps technology is used, it is not possible for users to retrieve detailed directions from one point to another, e.g. the path from their hotel to the Royal Pavilion.

In a two-by-two diagram, it is possible to see that there is a high-level opportunity to develop multimedia guide apps that display cultural heritage content (Fig. 14). The green circles represent the Brighton apps and the red circles are general ones. The empty top right quartile indicates that no competitors in the mobile market for this type of app in Brighton were identified.

After this review, it is clear that more user research and recommendations for developing commercial apps are necessary in order to improve the user interface design, to validate and understand the use of multimedia features and to enrich and design cultural heritage content.

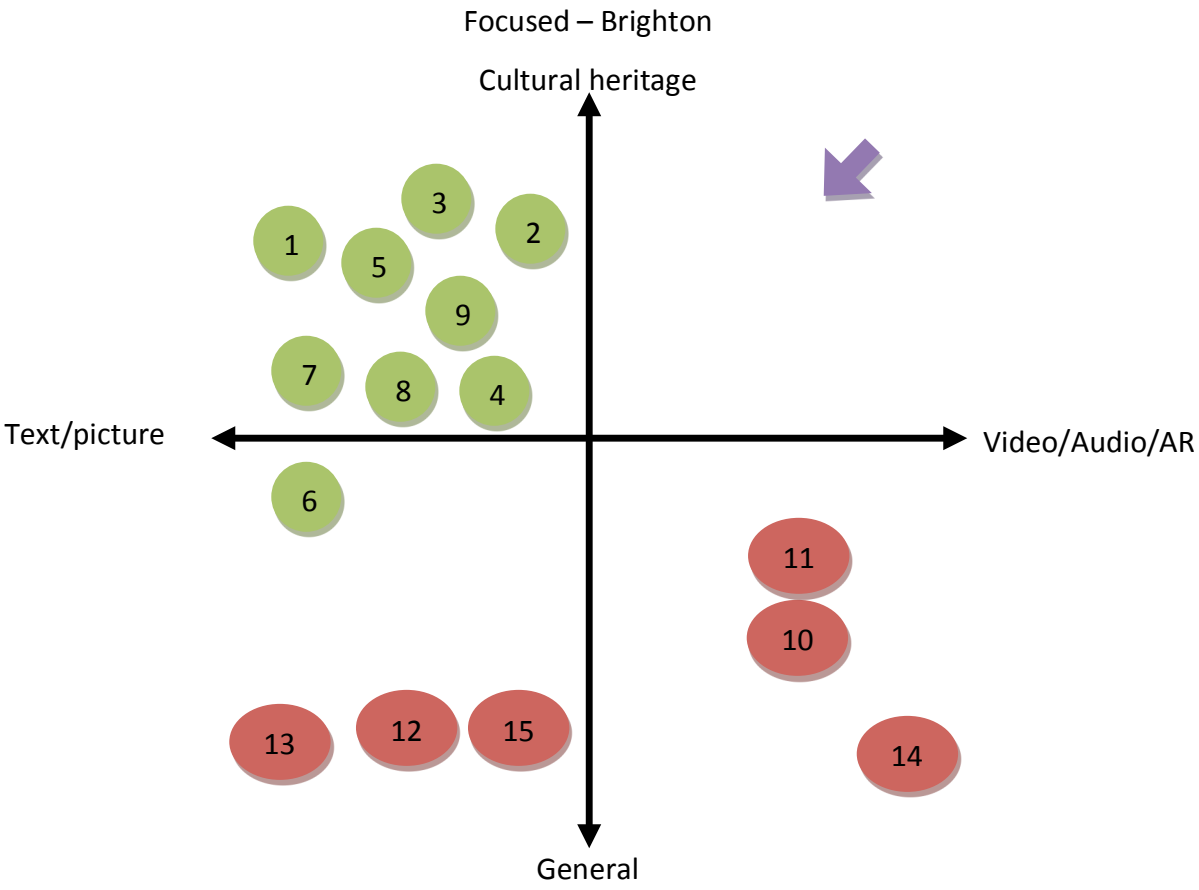


Figure 14: Two-by-two diagram competitors

(Labels for numbers are available in Appendix C)

3.6 Conclusion

This background chapter has provided discussions of the characteristics of visitors and of their experience of elements of cultural heritage. A few approaches use intensified content display and interface design to improve users' experience of outdoor contexts. However, this area still has its shortcomings. The presentation of information, content design and the context in which users interact with mobile guides in outdoor settings constitute the scope of this current work.

The main principles, guidelines and patterns governing mobile app design were reviewed and served as a guide to develop the mobile cultural guide prototype (Chapter Five: Prototype Design). A competitor analysis of Brighton apps and popular world apps concentrated on the

characteristics of navigation, tourism and cultural attractions. This gave an overview of the popular features, opportunities to launch cultural heritage apps in Brighton and visual references for developing future mobile guides. The strengths and weakness of these apps were evaluated in a comparative alignment chart. A closer look at Web-based content was necessary in order to provide a clear image of what is available regarding Brighton's cultural heritage, which is mainly monuments and sculptures situated in open spaces.

This overview provided a basis and strengthened the argument that more research with visitors and residents is necessary in order to provide recommendations for developing cultural heritage guides. The projects reviewed were general (not specific to cultural heritage content) and did not reflect the real experience of diverse users in outdoor cultural settings. For this reason, extensive fieldwork activities with visitors, residents and locals were undertaken in order to provide recommendations based on the strength of confidence and evidence (Chapter Four: Design Activities). Subsequently a framework of factors was designed in order to help designers to think about the main issues involved in designing mobile cultural guides (Chapter Seven: Results).

4 Design Research Activities

4.1 Introduction

This chapter describes the design activities that served as the basis for designing a prototype mobile guide. Three fieldwork activities were undertaken in order to generate requirements for the final prototype. The first was an attempt to understand the activity of being guided by *professional tour guides*. The second investigated *paper based guides* and examined how users followed this information source to acquire cultural heritage information. The third added a technological perspective, where participants accessed multimedia content through a *mobile touch screen phone*. The last two studies provided requirements, rated by strength of evidence during the tours. These requirements were employed to develop a mobile guide prototype for testing with users.

4.2 Design research activities

The literature review demonstrated that there is a lack of studies on effective information representation in location-based interfaces for use in outdoor mobile guides. More studies are required to identify the main characteristics of those environments and to explore how visitors perceive, handle and interact with mobile systems.

In this scenario, a qualitative, inductive and interpretative approach was taken, in which theoretical ideas about user interaction with mobile information devices emerged from a range of observational and other design research activities. In other words, as well as delivering requirements for such a system, these activities generated issues about the different design parameters – font size, page layout, navigation system, stop length, activity type and many more – for which recommendations will be generated. The main goal of the design activities for the prototype was to understand what people expect of cultural and historical tours and identify which aspects were involved during those activities.

We did this by looking at different ways of delivering cultural and historic information. The first study aimed to establish the basis of the activity. Hence, an observation study was chosen to understand the state of (human) tourist guides. The objective of the second fieldwork activity

was the identification of user's behaviour visiting historical places with paper-based guides. What was still missing was the interactive perspective with electronic devices: therefore, in the third study, users were observed following a mobile phone app to access information in outdoor settings.

4.2.1 Human tourist guides

In order to achieve a system that would be welcomed by the target user group, it was necessary to carry out close observation of current tourism practices and behaviours. Many tourists employ the services of a guide, either on a traditional package tour, or, increasingly in the world of short city breaks, in the form of a small, relatively informal walking tour, where the cultural, historical, artistic and social aspects of the cityscape are explicated on the move. With the purpose of understanding what people expect of cultural and historical tours and identify which aspects are involved during those activities, we adopted the participant's point of view, and observed three different walking tours from the programme of the Fringe Brighton Festival in Brighton, on the south east coast of England.

4.2.1.1 Methods

Participant observation of people taking a guided tour was chosen as the first fieldwork methods. Three walking tours were chosen to be part of the study. The tours were selected on the basis of their cultural and historical characteristics. The first was an "Historical Central Brighton Tour", which provided a general vision of the historical centre of Brighton to visitors. The second was the "St Nicholas Church talk and tour", which presented explanations about a specific landmark. Adding a less architectural and more literary perspective, the third tour was the "Brighton Rock Guided walk", which showed the locations of the film "Brighton Rock" and its original inspiration, the novel of the same name by Graham Greene. The length of the tours was on average two hours and a half.

Guides were contacted by e-mail or telephone to obtain permission for the study[27]. At the beginning of each tour, the guides introduced the researchers and advised the tour would be audio recorded. On the day of each tour, the guides were very helpful. Some of them even asked visitors for demographic information necessary for the research, e.g. their place of residence. Two researchers followed the tours[28]. One was responsible for the audio recording and the other for taking notes of behaviours and/or information that stand out during the tours.

At the end of the tours, guides were informally interviewed. Additionally, visitors received a postcard explaining the research and providing contact information to return the card by post or give it back to the researcher (Candello & Pemberton, 2008). The method applied was inspired for the Cultural Probes proposed by Gaver et al (1999), which was designed to provoke inspirational responses from people in diverse communities (Figure 15).

Figure 15: Post Cards

[27] The research was approved by the management of the Fringe Festival.

[28] Eun Joo Lee and Renata Schimabukuro helped to record the audio in the tours.

4.2.1.2 Data Analysis

The main objectives of this part of the overall study were to characterise the reality of the field and to look for opportunities to use technology to improve the visitor experience. Therefore, an investigation of visitor behaviour was necessary to understand where new technologies fitted in and how they should be used. With this in mind, a naturalistic approach (Bryman: 267, 307) was undertaken during the analysis process. The researcher sought to understand social reality on its own terms "as it really is". There were no pre-established categories to seek for. Rather, the categories that emerged were a result of participant behaviour.

The space for talking was given by the structure of the tour or when visitors asked for information. The St Nicholas Church tour offered coffee and cookies, providing a receptive atmosphere to interact with visitors and guides. With the exception of those situations, the perspective of the listener and observer, rather than that of the speaker, was employed

Audio transcriptions and field notes were the main data analysed. Field notes guided the research to look for categories while listening to the audio files. Brighton is very windy in May, which resulted in rather bad quality for the audio recordings. In spite of that, it was possible to ascertain the major issues and patterns among tours.

To obtain an overview of the target audience, the place of residence of participants was also examined. In addition, the number of people interested in the study – the ones who gave back the post cards – was identified.

4.2.1.3 Findings

Overall forty-two visitors attended the tours. Twenty-nine participants (70%) gave back the cards with their contact address. Thirty-three participants (78%) were residents of Brighton. Eleven participants were taking the tour alone and the remainder were accompanied by partners or family. The Brighton Rock tour was the one with a larger number of couples and family groups, who were less interested in participating in the research. The St Nicholas tour and the Historic central Brighton tour both had the same proportion (33.3%) of couples. The St Nicholas tour was the one with the largest proportion of lone participants overall (54%). In

general, the lone participants were also more likely to give their consent to participate in the subsequent research.

A number of observations were made of guides and visitors behaviour during the tours. They are examined in the next section.

A) St Nicholas Church tour

This tour was the only one that was divided between indoor and outdoor settings. First, the guide gave explanations inside the church and later showed the graveyard. Eighteen participants took this tour. They were the most interested in participating in the research. Ninety percent gave the post card back.

In the first fifteen minutes, the guide summarised what would be seen in the tour. Before moving to the next topic, the new topic to be explored was always mentioned. This gave awareness and a feeling of continuation for participants. Support material was also used during the explanations. Drawings of the ancient church were presented, in order to show the evolution of the architecture. Moreover, the guide handed out paper guides with the main points of interest inside the church. He did not refer to this material during the tour. Consequently, only two visitors were seen to consult it during the tour. Very often the guide questioned participants while explaining the objects and it transpired that some of the participants in the tour had a connection with the church. For instance, one man accompanied by his daughter had been baptised there, while others had relatives buried in the graveyard. These situations gave space for discussions and exchange of ideas between the guide and visitors.

During the tour participants touched the objects inside the church, made comments and asked questions. Only one woman took pictures outside the church. It is true that majority of the participants were from Brighton. This might be a factor that impacts on the decision to make a photographic record of the event, in that they can visit the church any time they want. Locals also tended to frequent the Brighton Festival every year. One of the local participants mentioned she took tours every year during the festival, sometimes the same tours, as in the

case of this tour. This was the third time she had taken the St Nicholas church tour. She said she forgets the tours during the year and likes to take them again.

Opportunities for improvement were identified for some parts of the tour. Printed materials were small and not easy to see when the guide was holding them. The same occurred with objects details pointed out by guides. Some of the objects were attached to the ceiling, which made them very difficult to make out. The guide did not use a microphone while in motion (90% of the tour). It was hard listening to him. Occasionally the guide tried showing certain elements: however he was not on the right side of the church. The employment of technology might solve some of these drawbacks. For example if participants had an individual multimedia guide, the guide could use a device to speak to them. They would also be able to see the pictures of the objects and details. Finally, they would be able to consult the pictures of objects to which the guide refers.

B) Historical Central Brighton tour

This tour had a small number of participants (9) comparing to the others. Six participants gave back the post cards with their contacts. The tour was delivered by a local resident. The guide was extremely well connected to Brighton and history. He even mentioned that some of his relatives were buried in one of the cemeteries on the route.

In the same way as the previous tour, he gave a summary of the topics and sequence of the tour. Additionally, clear instructions to move to the next point were delivered clearing a clear voice. In spite of this, environmental noise from traffic and wind disturbed the experience in several parts of the tour.

Visual information was employed by the guide during almost all the tour. Most of the speech was based on real objects (including buildings) in the environment and on graphic material. The guide had a huge folder with visual references (pictures, maps, paintings). This brought the history alive. An interesting point of the tour was when the guide compared two maps of Brighton and discussed the city's development. He also asked for participants get closer to see the images and maps. Another entertaining moment was when he showed a warehouse. It was

empty and the floor was original. He filled the place with stories making participants use their imagination to follow him. Extra information was communicated to participants in case they wanted to know more of certain subjects. In addition, guidance was given on choosing other tours in the festival and visiting museums in the city.

However, four participants left the tour before finishing. Two were very young and gave the impression they were not interested in the subject. Others had to leave because of the time availability. Despite the festival magazine stating that the tours would take one hour and a half, they took about two and a half hours. Some participants were not prepared for this.

Opportunities to use multimedia guides were found when the environment disrupted the tour and to improve the delivery of visual information. Mobile devices with headphones would help participants to listen to the content and maybe to see better and more closely the images presented. The content would be clearer without some references that were not core to the activity. Hence, if the content was available in a multimedia based system, hyperlinks could be included to access extra information.

The guide was receptive and shared his opinion of using multimedia mobile guides in the tours. He liked the idea of having pictures and videos on the mobile phone. On the other hand, the use of private audio guides was not interesting because people could not ask questions if they had questions.

C) Brighton Rock tour

The Brighton Rock tour did not have a historical perspective like the other guides. The book "Brighton Rock" gave the structure of the locations visited in the tour. Fifteen participants were on the tour. Only four of these returned the post cards with their contact details. Ten people were locals. Twelve people had read the book or watched the film. Unlike the other tours, nobody was carrying cameras.

The guide started the tour summarising the locations that would be visited on the day. When the location was far away he pointed at it and explained which scene of the movie was shot

there. Sometimes it was not easy to be sure that participants were looking at the right spot. Several comments about the weather and Brighton life were made on this tour. The guide also reminded participants that a good way to find out about festival events was through radio advertisements. In this tour, several roads had to be to crossed, most of them very busy. Several recommendations were given for the group to cross the street all together to avoid accidents.

The guide was very clear. His support material was the city. Very often he pointed to places or stopped in front of film locations to remind participants of the scenes. Despite the fact that a few participants had not read the book or seen the film, it was still possible to follow the tour. For those participants, the guide gave a brief introduction about the story, illustrating this with large photographs of the characters in the movie.

The locations were not particularly close to each other. This resulted in conversations among participants on the way. They indicated books to read, and also shared their knowledge about the works of Graham Greene. Rarely did they ask questions while the guide was talking. The questions were asked between locations and not all participants were able to hear questions or answers.

Plenty of opportunities to use mobile multimedia guides were identified in this tour. The subject is a novel and a film. Opportunities to use video and more illustrations about the author and period Brighton would enhance the experience. It would also be possible to access pictures or search for directions of points mentioned but not visited by the guide on the day. As with other guides, images could be better seen if visitors had the opportunity to see them on mobile devices with reasonable size screens. A database with common questions could be available for visitors to access or add new questions during the tour. Additionally, traffic warnings and the location of the next point to stop might be part of the multimedia guide.

At the end of the tour, the guide, Julian Clapp, shared his opinion of having a mobile multimedia guide.

> I think it certainly helps. They like to be able to see the pictures on the phone. There is a lot of people who come on the walk haven't actually seen the film before, so they actually like to see the pictures and if you read the book you actually see the picture – ah it's the person that plays that part. I think it brings to life for people.
> I don't show videos in the tour or in my website because probably I'd have to pay for them. I don't really know if people want to watch part of the movie before coming here. I don't really know. A lot of people that come in this walk are old people. Some really I don't know if they are into mobile phones. My average age people is 30 plus.

In his opinion, there are clear opportunities for examining how people access pictures and videos in outdoor settings.

4.2.1.4 Discussion

The key elements of the tour genre, as expected, were historical and cultural information, together with instructions to look at certain landmarks and to move to other sites. A summary of the tour was also given. Of particular importance for this study is the fact that in addition to giving and audio commentary, guides showed visual information to illustrate what they were explaining, including pictures, maps, screens prints, paintings and design projects (see Fig 16). They also included information to be used outside the tour itself, such as recommendations for other activities in the city. This highlights the importance of media during the experience of informal learning tours. Damala (2007) points out that mobile guides can help in this task:

> They can be context aware, facilitating the retrieval of the right information on the right spot; they can make use of wireless technologies, taming the greediness of rich multimedia content; […] they are able to be personalised to tailor different needs and provide suitable learning material for casual or initiated visitors, they can combine all forms of "traditional" interpretation means (audio, video, text but also role playing activities etc.). (Damala 2007:1).

Visitors, on the other hand, didn't carry a lot of devices, just cameras. They gave recommendations for books, movies and so on for other visitors and also added their own comments to the guides' explanations. In all the tours, people asked the time and length of the tour and asked questions to confirm or ask for more information about what the guide showed. It was a surprise that few visitors took pictures during the tour. This might be due to the public profile on these tours. The participants were over thirty years old and most of them were local to Brighton. They see the city everyday and perhaps did not have any interest in capturing the

tour. Additionally, when photos were taken, this happened between stops or when the guide was not talking. This may indicate a kind of respect for the guide and his work.

The method used in the study had some drawbacks. Participants were confused when they received two similar post cards. The main idea was they could take home the post cards and send by post one of them filled out. On the other hand, they filled them out in the day of the tour and gave back to the researchers. A better way would be to have a detachable form with the fields to fill in instead to give two post cards. These issues are illustrated in the diagram below (Figure 16).

4.2.1.5 Conclusion

The exercise enabled us to find out what sort of information was traditionally delivered to tourists on guided tours, the questions they asked, the rate and speed of information flow, the characteristics of those on the tour and their behaviour during the tour.

We also clarified some methodological issues. On the tours related to cultural heritage and history, people were more interested in participating in the research than those on the Brighton Rock tour. They understood better the purpose of using technology to access information in outdoor settings. Lone participants were also keener to help than those with partners or friends. For instance, on the Brighton Rock tour participants with company were in the majority and not so many gave back the post cards with their contact details. As mobile phones are individual devices, this has appeared to be a target opportunity.

As we have seen, the casual observer method did have some limitations and follow up activities were planned. In the subsequent sessions, a tour with a paper based guides and a tour with mobile devices were examined. Nevertheless, this preliminary fieldwork was extremely valuable as a pragmatic device for familiarising the researcher with the cultural heritage domain and developing a basic framework for guide and visitor behaviour.

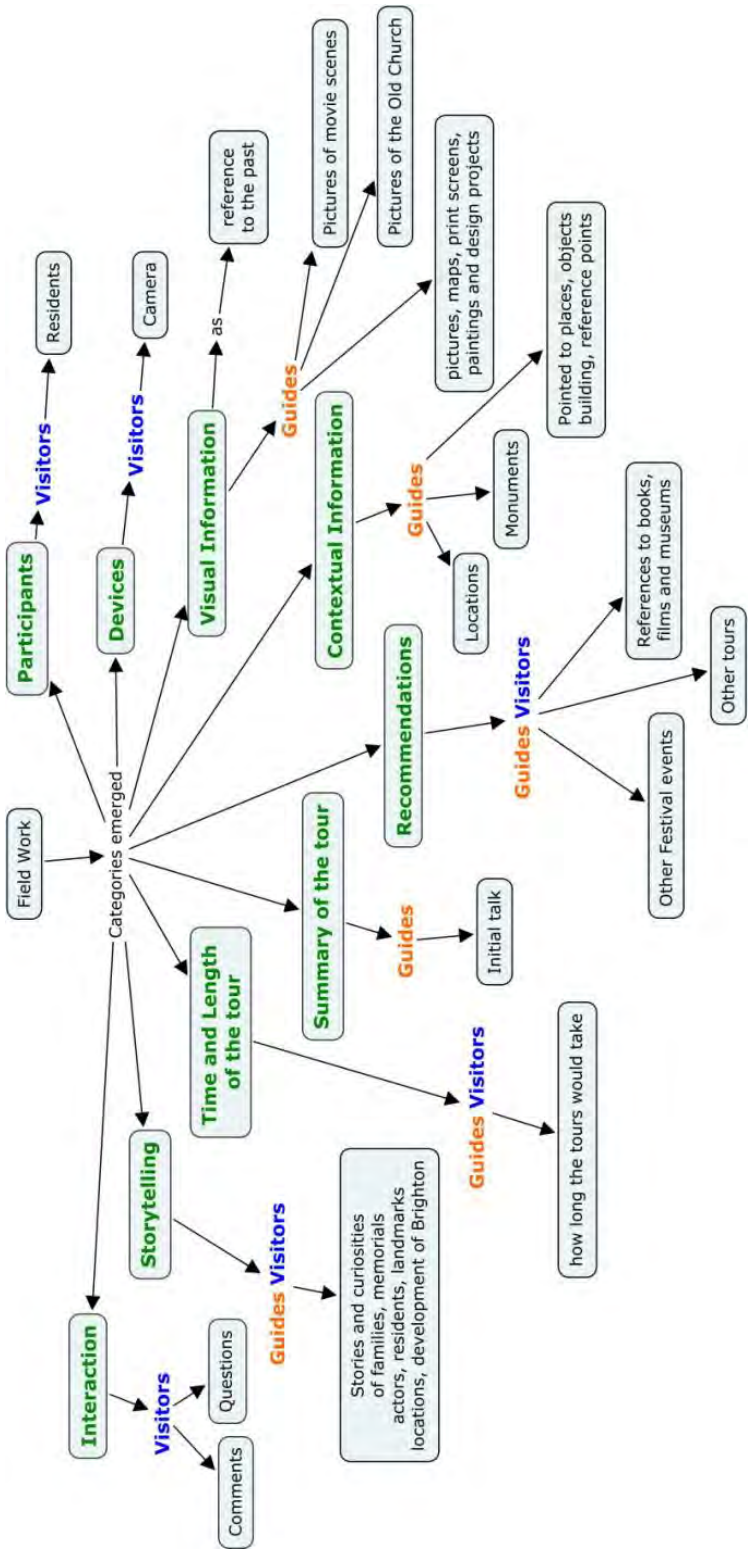


Figure 16: Results of Brighton Festival study

4.2.2 Brighton Festival observation – Paper based guides

This section shows the results of studying users of a booklet-led trail in Brighton, which helped to identify requirements and opportunities to design information for cultural mobile guides. Unlike the participant observer method used in Study One, in Study Two, we took an observational approach as a group of volunteer "tourists" took part in a short sculpture trail in Brighton and were subsequently interviewed. The results of Study One showed that not only tourists but also local people took part in cultural activities in the town. As a consequence, it was decided to aim the second study at three distinct groups: first time visitors, short-term residents and long-term residents.

4.2.2.1 Methods

A convenience and snowball sample was used to collect the data. An invitation to take part in the study was sent by e-mail to university e-mail lists, published on the researcher's blog[29] and handed out in conferences and workshops[30]. Overall, 16 trails with 20 adult participants were undertaken. Three seven-year-old children and a baby also took part in the tours, accompanying their parents. Only the parents answered the questionnaires. Eight participants were long-term residents or locals, defined as having lived in Brighton for more than three years. Eight participants were short-term residents, living in Brighton for six months to one year. Additionally, four first time visitors participated in the experiment. Twelve participants were international, i.e. not from the UK. Participants were aged between 20 and 49 years old.

Participants took a tour of six public monuments within a half-mile radius, making use of a booklet containing text, photographs and a map describing public monuments in the centre of the town (Figure 17). The monuments, in linear sequence of the booklet pages, were: (1) Sir John Cordy Burrows; (2) Victoria Fountain; (3) War memorial; (4) Statue of George IV, (5) Queen Victoria, (6) Ceres at the Corn Exchange. Participants are advised to follow the booklet as they desired. They were asked to express their thoughts aloud as they proceeded. The length of the tour was between 20 – 30 minutes. All the participants started the tour at the same location, some of them alone, others accompanied by family or friends.

29 http://heloisacsp.blogspot.com/

30 London Hopper Colloquium and Cmis Research student conference

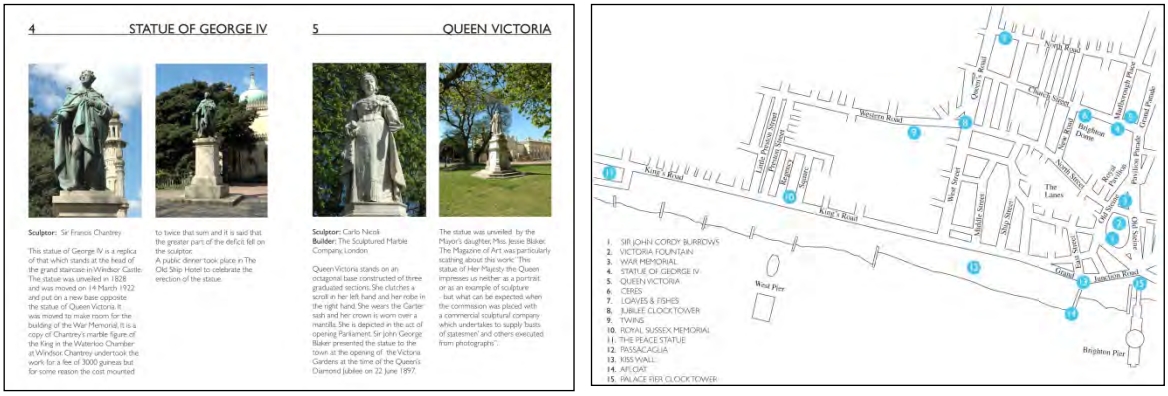


Figure 17: Booklet trail

The tour was recorded with a Mini DV video camera. An extra video camera equipped with a microphone was worn by the participant, attached to a baseball cap (see Fig 18). The purpose of this camera was to observe scenes that would not be possible with the other video camera, such as which pages the visitor was viewing, which details they spent more time observing and where their gaze was directed. In addition, for participants taking the tour in company, it was possible to observe the expressions of their partners. The microphone was also an important piece of equipment to capture their 'thinking aloud' and conversation between participants on the same tour.

After the tour, participants answered a questionnaire and a semi-structured interview was conducted. This phase lasted 30-40 minutes and was held in a café. While the researcher asked questions, participants enjoyed a cream tea in exchange for their views.

A pilot study was necessary to measure the length of the tour and identify any drawbacks and possible improvements. The volunteer for the pilot study was an expert in HCI[31], who helped to enhance the study. The pilot trail and questionnaire served as the basis for the participant studies. The whole activity took approximately one hour. Some questions in the questionnaire were refined, such as the identification of visitors, first time visitors, and long and short-term residents. In addition, adjustments with the sound and camera were necessary.

[31] Prof. Dra Vania Palua de Almeida Nereis – eleven years of experience in HCI.

Figure 18: Brighton sculpture study

4.2.2.2 Data Analysis

The method selected to examine the videos and interviews was content analysis, in which the data was analysed using a categorisation scheme [10]. The categorisation scheme arose from the data itself and the hypotheses also guided the research to find new relations and categories (Table 8). This was facilitated by the use of qualitative research software to help to organise and analyse audio, video and interviews.

[H1] It can be assumed that the text is too long to read in front of a sculpture in an urban area.
[H2] It can be assumed that type was too small to read.
[H3] It can be assumed that the pictures help to recognise the sculptures.
[H4] It can be assumed that it is easy to identify details of the sculpture on the booklet pictures.
[H5] It can be assumed that it is easy to follow the map
[H6] It can be assumed that is difficult to look at the booklet information while in movement.
[H7] It can be assumed that the noise of urban area can disturb the visitor in the tour.
[H8] It can be assumed that the traffic of urban area can disturb the visitor in the tour.
[H9] It can be assumed that the density of people can disturb the visitor in the tour.
[H10] It can be assumed that the weather can disturb the visitor in the tour.
[H11]We predict that non-UK residents they will have difficulty in identifying certain cultural references on the text.
[H12] It can be assumed that locals will find the sculptures faster than UK and non- UK tourists.
[H13] It can be assumed that local people and specialists would like to add background information on the booklet.
[H14] It can be assumed that specialists would require more information than the other users.

Table 8: Hypotheses

The data sets available were video transcriptions, semi-structured interviews and the route that participants took to find the monuments. Both visual and verbal transcriptions were taken into

consideration, since the context plays an important role in cultural guides. While watching the videos, prints of the map were used to mark the route that each participant took.

The data was organised into five main categories, which helped in validating the hypotheses and gave new insights about the tours. The main categories that emerged were Navigation, Presentation, Content, Interaction and Internal factors.

Context – The main issues related to what participants do on their way and how they manage to find the monuments. The map was the most used resource during the tour and considerations about it can be seen in the next section.

Presentation – Concerns about how the content in the booklet and the information displayed in the environment was organised fits on this category. Not only observations, but also suggestions of text, pictures and map presentation are discussed here.

Content – Interest, deficient content, redundant information, lack of references to allow understanding of the content, complex terms and English words were key factors affecting participants in this category. Additionally, the content requirements are displayed according the type of monument.

Interaction – At this point, we consider how participants interact with artefacts and other participants during the tour. Some participants were accompanied by friends or family: discussions that arose from interactions gave us insights into how mobile multimedia systems should be designed. Also, the ways that they approached the monuments and obtained information in situ are mentioned here. Additionally, it was possible to identify how participants use the booklet outdoors.

Internal factors – Our sample had diverse backgrounds. First-time visitors were from overseas and short-time residents have a varied background, comprising international students and UK residents. We consider long-term residents, i.e. participants who have lived in Brighton for more than three years, but this does not necessarily indicate that they were born in UK.

Background information, familiarity with the language and also certain behaviours made us think how mobile guide systems might improve the experience for assorted cultural background users.

In this work we considered how the navigation during the tours was supported by the presentation, visitor's internal assumptions and interaction of the participants with the environment and artefacts to access the content. Those categories were connected and it was not always possible to analyse them separately.

4.2.2.3 Findings

With the purpose of presenting the findings, categories were classified but also dissolved in the text, as the boundaries among them are not so clear. Context, presentation and content were described in sections, while interaction and internal factors were spread across sections in the discussion. Additionally we indicate the strength of evidence with which issues appeared in the tour, as well as requirements themselves. The strength of evidence is presented on a rating scale, followed by this symbol - * -. This represents the frequency with which certain issues were identified with different participants in the study. Therefore, an issue that was identified with more than three participants *** was considered of high relevance. Issues were associated to requirements to develop the mobile app prototype.

A) Context

The data gathering showed that participants could find their way satisfactorily with the map and the environment information available. However, some factors interfered in their experience in finding the place or enjoying the tour. In this section, we discuss the main issues participants faced on their way, environmental factors that had an effect on participants while on the move and how they followed the map.

KEY:

S/E = Strength of evidence

***(3) – number of affected participants

Each requirement section below consists of a discussion, a summary version of the issue and the related requirement.

a) Participants on the move

According to our observations, participants read the text and looked at the map while walking. Very often participants crossed the street riskily while reading the booklet text: this issue is explored in more detail at the section about traffic. It is also true that whenever was possible they checked the text of the following monument. According to all participants it was easy to use the booklet outdoors. This was expected because the booklet was a familiar object and most of the participants mentioned they used travel books previously.

When analysing the video recorded it was possible to identify how participants used the booklet outdoors. Some of them were holding soft drinks, coats and cameras, which made it hard for them to read the booklet as they walked. Others utilised the booklet as a sun visor to allow themselves to see the monuments more easily. Participants also kept the booklet open on the page of the next monument as they went between monuments, sometimes in conjunction with the map. This shows the importance of having the information that is the visitor's focus of interest available as they move between points of interest.

Issue: Participants access the next monument page and the map while on the move. S/E ********** (10)

(R1): The system should display the last information accessed (e.g. next monument/map) on the screen.

When their attention was concentrated on one object, some of them folded the booklet page to see just information about that object of interest. This gave an idea about how flexible should be the presentation of the content when users interact with it.

Issue: Fold the booklet to focus on the image and/or text. S/E **** (4)

(R2): The system should have different styles of screen presentation according to user needs. See all the pictures of the monuments on the tour; show the previous, the focus and the next monument information.

Participants were not only interested in the monuments of the booklet, but also in monuments they noticed on the way, such as the Royal Pavilion - a huge Oriental palace - on the route and an obelisk near to the War memorial monument that they also saw on the way between monuments. Fifteen participants (75%) said they would have liked information of one or both of those monuments on the way. Visitors most of the time wanted to know more about these monuments and took pictures without knowing what they were. On the other hand, short - and long- term residents knew certain landmarks, such as the Pavilion, but did not have a clue about what the obelisk – a lesser-known artefact - was for. They were very disappointed that those monuments were not in the booklet and claimed this information should be compulsory in guides of this kind, as illustrated below:

Participant 2 (P2) "So we need to go … you see that map… you see the Pier. Yes the Pier is on that map. I am a bit shocked that we are walking right past the Pavilion and not talking about it. I am not … this definition I am a bit uncertain as to whether it is …?" Participant 3 (P3) "And here is an obelisk". P2 "We are not talking about that." P3 No we are not talking about that. P2 "Is it on the list though? No it is not." P3 No it isn't. P2 "So this is another war memorial. So, that one is obviously more important than this one. But I don't know why. I am confused. Is it just me?"

Issue: Participants would have liked information of some points of interest on the way. S/E ********** (15)

(R3): The system should have information on monuments that participants might see while between planned points of interest or offer the user possibility of retrieving this info by some other means, e.g. websites.

Visitors and residents were curious about what buildings were used for nowadays. In the same way, long-term residents mentioned that this information was missing and highlighted that it should be in the booklet. Additionally, some of them visited the Pavilion and Brighton Museum in the days following the tour, showing that the sculpture trail awoke their interest.

P2 And what is the building used for now? It is a venue isn't it? P3 Yes a Theatre. (Short-term residents in front of the sixth monument)

Issue: Participants wanted to know opening times, prices of some venues on the way. S/E **** (4)

(R4) The system should show operational information about the places that users are passing by.

b) Map

The majority of the participants agree that it was easy to follow the map: they did not ask for further information and it was easy to find the sculptures. Furthermore, 14 participants (70%) said that it was easy to identify how far they were from the next sculpture on the map. (Table 9). Even though the answers were highly positive, it is relevant to check if there were reasons that participants chose agree (A) instead of strongly agree (SA) on the usability scale. It is pertinent to investigate which situations participants passed through on the tour, resulting in their choices.

	SD	D	N	A	SA
The map was easy to follow	-	-	1	8	11
I asked other people for further information	14	5	-	1	-
It was easy to find the sculptures.	-	-	-	7	13
It was easy to identify how far you were from the next sculpture on the map	1	2	3	10	4

Table 9: People who followed the map

The reason for participants marked "agree" instead of "strongly agree" in the questionnaire fell in two situations that are not strongly related to following the map. The main problems that they confronted, and which affected their answers, were related to changing their routes and

finding a particular sculpture on a building facade. In the first situation, they had to take alternative ways to see the monuments, and sometimes they were not sure that it would be possible to see them. This happened because the fences of the Brighton Festival tents were pitched near to the monuments, not allowing participants to get closer or see the sculptures. Every now and then, they were frustrated with the situation, e.g. P1 (a local resident) on the way to see the statue of Sir John Cordy Burrows:

We are going to see Edward (the sculptor). Is all this stuff on the way or is he actually available for me to see? […] Surely you should be able to get round here. Yes. […] I know the fountain. But I have never noticed the statue, of Sir John. Oh there he is! He is hiding! Aaagh. All the way back, over there. Dammit. He is frustrated because the fence is closed and he cannot get closer to the sculpture. *Oh go on then, I will have a look at him. At least we have to go all the way back. I was being dozy. If this hadn't been here though,* P1 points to the fence of Brighton Festival tent that is closed*. I would have seen that straight away. I do have to say that in my defence. And that is nothing to do with the map or the guide that is this fault.*

Issue: Participants followed the instructions of the map but had to change their route because of obstacles on the way. S/E ******** (8)

(R5) The system should be sensitive to events that occur in the city, providing instructions of the obstacles that possibly interfere with their walking tour.

The second difficulty was related to environmental clues and traffic. In spite of most participants declaring strong agreement that was it easy to follow the map, video recordings also showed that ten participants were disappointed when following the map to find the last monument. Visitors and some short-residents were confused by the map and thought that the number six was in another location according to the map (at the Brighton Dome instead of the Corn Exchange). Others followed the map and crossed the road to be on the same side of the monument. The monument was up on the façade of a building and participants couldn't see it unless they crossed the street. Three participants did not completely cross the street and put themselves at risk by trying to view the sculpture from the middle of the road.

We can cross here. So there is like the modern entrance of the Corn Exchange and that is where it should be. But I can't see it. I can't see it. P6 tries to see the monument six from the same side of the road*. It is just the bus. Maybe I will just go from the other direction.* She goes to the middle of the street *OK. That is a nice one. I can take a picture of it.* (Short-term resident)

Issue: Participants followed the instructions of the map and were not able to see the sculpture from the point the map indicated. Therefore, had to figure out where the sculpture was.
S/E ********** (10)
(R6) The system should provide verbal or visual information on which is the best viewing point for the monument.

Short and long term residents used landmarks to localise themselves and suggested different routes should be displayed on the map. They mentioned natural and urban landmarks such as historical buildings, gardens and the sea. Locals know the city and want to show off the most useful or scenic routes in the city for visitors.

*I remember the Corn Exchange is next to the Pavilion. (*Local resident)

*Yes. It would also … I feel like it would be nice if it said now walk away from the ocean and turn left on North Road. (*Short-term resident)

Issue: Landmarks were used for way finding, including natural landmarks. S/E ****** (6)
(R7) The system should display the main natural or artificial landmarks in the city. For example the seafront and parks are considered as landmarks.

In general, participants used the map a lot to situate themselves and identify how many monuments they still had to see. It is true that visitors and short-term residents looked more at the map than long-term residents. Long-term residents used the map in situations when they were lost, or not sure about the location. It might be because their eyes are used to the surroundings. In those cases, the map was always open and they used their fingers to mark the current location, point of interest and/or the page of the next monument. Some of them (6) suggested the use of GPS location in the final application. Participants also rotated the map several times, at different angles facing to the places where they wanted to go next.

Where is this? Do I have to find it? […]This isn't fair I am not good at maps. […]You know what is not on this – is this obelisk over there – this Masonic obelisk – or if it is on here …? Right OK. I want to go to but I am no good with maps. So that is 1 – 2 and I am terrible with maps. Is this a kind of rule, we can't... You can't help me? Oh no what am I doing I am an idiot? Four is like OK

come with me. I know where we are going. I may look like I don't know where I am going but I do. (Local resident on his way to the fourth monument.)

Issue: Participants marked current location on the map with their fingers. S/E ***** (5)

Issue: Participants marked next point to visit on the map with their fingers. S/E ***** (5)

Issue: Participants marked the page of next monument on the map with their fingers. S/E **** (4)

(R8) Users should be able to highlight the current location and points of interest on the map. ********

Issue: Participants rotated the map to align to their direction. S/E ********** (10)

(R9) User should be able to rotate the screen to see the map according to user's direction.

Some participants described how they would like to see the map. The main recommendations concerned the display of green spaces and icons of the monuments on the map. The numbers were on the map and a legend was next to the map with labels. (Figure 19). Participants found it complicated to look at the map to see the number of the monument, check what this number signified and later look back to the booklet pages to see what the monument was. Once they saw the pictures, they repeated the same steps again for the next monument.

*P1 points to the map and says "It would be an idea to have a bit of green in there to represent an actual green place - as it would give me an easier reference point I reckon. If I was a tourist, because on the map it does look a bit like, number 5, the Queen, is in between like two roads. Which she is, but you wouldn't really know from the map that it is a green space. That is the thing. There is a picture, yeah. (*Local resident)

The map should be improved. You should try to make it clearer and more attractive. It should have a scale - how long does it take to the next sculpture. How far it is… For example include in some pictures some comments for each sculpture. It should have little pictures on the map, so you don't have to check the picture in the text page. In the legend maybe you can have the pictures not just text. The map should be more accurate, to let tourists to know the distance. The character could be larger. (Visitor)

For some participants it was not clear the numbers and the labels on the map. The names on the map were not always related to the numbers on the map. Likewise the number six on the map is next to the Brighton Dome and not to the Corn Exchange.

Issue: Visual presentation of the map was not clear. ******* (7)

(R10) The system should be illustrative. Thumbnails of the monuments should be displayed on the map. ** (2)

(R11) The icons representing the points of interest should be placed in an accurate position on the map that matches with the real world monuments

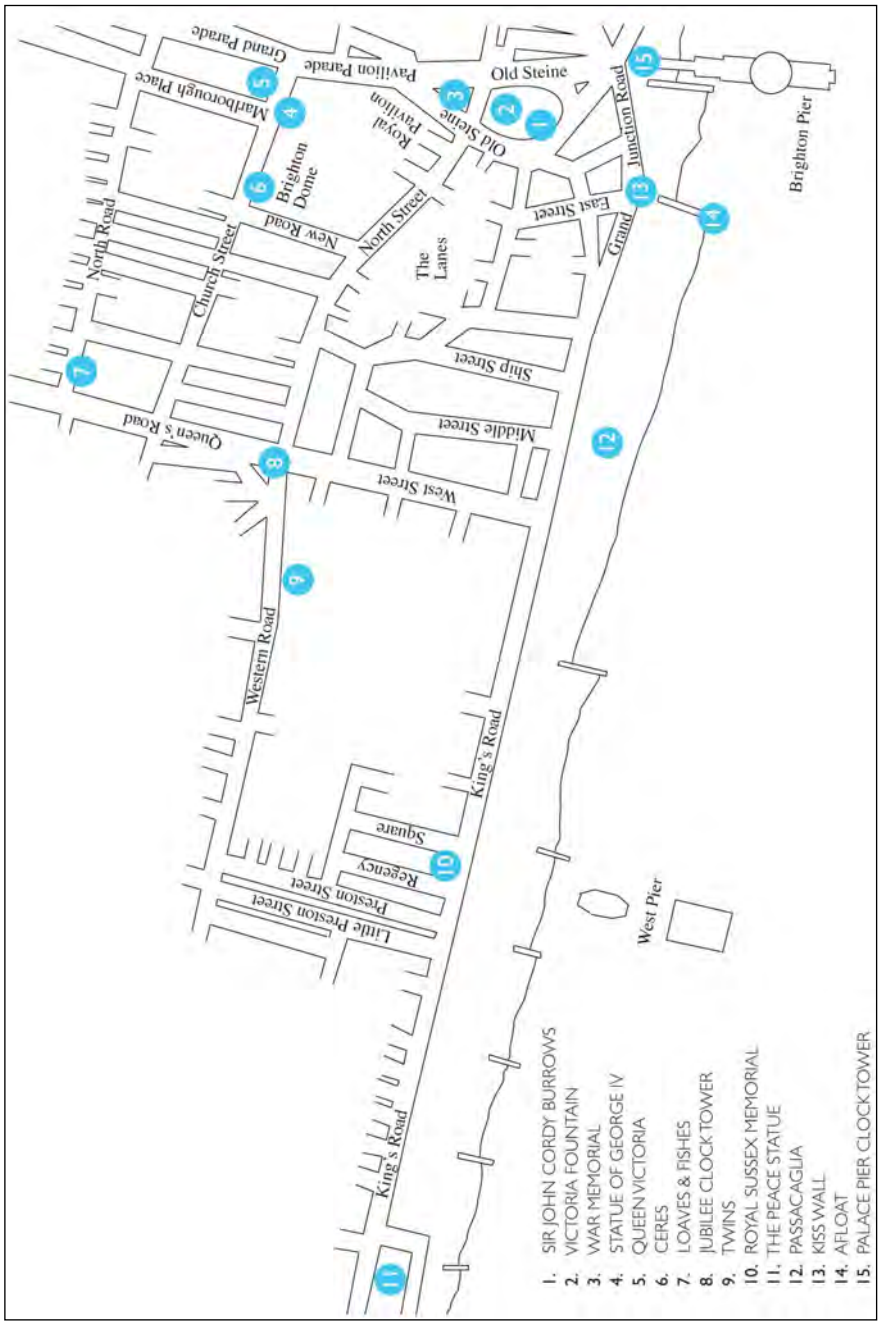


Figure 19: Map

c) Environment

Although all the participants found it easy to follow the booklet outdoors, some of them indicated factors that disrupted the experience. Some assumptions on how the surroundings influence participants are described here. Noise, traffic, crowd density and the weather were the main factors observed.

Traffic

In the questionnaire and also on the trails observed it was clear that the environment affected participants' experiences. Most of the short-term residents and all the visitors indicated that the traffic made the experience a *little difficult* (12) while nearly all the long-term residents (5) evaluated the same issue as "*a lot*". The traffic was one of the main causes of frustration during the tour. Five of eight long-term residents indicated that they were very disappointed at having to cross a large number of streets, or they didn't have a place to cross at some points. Visitors also verbalised their disappointment, whereas short-term residents (1) seldom complained about the traffic while on the tour. (Table 10).

	not at all	a little	a lot	Unassigned
Traffic	2	**12**	5	1

Table 10: Traffic

Most of the visitors were frustrated with traffic issues. Visitors (4) were more frustrated when they followed the instructions on the map, and they had to change their path, crossing the street or changing their direction, to find the next sculpture. Visitors also tended not to know where the traffic lights were, which caused frustration.

P9 looks at the Dome. Points to the street and says that she doesn't know where to cross the road. P9 looks at the traffic light and says that it is better to cross there. […] P9 looks at Corn Exchange building, where the monument is located and points to the picture in the booklet. *"Look this is what I'm seeing..." Disappointed points to the side that she has to go to see the monument.* P9 waits for the traffic and complains *"there isn't any traffic light around!"* (Visitor)

With long-term residents (6) the main problem was the number of streets on the tour and the time waiting for crossing the street. Participants accompanied by children were in this category.

As one might expect, they knew the city, so the environment was not new and did not attract comment. Every time they had to wait for the traffic they were impatient. In their opinion, the city is much busier than it used to be, now there are a lot of people living in Brighton and they have to wait for the traffic.

This is not just a tour of sculpture, it is a tour of pedestrian crossings it seems. One wonders how many other people who have taken this route previously have actually survived the trail. Are we in luck with the green man?" (Local resident)

On the way to the 4th monument the researcher asks the participant: *"How long have you lived here?"* P19 says *"Since 89. Quite a long time. That's 20 years isn't it? Golly that is a long time!" "When you arrived here it was completely different or not*?" P19 says *"Some parts of it definitely. This part I suppose is pretty much the same. But it has got a lot busier, and a lot more commercial; especially the shops and the sea front it has got a lot more … yes and loads more people coming from London to live here so it has got a busier sort of life."* (Local resident)

At the same time as participants complained about the traffic, they took advantage of the waiting time at the traffic lights to read about the sculptures and find their way.

Waits for the traffic light and has the booklet closed. She presses the button and waits. She opens the map to check if she is on the right track. *"I think so, now we can cross".* She crosses the road in the green light. (Visitor)

Several participants read the text while walking, even when they were crossing the streets. It is clear that some participants did not pay attention to the traffic lights rushing for crossing the streets and risking themselves during the tour.

Bumps into one person while reading and stops for crossing the street. There are no traffic lights; P1 waits for the moment to cross. P1 crosses the street reading and commenting about the monument. P1 stops and looks up, at the Dome. (Local resident)

Issue: Participants complained about the traffic, did not know where the traffic lights were, read the text while walking. S/E ********** (15)

(R12) The system should provide aid with safety issues, advising about the best spot for crossing the streets or calling attention to the dangers of traffic.

Noise

Since the monuments were next to busy roads, the noise caused by the traffic was a relevant factor that affected long- term residents, short-term residents and visitors when reading the texts. The majority of the participants (11) mentioned that the environment noise had an effect on their experience. Five participants marked “not at all” and three “a lot”. It was not possible to identify any relevant differences among locals, residents and visitors. However, the day of the week on which participants did the tour provided some conclusions. All the participants who took the tour on the weekends indicated that the noise was a little or a lot relevant in disrupting their experience. Distractions with the traffic noise, density of people and building work were the main factors that disrupted their attention. (Table 11).

	not at all	a little	a lot	Unassigned
Noise	5	**11**	3	1

Table 11: Noise

*In the Victoria sculpture there was work in progress because of the Brighton Festival - a little noise. (*Short– term resident)

There was a traffic noise. It's not relaxing. You can't hear the others. It is really hard to concentrate. (Local resident)

It is clear that most of the participants (14) felt that the noise disturbed their experience. These results indicate the use of just one mode to transmit information is not enough in urban areas. The use of audio and visual feedback might be a possible solution for delivering the content.

Issue: According to participants, noise present in outdoor settings disturbed their experience. S/E ********** (14)

(R13) The system should provide not only audible but also visual information.

Density of people

Density of people	not at all	a little	a lot	Unassigned
	7	6	4	3

Table 12: Density of people

Ten in twenty participants mentioned that the quantity of people while were in the tour was a factor disturbing their experience. Fifty-fifty of locals, residents and visitors marked “a little” or “a lot”. Participants who took the tour in the afternoon and evening pointed more often to this circumstance (seven in ten participants). (Table 12).

In the same way, this happened more during the weekend afternoons than on weekdays. It is true that residents and visitors were the most distracted by a concentration of people around the sculptures. Seven in eight residents and three in four visitors were upset with crowds during the tour, while four in seven locals chose the options a little or a lot.

At the last sculpture - I couldn't see anything. There were a lot of people in front of that and a trunk. The time was wrong, it was late. (Short-term resident related his experience in the interview).

Long-term residents were more concerned with traffic than noise. This might be a language-related issue. Locals did not have difficulties reading the text and understanding the references in the text. However, most visitors and short-term residents who took the tour were foreign and spoke English as a second language. Consequently, local residents might have been more focused on the task than visitors and short-term residents who had to put in extra effort to concentrate on the text. If so, it is clear that the environmental factors as noise, traffic and density of people had an important role in distract visitors and residents during the tour.

Issue: Participants who did not have English as a first language were more distracted by the environment than native speakers. S/E ********* (10)

(R14) The system should be able to display basic information clearly, so that, it will not be cognitively demanding in outdoor environments.

Weather

The weather did not have a relevant effect in the experience as often as was predicted. Most of the participants indicated that the weather perturbed their experience “not at all”. It could be concluded the season (spring and summer) in which the tours occurred was a decisive factor that affected their opinion. In the winter, maybe it would not be the same.

B) Presentation

In this section we discuss the main findings in relation to information presentation. The representations in the leaflet were composed of text and photos.

a) Text

It was expected the booklet text would be too long to read in front of monuments. In addition, we wanted to verify if it was the right amount of information for our different type of users. (Table 13).

	SD	D	N	A	SA
The text was too long	3	7	3	4	3

Table 13: Text

The data collected showed ten participants disagreed or strongly disagreed that the text was too long. On the other hand seven participants agreed or strongly agreed that the text was too long. This data doesn’t offer a clear conclusion. However, the participants that marked SA/A were in their majority visitors and short-term residents, while those who marked SD/D are long-term residents. It could be said that the length of the text displayed has a relation of how participants understand the content, or are engaged with it. Looking further at the video recordings it was observed that long-term residents were better able to understand the references in the text and have familiarity with the history referred to. Additionally, international visitors and short-term residents highlighted that they were interested first in the basic information, and did not understand some references and complex words in the text. The main phrase that caused difficulties in understanding was “theatres of WW1”.

When you go around you don't read that much. (Short-term resident)

The text was too long I just picked some things. (Visitor)

Participants in front of War memorial:

*People won't understand what theatres are in the text. (*Long term resident)

…In the (mumble) theatres of World War 1. First World War. What is it? (Mumble) theatres? Right Oh I see. OK. (mumble). Oh I think you know. […]I was wondering what this is when it says this represents a theatre, I don't understand that. Theatres of World War 1 - are carved in the stone panel – it is not theatres do you see … what do they mean by theatres? It is scenes of the war? (mumble)(chuckles). (Short-term resident).

I have difficulty with technical words - carved, plinth. (Short-term resident).

The same number of participants disagree (SD/D) and agree (SA/A) that the language of the text was complicated. Looking closer to the demographic data it is possible to see differences among types of participants. As expected, most of locals did not find the text complicated. Five in eight disagreed with this statement. On the other hand, this proportion was different for visitors and residents. Three in four visitors ticked SA/A and one ticked neutral. All the visitors are from overseas and were in Brighton for the first time. Misunderstandings of words and lack of contextual references were the main problems identified by them.

In the case of residents, four in eight did not find the text complicated and three reported the opposite. The former participants lived in Brighton for more than six months. Of the latter participants, two of them are foreign and lived in Brighton for less than six months, while the other was a specialist in cultural heritage. It could be said that the length of residence also had an effect on how participants processed the information. Both of the specialists on the tour agreed or strongly agreed that the text was complicated. It can be deduced, that they were concerned with delivering accessible cultural information for everyone, not simply for themselves.

Visitors in front of George IV statue:

P24 looks at George IV. P23 *"a public dinner took place..." P23 "Public dinner". P23 "in a hotel. Where is the old ship hotel?" P24 "old ship hotel I dont know".* They look at the monument and

P23 asks *"so this bus stop is old ship?"P24 "no it is old steine" P24 points to the bus stop. P23 "I want to go inside".* He points to the Pavilion building.

In the interview, not only residents and visitors expressed their wishes of having more clear and contextual information in the text. Actually, 15 participants at some point of the tour commented that they did not know the meaning of some words or understand the context. Participant comments:

What is Ceres? Ceres? Ceres. Do you know what Ceres is? It is a beer P15 No it is in Greece. P16 Ceres is a brand of beer. (Short-term resident)

This is about the Victoria fountain – as an American - it never says here that it is Queen Victoria. I assume that it is Queen Victoria because it is the Victoria Fountain, but it doesn't say. (Short-term resident)

P24 says *A lot of words that I don't know* P 23 *me too. P24 I can't understand it.* P24 looks at the information about monument one. *P23 A lot of English history. P24 Do you understand? P23 No.* (Visitors)

So this is the Goddess Ceres and the central figure is placed on a vesica piscis and assumes an Asian posture and aspect – I have no idea what that means. (Long-term resident)

Issue: Participants did not know the meaning of specific technical words or understand the context. S/E ********** (15)

Issue: Non-native visitors and short-term residents had difficulties to understand the meaning of some words in the text. S/E ********** (10)

(R15) The system should make available explanations of terms, words, expressions and so on in hyperlinks. ***** (5)

Long-term residents and specialists mentioned that the text should have more contextual references, and some of locals did not know some of the historical references in the text, for example the relation between Queen Victoria and George IV and the fact that the Prince Regent *was* George IV. Locals also indicated some references that probably visitors and short-term residents would not recognise, such as a famous local character who is mentioned in the text. Visitors, on the other hand, did not perceive this information in the text. It might be because it did not have any meaning for them.

Residents were surprised that the text did not mention that the Queen Victoria statue was in the Victoria gardens. They obtained this information from the plaque in front of the statue. Information in situ played an important role in the tours. Some of the monuments displayed text in Latin, whose meaning visitors looked for unsuccessfully in the booklet. However, when the participants had the contextual reference they enjoyed seeing the monument and spent more time in doing so. For example, the War memorial monument was the most popular point of interest. Visitors mentioned that it was one whose history they were familiar with, so that they did not need so many references to understand the purpose of the monument.

Participants also mentioned that the text was very descriptive. A great number of participants mentioned that the text described what they could see. For instance, the portion that describes the Queen Victoria statue, informing readers that it has an octagonal base, does not explain *why* that shape was used. The same occurs with the War Memorial text. Visitors looked for basic information whilst locals/long-term residents and short-term residents wanted more specific information based on their knowledge about the subjects.

Yeh. Yeh. I can see that there is a dome on there and four plinths, it would be nice if that was put in context, like say this was not typical of the time, or it is different from other war memorials because …. Or that that arrangement has a symbolism. Why does it like that? I can see that it has a dome and four columns, but why? Is the dome a Brighton thing or is it something else" […] I would like to know something about why people need a memorial. (Short-term resident)

I'd like to know who he was, what's the motive for putting up this statue: is it celebrating him? It would be interesting to know what he did and in which period. What happened for them to want to put up this tribute to him? (Visitor)

I would like the description a bit more. So that … it is much centred on what she looks like but I would like a bit more information on what she was like as a person, and also on all the sculptures really. Especially on the actual living subjects. A bit more of a balance of information really. (Long-term resident in front of Queen Victoria Statue)

Issue: The text described what users could see in front of the monument. S/E ****** (6)

(R16) The content should generate user interest in the history of the piece and not repeat information that they can clearly see in the object.

The video observations demonstrated how participants read the text in front of public monuments. Visitors skimmed the text looking for numbers and names. They also looked for familiar terms and dates.

If the text were in topics it would be easier. … Date, who is the designer of the monument… It is better than just a block of text. Looks at the text and says "ok". (Visitor)

In the interview participants also gave suggestions of how they would like the information.

I missed a structure in all them. It should have the same category of information like date, who built it... I would like to see the information as points (bullet). As you read you don't understand. Separate the information that is relevant. Names are not important to me. Content, purpose and reason is. [...] It should have the main pictures with bullet points of main features such as: date, material and additional information (Short-term resident)

The text was too long; it should have short paragraphs and statements. (Visitor)

The information should be more structured - specific blocks of text. Focusing on what is this; who did it and interesting facts. You can't find it immediately. I suggest that the content should be divided by centuries - connections. In order to identify periods of Brighton history that are relevant and the sculptures that are part of it. In the Victoria one I was thinking where was the Victoria Gardens? I read on the stone. It wasn't in the booklet. (Short-term resident)

Seven people including visitors (2), short-term residents (3) and long-term residents (2) used their fingers to follow the text and localise themselves while reading. Participants were distracted by the environment, and sometimes to find where they were in the text took a little while. Additionally the booklet text is divided in two blocks; certain participants read the first block and did not read the second one.

It is important to notice that the basic information about the monuments was not always in the first paragraph of the text. Taking this into consideration, participants had to read all the text to find what they wanted to know, or get closer to the monument and try to understand the information in situ.

Visitor looks at the booklet and at the monument. I don't know what goddess Ceres is! […] Visitor reads the text in the booklet Ceres was the Roman Goddess of agriculture and grain and comments this is the last information in the first block, I was looking for this since from the beginning.

Participants not only read the booklet text but also the information displayed in the monument site. It was observed as a difficult activity because certain texts written on the plaques and signs are not legible. The fences of the Brighton Festival covered some of the texts on the monuments; others were not clear because of environment interferences. It shows the necessity of replicate them in the guides.

They stop in front of the monument and read the plaque, get closer to the plaque to see well. P23 *"1995 ...to found the English Heritage" "I don't know what is that.* (Visitors)

Issue: Visitors and short-term residents identified the text longer than long-term residents. S/E ****** (6)

Issue: Participants used their fingers to follow the text. S/E ******* (7)

(R17) The system should display the small amount of text and topics starting with dates.

(R18) Additional information should be displayed in hyperlinks ***** (5)

Issue: It was not always possible to read easily the texts on the monuments. S/E ****** (6)

(R19) The system should display replicas of the written text and the informative plaques of the monuments.

b) Typeface

It was expected that participants would have difficulties reading text outdoors, but the answers to this question made it clear that the typeface was legible in outdoor environments. The type size in the booklet was 10pt in a dark gray colour. The background was white, which gave a good contrast for reading (Pettersson:2002). Most of participants disagreed that the type size was too small to read. The only participant who found the typeface small was between 40-49 years old and had a background in cultural heritage and museums. She was taking the tour with a colleague and two children. The children did not have problems reading the text size. (Table 14).

The type size was too small to read	SD	D	N	A	SA
	3	10	5	---	1

Table 14: Typeface size

Issue: Participants agreed the typeface was not too small to read in outdoor settings. S/E ********** (18)

(R20) The typeface should be at least 10pt.

(R21) The background and the text should have a good contrast.

c) Pictures

Are photos redundant when participants can see monuments for themselves? According to informants, the photos helped in wayfinding and served as a confirmation that they were in the right place. Most of the participants (18) agreed that pictures helped in identifying the sculptures. All visitors agreed on this point. Additionally, some of them suggested that pictures of landmarks should also be displayed in the guide. The only participant who did not find the pictures useful to identify the sculptures was a local resident. This may indicate he knew already where the sculptures were. (Table 15).

The photos were useful to identify the sculptures	SD	D	N	A	SA
	-	1	1	4	14

Table 15: Photos for identification

Now, where are we going? To Marine Parade- Oh they haven't got the Dome on the map – the Pavilion – oh yes they have – they should show us a picture of it shouldn't they, so that we can see it, one of those funny little shapes. (Local resident)

The sixth monument I couldn't notice without pictures. (Short-time resident)

The pictures helped them to see what was near by the monument. The background gave a clue where the monument was located.

P23 stands up, looks at the map, looks at the environment. P24 looks at the picture in the booklet and say that it is the same background, points to it. (Visitor)

Although pictures helped in wayfinding for participants, is not possible to draw the same conclusion with regard to viewing the monuments' details. A large number of participants were

neutral, eight disagree and five agreed that the images helped them to see the details of the sculptures. Residents were in the neutral position. On the other hand, all the visitors answered this question positively showing that images were important not only for localisation but also to better examine the monuments. (Table 16).

The images helped me to see better the sculptures details	SD	D	N	A	SA
	3	5	7	2	3

Table 16: Photos and details

The pictures also helped to see the overall monument, when the monument was too high or when it was better appreciated from a distance. In front of a tall sculpture, participants moved around to see it from different angles and also to see it as a whole. This shows that to appreciate certain monuments the right distance matters.

Participants in front of Victoria Fountain:

So, I think that is – that is this part done I think. Next is the War Memorial. But I might stand back a bit and get more of a look at this at a distance. Ah yes, of course you get a much better idea of the scale of the whole thing with the reservoir around the bottom. If you stand back - and the size of the rocks at the base is more apparent. Indeed I shall move on. (Local)

I'm trying to look at the fountain from the angle that I have in the picture. I can see the blue building behind, so I am in the same position that the picture was taken. (Visitor)

In front of the Queen Victoria sculpture: "I like the Queen Sculpture stone. Much lower make it easy to view. The George one is difficult to view… harder" (Local)

The photos also helped participants who could not get close to monuments due to obstacles that they found on the way or because they did not want to step on the grass. In the first case, fences of a seasonal festival in Brighton blocked their way. In the second, visitors from some cultural backgrounds did not feel able to step on the grass.

Issue: Pictures are important for identifying monuments. S/E ********** (18)

Issue: Pictures are important for see the monuments details. S/E ***** (5)

Issue: Pictures are important for see the overall monument. S/E ****** (6)

Issue: Pictures are important to see monuments are not possible to get closer. S/E *** (3)

(R22) The system should display pictures of the monument to support participants in way finding and see better the monument details.

(R23) The system should have zoom in zoom out features to help seeing monument details.

C) Content

Several factors played a role in how the content was accessed by the participants. The main factors were language difficulties and lack of understanding of contextual references. Participants also made connections among monuments in the tour and verbalised what more they wanted to know.

It is possible to classify points of interest into three groups: commemorative portrait statuary, commemorative monuments and architectural monuments. The statues of John Cordy Burrows (1), George IV (2) and Queen Victoria (3) were considered commemorative portrait statuary, the War memorial (4) and Victoria Fountain (5) were seen as commemorative monuments and Ceres (6) as architectural monument.

a) Commemorative portrait statuary

When visiting the commemorative portrait statuary, all the participants wanted to know more about the person who was the motive for the monument than the sculpture itself. The main questions that arose were: Who was s/he? What did s/he do for Brighton? What is the connection of George IV and the Royal Pavilion? What is the relation between George and Queen Victoria? Are they from the same family? How old is s/he here? Why is s/he in this position? What is s/he holding? What does it mean? How did people react to it when it was erected? (Figure 20).

Once in a while, information on a sculptural piece was requested: What is the material? What is the style? What would be the price of it nowadays? Why is it here? What is written on the plaque/sign/plinth?

Figure 20: Commemorative Portrait statuary (1, 2, 3)

Figure 21: Commemorative Monuments (4, 5)

Figure 22: Architectural monuments (6)

Locals and specialists mentioned that the text should have more contextual references. Some of them did not know some of the historical references in the text, for example the relation between Queen Victoria and George IV and which Prince Regent was George IV. Locals also

indicated some references that probably visitors and short- term residents would not recognise such as George Blaker, a famous local character who is mentioned in the text. Visitors, on the other hand, did not perceive these issues at all.

Issue: Participants wanted to know more about the subject portrayed in the monument. S/E ********** (14)

(R24) Who; when; why are the main questions that should be covered of commemorative portrait statuary.

Issue: Participants wanted to know more about the sculpture material and style. S/E ********* (9)

Issue: Participants wanted to know more about the sculpture date. S/E ********** (12)

(R25) Information about material, date, and style are extremely relevant when exploring the sculpture piece.

b) Commemorative monuments

In the case of commemorative monuments, the inauguration date was essential, followed by meanings of representations in the monuments. The predominant comments in the interviews and video observations were: What is the history behind it? When was it built? Why is it in this place? Which War was it? Were they from Brighton? How many people died in that war? What is the meaning of the colours and shapes? Does the "water" have a particular meaning? (Figure 21).

While visiting the Victoria Fountain, participants were intrigued by the dolphins displayed on the monument and the name of the fountain. Visitors and short-term residents were not familiar with English history; as a consequence, they felt the lack of references related to the name of the monument.

Actually, something else this is about the Victoria fountain – as an American - it never says here that it is Queen Victoria. I assume that it is Queen Victoria because it is the Victoria Fountain, but it doesn't say. (Resident)

Why are the fishes there in the Victoria Fountain? (Resident)

Participants wanted to understand what was written on the monuments, likewise on the statues. In the case of the War Memorial, what they saw was not clear and descriptive. It was part of the monument and more references would help to contextualise the theme.

There is no mention of the poem or the writing on the actual … underneath the coat of arms. I would like some more information about that really. What is the actual reference to? That is the only thing. I will walk round the back of it. […] So there must have been a lot of campaigns afterwards because there is practically every country in Western Europe there. And in the Falklands and stuff – Palestine is mentioned. (Local)

Issue: Participants were interested in the meaning and the motive behind the architecture. S/E ********** (11)

(R26) The date and the purpose should be clear when the system displays information about commemorative monuments.

Most of the participants were moved by the theme of the War memorial. It was the most popular point of interest that locals, residents and visitors were interested on it. Visitors mentioned they were familiar with the history, so that they did not need so many references to understand the purpose of the monument.

Issue: Visitors were familiar with global subjects. S/E **** (4)

(R27) Consider in the system the knowledge that users probably have about the subject, e.g. World Wars.

The expectation to see the monuments working was also a factor in making participants satisfied with the tour. Participants were disappointed when monuments were not working, e.g. the fountain.

Looks at the S2 and complaints that it is not working. "It is not working. Why this information is not here? It is something that called my attention". (Visitor)

Issue: Participants would like to see how the monument is working e.g. fountains. S/E *** (3)

(R28) The system should provide a video or a picture of the monument particularly where movement is involved.

Moreover, participants were particularly disappointed when the content presented unrelated information. In the case of Victoria Fountain, the text mentions that there were goldfish and water lilies in the water. Consequently, almost all the participants checked if they could see what was mentioned in the text, causing frustration.

I just read the part here that says – that there are gold fishes as well and I want to have a look, but I don't see anything. Ah sorry. I just read now that it was originally filled with gold fish. So let's move to the third one. (Resident)

Issue: Participants were disappointed at not seeing on the monument information described by the booklet. S/E ********** (10)

(R29) The system should not lead people to see what does not exist in the environment. Instead, it should provide multimedia information that gives users that information.

Long and short-term residents liked the opportunity to experience places of the city that they do not visit normally.

Shall we go round the other side? I have not been round the other side before actually. It is really lovely isn't it? It looks Egyptian – that pale stone and the pale water. It is really lovely. Here we go there is another one – oh – these are all the memories of people who died. If you read it … this memorial was dedicated to the service men and women of Brighton who gave their lives in the First World War, Second World War and subsequent campaigns. Their names are recorded in the book of remembrance in the Parish Church of St. Peter. Is that the big one up the road? (Local)

However, I would like to take this opportunity to find the back of this – try and walk round and see if we can … And as you can see the traffic and buses whizzing past us here. And that is something that I didn't know, having not been round the back of the War Memorial before, but it is actually accessible - although of course you are asked not to do it. (Local)

Issue: Long and short term residents appreciated the opportunity to visit places they are not familiar with S/E ********** (11)

(R30) The system should encourage participants to look at the monument from diverse spots. Encourage users to move around the monument.

c) Architectural and decorative monuments

Meaning and history were the most frequent factors that boosted participant interest in architectural monuments. The main questions and comments were: What does it represent? What is this building used for? When was it built? Why was it built in this style? What is the material? Participants found the text complex, with references to other places in Brighton and words whose meaning they did not identify straightaway. Although the text contained unintuitive words, it covered the history of the building and gave context to the participant's experience (Figure 22).

It was originally a riding school for the Prince of Wales and formed the west wing of the Dome, originally the stables. So the Dome was stables? It is now a Grade 1 listed building: it acquired the name 'Corn Exchange' on 1 October 1868 when the corn market transferred there from the King & Queen Inn. P2 Where is the King and Queen Inn? P2 It is to the left. It was also a military hospital in WW1. P3 Interesting. That is interesting. P2 that is interesting. P3 but I want to know why they did this because it seems very strange now I look at it. (Residents)

The word 'cereal' is derived from her name. Fancy that! There are lots of random snippets of information here aren't there? And the Corn Exchange was built between 1800 and-1808. […] Corn Exchange on 1st October 1868 and was a military hospital in World War One. Very good. See is that the main bit of it do you think? What do you reckon? It is a bustling spot isn't it. You wouldn't notice it unless you have got this, at all would you? No you wouldn't. (Long-term resident)

P14 looks at the booklet and the monument. "I don't know what goddess Ceres is!" […] P14 reads the text "Ceres was the Roman Goddess of agriculture and grain" and comments "this is the last information in the first block, I was looking for this since from the beginning" (Visitor)

Issue: Participants would like to know the meaning of representations on the sculpture. S/E ******** (8)

(R31) When the monument is decorative, any meaning of shapes and colours should be emphasised in the system.

As with the Pavilion building, visitors and residents were curious about what the building was used for nowadays. In the same way, locals mentioned that this information was missing and highlighted that it should be in the booklet.

In the Corn Exchange I would like to know more information about events, shows and the functionality of the building, such as music and events venue should be in the guide. (Long-term resident)

Issue: Participants would like to have operational information of buildings. S/E ****** (6)

(R32) When the monument is in or on a building, the system should provide information about the venue's present/past function.

All the participants, including locals, saw the Ceres monument for the first time. This made them appreciate the opportunity to see it. According to participants, without a guide it would be difficult to find it. Even with the guide, as it was illustrated before, some participants had problems finding it.

It is also something that I haven't really looked at, I haven't really noticed at all. Without the guide I would have walked past that, I hadn't really even noticed even though I have been living here. I have moved back here for the last 5 years-ish. (Local)

d) Relations among the sculptures

Some participants looked for connections among the monuments in the tour or/and external monuments. Some of them compared dates, names and places, while others tried to make relations among sculptors, materials and subjects.

I don't get that one. All the others are linked – like – apart from the Queens, they all did something for Brighton, whereas that one is just advertising that they sell corn with a Roman goddess. […] No. They don't really have a connection. All I could see was a … let's celebrate, not celebrate … remembrances … or to remember historic dates, or events. Mostly of people, like George and Victoria and the Mayor. But that one is just … from what I could gather that one was built because it was just a goddess of agriculture and grain, and that is where they used to sell the corn. (Short-term residents)

In front of George IV: *This one is different from the first ones we have seen. The one where the – the first one was – mayor– wearing clothes and – it is more formal dressing. This one is like – I don't know, let's have a closer look. OK, so this one is different than the first ones we have seen.*

Sir John Cordy Burrows, and this one is also a replica it is not the original. The other one was original. And … this one was built in 1828, and the other one was in 1984 – so it is like 25 years ago, the first one, this one is more than 100. I don't know if I should be comparing them both. I think the first one was also made of marble or rock and this one is made of iron. Although it says that the original one is made of marble. I don't know. This one looks iron. (Short-term residents)

Two points of interest were compared to information familiar to participants. The Queen Victoria statue was compared to other statues in England. In the case of the War memorial, participants compared it to other war memorials or familiar references such as Roman Bath. They wanted to know why the memorial was in that shape, and also some visitors identified Greek references in the plinths. UK residents mentioned the quantities of war memorials in England and how in their opinion this one was different from the others. It could be used to compare differences between memorials.

I'm familiar with Queen Victoria. There's a sculpture of her in Reading. Here she is older than the one that I know. (Visitor)

It is really bizarre for an English kind of war memorial: most English war memorials are kind of more like that bit – that statue – that first statue that we saw. (Local)

P23 points to the symbol engraved on the top of it and says *"Do you know what is it" P23 "I know it is from Greece". He doesn't understand looks at her "It is from Greece you mean". P23 "I'm not really sure ... the winner had this" pointing to the olive wreath on the stone . "I don't know how to say it in English: I know in Chinese".* They go around and read what is written on the top of which side of the columns. P23 asks to P22 if maybe it is a sentence. *P22 Im not sure. P23 "It is a sentence and it starts here" points to the stone. P23 "so, it is a sentence, I'm so clever". [...] It is really quite beautiful and simple; reminds of all – kind of – with the colonnades and the columns (whatever you call them) they are kind of like pillars – like the old Roman kind of things.* (Visitors)

Issue: Participants compared similar monuments known to the one they were visiting. S/E ***** (5)

Issue: Participants compared monuments in the tour. S/E ********** (10)

(R33) The system should help users to relate various aspects of the piece to others.

4.2.2.4 List of requirements gathered in the booklet study

Issues were classified by strength of evidence and accompanied by requirements (Table 17). Some requirements were part of the suggestions given by participants. Others were added by the researcher in response to drawbacks and other issues that emerged in the analysis. Usually issues resulted in one requirement. A few issues led to more than one requirement, which represented more opportunities and options for development. Diverse issues occasionally resulted in the same requirement, hence a proposed solution for several issues.

The requirements gathered did not always arise from problems found. For example R20 and R21 are related to participants' satisfaction with the information source. The size of the typeface and background contrast was well received by participants. The same occurred with R23, in which participants recognised the importance of having pictures of the monument in order to help in way finding. A list and a table of requirements (both ordered by strength) are available below.

(R20) The typeface should be at least 10pt.
(R21) The background and the text should have a good contrast.
(R22) The system should display pictures of the monument to support participants in way finding and see better the monument details.
(R23) The system should have zoom in zoom out features to help seeing monument details.
(R3) The system should have information of monuments on the way or offer the user possibilities to retrieve this info in somewhere else – websites
(R12) The system should aid with safety issues, advising them where it is the best spot for crossing the streets or calling their attention for traffic roads.
(R15) The system should make available explanations of terms, words, expressions and so on in hyperlinks.
(R13) The system should provide not only audible but also visual information.
(R24) Who; when; why are the main questions that should be covered of commemorative portrait statuary.
(R25) Information about material, date, and style are extremely relevant when exploring the sculpture piece.
(R26) The date and the motive should be clear when the system display information about commemorative monuments.
(R30) The system should make indications to look at the monument from diverse spots. Encourage users to move around the monument.
(R1) The system should display the last information accessed (e.g. next monument/map) on the screen.
(R6) The system should provide verbal or visual information of which is the best way to stand to see the monument.

(R9) User should be able to rotate the screen to see the map according to his/her direction.
(R29) The system should not lead people to see what does not exist in the environment. Instead, it should provide multimedia information that gives users that information.
(R33) The system should help users to relate various aspects of the piece to others.
(R5) The system should be sensitive to events that occur in the city, providing instructions of where are the obstacles that possible interfere in their walking tour.
(R31) When the monument is decorative the meaning of shapes and colours should be emphasised on the system.
(R10) The system should be illustrative. Thumbnails of the monuments should be displayed on the map.
(R11) The icons representing the points of interest should be placed in the best position on the map that matches with the real world monuments.
(R17) The system should display the small amount of text and topics starting with dates.
(R18) Additional information should be displayed in hyperlinks
(R7) The system should display the main natural or artificial landmarks in the city. For example the seafront and parks are considerate as landmarks.
(R16) The content should generate user interest in the history of the piece and not repeat information that they can clearly see in the object.
(R19) The system should display replicas of the written text and the informative plaques of the monuments.
(R32) When the monument is in or on a building, the system should provide information of what the venue's present/past function.
(R8) Users should be able to highlight the current location and points of interest on the map.
(R2) The system should have different styles of screen presentation according to user needs. See all the pictures of the monuments on the tour; show the previous, the focus and the next monument information.
(R4) The system should show operational information about the places that users are interested.
(R27) Consider on the system the knowledge that users probably have about the subject. For example Wars.
(R28) The system should provide a video or a picture of the monument particularly where movement is involved.
(R14) The system should be able to display basic information clearly, so that, it will not be cognitively demanding in outdoor environments.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R20	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
R21	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
R22	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
R23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
R3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
R12	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			

R15	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
R13	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
R24	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
R25	*	*	*	*	*	*	*	*	*	*	*	*						
R26	*	*	*	*	*	*	*	*	*	*	*							
R30	*	*	*	*	*	*	*	*	*	*	*							
R1	*	*	*	*	*	*	*	*	*	*								
R6	*	*	*	*	*	*	*	*	*	*								
R9	*	*	*	*	*	*	*	*	*	*								
R29	*	*	*	*	*	*	*	*	*	*								
R33	*	*	*	*	*	*	*	*	*	*								
R14	*	*	*	*	*	*	*	*	*									
R5	*	*	*	*	*	*	*	*										
R31	*	*	*	*	*	*	*	*										
R10	*	*	*	*	*	*	*											
R11	*	*	*	*	*	*	*											
R17	*	*	*	*	*	*	*											
R18	*	*	*	*	*	*	*											
R7	*	*	*	*	*	*												
R16	*	*	*	*	*	*												
R19	*	*	*	*	*	*												
R32	*	*	*	*	*	*												
R8	*	*	*	*	*													
R2	*	*	*	*														
R4	*	*	*	*														
R27	*	*	*	*														
R28	*	*	*															

Table 17: Issues by strength of evidence

Requirements suggested by participants were also identified as relevant in the observations and interview data (Table 18). Some of the suggestions were related to participants' previous experience with wayfinding systems, such as Google maps. They expected to see their current location and main landmarks in the city. Other considerations covered the interface design, such as: typeface, amount of text displayed on the screen and different styles of screen presentation. Additionally, the language turned out to be an important topic for international participants.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R20	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
R8	*	*	*	*	*	*	*	*										
R17	*	*	*	*	*	*	*											
R15	*	*	*	*	*													
R18	*	*	*	*	*													
R7	*	*	*	*														
R2	*	*																

Table 18: Requirements suggested by participants

4.2.2.5 Discussion

The method for capturing data and the data analysis in Study Two allowed us to examine participants' behaviour more carefully than in Study One. During the tour, participants who were accompanied by children or friends preferred to take the tour without the company of the researcher. The others mentioned that the presence of the researcher made them more comfortable in applying the talk aloud technique and not so embarrassed about using the baseball cap with the micro camera attached. Participants with company explored more the content and environment. In the four tours taken by groups, it was possible to notice that they read the content of the booklet and plaques, they touched the monuments and also discussed the subjects to a greater extent than the others.

The interviews clarified some attitudes and gave a second opportunity for participants to express their thoughts. Participants who did not talk aloud so often during the tour usually gave more feedback in the interviews. The place where the interview was carried out provided a cosy atmosphere for them to express their thoughts. The use of content analysis software (Nvivo) facilitated making the connections among participants' observations and recognising patterns in the data.

4.2.2.6 Conclusion

This study with a paper-based information source was relevant to understanding how long-term residents, short-term residents and visitors interacted with content and environment without being distracted by any new technology.

It was clear there were differences of approach among the participants. The length of residence was an important factor that had an effect on how participants picked up information and in wayfinding activity. In addition, participants who labelled themselves as very interested or specialists in cultural heritage read more of the text, made more connections among the monuments, discussed the subjects more often and made more suggestions to improve the content than others. Moreover, participants' nationality played an important role. Native speakers paid more attention to the text and only had difficulties in understanding technical words from the field of Architecture and Art.

It was intriguing that locals and long-term residents did not always locate the monuments more easily than others. But it is also true that visitors were more often lost. The data collected also showed that locals and long term-residents were surprised to see monuments that they did not realise existed before. Additionally, they gave suggestions about how to improve the content based on their knowledge and experience. Participants also compared the experience with previous experiences of this type of activity. Some of them related their experience with mobile multimedia guides. Others gave suggestions about how they expected the content to be delivered on mobile guides.

A large set of requirements was gathered in this study. Issues were described with requirements and the strength of evidence with which they emerged. The results indicated ways and opportunities to explore certain issues with support from mobile devices. The perspectives indicated with the results of the follow up activity with a mobile phone app (Study Three, below) served as the basis for the mobile guide prototype development.

4.2.3 Brighton sculpture trail – Mobile phone study

This section presents the findings of a study focussing on the impact of the use of mobile technology in the visitor experience. Twelve participants of diverse nationalities and backgrounds took a tour, using a mobile phone app with multimedia content. The tours happened during the Autumn of 2009 in Brighton. The average age of the participants was 20-29 years old. Some of them took the tour accompanied by friends and children.

The aim of this study was to understand how the historic and cultural information was accessed in outdoor settings with mobile technology. Moreover, it focussed attention on the design of multimedia content, and the main benefits and drawbacks of its use. The results of this study were compared to a previous study with a paper-based guide.

4.2.3.1 Methods

Even though a rich set of requirements was addressed with the booklet study, a lack of understanding of how people access cultural information with mobile devices and an understanding of technical characteristics of this platform was also needed.

Twelve participants aged from 20 to 49 years old attended the field study. Ten participants were internationals (Brazil, Taiwan, Mexico, Finland, Sri Lanka, France, Ireland and Nigeria) and two UK citizens. Three participants were English speakers. Five of them have lived in Brighton for less than three months (considered visitors), five were short-term residents living in Brighton for about one year and two were locals. All the participants described themselves as interested or very interested in cultural heritage artefacts. Ten participants had previous experience with multimedia guides, two participants used city guides and the remainder reported having had experience with indoor mobile guides in museums and galleries. Four of

them said that they had never used a touchscreen device and the other eight had used it or have their own mobile touch screen phone. Seven participants were familiar with the HCI field and five of them were attending the module Usability Evaluation in University of Brighton.

The mobile phone app selected was Wikitude by Mobilizy[32] available for Android and iPhones. The preference for this app was based on the diverse modes of retrieving content and way finding. The majority of mobile apps employ modes of interaction that are available in the Wikitude system such as: map, list and camera view (Chapter 3 - Background) in order to show points of interest (POI). The content, in those popular mobile apps, is usually displayed with text and pictures. Some of the mobile guides available on the market also include audio and video content. The Wikitude app was chosen because it displays these possibilities for presenting and accessing information (Figure 23).

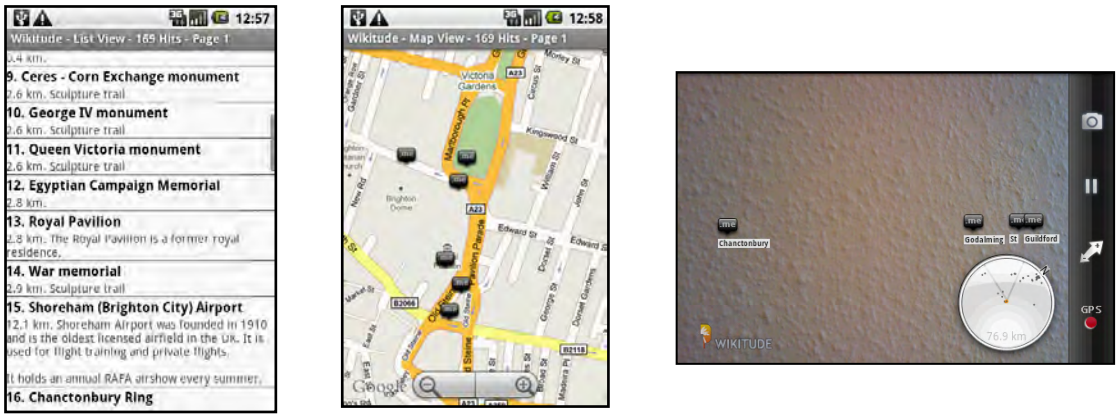


Figure 23: Wikitude mode views

Additionally, it was not cumbersome add information to the app. The content was added on Wikitude.me[33] (Figure 24), where it was possible to tag points of interest and location-specific hyperlinked content on the Web. Users accessed the tagged content in the Wikitude app version 715[34] through a touch screen (HTC Magic android) mobile phone. Users could also select the icons using a scroll pad, which in fact was rarely used. The app was available for downloading without any cost.

[32] http://www.wikitude.org/
[33] http://wikitude.me/
[34] Version installed in 14/10/09

Figure 24: Wikitude.me

The mobile trail was constituted by four POIs. In the beginning of the session, explanation of how to use the system was given to participants. The first POI information was used as guidance. Subsequently participants used the mobile phone to access the other three spots available. All the participants started the tour in front of the same monument.

The content for each point was displayed on a webpage containing the same information as the previous study with a booklet (Figure 25). For the first three monuments, visitors could acquire more information available on the Web (Wikipedia or Public Sculptures of Sussex website) and listen to a podcast. For the last monument the podcast was not available. Additionally, two further POIs were added to the map in case participants wanted to access them en route to the main points. These were the Royal Pavilion and the Egypt memorial. These were linked to Wikipedia and Public Sculptures of Sussex website. Users accessed content by clicking on the icons displayed on the map, list or camera view.

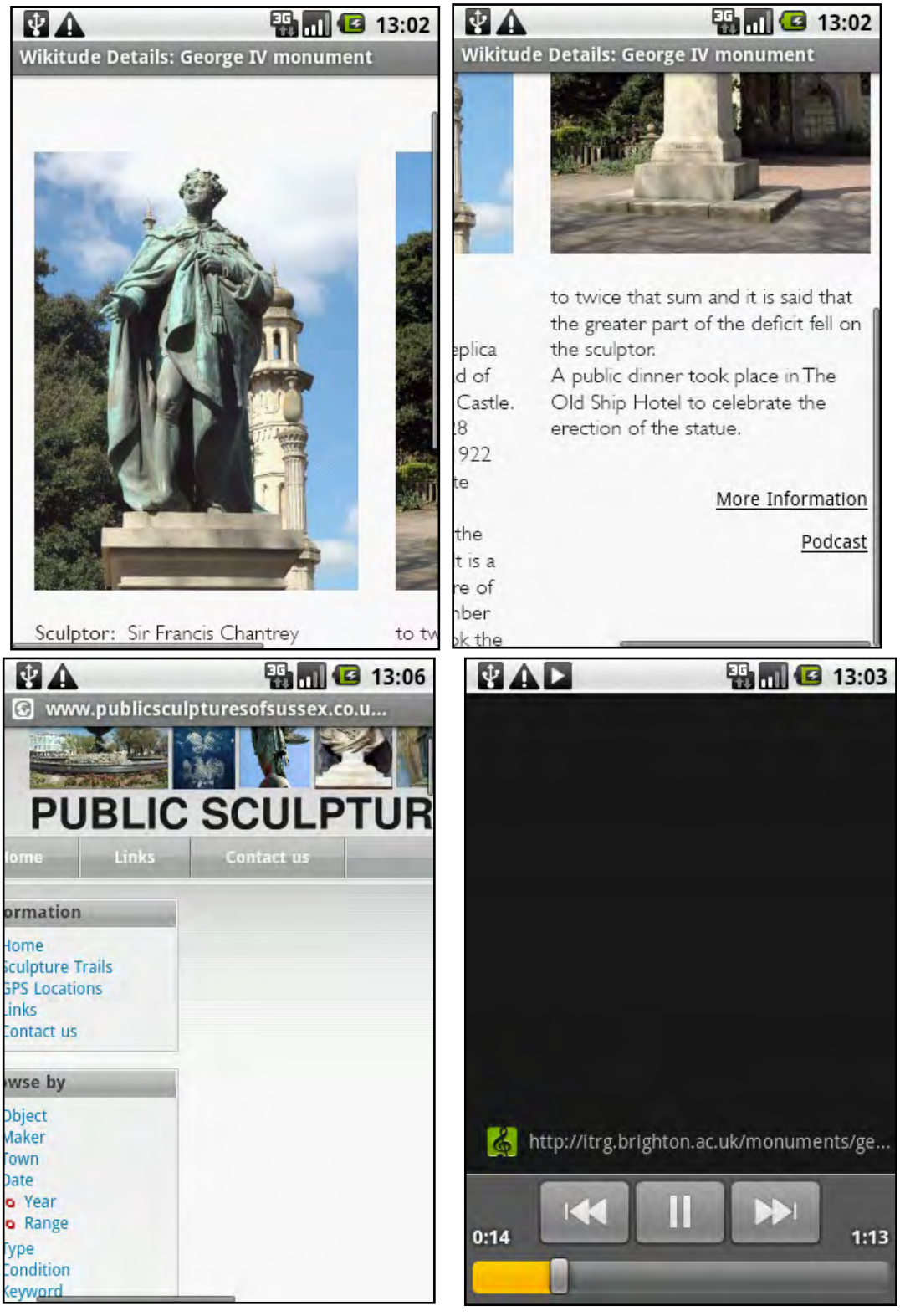


Figure 25: Content pages

Participants were free to stop and gather information of any POI on the way. They also were asked to express their thoughts aloud as they proceeded. The length of the tour was on average 15 – 25 min. A video camera with a microphone was worn by the participants and attached to a baseball cap. After the tour, a questionnaire and semi-structured interview were conducted. Participants were rewarded with a £12 food voucher.

The questionnaire contained Likert scales, Semantic differential scales and System Usability Scale (SUS). The semi-structured interview contained four open-ended questions. Participants were given the choice of answering the questionnaire outdoors (benches in a square) or inside the Public Library of Brighton. The researcher made herself available to answer any questions participants had during the tour and after the experiment. Besides, they were advised to include any information that they thought relevant to report in the questionnaire (Figure 26).

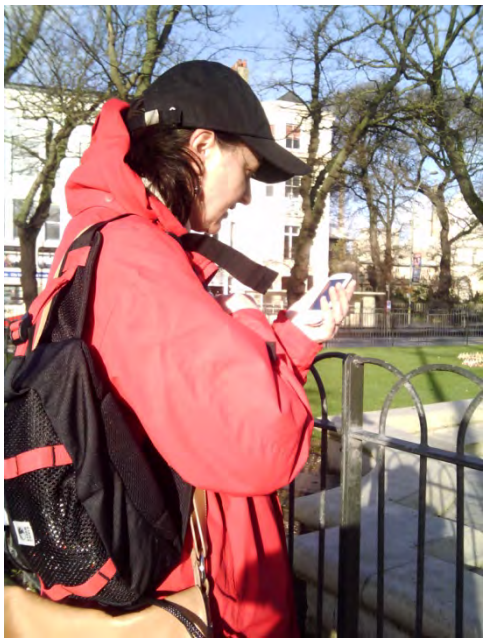


Figure 26: Participant doing the tour with the Wikitude app

4.2.3.2 Data analysis

Video observations, questionnaires and interviews were the resultant data. The data analysis was also based on the categories unveiled in the previous study with paper-based guides. Although the emergent categories had similarities to the prior study, the interaction between

users and information source (mobile phone) resulted in new insights and requirements to develop mobile guides. A pilot analysis session was arranged with usability experts in order to discuss the validity of preliminary findings and guide the process.

4.2.3.2.1 Pilot analysis session

Three usability experts undertook a pilot analysis session[35] once all the tours had been conducted. The aim of this meeting was to guide the observation analysis. Accordingly, the tour selected for the session was one in which participants visited all the points of interest and followed the Think aloud technique in a satisfactory way. The participants in this tour were aged 20-29 years old, students and lived in Brighton for less than three months.

Usability experts were asked to take notes of user frustrations, positive and negative comments, way finding and content issues and/or other behaviours that would call their attention. When evaluators identified interesting behaviours, the video was paused to give place for discussion. Significant points relied on:

Traffic safety – Warnings of traffic safety should be recommended to users before the tour starts. The consent form should have warned participants of traffic risks. Once in a while, they crossed several dangerous roads and did not respect the signs.

Own phone – It would be interesting to have participants familiar with the type of phone used in the study and examine if the problems that appeared are related to the Wikitude app or because they are not used to the phone.

Language – None of the participants in the tour pronounced the name of the last monument "Ceres". This could indicate they did not know how to speak it or were afraid to commit mistakes.

Podcast – participants looked for a podcast at every monument that they visited. Some POI did not have a podcast available, which resulted in user frustration and waste of time attempting to access it. They sought for short podcasts as well.

Information on your fingertips – Participants accessed the information available for them during the tour. The advantages of having information anytime they wanted to consult it were

[35] Marcus Winter, Richard Griffiths and Lyn Pemberton.

noticeable. More than this, users appreciated categories available for search on the Pavilion Wiki page.

Immersion – The focus of attention was on the device attributes and not on surroundings. A participant was looking for a sculpture during the tour. She passed beside it and did not notice the sculpture because her attention was on the phone screen. It might be an alternative to have less information on the screen, making the participants more aware of the area. The podcast was a good example; it pushed those users to the context as their eyes were free.

Imagination and interest – The content should engage the imagination. In the opinion of experts, the system should give a small amount of information and provide more if requested. The system should also lead users and tell them things that are interesting. For example, it might give links among monuments, such as the connection of George IV and the creation of the Royal Pavilion, the Queen's age and George IV´s age, e.g. she was very young when he built the Pavilion.

Those points were considered in the follow data analysis.

4.2.3.3 Findings

The preliminary expert analysis highlighted major and general issues to guide the analysis. However, observation of details and focus on participant's behaviour and speech were employed to provide a better view of their experience. Categories employed on the previous study with paper based guides, served as the foundation for this analysis as well. Major attention was given to multimedia features on the screen and how users interacted with them. The interaction perspective was focused on the overall participant's behaviour while they navigated in the space. Additionally, this perspective covered environmental elements that may have disturbed or interfered with their access to information.

The major focus of this analysis remained on the ways information was displayed on mobile devices to help users to access the content. Consequently, the attention was not on how users find their way, but how the multimodal interface and context led them to engage with POIs and content displayed on the screen.

Presentation, Context and Content were examined through the interaction perspective. The category presentation is named here Look and Feel due to the nature of information source. Participants used their senses of touch, hearing and sight to navigate with the mobile device app.

In the same way as the previous study, issues were identified and rated according to the occurrence in the tours. Additionally, requirements to improve or support those issues were delivered.

A) Look and Feel

Presentation of the elements on the screen played an important role during the tours. Haptic technology, the sense of touch, was also a crucial element in the user's interaction. Graphic and haptic issues were found here with the aim of gathering requirements to improve the experience of users. Organisation of the information on the screen and audio features were also covered.

a) Text and Typeface

Most of the participants found the text size not too long to read and the type size readable. Even though, it is true that participants read much less quantity of text than in the paper based experiment. Nearly all participants were distracted by the technology and their primordial goal, at least for most of them, was to find the monument and not to access the content. While they accessed the text page, they scrolled the pages to see what was available and did not always read the whole text. (Table 19).

	SD	D	N	A	SA
The texts about the statues were too long	5	3	3	-	1
The type size was too small to read	2	4	3	3	

Table 19: text and type size

It shows like the details of the place when what I want to know is how to get there first. International/ Short term resident

I'm just reading relatively quickly. So it's First World War. Visitor

The only participant who found the text too long also found the type small to read. This was a local, 40-49 years old and accompanied by children. In the video observation, it was apparent that the focus of attention was not just on the text but also on the children. Interruptions in the reading occurred, making it awkward to return attention to the text.

George the IV monument, it is where we are. Do you want to read GIV statue? Has a tight little text. Local was asking her child to read the text of the monument.

Another clue that the majority of participants did not read all the text was noticed when they were accessing the information about George IV. The text in the first column was omitted; this was a display error, but only few participants noticed that.

Issue: Participants did not read the whole text on the main page. S/E ********* (9)
(R01) The system should display brief information of POI and display possibilities to access extra information.
Issue: Participants appreciated to have more information available in hyperlinks. ******* (7)
(R02) The system should display possibilities to access extra information.

Only three participants agreed that the type size was too small to read. Two participants were over 40 and all three of them worked, or had a background, in the graphic or/and interaction design sector. Therefore, it was not clear if they really found the type size small or if they were concerned of how others would read that. Some of them mentioned that it would be harder for elderly people to read it. They also expected to have possibilities to change the type size. During the tours some of those participants tried to make the type size bigger pressing on the zoom button, which was not working in this section.

If I zoom in (he clicked on the magnifier button) this is not zoom…. Ok. I would like the text a little bigger but I can read it. I can't read the bottom of the text - the last line is cut. Local and expert in HCI

Participants also found difficult in identifying the icon labels in the camera view mode. The type size was smaller than the one displayed in the text and the list view. Additionally, interferences of the background made it even harder to read the characters on the screen. (Figure 27).

Let's go to camera view. It doesn't tell me anything about it. I can't read that words anyway. I'm going to the list view. Local and expert in HCI

Issue: Participants tried to zoom in the text. S/E *** (3)

(R03) The zoom function should be working in all sections of the system.

Issue: Participants identified the type size in the camera view mode as small to read. S/E *** (3)

(R04) When the background is in movement, tests are necessary to identify what is the best type size for users.

Figure 27: Example of camera view mode

b) Hyperlinks

Two links were present in the system: "more information" and "podcast". Podcast is discussed in the next topic. Seven participants marked the "more information" hyperlink as essential to have. Users also appreciated the presence of it even if they did not use it. In their opinion, it gave credibility to the system having extra information.

This link retrieved WebPages not designed for mobile phones, which caused a bit of frustration in certain participants. For this reason, participants enjoyed the pictures on the web sites but did not engage with the content. Additionally, participants identified the information displayed on the Public Monuments of Sussex website as very technical.

Now I've just finished reading. I'm clicking on more information. She waits for loading the page. *I've just arrived at publicsculptures.com. Good pictures. I'm trying to find more info about the War Memorial. It is quite interesting. I'm not going to read everything because it is a long text.* Native speaker/Short-term resident

Visitor stops to see the Obelisk and has the website open. *Good pictures representing the Obelisk. Visitor checks the next one that is the Royal Pavilion. The page is full of details it is not straightforward.*

It is a bit of a scroll down. I'm not sure why there is this big place here. Why you can't have in that side, it is most like you don't know if it is loaded or not. Ok I know what that is I'm not looking to the right thing. Ok. This is not exciting info to watch back. Why is it an obelisk? It is an obelisk because it was done in the Egyptian Campaign I understand. Information seems quite a technical; it is like I'm reading a manual. It is not singing to me. Perhaps more narrative will be more valuable. I'm kind of not interesting on that. It must be presented in a more natural narrative sentence. Local is accessing the webpage of Egyptian Memorial.

Issue: Users were satisfied to have links to access more information about the subject. S/E ***** (5)

(R05) The system should have more information of the subject in case users want to know more about it.

Issue: Participants did not engage with technical information about the monument. S/E **** (4)

(R06) The information should be displayed in a more narrative way. * (1)

Issue: Participants had difficulties to navigate on websites not tailored to mobile phone displays. S/E ****** (6)

(R07) When displaying websites on the app, a mobile version should be available. ** (2)

The label "More information" provided misconceptions. In wayfinding situations participants clicked on this link to get directions. In addition to it, anytime they were looking for something,

such as podcasts, they accessed it. The context indicated and gave meaning for the label (more information). In order to avoid misunderstandings the name of the link should be clearer, or the system should identify in which situation the user is.

I read all the text about the sculpture but not in the links. The links, for me, it wasn't useful but it is good to know that you can know more. Visitor and international

Issue: The label "more information" caused misunderstandings. S/E**** (4)

(R08) The system should be sensitive to user context.

(R09) The links should have clear names according to their function.

c) Podcast

Podcasts were available for participants to access on the app. The audio files were extracted from a podcast available on the website VisitBrighton[36]. The podcast was an informal conversation about the POIs and it was recorded in outdoor settings.

Largely participants appreciated the presence of the podcast on the system. They mentioned it during the tours and in the questionnaire. Additionally, there was clear evidence that they were interested in accessing the podcasts. For instance, in some monuments there was not a podcast available and they looked for it, which caused disappointment. Participants accessed the podcasts in front of the monument, but also used the time to walk to the next monument and the waiting time at the traffic light. None of participants questioned the label "podcast" as well. This was a sign this concept was internalised.

A substantial difference between non-English speakers and native speakers was identified. Long-term residents, most of them from England or English speaking countries, appreciated and preferred the idea of listening to two people talking in the same podcast. However, in the questionnaire answers, five internationals rated this podcast as *useless*. Those users had problems with the structure of the podcast, language and background noise. It could be said that participants familiar with the language were less susceptible to the noise of the

[36] http://www.visitbrighton.com/site/maps-guides-and-interactive/podcasts

environment (traffic, people talking on the street) and understood the speakers better. Internationals suggested having one speaker in the podcast. Audio files should be recorded in a studio and be more formal. In their opinion, it was difficult to understand one of the speakers already, and even more when the other replied demanding more attention and focus on the task.

The audio guide was like a debate, a TV show. I'm not there to watch; you have to be relaxed to listen to that. You need someone to give an idea. I was very distracted by the audio, because it requires effort to listen and pay attention. It has to be something that does not interfere in the experience. International related her experience in the questionnaire.

Let's see the podcast. So it is the same one as before. No no. This is different. Only one minute long. Ok It might be interesting to have say options 1 2 3 additional info. And how I'm interesting on this I might want to go actually, hear a bit more. It would be a nice feature. Native speaker

I don't know why there are two persons speaking in the same time, it is quite hard to understand. Maybe I prefer one person to speak and to have more details with one person, one voice I prefer that. Because of the noise of the road it is hard to understand everything so I prefer one person to speak. International visitor

Issue: Internationals had difficulties in understanding the podcasts. S/E ***** (5)

(R10) The audio should not demand so much attention of the user in outdoor settings.

(R11) The audio should be recorded by one speaker and in a studio. *** (3)

(R12) The system should display different language choices. *** (3)

The screen was black while the podcast was playing. This was done on purpose, in order to identify user's attention to monuments. An unexpected result was that several participants would focus their attention on the screen while listening to the podcast. Moreover, they proposed possibilities to see visual information on the screen while the audio was playing.

Several other suggestions were made about the podcast format. Some wanted the podcast in other languages and others suggested having more podcasts. In the context of the experiment, it was not considered so necessary to have the audio in different languages: international participants were in Brighton to learn and improve their English skills. In a context that did not

privilege language learning, this recommendation might be necessary. The second suggestion was to have different podcasts organised by theme.

Let's check the podcast. This is the left one. I don't know if all they have one. There is no picture or anything. For tourists if it is not your natural language it is very difficult to understand. Too quick for many people, it is like a conversation. You have the other voice behind and it is low. We have just only one set (headphones). You could have this in other languages. Traffic noises…Sometimes you cannot listen because of the traffic. It is a nice idea though you can only read but just listen. You could be walking and listen. You should have for two people (headphones). Like a split. International and short-term residents were discussing about the podcast.

Issue: Participants looked at the screen while the audio was playing. S/E ***** (5)

(R13) The system should display visual information on the screen while the podcast is playing. ** (2)

(R14) Information should be displayed on the screen in order to incentive users to look at/ touch the monuments.

The ones who made the tour in company complained of the volume of the audio, mainly because they had to split the headphones. Consequently, the noise from traffic and density of people disturbed the experience even more. They more often also missed the volume controls on the screen. Additionally diverse participants pressed the podcast link and then the podcast started playing immediately, not allowing them to put on the headphones before listening. One alternative could be press on the podcast link and they select play when they are wearing the headphones. More tests are necessary to confirm this situation.

It automatically started it is kind of frustrating so I plug in and if I knew I would set up the volume out. Let's start again. Is there any volume control? Yes, this is quite gathering. This is the kind of narrative that I'm up into. I probably even not click for more info I might read that introduction page and click on the podcast particularly if I listen to it, more engage it is just 2 min long I quite like this. I quite like the way that they talk and give me some context about. That's quite good. Native speaker

Issue: Participants with company had problems to listen to the podcast with one pair of headphones. S/E ***** (5)

(R15) Users in company should use different devices or the system should advise users at the beginning of the experience of the necessity of two sets of headphones to follow the tour.
(R16) The system should allow users to see the transcription of the audio on the screen, in case they cannot hear it because of the environment noise.
(R17) Volume function should be available on the screen. ** (2)

Issue: The audio file started before participants wearing the headphones. S/E **** (4)
(R18) The podcast should not start playing before users press play. * (1)
(R19) Users should be advised to wear the headphones as soon as they access the audio page.

d) Pictures

The participants agreed overall that the pictures were useful in identifying the POIs in the study. It was also apparent in the video observations. Besides, pictures helped short-term and long-term residents to remember where monuments were located. The background of pictures showed nearby monuments and context, hence, it also helped them to localise themselves.

I see the monument. I got here because I know my way around and because I know the pavilion and you can tell from the picture that it is close to the Pavilion. Short-time resident

Issue: Pictures assisted participants in localising monuments and themselves in the environment. S/E ********* (9)
(R20) The system should have visual information that provides clues where the monument is; e.g. visible background showing elements around it.

The interest for pictures was not only wayfinding, but also to afford a better view of the sculptures' details. Eight participants said the pictures helped them to see the details better. Four disagreed. It was observed that the respondents who disagreed seemed to interact more with the environment and monuments. They got closer more often to the sculptures. Certain participants were immersed in the experience of being guided by a mobile phone. On some occasions, pictures substituted for their interaction with real monuments. Very often they looked at the pictures on the mobile phone and did not get closer to the monument or even notice the real monument. In the case of the Corn Exchange, certain participants found the

place, knew that the sculpture was embedded in the façade and did not cross the street to see it. Sometimes the monument was hidden by vehicles parked in front of it. These users were satisfied with seeing the picture on the system.

Where is the sculpture? Ah we can't see - Big bus. We can see the picture anyway Visitors

I can see Corn exchange in front of me because of the sign. I haven't seen the real sculpture. I was interested in getting there and I got here. Short-term resident looked at the picture to make sure she was in the right place.

The users that found it useful to have pictures to see details were a little frustrated with the way the pictures from the websites were displayed. The pictures were not visible or not easy to find on the screen, unless users scrolled the page. Those participants also suggested how they would like to see the pictures:

The page is not well designed because the photos are out of the page. It is strange to take some info here. Visitor

I would like to see the whole picture. One picture per screen but it is like easy enough to say that I'm in the right place. This info is more nicely laid out than when I was back to Egyptian Memorial (website) that info was a little bit like statistical, this is more interesting to read ... Ok. Local

Issue: Pictures assisted participants to see details of the objects. S/E ******** (8)

(R21) The system should provide pictures of the monument.

(R22) Users should be able to zoom in/out the pictures

Issue: Participants looked at the pictures and not at the real monuments. S/E ****** 6)

(R23) The content should engage the visitors with the monuments, not substitute the experience with the real object.

Issue: Pictures were cut out on the website screen. S/E ** (2)

(R24) When displaying websites on the app, a mobile version should be available. ** (2)

Moreover, the pictures helped participants to know what was inside the buildings. Participants who did not know of or had not visited the buildings before were more excited about it. Others

who knew the buildings did not give much value to these pictures. It was true the pictures added information and context to the experience.

In the first time I didn't see the pictures I just followed the map. Initially the map wasn't so helpful. If I have used the picture I would be able to know what to see. Visitor

It is beautiful! Oh! Yeah! Impressive! Visitor looks at the pictures inside the pavilion.
Pretty nice pictures you can see the inside of the Royal Pavilion. It is good I didn't pay to visit. I'm zooming in the internal picture of the monument. It is very beautiful. I will check other details, maybe history… Visitor

Issue: Participants were curious to know about the interiors of the landmark buildings S/E ***** (5)
(R25) The system should add new information to the experience, such as pictures of inside the buildings.

Sometimes participants touched pictures on the screen and the system started loading the same image bigger, making them wait for the download.

I accidently press on the picture. It is open now ahhh… I go back. Visitor

Issue: Participants tap the pictures displayed on the screen by mistake. As a result a large version of the picture opened. S/E *** (3)
(R26) Users should be able to control the zoom function.

Participants did not often take pictures with their cameras of the monuments they visited. Only two visitors took pictures of the monuments in the tour. It might be because the sample used in the study was composed of long-term residents, short-term residents and visitors to the city for three months. These participants had opportunities to see points of interest another time, as they were not in the city just for the day.

B) Context

In this section we discuss elements that had an effect on the interaction of the user with the device. Characteristics of the system, environment issues and participants collaboration during

the tour are taken into consideration. Most of the time participants were immersed in the experience and did not engage as expected with the monuments. It is also true that participants accompanied by families and friends collaborated to find the monuments and interacted with their surroundings more often than those without.

Not all the participants had used touch screen devices and the Wikitude app before; as a consequence they learnt how to interact with these technologies on the tour. The System Usability Scale was applied to obtain feedback on the strengths and drawbacks of the mobile device and application. The system had three ways to access information on the screen: List, Map and Camera View. Participants used the map to locate themselves in the environment, the list view to identify the monuments around them and the camera view was not frequently used.

The weather was also an issue: it was a little cold and raining most of the days. The tours happened when the autumn started; this meant that not everybody was properly dressed for the season. Besides, the urban noise and traffic issues made also the experience less pleasurable.

a) Immersion

The use of a mobile device to show points of interest in the city required visitor's attention. They explored the environment less than in the paper-based study. In the previous study, visitors touched the monuments, shared their ideas and opinions about the content and also read the text more. Some of these issues appeared in this study but on a much lower scale.

Participants doing the tour alone tended to take their eyes from the screen. They used the app while crossing several roads. They passed by target monuments without noticing them. They bumped into others citizens on the pavement. And finally, after finding the monument, they looked for the next one without offering the deserved attention to the current content.

It is true that information displayed in the app did not invite them to offer more attention to POIs and explore the surroundings. Consequently, they did not engage with public monuments by themselves. This was also discussed in the Pictures section (d).

Nowadays, there are huge possibilities to employ multimedia information on mobile device apps. Information multimedia design for this purpose should be presented to attract and engage visitors. It should be projected for interaction with the real world artefacts, and not keep user's attention only on the screen. Some participants also noticed this drawback:

I think you can get lost with the information rather than you engage with the buildings. […] You actually miss a lot of stuff. You know what I mean. You keep looking at that (mobile) you try to get this sorted out and you miss the rest. Of course it would be different with a town that we don't know of course we saw this already. Quite nice thing I think is the podcast you can listen for the stuff. But that is also one person kind of thing. […] It is like a quite impersonal way to see a town in that way. It was what I was thinking you don't really engage town. You get very lost in that thing (mobile). Too much surfing… Residents discussing about the mobile device

So Ceres corn exchange monument. What is it? Bump into people while walking. Short-term resident

Issue: Participants were immersed on the digital experience and not engage with monuments and surroundings. S/E********* (9)

(R27) The system should engage users with monuments and history.

b) Participants with company

When friends or children accompanied participants, two situations occurred. Firstly, the person holding the mobile phone read the text aloud and gave directions. The other listened and gave comments. Secondly, both looked at the screen and read together the text in silence. It was noticeable in both situations that these participants paid more attention to the content than the others who took the tour alone. Likewise, they collaborated and interacted with the system more often. Consequently, they gave more feedback and suggestions to improve their experience.

Agreements were necessary to move forward and please all participants doing the tour together. Certain tasks were cumbersome to achieve, e.g. listening to the podcast with one pair of headphones. It was common to see participants tapping the screen while their partners were holding the phone. Typically, they helped each other to localise themselves and find certain features on the app. This attitude sometimes restricted the interaction freedom of the ones holding the device.

Participants accompanied by children also found it difficult to follow the tour and concentrate. It did not occur so often during the booklet study, in which participants had a more established division of tasks and the information source was not interactive. It is not possible to affirm participants would have the same drawbacks using their own phones.

I can't really concentrate with you. I tried listening to the podcast but she is really busy chatting through it. Participant did the tour with a child.

Participant 6: So George the IV was the dude who did the Royal pavilion, right? Participant 5: Do you know who sold the Royal Pavilion to the state? Participant 6: Who? Yes I know. Participant 5: Queen … Participant 6: I know this one Participant 5: Queen Victoria Participant 6: exactly I know like the Queen Victoria station. Participant 5: You know why? Participant 6: why? Why did she sell? She didn't like it personally.

Issue: The system was not so attractive to children. Parents were not able to focus on the activity. S/E*

(R28) The system should have activities, or questions that provide engagement between parents and children.

c) Learning the system

The majority of participants had used touch screen devices previously. Four in twelve never used this type of device before. In the first monument, as commented before, a short explanation was delivered about the main functions of the device and application. Participants with previous experience with other devices asked more for clarifications of app functionality.

In order to gather feedback of the device and application we employed the System Usability Scale (SUS). (See Chapter 2)

While answering the SUS questions, non-native English speakers misunderstood certain words such as “cumbersome”. Six users asked for the meaning of this word. The same issue was pointed out by Finstad (2006) who replaced this term with “awkward”. It is advisable to change this term in future tests.

A study that looked at the overall usability in mobile phones found the total mean score was 65.9 in 372 surveys (Bangor et al 2009). In this study the overall score was 62.71. Therefore, the score is in the marginal acceptability range. As a result, it was possible to identify relevant elements to improve the experience. If the system is not acceptable or has low acceptability by users, technical and usability issues might suppress other relevant issues to enrich systems.

With reference to the device, several participants had problems with the location of the volume button; it was placed on the side of the android HTC phone. Users constantly pushed it by mistake, mainly in situations when they turned the screen to a landscape orientation. Users of other touch screen phones (e.g iPhones) had certain difficulties in understanding how to interact with the Android phone at the beginning of the tour. This issue appeared when they used other modes of interaction, such as zoom in/out the screen.

The screen is not so sensitive - you have to press the button to zoom in. I prefer to use the finger, like in the iPhone to zoom in. Participant with previous experience with iPhone device

Issue: Participants familiar with other kind of devices had problems with learning a new mode of interaction. S/E*** (3)

(R29) Consider previous user experience with touch screen mobile phones. Use modes of interaction that may be intuitive for a wide range of users.

Issue: The result of system usability scale (SUS) answers was in the marginal acceptability range. S/E********** (12)

(R30) When testing apps with users, designers should consider solving crucial usability and functionality problems. In this way, new interesting issues for improvement might emerge from the user tests .

d) List

In the list view, the information on how far the monument was from their location was displayed in a linear way: the closest monument appeared at the top of the list. When they tapped on the name of a POI that was part of the tour, they saw its content and picture.

I'm just confused. I'm not paying attention to the map. Local turns the mobile and stops walking. She continues on her way looking at the map. *I suppose that is here somewhere. Let's go to the list to see what actually I'm looking for.* Local looks at the picture of Corn Exchange and continues the tour.

Additionally, they observed the list view in order to see how many points of interest were available on the tour and which one was the next to visit.

I thought that it would be like a tour that tells you what to do next. Me too - You can even have a little tour there like you would use or not, but you know. Short-term residents

I'd like to know which sculptures I have to find. From the map I don't know which ones I have to find. Now I'm waiting for the list and it is coming out. Ah Ok. Now I have to find 4, 5 and 6. Short-term resident

Issue: Participants found it valuable to know how far the monument is from their current location. S/E****** (6)

(R31) The information of how far the monument is essential. The system should show closest monuments to participants in ascending order of distance when a list view is available.

Issue: Participants used the list view to access the next monument information. S/E********** (10)

(R32) The list view is essential to make participants aware of how many monuments are around and to access content.

Issue: Participants expected to be guided by the system, e.g. a linear tour. S/E**** (4)

(R33) The system should provide a linear tour.

e) Map

	SD	D	N	A	SA
It was easy to find the sculptures	1		3	5	3
It was easy to identify how far you were from the next sculpture on the map	1	3	3	4	1

Table 20: Map 1

		1	2	3	4	5	6	7	8	9	10	
Identifying the monuments on the map	difficult			2	2	2	1	1	1	1	2	easy
"You are here" icon	unhelpful					2			3	3	4	helpful

Table 21: Map 2

Eight out of twelve participants found it easy to find the monuments in the tour. Participants used their previous experience of the city, signs in the environment and distinct modes of interaction. The modes of interaction provided by the system were: map, list and camera view. The mode most frequently used to help in way finding was the map. Not all the participants identified the POIs on the map easily (Table 20,21). The answer to this question was very diverse. Users with previous experience with touch screen devices and Google maps identified the POIs easier. On the other hand, three participants who found it trivial to identify the monuments on the map disagree that it was easy to identify how far they were from their current position. Not all participants used the scroll pad to select their targets. The ones who used it saw a white balloon with the name of the monument and the distance from it written down. They appreciated knowing how far the monument was on the map screen. The others were not aware of it. In the list view this information was clearer and easier to access; consequently participants consulted the list view more often this information.

I can walk I can see that I'm getting closer to it as well in the map. It was 0.3 km and now it is 0.1km. So I suppose I'm getting closer. I'm going to the list so ok the George and the Queen is getting closer as well. Participant identified how far she is from her target.

On the contrary to what happening when they accessed the list view, participants were not satisfied to see the POI content when tapping on the icon labels. They usually looked for directions when pressing on the map icons. This situation occurred mainly with short-term residents.

I want to go to the Queen Victoria monument. She presses the balloon on the map and says it is like 2min away from here and I'm… Presses the balloon once more by mistake Ops! She goes back to the map. You see when I click on Queen Victoria monument it actually shows me information about it. And with this Egyptian it didn't show me anything. Short term resident was looking at the map.

Issue: Participants expected to be guided by the system. e.g. linear tour. S/E**** (4)

(R34) The system should provide a linear tour.

Issue: Participants looked for directions on the map. S/E********** (12)

(R35) The map should display a way to retrieve directions to go to a point of interest.

Not everyone who did the study was a map person. Recent residents could not identify distances on the map readily or interpret the units. According to a field study made by Vertesi (2008), users found it easy to use the London underground map because they identified which station they were and where they wanted to go. They also saw the trajectory to get there in simplified lines and colours. Participants of the mobile app study missed seeing a trajectory traced from where they were to their destination. Their expectation came from their familiarity with other wayfinding systems, such as Google maps and mobile maps.

I don't know, some sort of guide of how to get there would be useful. I guess like you are in a certain place exactly, so ok, you select where you want to go show me the route. It might have one I suppose I don't know. Ok says 1.2 km can I click on it? It just gives me the details. Local

Issue: Participants were lost and expected to have a way to consult directions to their destination from where they were in the map. S/E******* (7)

(R36) The system should provide a trajectory traced from the current location to the target location.

Participants really appreciated the GPS technology in the app. This made it possible to identify on the map their current location represented by the icon “You are here”. Ten users found this icon helpful on the screen. However, they noticed an update delay in displaying their current location.

I don’t know if the map can have the same function as a GPS. It seems yes because the cross that shows where I am (you are here icon) moving but not in the same speed as I’m walking. Short term resident

Issue: Users found the icon “You are here” helpful. S/E********** (10)

(R37) Icon “You are here” is relevant to show user’s current location. It should be updated regularly.

The icons added on the wikitude.me system by the researcher had the same graphic – a balloon with dot me. Consequently at first glance the identification of POIs was not straight forward. Participants had to select the icon to identify the POI, which caused disappointment and resulted in complaints. Moreover balloons with the name of POIs prevented users viewing what was around their target on the map.

The map is a bit confusing I would say. Because it shows me a bunch of me me me (very upset) and when you click on one thing It shows like the details of the place when I want to know how to get there first.[…] I can’t really understand this map to many things like me me me together. Short term resident

I just click on the bubble to see what it is. Yes it is a statue. Visitor

How can I find this? Let’s use the map. How do I move this (balloon) from the screen? […] The roads from the map are different. What the map tells me it is if two roads, I don’t know what side of the road. Visitor

Issue: POIs had similar graphic and shape (.me) on the map. Participants had to select them for identification. S/E******* (7)

(R38) If POIs are illustrated in a map, they should be displayed in different colours or/and shapes for users identify them easily.

Issue: The icons and labels covered the map, making difficult for users identify their way on it. S/E** (2)

(R39) When open overlays on the map don't hide the surroundings it is awkward for way finding.

(R40) Users should be able to open and close overlays (icons/labels of the monuments) on the map easily.

Furthermore, the map displayed some POIs that were not part of the tour, such as: Brighton Dome, Brighton Museum and a plaque in front of Queen Victoria. Links were not available; however, participants thought they could access it. This resulted in frustration and waste of time looking for those POIs and content.

Issue: Participants wanted to access information not available in the app, about monuments on their route. S/E****** (6)

(R41) The map should display only the POIs for a particular tour, or have information available for the attractions en route.

e) Camera view mode

The novelty of the augmented reality application and how participants interacted with it brought up some issues to be considered when choosing modes of interaction. Seven in twelve participants used the camera view mode to find their way. Most of users found this complicated to use. They were first time users and were just figuring out this functionality. None of the participants adopted the camera view as their unique tool, but utilised the list and the map together. It was not easy to identify the POIs in this view, as well the directions. Likewise on the map, icons were displayed in the same format ".me". This made the identification of POIs difficult. In addition, this mode displayed the name of the monument only when participants tapped on the icons. As participants moved through the environment, the non-identifiable icons moved on the screen. Consequently every time they looked at the screen while in movement the icons were displayed in different spots. When they were in front of the POI, sometimes the camera view mode did not display the POI they were in front of. Additionally, it was noticeable participants were more immersed in the experience when using

the camera view mode. Even though they could see the environment through the screen, they did not notice what was around them, traffic lights for example. Very few participants (2) used the camera view for wayfinding. They realised the icons on the screen where moving according to their location, so that when they were getting closer to their targets the relevant icons were shown bigger on the screen. Others identified all tagged POIs on the screen, which gave a sensation of awareness and control. Suggestions of how they would like the elements on the screen also emerged. For instance participants implied they would prefer to see the content projected on their view through the screen instead of POI pictures. Since it was possible to see the real object through the screen, a replica of it was not needed in this view.

So I just pressed and I'm following the little balloon with the ".me" I see if I can get there just using the camera. I'm looking at the camera. I think I'm close. It is keeping moving that is annoying, but I move the thing. So north, it is wired should say turn left turn right it would be very helpful. It really doesn't say a lot. I know that I'm close because if I see the little boll the north and the little things written on there - Km for example. I know that I should cross the street because the little balloon is in the left side of the screen. (ID) I'm going to the map to see I'm doing the right thing. I see in the map that I'm close to where I want to go. I go to the camera again. Short term resident

Issue: POIs had similar graphic and shape (.me) on the camera view. Participants had to select them for identification. S/E*** (3)

(R42) If POIs are illustrated in camera view mode, they should be displayed in different colours or/and shapes for users to identify them easily.

Issue: The camera view did not show participant's current location. S/E*** (3)

(R43) An Icon such as "You are here" should be present on the camera view mode to show current location.

Issue: Participants found unnecessary to have the pictures of the monument in this view. They preferred to see the real POIs on the background with content. S/E*** (3)

(R44) The content should be displayed as an overlay on the camera view.

Issue: Icons moved according to participant's steps. It was not easy to identify their destination point. S/E*** (3)

(R45) Participants should be able to control the elements on the screen and return to previous state of the system, e.g. identify where they started and where they are going to.

Issue: Participants used the camera view to see which monuments were around them. S/E** (2)

Issue: Participants identified where they were getting closer to POIs in the camera view. S/E** (2)

(R46) The camera view mode should offer an overview of POIs in the tour showing them closer to user's location.

Issue: Participants used the map and list view to support their interaction with camera view. S/E******* (7)

(R47) The camera mode is a very abstract mode for way finding and not easily understood by all participants. It should be supported by other modes of view.

f) Environment

Not all the participants related in the questionnaire the impact of weather and environmental conditions on the tours. Only five participants reported that weather, traffic and noise had an effect on their experience. Others occasionally verbalised their complaints during the tours. It was possible to identify behaviours that occurred as a consequence of environmental issues. For instance, users turned up the volume in noisy conditions or were in a rush to finish the tour in certain weather conditions.

In some tours the weather was not very suitable for an open air tour, as it was cold and raining. Nevertheless, it was decided to keep to the schedule in order to examine how participants would interact with the mobile phone in adverse weather conditions. Participants were without gloves and they tried to warm their hands in their pockets. In spite of this, participants who were cold accessed a similar number of functions to others. Otherwise, they were faster, stayed less time in front each monument and did not stop so often on the way.

I would like to know more about George (reads the text in silence and looks at Queen Victoria). Uau! Ok It is in 1928. I'm really getting cold. Do you have tissue? Visitor

I didn't use the audio because of the cold. I didn't want to stay so long in front of the monument. Long-term resident

Unlike the experiment with booklets, in this study participants were more careful with traffic safety. Seven participants respected the traffic lights and took advantage of the waiting time to read the text and find their way. However, a few participants still took risks crossing roads (3). Four participants identified traffic as a factor that made it difficult to use the app. They complained of the number of streets to cross and the traffic noise. The noise of surroundings disturbed users mainly when they were listening to the podcasts.

Issue: Participants who were cold did the tour faster, spent less time in front each monument and did not stop so often on the way. S/E***** (5)

(R48) Information should be available on the system to be accessed after the tour, in case environment conditions disrupt the experience.

Issue: It was difficult to listen to the audio and focus on the text because of noisy surroundings. S/E **** (4)

(R49) The system should display visual and verbal information, so that users can make their choices of which representation is suitable to environment and weather conditions.

Issue: Participants crossed the streets without paying attention. S/E *** (3)

(R50) The system should advise users when attention is required to cross the streets.

(R51) The route of the tour should prefer routes that do not force participants to cross several streets. It requires attention and accidents may happen.

C) Content

Participants did not give substantial feedback in relation to content. They usually scanned and scrolled the text to see what was available. They spent more time looking for the places than accessing the content. The primordial questions were “what” and “where”. The secondary ones were “who”, “how” and “why”. The necessity for the basic information after finding the target was apparent. Participants wanted to see this information in the first sentence they read, while most of the times the basic information was spread across the text. Their level of attention was very low: some users were distracted by the technology and couldn’t focus on the content. The novelty of the camera view was the main distracting feature in those cases. They very quickly moved their focus to other tasks.

Sometimes, after reading or scanning the text, they tapped on the “more information” link. This shows that basic information works as an anchor to engage users and instigate their interest. Additionally, the system should allow participants to go further if they want to explore more the content in a clear way.

Why it is an obelisk? It is an obelisk because it was done in the Egyptian Campaign I understand. Information seems quite a technical; it is like I’m reading a manual. It is not singing to me. Perhaps more narrative will be more valuable. I’m kind of not interested in that. It must be presented in a more natural narrative sentence. Long-term resident

I’m probably willing for more information but… I’m late to be honest. It is taking me to a website. I’m not going to read that - I need to go back. We are not going to see the podcast to this one we go for the next one. Let’s go back to the list. Long-term resident

Give me all the details but I want to know what that is. Short-term resident

Issue: Participants were distracted by app features. S/E ***** (5)

(R52) The basic information should work as an anchor to instigate user’s interest.

(R53) The content should be able to engage users in the beginning of the text, because they might lose their focus of attention to the detriment of the options available to interact with.

Issue: Participants had to read a large amount of the text to find essential information in it about the subject (Who? How? Why?). S/E ********* (9)

(R54) Users should be able to see essential information straight away; consequently they do not have to search for it in the whole text.

In the main text, participants did not found it interesting when the text simply described the monument and did not add any new facts to it. Otherwise, they appreciated when relevant contextual information was presented, such as date, location and the meaning of any symbols. Contextual information that was provided by the surroundings called the attention of a few participants. There was a plaque in front of Queen Victoria, in which participants tried to decode while reading. It was not legible what was written down on it. A copy of this text would be useful to have in the app.

Can I go there? She points to Queen Victoria plaque. Oh not so clear! Visitor

Octagonal base… we can see this by ourselves. So the first bit is just a bit of boring detail what she is really standing on - completely irrelevant. She is depicted by the Parliament, that is quite interesting. Child: What is that? Mother: I don't know darling. Mother looks at the plaque in front of the sculpture. She starts reading the plaque aloud with some problems in making out the letters on the stone.

I think you don't need to know the octagonal base. As my teacher would say too much information... Long-term resident

Mother: It is really obvious information on it. I don't really want to know that. Ceres is the Roman Goodness of the Agriculture and grain. The Romans used to call her Demetria. And do you know what? Cereal the word comes from her name. It was originally a riding school … stables. Daughter: I know that. Mother: It is called the Corn Exchange because the corn market came from the King and Queen In and apparently it used to be the corn market. That is very interesting I have to say. So there is a lot of information that you don't need too.

Issue: Some parts of the content described information users were able to see on the POIs. S/E *** (3)

(R55) The system should not display information that users can see anyway. It should engage users not describe what they can see.

International participants who had lived in Brighton for less than three months, called here visitors, were afraid to pronounce some words in the tour. It might be because they were not confident with their language skills and also because they were being filmed. They may also not have known the meaning of some words.

Hehe George V, it is IV (starts reading). What does unveiled mean? Visitors

Issue: International participants did not know, or were not confident about, how to pronounce certain words in the information system. S/E **** (4)

(R56) The system should have available an audio sample of the text, or at least the name of the monuments. Hence, international users can learn to pronounce some words.

(R57) The system should have an audio glossary with words and meaning, just in case users need to use it.

4.2.2.4 List of requirements gathered in the mobile phone based study

Some issues occurred more than once in different contexts. For example the need for “You are here” icons was identified when participants used both the map and the camera view. Others were related to single features, such as the requirement to have visual information on the screen while the audio was playing.

The issues with high scores resulted in requirements to improve wayfinding (R37) and interface design elements (R20). Besides, several recommendations about modes of requesting information (R35 and R30) were also highlighted. The last requirements in this list (R24, R39, R40, R44 and R28) were specific to participant’s context (with children) or mentioned by participants familiar with the HCI field. These last observed more functions on the app and spent more time doing the tours. Other participants did not always notice the issues spotted by the HCI experts. Despite this, they were very relevant for improving mobile guide interfaces. In other cases, participants suggested requirements to overcome issues (Table 22). Not only participants familiar with HCI issues, but also international participants (R11, R12) were in majority in suggesting improvements.

	1	2	3
R11	*	*	*
R12	*	*	*
R13	*	*	*
R07	*	*	
R24	*	*	
R13	*	*	
R17	*	*	
R06	*		
R17	*		

Table 22: Requirements suggested by participants

Below is the list of requirements based on the occurrence of issues (Table 23):

(R30) When testing apps with users, designers should consider solving crucial usability and functionality problems. In this way, new interesting issues for improvement might emerge from the user tests
(R35) The map should display a way to retrieve directions to go to a point of interest.
(R32) The list view is essential to make participants aware of how many monuments are around and to access content.
(R37) Icon "You are here" is relevant to show user's current location. It should be updated regularly.
(R01) The system should display brief information of POI.
(R20) The system should have visual information that provides clues where the monument is; e.g. visible picture background showing elements around it.
(R27) The system should engage users with monuments and history.
(R54) Users should be able to see essential information straight away; consequently they do not have to search for it in the whole text.
(R21) The system should provide pictures of the monument.
(R22) Users should be able to zoom in/out the pictures
(R02) The system should display possibilities to access extra information.
(R36) The system should provide a trajectory traced from the current location to the target location.
(R38) If POIs are illustrated in a map, they should be displayed in different colours or/and shapes for users identify them easily.
(R47) The camera mode is a very abstract mode for way finding and not easy of comprehension for all participants. It should be supported by other modes of view.
(R07) When displaying websites on the app, a mobile version should be available.
(R23) The content should engage visitors with the monuments, not substitute the experience with the real object.
(R31) The information of how far the monument is essential. The system should show closest monuments to participants in an ascendant way when a list view is available.
(R41) The map should display only the POIs for a particular tour, or have information available for the main attractions on the way.
(R25) The system should add new information to the experience, such as pictures of inside the buildings.
(R10) The audio should not demand so much attention of the user in outdoor settings.
(R11) The audio should be recorded by one speaker and in a studio.
(R12) The system should display different language choices.
(R13) The system should display visual information on the screen while the podcast is playing.
(R14) Information should be displayed on the screen in order to incentive users to look at/ touch the monuments.
(R15) Users with company should use different devices or the system should advise in the beginning of the experience the necessity of two sets of headphones to follow the tour.
(R16) The system should allow users to see the transcription of the audio on the screen, in case they cannot hear it because of the environment noise.
(R17) Volume function should be available on the screen.
(R48) Information should be available on the system to be accessed after the tour. In case of environment conditions disrupt the experience.
(R52) The basic information should work as an anchor to instigate user's interest.

(R53) The content should be able to engage users in the beginning of the text, because they might lose their focus of attention in detriment of the options available to interact with.
(R05) The system should have more information of the subject in case users want to know more about it.
(R06) The information should be displayed in a more narrative way.
(R18) The podcast should not start playing before users press play.
(R19) Users should be advised to wear the headphones as soon as they access the audio page.
(R08) The system should be sensitive to user context.
(R09) The links should have clear names according to their function.
(R33) The system should provide a linear tour option.
(R34) The system should provide a linear tour.
(R49) The system should display visual and verbal information, so that users can make their choices of which representation is suitable to environment and weather conditions.
(R56) The system should have available an audio sample of the text, or at least the name of the monuments. Hence, international users can learn to pronounce some words.
(R57) The system should have an audio glossary with words and meaning, just in case users need to use it.
(R03) The zoom function should be working in all sections of the system.
(R04) When the background is in movement, tests are necessary to identify what is the preferable type size for users.
(R26) Users should be able to control the zoom functions.
(R29) Consider previous user's experience with touch screen mobile phones. Use modes of interaction that may be intuitive for a wide range of users.
(R42) If POIs are illustrated in a camera view mode, they should be displayed in different colours or/and shapes for users identify them easily.
(R43) An Icon such as "You are here" should be present on the camera view mode to show current location.
(R44) The content should be displayed as an overlay on the camera view.
(R45) Participants should be able to control the elements on the screen and return to previous state of the system. e.g. identify where they started and where they are going to.
(R50) The system should advise users when is required attention to cross the streets.
(R51) The route of the tour should privilege ways in participants do not have to cross several streets. It requires attention and accidents may happen.
(R55) The system should not display information that users can see anyway. It should engage users not describe what they can see.
(R24) When displaying websites with pictures on the app, a mobile version should be available.
(R39) When open overlays on the map don't hide the surroundings it is cumbersome for way finding.
(R40) Users should be able to open and close overlays (icons/labels of the monuments) on the map easily.
(R46) The camera view mode should offer an overview of POIs showing them closer to user's location.
(R28) The system should have activities, or questions that provide engagement between parents and children.

	1	2	3	4	5	6	7	8	9	10	11	12
R30	*	*	*	*	*	*	*	*	*	*	*	*
R35	*	*	*	*	*	*	*	*	*	*	*	*
R32	*	*	*	*	*	*	*	*	*	*		
R37	*	*	*	*	*	*	*	*	*	*		
R01	*	*	*	*	*	*	*	*	*			
R20	*	*	*	*	*	*	*	*	*			
R27	*	*	*	*	*	*	*	*	*			
R54	*	*	*	*	*	*	*	*	*			
R21	*	*	*	*	*	*	*	*				
R22	*	*	*	*	*	*	*	*				
R02	*	*	*	*	*	*	*					
R36	*	*	*	*	*	*	*					
R38	*	*	*	*	*	*	*					
R47	*	*	*	*	*	*	*					
R07	*	*	*	*	*	*						
R23	*	*	*	*	*	*						
R31	*	*	*	*	*	*						
R41	*	*	*	*	*	*						
R25	*	*	*	*	*							
R10	*	*	*	*	*							
R11	*	*	*	*	*							
R12	*	*	*	*	*							
R13	*	*	*	*	*							
R14	*	*	*	*	*							
R15	*	*	*	*	*							
R16	*	*	*	*	*							
R17	*	*	*	*	*							
R48	*	*	*	*	*							
R52	*	*	*	*	*							

R53	*	*	*	*	*							
R05	*	*	*	*	*							
R06	*	*	*	*								
R18	*	*	*	*								
R19	*	*	*	*								
R08	*	*	*	*								
R09	*	*	*	*								
R33	*	*	*	*								
R34	*	*	*	*								
R49	*	*	*	*								
R56	*	*	*	*								
R57	*	*	*	*								
R03	*	*	*									
R04	*	*	*									
R26	*	*	*									
R29	*	*	*									
R42	*	*	*									
R43	*	*	*									
R44	*	*	*									
R45	*	*	*									
R50	*	*	*									
R51	*	*	*									
R55	*	*	*									
R24	*	*										
R39	*	*										
R40	*	*										
R46	*	*										
R28	*											

Table 23: Issues by strength of evidence

4.2.3.5 Discussion

The public who responded to the study was very varied with respect to technology background, length of residence, and nationality. This resulted in a rich set of data and reflected, on a small scale, the kind of audience interested in using mobile guide applications in cultural heritage settings. The sample number was enough to trace participants' experience with mobile devices. In these latest tours, the repetition of some issues was noticeable, showing that more tours would not add new findings.

The method of collecting data using a head camera with microphone built-in was efficient. It focused on what participants were looking at, their interaction with the mobile phone and surroundings. Participants felt less awkward about being filmed. The head camera was not in their line of sight, which probably resulted in a more natural behaviour on the tour. On the other hand, the presence of the researcher, for traffic safety reasons, might have interfered with the results to some extent. Lone participants tended to appreciate the presence of the researcher: for them, this made it easier to employ the thinking aloud technique.

The post-tour activities, questionnaires and interviews, gave participants the chance to give their opinions and suggestions. The setting for answering the questionnaire was also an important detail. Participants who answered the questionnaire and conducted interviews in public spaces were more dispersed. The ones that used the Public Library of Brighton to do the post activities answered the questionnaires faster and had more comments about their experience. International participants had problems with some words, such as "cumbersome" present in the SUS scale. Pilot tests with non-English speakers are necessary to avoid those mistakes.

The use of a scale rate in the data analysis gave credibility and assurance to requirements gathered. The level of confidence for employing these requirements with the paper-based results is higher with this method. The same method was utilised in the prototype data analysis.

4.2.3.6 Conclusion

The field study emphasised issues in using mobile devices in outdoor settings. Occasionally the use of mobile devices distracted users from consulting information about POIs in the tour. They spent more time interacting with mobile device features than experiencing cultural heritage information. Several opportunities were opened up by this study to improve user's experience with those devices, for example, engaging users with real objects. The podcast screen was a good illustration for showing how immersed participants were. Even though the screen was black, while audio was playing, participants fixed their eyes on it. In this case, the app should lead participants to notice more details about POIs. Audio or text instructions displayed on the screen might be a good solution to direct their sight to real objects.

Attention was also identified as restricted in outdoor settings. Participants did not spend a great amount of time reading the texts and observing the sculptures. They sought for basic and brief information about POI. Hence, opportunities to use hyperlinks more often was offered to deliver extra information. Participants more interested in the content followed the hyperlinks available; this showed they did not have a problem accessing more pages. Pictures also intensified the experience working as a fast tool to identify POI location, mainly for short and long term residents. Pictures of inside the buildings, when available, also pleased the participants in the tour.

International participants marked other interesting points. For instance, the noise of surroundings and podcast record disturbed them much more than UK residents. Additionally, internationals would prefer not listening to a conversation about sculptures, but having one speaker recorded in a studio. More investigation is necessary to identify those preferences to deliver audio, because in this tour only three native speakers were participants.

It is also true that participants with company were in a more natural environment than lone participants. They followed the think aloud technique naturally, having a conversation with their partners. Besides, they gave more feedback and explored the app more than lone visitors.

The most used view mode was the map, followed by list and camera view. Participants were more familiar with the map, and expected to retrieve clear directions using this feature. List view was employed to see an overview of content available, and identify the spatially closer POIs by their distance displayed in numbers. The camera view was not so well received by users. It might be because it is a new technology users are not familiar with. Some elements in this view should be improved, like the type size and visual graphic of icons. Users did not find it easy to orientate themselves consulting this feature.

In general, the use of the same information as the paper-based study displayed by mobile phones did not enhance the content. On the contrary, participants were more focused in interacting with the app features to find POI than finding out about them. Some opportunities were found to improve and engage users with cultural heritage employing mobile technology. The content of a paper-based guide has to be adapted to a multimedia perspective in order to add to instead detract from user's satisfaction and experience with cultural heritage content.

4.2.4 Diagram of the activity and factors

An outline of elements identified in the three studies is covered here. These elements were the ones to take into consideration when developing multimedia guides with cultural heritage information. Look and Feel, Context, and Content elements may affect the interaction among visitors, surroundings and information source. The experience of being guided may result in leisure, immersion, informal learning, spatial and topological knowledge. Visitors always bring their internal factors e.g. their interest, familiarity with information source technology, culture and demographic background. These characteristics change the nature of their interaction with information source and surroundings. By surroundings, we mean the city environment and the POI in the tour. Information sources are considered to be paper-based guides, mobile devices, human tour guides and environment signs (Figure 28).

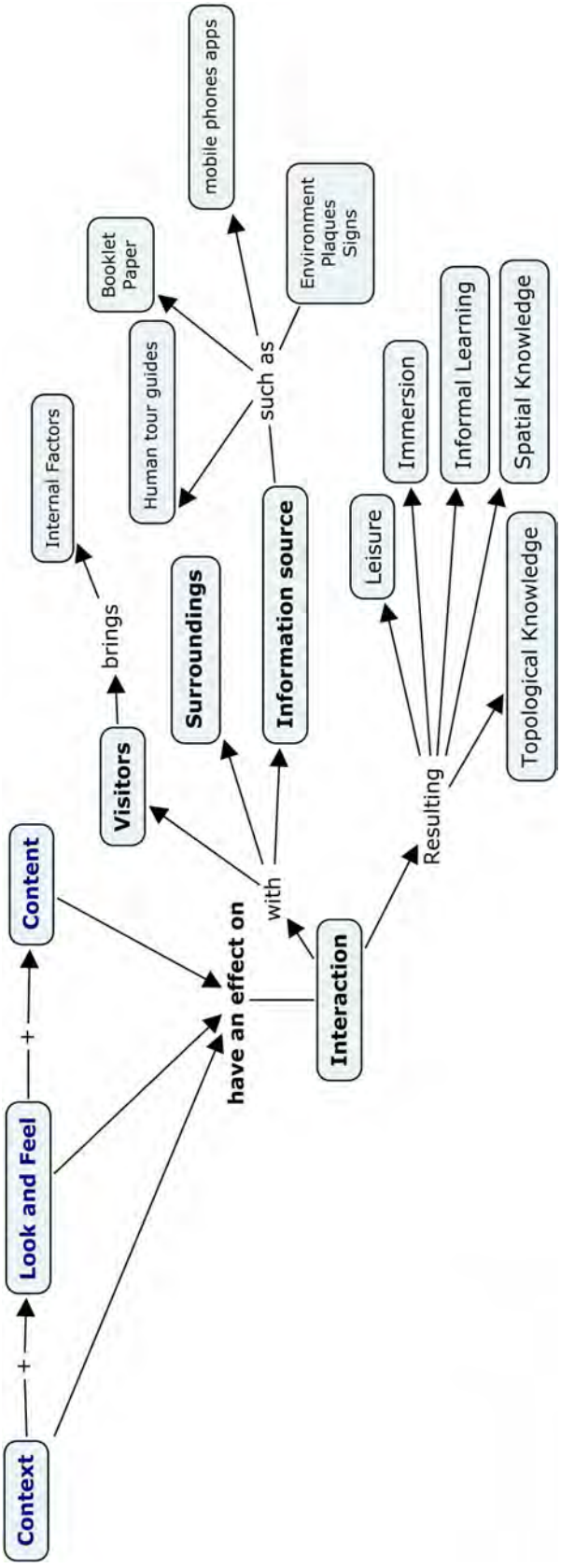


Figure 28: Diagram of the activity

Below, detailed diagrams of user experience with cultural heritage guides are classified by context, content and look and feel elements. They are preliminary diagrams of factors and cover elements identified in the user's activity with different information sources guides (human, paper, mobile device).

Context was divided into the following categories: audience situations, information source situations, environment situations and wayfinding situations. The first case refers to user's internal factors and characteristics. The second covers information source differences and constraints. The third, environment and weather situations are considered. The last case refers to way finding and navigation situations. They mainly used maps and lists to access directions. The map was present in all the tours analysed. It was identified as an essential mode to aid in way finding situations. Certain elements were more relevant, according to diverse user characteristics. For example, for internationals, language issues (glossary for certain words) might be more essential than for native speakers (Figure 29).

Type of POIs presented in the tour and type of content users expect to see and listen were the main elements identified in the content accessed. According to different characteristics of POI, certain elements of content should be highlighted. For instance, when it is a museum/exhibition venue, it should display operational information and what the building is nowadays.

Additionally, it is paramount to know how to design multimedia content, and choose the right feature to present information. Pictures, text, audio, video and map were part of user's experience with content. Multimedia content may improve or detract from the experience. Videos could be used to show how the monument was working in the past, for example. In the mobile phone study, the text and audio information could incentive users to pay more attention on the monuments. Pictures were identified as essential for wayfinding. Audio was relevant to some users who preferred to have their eyes free to observe POI while listening to it (Figure 30).

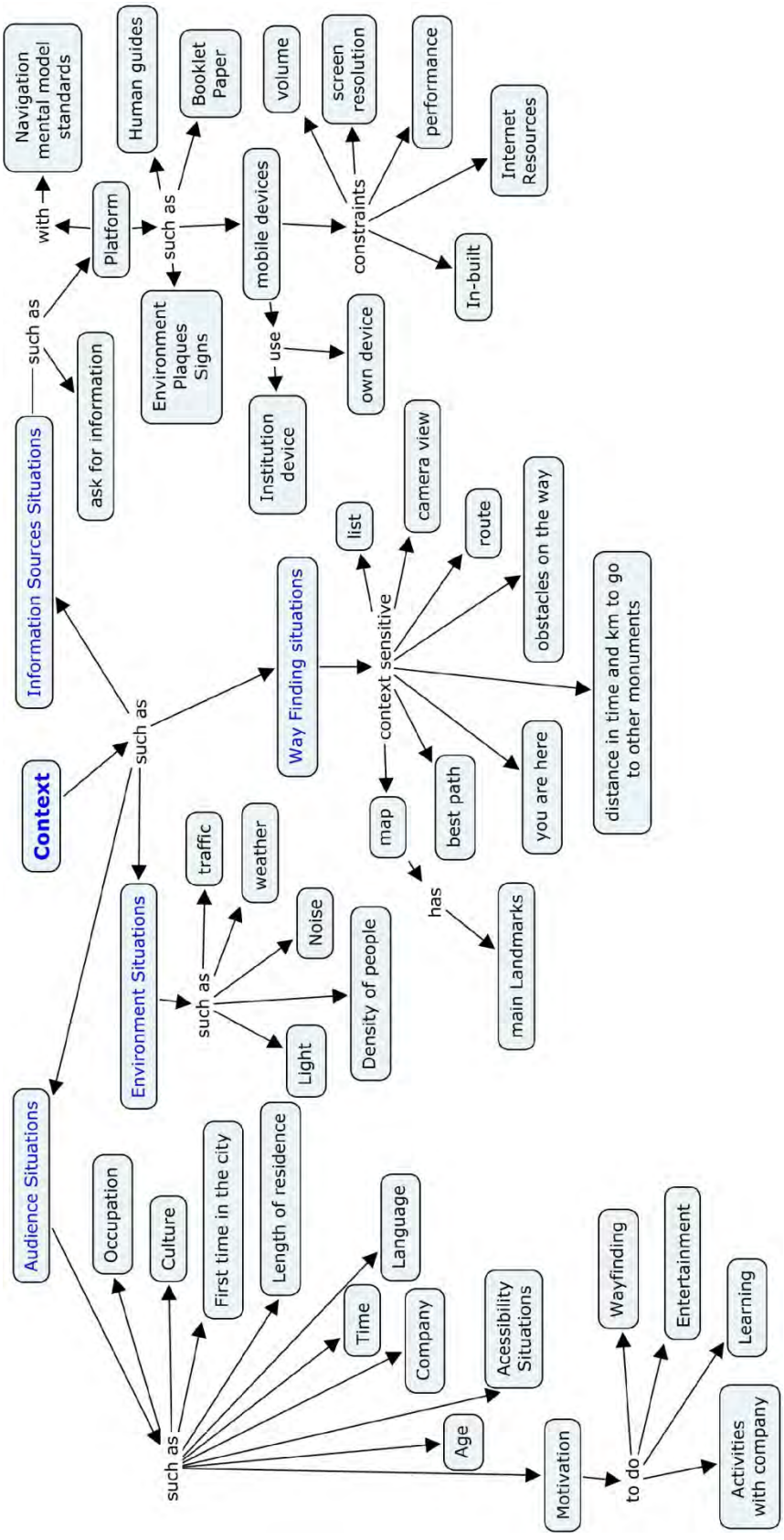


Figure 29: Diagram of factors – Context

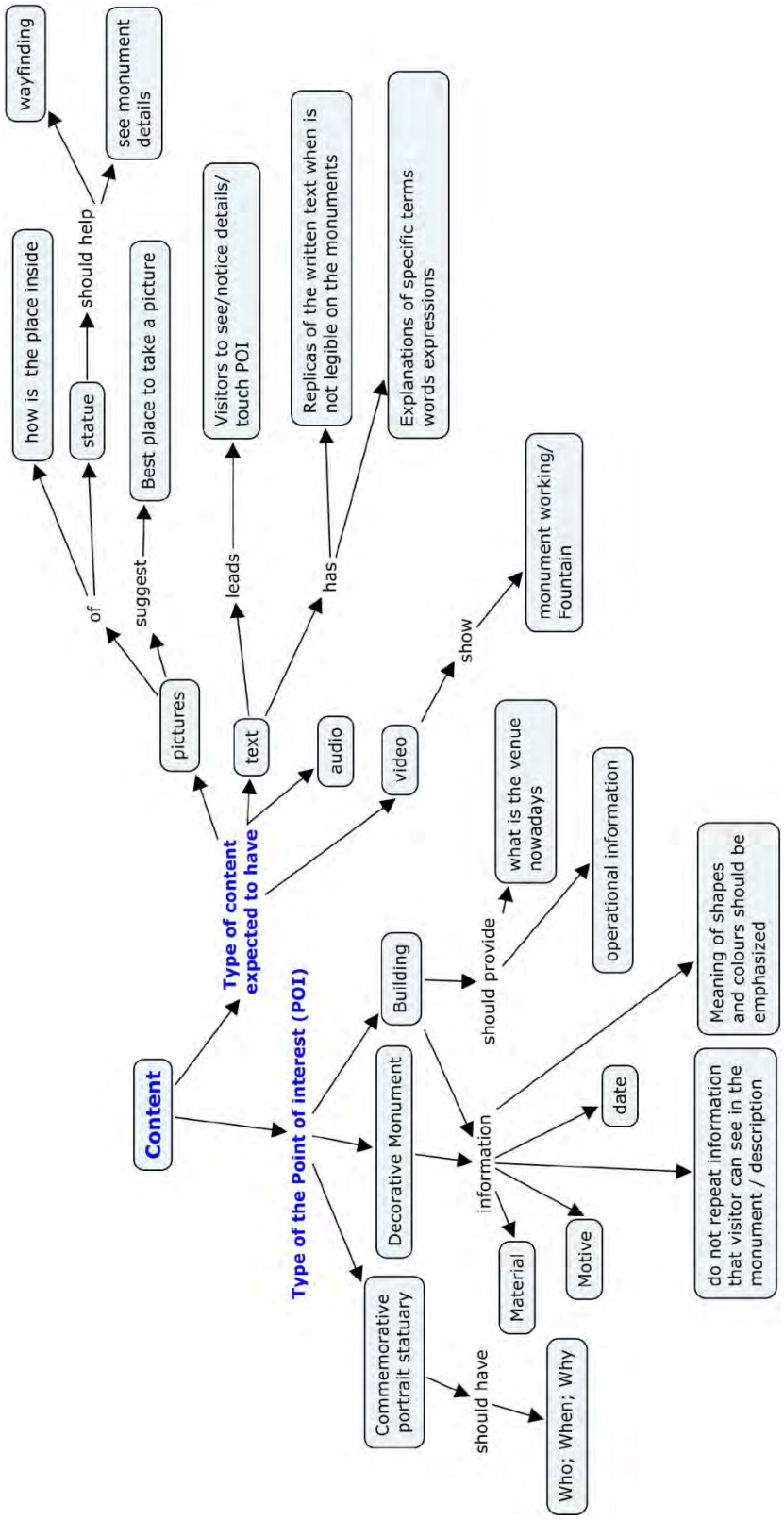


Figure 30: Diagram of factors – Content

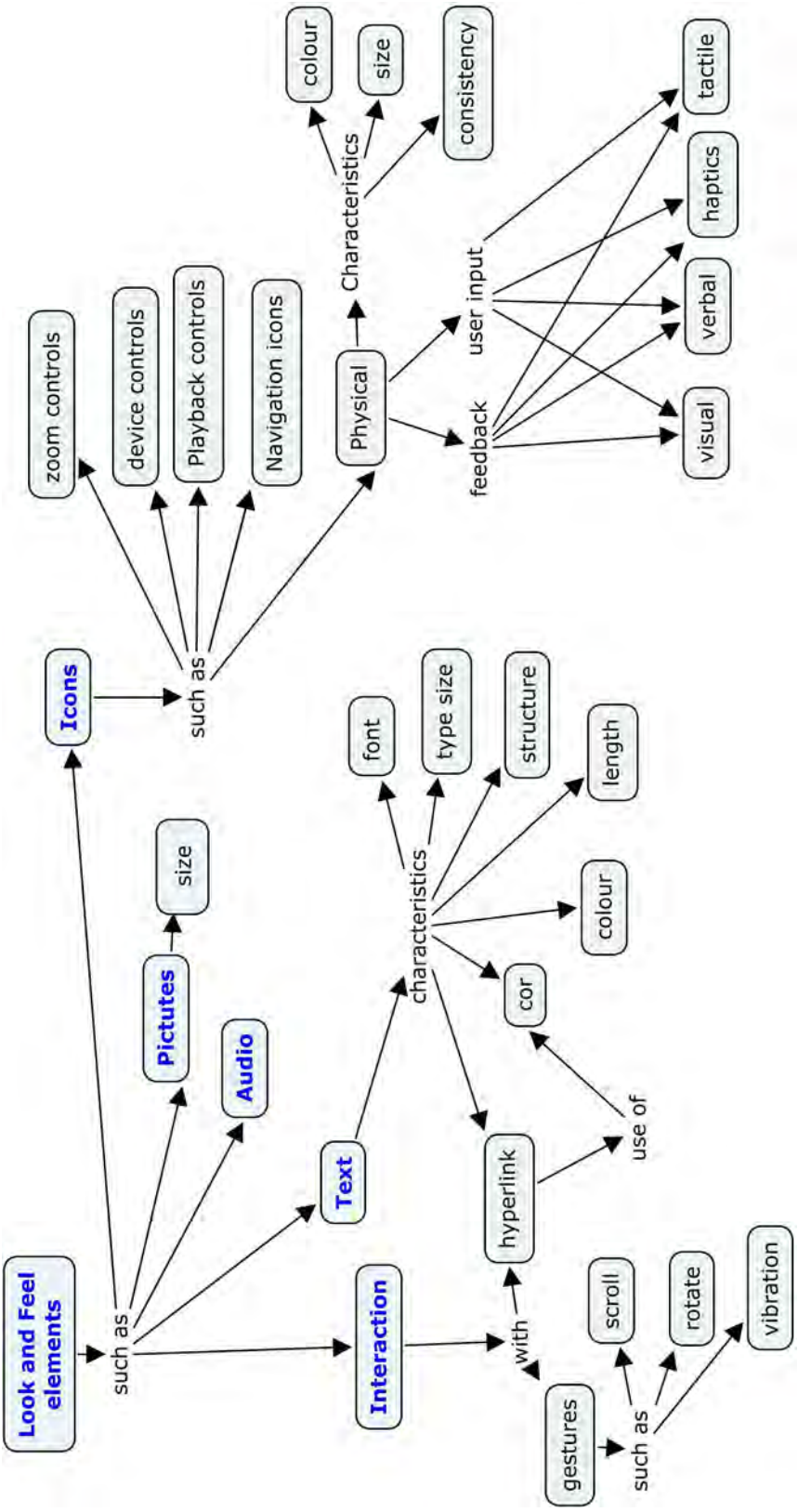


Figure 31: Diagram of factors – Look and feel elements

Look and feel elements were: icons, pictures, audio, text and feedback provided by user interaction while accessing POI content. Modes of retrieving directions employed in wayfinding

activities were discussed in the Context category – list, map and camera view. More investigation is necessary to understand certain elements preference of usage and how to present them. Text was the element with more requirements gathered. Picture, video and audio were tested more in-depth during the prototype evaluation. Icons were the main controls of touch-screen devices such as: zoom controls, device controls, playback controls and navigation controls. Physical controls had to be learnt during the field study with the mobile device, as far as users were not familiar with the device. They did not know where the volume controls were located, for example. (Figure 31).

A more complete version of those diagrams, a framework, is presented in the Results chapter with additional elements gathered during the prototype evaluation.

4.3 Conclusion

The three field studies contributed to mapping out elements of user experience with cultural heritage content in outdoor settings. Additionally, issues and requirements classified by strength and relevance served as the guide for the development of the prototype design.

The first study aimed to understand the nature of being guided by a human tour guide. The second study was focused on understanding how participants followed a paper based guide and opportunities to improve the content employing mobile technology and multimedia content. The third study introduced the use of some multimedia features into the experience. It also pinpointed opportunities for improvements in delivering cultural heritage information through mobile technology. In general, the use of multimedia features in the last study did not improve user's experience as expected but indicated where changes should be made to increase user's interest on the content. It was clear that simply adding multimedia features did not enhance the experience. Changes in the content structure and considerations of participant's characteristics were also necessary. Language issues, grasp of technology and some familiarity with the theme of the tour (locals versus visitors) were strong indicators of differences in the user's experience with cultural heritage content. Outdoor constraints were also relevant. For this reason, diverse modes of presenting information might be one solution. Having a variety of features (text, video) might be useful in noisy surroundings for example.

The use of video was not covered during the studies; it was, however, included in the mobile guide prototype (Chapter 5).

Requirements gathered from the paper based and mobile phone study was grouped into three main categories: Look and Feel elements, Context and Content. Firstly, look and feel requirements covered multimedia and gesture elements. Secondly, context concerned requirements related to situations participants faced en route. The term context was selected instead of wayfinding and navigation. It was more appropriate because the term context encompasses not only situations in which user tried to find directions but also actions that occur in parallel. Context also covered environment issues and weather conditions. Thirdly, content requirements indicated ways to better organise and select cultural heritage information to present on mobile phone screens. Overall, 33 requirements were gathered from the second study and 57 requirements from the third study. In the next chapter (5), the requirements emerging from both studies are organised to compile one main list. A selection of those requirements was then applied in the design of a mobile guide prototype.

Preliminary diagrams of user's activity and factors were also described in this chapter. Factors were classified into three categories – Context, Content and Look and Feel elements. Likewise the requirements gathered into this structure facilitate designers of mobile guides to identify factors that belong to user experience and which ones to consider when developing applications of this nature. These diagrams were the basis for a framework of user's experience with mobile guides described in the Results chapter (7).

Thus, the data collected in the studies presented in this chapter reinforce the relevance of user research in real settings. It resulted in a set of requirements for developing a mobile guide prototype and representations of the main factors highlighted on the experience. Directed by this research, the design and development of the prototype mobile guide presented in the following chapter consisted of applying these requirements and evaluating the resulting interface, resulting in tested recommendations for mobile guide designers.

5 Design, Prototype and Construction

5.1 Introduction

This chapter includes a selection of requirements gathered from Literature Review, Competitors Analysis and Design activities with potential users to be applied on the mobile guide prototype. Additionally, personas and scenarios were created to support the design process. Personas were inspired by real participants, and in addition scenarios covered situations observed in the previous field studies. This approach gave an overview of possible users' interaction with the prototype. On the basis of this material, a low-tech prototype was developed, followed by a high-tech prototype for evaluation with experts and users in outdoor settings.

5.2 Requirements selection

This work considers users as informants in the design process. Participants' views of diverse information sources to access cultural information in outdoor settings were gathered in the design activities (Chapter 4). A scoring system was developed in order to give confidence in the requirements generation process. Issues observed and recommendations made by participants were organised systematically. The strength of evidence and confidence levels were based on video observations of participant behaviour and reported opinions. Issues raised in these settings were marked by strength of evidence, as were the requirements to which they gave rise. When participants indicated design requirements to overcome problematic issues, a score illustrating the level of confidence was added.

The design process started when the first requirements were gathered. It was an iterative process (Preece 2007). Three sources were used to acquire requirements for the mobile guide prototype. Appendix (A) lists all the requirements identified in the background literature review and the competitors' analysis. Requirements from the field studies are listed in Appendix G. Not all the requirements were chosen for application in the design of the mobile guide prototype. Some had a low level of confidence, while others were discarded because of time and technological constraints. Selected requirements were marked as – S – and non-selected requirements as –NS.

5.2.1 Requirements from literature

Several projects in the field indicated relevant requirements for designing mobile applications. Additionally, design guidelines from diverse mobile companies were reviewed showing which ones were more plausible for different devices. General requirements and guidelines appointed were applied in the prototype design (Appendix A).

5.2.2 Requirements from competitors

The fields of location based applications and mobile guides are growing rapidly. Applications that are built on the mobile phone, native applications and web applications are facilitating the area of cultural tourism. Some approaches are novel, such as the incorporation of Augmented Reality.. A list of usual features and requirements indicated by these sources is given in Appendix A.

5.2.3 Requirements from design activities with potential users

The field studies (see Chapter 4) provided 90 requirements. A white board was used to visually categorise similar requirements. Some requirements and issues appeared in more than one study. Therefore, the duplicate ones were discarded. The resulting requirements of the studies were organised to compile one main list in Appendix G.

Overall, 50 requirements were applied in the design of the mobile guide prototype. Where appropriate the requirements are accompanied by the reason for their selection. Certain requirements were not applied because of time and technical constraints. They were kept to identify if they appear in the evaluation phase, which would give higher strength of evidence. New concepts were applied in the mobile guide prototype, such as: audio recordings based on international participants' opinions; hyperlinks; new ways to call the attention of users to monuments details. Those were also analysed to identify evidence and confidence strengths.

5.3 Conceptual Design

The conceptual design is a group of ideas and connected concepts about what the system should do and what interface it should present (Preece 2007). Some design tools can be employe with the aim of clarifying user goals and interaction cycles (Ginsburg 2011; Jones

2006) with the low-tech prototype . Personas and scenarios were chosen to incorporate user research into the design process. A low-tech prototype with the app's main functions was developed supported by information acquired from literature review, competitors and field studies. Fictional users and scenarios were employed to visualise interactions with the future prototype and possible adjustments. Six personas covered main characteristics of field study participants. Four scenarios illustrated interaction cycles with the future prototype. It should be noted that scenarios were based on real situations that occurred in the field studies.

5.3.1 Low-tech prototype

After selecting the requirements and features the prototype should have, a low-tech prototype was developed. Sketches of features identified as essentials in the field studies were generated with the assistance of a rapid wireframe tool[37] (see Figure 32). In this stage, details of interface and content design were not covered.

The main features the prototype should have were defined, including:

- map;
- list;
- directions between the monuments;
- text, pictures, video and audio about POI;
- transcriptions of the audio file.

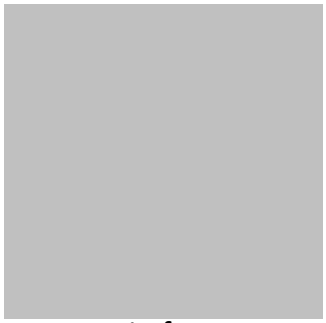
The aim of the prototype was to make sure of user needs and also test new features. In the requirements phase, it was not possible to draw conclusions about the acceptability of certain requirements identified in the field studies. Transcriptions of audio files were thought of as an alternative to help internationals users to better understand the audio. Likewise they could aid others to follow the audio files in noisy environments. The inclusion of video files and replicas of text on the monuments were also new functions for evaluation.

[37] http://balsamiq.com/

Figure 32: Low-tech prototype

5.3.2 Personas

The low-tech prototype displayed the main functions present on the mobile guide interface. The subsequent activity was to predict how users would interact with the prototype to minimise problems in the evaluation phase. Therefore, personas were created to avoid elastic users in the design process. The figurative personas covered international students, locals, first time visitors and parents accompanied by children. It was important to give real characteristics to those characters. This made it easier to identify how they would act and think, when reflecting about their interaction with a mobile guide app.



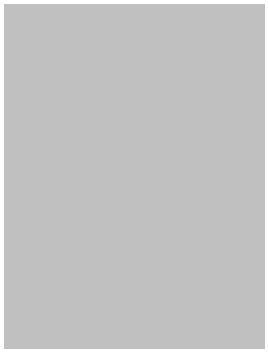
The first persona was inspired by students who were living in Brighton for a short time. In the field work, nine participants were students living in Brighton for less than two years and they shared similar views and attributes.

Manon is from France, 21 years old and studying Media at the University of Brighton. She bought a touch screen phone one year ago, and spends most of her time playing with apps available on her phone. She has lived in Brighton for 6 months, since she started her course at the university, and lives in a shared house. Manon is a very social person. She goes to parties and visit friends almost every week, mainly when she doesn't have deadlines for assignments to carry out. Manon is very addicted to Twitter and Facebook: she is always posting what she is doing and commenting about friend posts. She also uses Skype to talk to her family and friends from her hometown. She participates in local activities such as festivals and other events in the city. In her opinion, these events provide her with knowledge about British culture and the place that she lives. After her graduation, she wants to work in London in advertising. During the holidays, she travels to see her family, or they come to visit her. Her parents like to travel a lot, as does Manon, so every holiday they visit a different place.

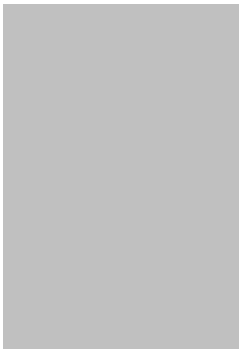
The second persona was a first time international visitor who had lived in Brighton for less than three months.

Gustavo is from South America and 26 years old. He is on holiday and decided to go to Europe. His sister is living in Brighton, England and he went to visit her. He wants to have an overall knowledge about the places he is going to visit. He is a junior architecture and work full-time in his job. Gustavo loves to travel and visit new places, but he had never lived outside South America. He studied English for three years and considers himself an intermediate level speaker. He wants to improve his English during the holidays. He is an early adopter of touchscreen mobile phones and still getting used to the technology. He bought a touchscreen phone one week before he arrives in England. He wanted to use Wireless Internet Connection on his phone to access travel information and communicate with his family.

The third and fourth persona covered participants in company (8 trails), short term-residents (9 participants), participants interested in art (19 participants) and specialists in cultural heritage (3 participants)



Grace is from York, 40 years old and works as a lecturer in Historical and Critical Studies. She has lived in Brighton for twelve years with her partner. She is very enthusiastic about English history and goes to local events that highlight Brighton history. She is also very keen on exhibitions of contemporary art. She uses the computer to prepare her lectures and answers e-mails several times a day. She is not part of social websites because she does not want to unveil her private life for students. She uses her key-based mobile phone to make calls and text messages. Last year she went to a conference in Luxemburg about history and technology. At the conference she used an audio guide that she could access by QRcodes from her phone. The organisers downloaded the application to her phone. She liked the experience: “My eyes were free to see the masterpieces”.



Susan is from America, 42 years old, and has lived in Brighton for two years. She goes to the US at least once a year to visit her family. She is an artist and found Brighton a suitable place to have her atelier, make exhibitions and develop a network in the field. She is an outgoing person, loves to meet her friends and try new things. She is an early adopter of touch screen phones; she bought hers because she wanted to try the new apps that enable artwork. On top of that, she was impressed how the device helped her to manage her social life. Features like calendar, social websites and sending messages are the ones that she uses the most. She also travels a lot to exotic destinations and next year wants to go to New Zealand. As an American she does not know so much about British Culture.

The last type of persona illustrated participants with children (3 trails) and locals (8 participants).

Charlie is 46 years old, married and has two daughters, one 7 years old and the other a baby. He works full time as a web designer in London and has one month of holidays every year. He tries to take his holidays in the school holiday period, so that he can enjoy it with his daughters. He was born in Brighton but his wife is from Ireland. Most of the time they spend the holidays in Brighton, because his wife is a nurse and cannot take holidays in the school holidays. Now with the baby it is even more difficult. He uses the computer full time in his job and also at home to do some freelance work. When he is not working he is watching TV. His favourites programmes are programmes related to travel (Around the world - BBC) and documentaries. He cannot wait for his children to grow up and travel more often. Because of his profession he is always up to date with technology. He uses his mobile phone for making calls, answering e-mails, listening to podcasts, playing games and watching TV on the train. He is always searching for novelties in the app stories.

Evie is 7 years old and loves reading. She goes to school every day and has theatre classes in the afternoon. She has a nanny that takes care of her and her little sister who is 2 years old. Her mum and dad are very busy as both work full time. She loves her holidays. It is the perfect time during the year because her dad is not working and can spend more time with her. The school have some outside activities for them to learn more about Brighton, so she knows the main attractions in city, such as the Pavilion.

5.3.3 Scenarios

Scenarios were used in a prescriptive way, a vision for the future mobile guide. They included detailed interaction cycles based on real situations. Four scenarios played out by six personas are described below.

Scenario One: Manon received an e-mail from the International student office about an application about the historic centre of Brighton that she can download on her phone. She wanted to try it and downloaded the app. She tried the app last Friday, when she did not have anything scheduled after handing in an assignment. It was a sunny day, a typical day in May. She was interested to know more about the monuments in the city. She went to the place that the guide starts, in front of the Pavilion, and opened the application. She looked at the map to see which monuments were nearby, and identified a sculpture beside her. She looked at the real sculpture and tapped on the icon to see information about the monument. She looked at the illustration, looked again at the monument and skimmed the text. “Next monument”. She went to map and identified that there was another sculpture across the street. “Queen Victoria” She couldn’t see it very well from where she was, so she selected the QV icon. The system showed her a picture of Queen Victoria. “Ok. Now I think it is better to cross this street”. The road was very busy. She looked at the map again to check what is around and saw the map indicating the traffic lights nearby and also the direction of the traffic. She went to the traffic light and waited for crossing the street. She is always confused about the direction of the traffic.

Scenario Two: Gustavo arrived from South America to visit his sister in Brighton. He is staying in Brighton for four days and going travelling around Europe. His sister was working all day and he decided to go for a walk to get the feel of the city. Before going to the centre, he decided to search for some information about Brighton on his phone. He Googled "Brighton"and selected "Visit Brighton website". He selected the link "Maps, Guides & Interactive", "walking tours" and "historical public monuments walking tour". He downloaded it to his phone and opened the application. He noticed that most of the monuments on the map were near to a big palace called the Pavilion. On the map he selected the directions icon. The system identified where he is and makes a route to the Pavilion. While he walked to the Pavilion, he saw a sculpture. He looked at the map and identified it as Queen Victoria. He selected the icon and saw the content. He stopped in front of the monument, taking care not to step on the grass, as this is prohibited in his home country. He took a picture. He found it difficult to see the details and understand some of the words that the text mentioned, e.g. "Garter Sash". He tapped on the word. The system showed the meaning and illustrations that the phrase. He selected the back icon and decided to listen to the audio. He was wearing his headphones, pressed play and looked at the illustration on the device screen. He read "tap here to see the text", and selected. Transcription of the audio was shown on the screen. The audio led him to see the monument and details of the sculpture. "The scroll means that the Queen will give a speech. You can get closer to the sculpture to see the Queen's expression". Gustavo got closer to the sculpture, even though he is not used to stepping on the grass in his own country. He selected the video. He watched the video with subtitles. He looked at the map again, identifying two monuments that are nearby. He selected one named "Ceres". He returned to the map and selected the icon route. The route is shown in the map indicating where he should cross the street. He follows the trail.

Scenario Three - A colleague of Grace mentioned she had taken a mobile guide last week with her daughter. Grace was curious about what kind of information was delivered by the guide and wanted to give a try. She invited Susan, from America, to do the tour on her day off. Susan appreciated the opportunity to find out more about Brighton history. Grace downloaded the tour from the "Visit Brighton website" and met Susan in front of the Pavilion. Grace tapped on the application icon to start the trail. Grace asked Susan "Have you ever been inside the

Pavilion?". "No, can you believe it? Do they have information about the Pavilion?" Grace looked at the map on the screen, identified the "you are here" link and selects the Pavilion icon. "Yes. They have some information about and also pictures from inside it". Grace gives Susan the mobile phone "Beautiful! Let me check the opening hours". Susan selects the website of the Pavilion. "9 to 5. Maybe we can go after the tour". Grace "It's ages since I visited it - good idea". Grace got her phone back and checked which monuments they had nearby. "George the Fourth" and read the information. She selected the name of the sculptor "Sir Francis Chantrey" and reads aloud the text "Chantrey undertook the work for a fee of 3000 guineas…" Susan asks "How much is that today?" Grace selected the 3000 guineas hyperlink and they see an illustration representing the amount of money in that time. "Wow. 3000 guineas was a lot of money. See a school master was paid about 50 guineas a year". Susan asked "Who was George the Fourth". Grace returned to the content screen and select "George IV". Grace read the text and selected the podcast. Susan "Do you have headphones?" Grace "Yes but just one set". Susan wears one headphone and Grace the other. "The sound, it is not so loud, the noise from the street…" Grace tapped on the screen and they followed the transcription together. After the audio, Grace goes to the list view to check how many monuments they still have to see. "Interesting - you can see here how far it is from where we are in metres". She selects the first one in the list that is the closest one, "Queen Victoria".

Scenario Four: Charlie was browsing the app store on his phone and found a monument guide for Brighton. He thought that it was a brilliant activity to do with Evie outdoors. In the first week of holidays, they went to the city to use the guide. Evie was so excited and wanted to hold the phone. After visiting some of the monuments in the tour, they stopped in front of Queen Victoria sculpture. Evie ran to see the plaque in front of Queen Victoria and started reading. She asked for help. Charlie tried to read the plaque but it was blurred and it is almost impossible to read. He opens the content page in his phone. "Evie, let's see if they say something about this plaque". Plaque, great!" They saw the reproduction of the plaque in a legible way. Charles let Evie to read it. Charles got the phone to see the list. "Next one Ceres. I don't know where it is". Evie said "Check the map, dad". Charles selected "directions" and the system showed the route on the map, indicating where they should cross the street. They cross the street and Evie said "The Dome. Does it say that it was a library?" Charles went to search

and typed Dome. He selected it and sees the information about the Dome. “No, not actually”. He saw the icon to add information. “Evie, we can add information for others. Do you want to?” He gave the mobile phone to Evie and she typed “It was a library before”. Charles checked the map and says that he hasn’t seen this (Ceres) monument before. “I know where the Corn Exchange but not this monument is”. They arrived in front of it and Charles gives the mobile phone to Evie for her to read.

5.3.4 Product definition statement

The product definition statement is understood as the declaration of your application’s main purpose and its intended audience (Iphone HIG, 2010). According to Ginsburg (2011) competitor analysis and design tools have an impact on the aim of mobile products. In this work, the use of personas and scenarios refined the objective of the prototype application and clarified interaction cycles. The app not only serves for navigation tasks and access content but also to investigate POI history in outdoor settings. It is the basis for discussions and aims to bring history alive. Thus the PD statement is as follows:

An app to help visitors and residents comprehend history through outdoor monuments in Brighton.

Besides the product objective, the prototype also assisted in clarifying uncertainties indicated by previous studies, for instance, to distinguish user’s preference of images – Subject picture or physical statue picture; audio preferences – quantity of speakers, settings and accent.

5.4 Physical Design

The prototype was developed for the HTC Hero phone, using the Android platform. The high tech prototype was designed based on interaction cycles described on the scenarios. In the subsequent sections, we describe interface design, content design and hardware and software integration.

5.4.1 Interface Design

The main screens of the prototype were traced using illustrator and Photoshop software. It was important to have an interface that integrated the main elements in the principal screens (Figure 33). This avoided users having to search for features when necessary. The screens were divided into three areas:

1. Contextual navigation bar, which displayed functions related to the section accessed.
2. Main navigation bar, where main icons for accessing sections were located.
3. The content area was changed according to each section.

Figure 33: Interface design

Look and feel elements were based on the requirements acquired in the field, human interface guidelines and competitor's analysis. A study of colours was necessary in order to distinguish hyperlinks, main text and icons labels. The interest of this research was more focused on displaying the content than wayfinding situations. Hence, print screens of Google maps were used in the app. This decision was based on the user's positive reception of this feature and familiarity (field studies).

5.4.2 Content design

A conceptual map was created to group information, have a clear idea of the size of the app and to guide the programming (Figure 34).

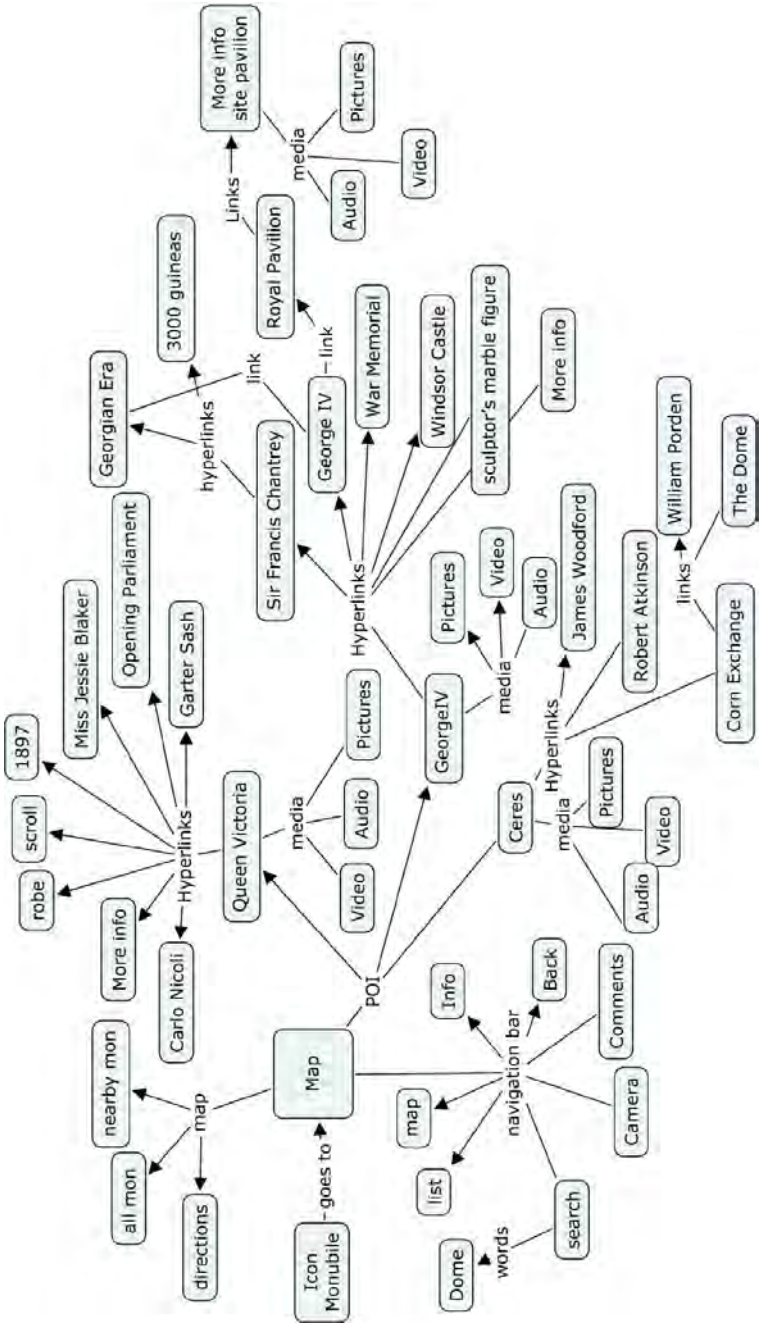


Figure 34: App map

The text about monuments was reformulated and new pictures were added to the screen. Additionally, video files and audio files were part of the app. It was decided to have three

sculptures available in the tour, two with most of the features. Audio files were produced and videos about the subjects were gathered from YouTube.com with copyright messages. Hyperlinks were added to the text, as illustrated on the map. The link “more info” leads users to websites (Wikipedia/ Public Monuments of Sussex websites). Experts in cultural heritage reviewed the content before testing with users (see Chapter 6).

5.4.3 Illustrated scenarios

The scenarios were also used to test the high-tech prototype before experts and users. The functions were refined based on the fictitious scenarios. This worked as an enhanced storyboard, showing interaction models and actions users should make to reach the scenario’s goal. (Ginsburg 2011; Jones 2006; Preece 2002).

Scenario 1:

Manon looks at the map > taps on the icon to see information about the monument> taps twice on George IV > Next monument > taps on the icon to see information about the monument > taps twice on Queen Victoria > Identify the pedestrian cross> cross the street (Figure 35).

Scenario 2:

Gustavo looked at the map and identifies Queen Victoria statue > He selected the icon and saw the content> He taps on the word “garter sash”> The system shows the meaning and illustrations of what is that > selects the back icon > taps on the audio icon> selects “tap here to see the text”> taps on the back icon> selects video> watches the video with subtitles (Figure 36).

Scenario 3:

Grace looked at the map on the screen, identified the “you are here” link and selects the Pavilion icon > see pictures from inside it> tap on “more information” icon (+) > Website of Pavilion opens> Tap on the opening hours> website displays the information - 9 to 5> taps on the map> tap on “George the IV” icon> read the text> tap on the name of the sculptor “Sir Francis Chantrey”> reads aloud the text > Grace selects the 3000 guineas hyperlink > they see and illustration representing the amount of money in that time. > Susan asks “Who was George the IV”> Grace returned to the content screen and selects “George the IV”> select the podcast> Susan wears one headphone and Grace the other>”Grace tap on the screen and they follow the transcription together> Grace goes to list >She selects the one in the list that is the closest one - “Queen Victoria” (Figure 37).

Scenario 4:

They stopped in front of Queen Victoria sculpture> Evie runs to see the plaque in front of Queen Victoria and starts reading it. She asked for help > Charlie opens the replica of the plaque in his phone>they read it on the phone > Charles taps on the list. > Charles selects “directions” > the system shows the route on the map, indicating where they should cross the street >they cross the street > Evie says “The Dome. Does it say that it was a library?”> Charles goes to search and types Dome> He selects it and sees the information about the Dome. > He sees the icon to add comments> Evie types “It was a library before” (Figure 38).

Illustrating scenarios with prototype screens was a challenge. Not all the interaction cycles were covered in the low-tech prototype. Therefore, thinking of the ways those interactions would happen on the screen needed a careful look at other mobile apps (competitor analysis) and trial and error to fit elements on the screen. Additionally, certain concepts were not clear on the interface. For instance, the use of “traffic lights” drawings was not clear on the interface due to the size. It was substituted by “pedestrian crossing” drawings. The scenarios also aid to map a list of functions the system should have. Some of them were developed, while others were coloured in gray, meaning inactive functions, in this case availability of subtitles in the videos. Certain gestures elements, such as show the video in landscape were applied to minimise steps to reach user’s goals.

Figure 35: Scenario 1

Figure 36: Scenario 2

Figure 37: Scenario 3

Figure 38: Scenario 4

5.5 Hardware and software integration

Several technical possibilities were examined to develop the prototype. The most plausible one was to develop in Adobe Flash lite embedded in an Android platform. The Android platform is open source, facilitating installation on mobile devices. Apple platforms are closed and it would be necessary to have permission to distribute an App. Programming in Flash was more intuitive and supported was given by research fellows[38]. From a research perspective, it was advantageous to program in software that allowed modifying details easily.

The device choice fell on possible mobile phones that supported Flash at that time. Adobe did not launch the plugin for full mobile Flash player till the start of the prototype evaluation. As an alternative, Flash Lite 2.2 worked successfully on certain devices. There were few books and online resources describing projects using this technology and which devices supported it. Therefore, prototype application tests were made in mobile phones that belong to the ITRG – Interactive Technologies Research Group in University of Brighton, including Samsung Ominia, HTC Magic and HP iPAQ and several reviews of mobile phones were reviewed to find a solution. The research showed that not all the devices that supported Flash Lite supported all the multimedia features it was aimed to use. Additionally, some of the devices tested were not touch screen and not a satisfactory resolution. The HTC Hero device was the only touch screen phone at that stage that supported video and audio embedded in Flash Lite player. The Flash player file was displayed in the browser. The choice of programming in Flash and not in Html was due to the Flash file allowing a full screen view. It was not possible to see in the html files that displayed the navigation bar of the browser. This phone device offered similar resolution (480x320px) to Apple IPhone, which was a popular device by fieldwork participants. The HTC Hero used in the prototype development and evaluation was borrowed from a company called Locomatrix[39], based in Brighton – UK.

Some functions it was not possible to program in the prototype due to the complexity of the task. GPS facilities were made up and pre-established in the system. Search, comments and camera were not also programmed. Those functions that did not work were in grey.

[38] Micah Rosenkind gave support for the programming
[39] http://locomatrix.com/

Participants were advised in the beginning of the evaluation sessions about the non-active functions, and were requested to say how they would like functions to behave. This gave insights and new possibilities for extending the prototype. Besides, it was important to have feedback about the content displayed and acceptability of multimedia functions. Without extra features functionalities, there was a prediction that users and experts would focus more on the POI content presentation.

5.6 Two versions of content display

In order to test users' preferences in content presentation, two versions of the content were part of the high-tech prototype. One version had a more complete set of multimedia features (Queen Victoria content) and another had fewer multimedia features (George IV content). Audio, pictures and video files available were diverse in length and type for each case. The Queen Victoria content had text with hyperlinks, informal audio with two speakers discussing about the monument, pictures of the monuments with extra information and a shorter video length. George IV content had a long text without hyperlinks, formal speaker in the audio file, pictures of the subject (George IV) and a long video of George IV's life. This offered room for researching overall user preferences with regard to multimedia presentation of content.

5.6 Conclusions

The method of collecting, grouping and selecting requirements from literature review, competitor analysis and design activities in the field proved to be an effective way of generating user requirements. The requirements chosen indicated new features and ways to present and interact with multimedia features in outdoor settings. Other requirements were discarded because of technological constraints or due to not being so relevant for this stage of the research, which focused on assets and generating content and interface design requirements. A low-tech prototype was sketched as a wireframe. This was a preliminary study of a prototype interface. Since it was not possible to cover all types of potential users, researched personas and scenarios were added to the design activities. This technique clarified user interactions with the future prototype and provided a list of must-have functions. The interaction cycles were illustrated with a working high-tech prototype. From this experience, it became clear certain functions could not be fully implemented. However, they were not

excluded from the interface design. Those functions were relevant to gather user and expert opinion in the evaluation phase.

6 Prototype Evaluation

6.1 Introduction

In this chapter we describe the evaluation of the mobile guide prototype. The high-tech prototype was evaluated by experts from the fields of Cultural Heritage and Human Computer Interaction (HCI). First, two experts in cultural heritage reviewed the *content* of the prototype. Afterwards, six experts from the HCI field evaluated the *usability* of the prototype using the Cognitive Walkthrough technique. The suggestions made by the experts were implemented in a second version of the high-tech prototype. Thirty-two users then tested this second prototype in situ.

6.2 Expert Evaluation – Content Review

The content used in the prototype was based on the booklet text and redesigned according to requirements assessed in the previously described fieldwork activities. Two experts[40] in cultural heritage reviewed the content to guarantee it was acceptable for the overall public and did not have any inconsistencies. Experts also add information to some parts of the content in order to bring the history alive. For example, in the excerpt "The sculptor undertook the work for a fee of 3000 guineas" they added the text: "3000 guineas was a lot of money. In the early 1800s a school master or mistress was paid about 50 pounds per year".

The suggestions made by the two experts were applied to the content. The new content was modified and added to the prototype. Some adjustments were necessary to fit the new content on the screen. Certain terms were explained in form of hyperlinks and others were included in the main text.

6.3 Expert Evaluation – User-experience review

Six experts[41] from the fields of HCI, Heritage Interpretation, Mobile HCI, Mobile Learning and Information Design evaluated the prototype to identify critical issues before the user-test session. Four experts had more than ten years of experience and the others between one and

[40] Jamie Kaminski and Anthony Mcintosh
[41] Ana Vitória Joly, Robin Heath, Galabina Yordanova, Ian Smith, Marcus Winter and Sanaz Fallahkhair.

five years in the field. All the experts were living in United Kingdom. Cognitive Walkthrough (2.2.3.3c) was chosen as the evaluation method. This method is commonly used to judge first-time ease of use in task-based scenarios. Hence, it was a suitable method to identify issues that might interfere with the quality of the user experience.

6.3.1 Method

Experts were invited to do the evaluation accompanied by the researcher in the lab. Experts were asked to follow a set of tasks on the touch-screen mobile phone, based on the four scenarios previously described (5.3.3), and fill in a specially designed form with their comments and suggestions. The application was accessed via wireless local network[42]. The activity took approximately 20-30 minutes. A brief explanation was given to show how the evaluation should be done and how to complete the Cognitive Walkthrough form. The form was based on the model proposed by Tullis and Albert (2008) and Preece (2007, p. 703), which requires evaluators to answer "yes" or "no" to four questions for every step of each task, adding their comments and suggestions. The four questions were:

1. A - Will the action be sufficiently **evident** to the user?
2. B - Will users **know what to do**?
3. C- Will users understand how to do it?
4. D- Will users understand from feedback whether the action was correct or not?

All the experts verbalised their thoughts while doing the tasks, which made it easier for the researcher to understand their points of view and takes notes of their interactions and recommendations as supplementary information.

6.3.2 Data Analysis

The resultant data from the experts' evaluations were the forms and notes taken during the activity. The researcher counted similar answers in the data to identify the major problems and the ones that should be left to test with users in natural environments. Ten tasks, illustrated in bold here, had critical feedback and attracted the majority of the suggestions for improvement

[42] http://www.cmis.brighton.ac.uk/users/hcdspc10/mobi.html

(see table 24). Most of the experts identified issues for improvement, but not all of them gave recommendations. The issues, suggestions and design rationale for the new version of the prototype are displayed in the next section.

Task: Finding information about one monument in the tour. Typical users: Visitors, short and long term residents that want to know more about the city (Brighton – UK). Device: Touch screen mobile phones (e.g. HTC Hero 320x480). Please answer for each step yes or no the A to D questions and insert your comments and suggestions on the following columns. A - Will the action be sufficiently evident to the user? B - Will users know what to do? C- Will users understand how to do it? D- Will users understand from feedback whether the action was correct or not?						
Steps	Tasks	A	B	C	D	Results
1.	Find the nearest monument from where you are	Yes (5) No (1)	Yes (6)	Yes (5) No (1)	Yes (5) No (1)	No (3)
2.	**See the content of this monument**	Yes (5) No (1)	Yes (4) No (2)	Yes (3) No (3)	Yes (4) No (2)	No (8)
3.	See the pictures available	Yes (6)	Yes (6)	Yes (6)	Yes (6)	--------
4.	**See the "picture of the plaque" in full screen**	Yes (4) No (2)	Yes (4) No (2)	Yes (3) No (3)	Yes (6)	No (7)
5.	See the text of the plaque	Yes (5) No (1)	Yes (5) No (1)	Yes (5) No (1)	Yes (6)	No (3)
6.	**Go back to the picture**	Yes (3) No (3)	Yes (2) No (4)	Yes (2) No (4)	Yes (4) No (2)	No (13)
7.	**Go back to the content of the monument**	Yes (3) No (3)	Yes (1) No (5)	Yes (1) No (5)	Yes (4) No (2)	No (15)
8.	Listen to the audio	Yes (6)	Yes (6)	Yes (6)	Yes (6)	--------
9.	Pause the audio	Yes (6)	Yes (6)	Yes (6)	Yes (6)	--------
10.	**See the text of the audio**	Yes (4) No (2)	Yes (4) No (2)	Yes (4) No (2)	Yes (5) No (1)	No (7)
11.	**Go back to the audio page**	Yes (4) No (2)	Yes (3) No (3)	Yes (3) No (3)	Yes (5) No (1)	No (9)
12.	Watch the video	Yes (6)	Yes (6)	Yes (6)	Yes (6)	--------
13.	Go back to the content page	Yes (6)	Yes	Yes	Yes	--------

			(6)	(6)	(6)	
14.	See the information of who is Jessie Blaker	Yes (6)	Yes (6)	Yes (6)	Yes (6)	--------
15.	**Go back to the previous state (content page)**	Yes (4) No (2)	Yes (4) No (2)	Yes (3) No (3)	Yes (5) No (1)	No (8)
16.	**Go to additional information, website about the subject**	Yes (3) No (3)	Yes (2) No (4)	Yes (2) No (4)	Yes (4) No (2)	No (13)
17.	**Go back to the app using the "browser controls"**	Yes (3) No (3)	Yes (3) No (3)	Yes (3) No (3)	Yes (3) No (3)	No (12)
18.	See the monuments nearby	Yes (6)	Yes (6)	Yes (6)	Yes (6)	--------
19.	**See the directions between Queen Victoria and Ceres**	Yes (5) No (1)	Yes (4) No (2)	Yes (4) No (2)	Yes (4) No (2)	No (7)
20.	Go back to all monuments	Yes (6)	Yes (6)	Yes (6)	Yes (6)	--------

Table 24: Experts' evaluation form results

6.3.3 Findings

Experts were satisfied with tasks 6, 9, 13 and 18 and did not give any suggestions about them. Design decisions were made based on the recommendations suggested by experts to improve the prototype before testing with users. However not all the recommendations were followed and justification is presented here. Firstly the recommendations adopted are described and afterwards the ones that were left to test in natural environments with users.

A rating scale was applied in order to measure the strength of the problematic issue and the confidence of suggestions. The strength of evidence is based on the work of Leavitt & Shneiderman (26: 24). They classify their guidelines into strong, moderate and weak research supported by numberical ratings. The issues and suggestions in this work are accompanied by a symbol - * - to signify how often that issue and/or suggestion was mentioned by different experts. Due to the number of experts in this evaluation, issues that have more than *** have higher strength of evidence. The design rationale topic explains the reasons for applying the suggestions or discarding them before testing the prototype with users.

6.3.4 Recommendations applied to the final prototype

The overall recommendations applied in the final version of the prototype were basically to improve the interface design. The main suggestions were to increase the size of icons, improve organisation of elements on the screen and enhance visibility of the commands. The issues presented here were organised by graphic and multimedia elements displayed on the screen followed by the suggestions and design rationale explanations.

A) Icons

Issue: Icons are not easy to identify and the size is very small on the map *** (3)

Suggestion 1: Increase the size of the icons *** (3)

Suggestion 2: Icons on the map should pulse * (1)

Design Rationale: The icons on the map were increased and vibration feedback was added when users tap the icon.

Issue: “You are here” label is not visible ** (2)

Suggestion: Increase the size of the typeface and make it clearer ** (2)

Design Rationale: The size of the icon and label was increased.

Issue: It is not clear that you have to click on the label to see the content *** (3)

Suggestion: Add Google maps style button e.g. arrows

Design Rationale: Arrows were added to the overlay box with the name of the monuments in order to make this action more visible.

Issue: The arrows are near to the other icons on the interface, user might hit them by mistake ** (2)

Suggestion: Place the arrows closer to the pictures * (1)

Design Rationale: The size of the arrow icons was increased and placed closer to the pictures.

Issue: The label and the icon “text” are confusing in the text of the plaque screen ** (2)

Suggestion: Change the icon, “I” is more suitable for “more information” * (1)

Design Rationale: The icon was substituted by a new icon with “I”and “+” symbol. Further a label “info” was added to the picture of the plaque.

Issue: The icon “text” does not make clear that it leads to the audio transcription **** (4)
Suggestion 1: Do not use the same icon used in the text of the plaque
Suggestion 2: Subtitles is a more common term * (1)
Design Rationale: The icon of the text on the plaque was substituted by a new version. The label “subtitles” was adopted.

Issue: It is not clear the transcription button is related to the audio file *** (3)
Suggestion: Place button closer to play controls *** (3)
Design Rationale: The transcription button was placed in the right hand side of the playback controls.

Issue: Audio button in the video control can confuse the user ** (2)
Suggestion: Remove Audio Button ** (2)
Design Rationale: The audio button was removed because, in the expert opinions, users might think the audio icon was the audio of the video.

Issue: When the user is in “all monuments” page the icon should be highlighted * (1)
Suggestion: Highlight the “all monuments” icon * (1)
Design Rationale: All the icons in the app were reviewed to check if they are highlighted when active.

Issue: Information about the system should be out of the navigation bar * (1)
Design Rationale: No solution was indicated for this issue. It was decided to cut this function from the navigation bar and test with users the need for it.

Issue: In the content page “directions” option is not available, it is in maps ** (2)
Suggestion: User should be able to access “directions” when he/she is in the content page. ** (2)

Design Rationale: A design decision was made to have the directions in the main Navigation Bar, which is available in all the pages of the app.

B) Pictures

Issue: It does not show how many pictures are available ** (2)

Suggestion: Show the number of pictures available in numbers ** (2)

Design Rationale: The number of how many pictures are available and the user's position within them was added on the content screen.

Issue: It is not clear that there is a magnify option in the pictures **** (4)

Suggestion: Add magnify icon or a plus "+" icon in the picture

Design Rationale: The option to have an icon to go to full screen mode in the pictures session was discarded. The size of the icon would be very small to fit next or in the thumbnail pictures, and, the details would be obscured. For this reason a label "Tap to see full screen" was applied in the first picture of the picture gallery to indicate the availability of this action.

Issue: Go back to the picture from the text of the plaque screen is not clear ***** (5)

Suggestion: Add a back button ** (2)

Design Rationale: a "back" button to give clearer indication how to go back substituted the picture in the text page.

C) Audio

Issue: The size of playback buttons are too small to select ** (2)

Suggestion: Increase the size of the buttons ** (2)

Design Rationale: The size of the buttons was increased.

Issue: The picture of the audio page changed. It is more information to process * (1)

Suggestion: Do not change the picture * (1)

Design Rationale: The picture of the statue was illustrative and did not add any information to the user. The picture was substituted for a text "While you listen to the audio move closer to appreciate the monument". According to the results of the third fieldwork (Chapter 4),

participants keep their eyes on the screen of the mobile phone while they listened to the audio. In order to incentive those to look at the monument it was decided to have this message on the audio screen.

Issue: It is not clear how to go back to the audio screen ***** (5)
Suggestion: Remove the highlight of “text” icon and add “back” icon to go to previous screen state** (2)
Design Rationale: It was decided to join the audio screen and the transcription screen to solve this problem to go back from the transcription to audio screen.

D) Hyperlinks
Issue: When glossary overlay boxes are selected the other icons on the screen are still active. Users might tap on them by mistake** (2)
Suggestion: Make the other icons inactive when overlay boxes are selected** (2)
Design Rationale: All the functions on the screen were programmed to be inactive when the overlay boxes are selected.

Issue: It does not go back from the overlay boxes when the user taps on the screen** (2)
Suggestion: Tap outside the box to go back* (1)
Design Rationale: It was programmed to go back when user tap in anyplace on the screen.

Issue: It is not clear the icon “+” leads to an external link **** (4)
Suggestion: Change the icon * (1)
Design Rationale: When there is an external hyperlink in the page, it was defined that it would be written the word “website” in the link e.g. Sculpture Website

6.3.5 Recommendations not applied on the final prototype

Some suggestions were applied, while others were discarded or postponed. The reason for not applying some changes was either due technical problems or in order to make sure how users would experience those issues in natural environments.

A) Icons

Issue: The navigation bar is always available. It can distract the user* (1)

Design Rationale: No solution was indicated for this issue. The navigation bar was kept in all the screens of the app to make options available any time users want to access.

B) Pictures

Issue: IPhone users will try to pinch instead of tap to select full screen picture* (1)

Suggestion: Make it available to tap and pinch* (1)

Design Rationale: The option to pinch was not implemented for technical reasons. Besides, without this function it was possible to measure the need for it with users of diverse mobile platforms.

Issue: It is not clear that by tapping on the picture the user will go back from full screen mode **** (4)

Suggestion: Provide a back button *** (3)

Design Rationale: Most of the experts when did this task mentioned it was not clear how to go back. On the other hand, all them tap on the full screen picture and returned satisfactorily to the previous page. They affirmed – "I did it by chance". It was decided to test this function with users in order to understand if tap is a natural action to go back when no controls are available on the screen.

C) Audio and subtitles

Issue: The audio does not play after tapping on "audio button"** (2)

Suggestion: The audio should play straight away in order to minimise the number of clicks. ** (2)

Design Rationale: It was chosen to test this issue with users. Conforming to the requirement phase, participants spent some time putting on the headphones after selecting the audio option. This implies that once in a while they had to rewind or start the audio file again. For this reason, the audio starts playing after the user taps the "play" button.

Issue: Difficult to see the continuation of the transcription text* (1)

Suggestion: It should scroll when I press it * (1)

Design Rationale: The arrows to scroll the text were placed on the right hand side of the screen to facilitate one-handed interaction. The suggestion was not implemented because we did not have enough evidence and confidence to change this action, before testing with users.

D) Hyperlinks

Issue: It is not evident why links are in different colours ** (2)

Suggestion 1: Clearer distinction of glossary and hotlink * (1)

Suggestion 2: Colour-blind people will not notice * (1)

Design Rationale: The prototype was made in Adobe Flash. It was quite complicated to insert an icon in the text after a hyperlink without changing its position when accessing from different devices. For this reason, the colour pattern was used. It was decided that links to the system and glossary overlay boxes would have the same colours. The external links would be the ones with a different colour.

Issue: It is not clear how to go back to the app from external links *** (3)

Suggestion: Do not rely in the hardware, rely on the screen controls* (1)

Design Rationale: Ideally, to open the external link inside the app it was the plan. It is not possible to embed web pages in Adobe Flash Lite, the only solution was to make a native Android application. Consequently, this function could not be changed and users should use the back button of the phone to go back to the app after accessing external links.

E) Map

Issue: It is not clear the icons are monuments on the map** (2)

Suggestion: The icon for the monument should be something that looks like a monument * (1)

Design Rationale: Due to the restricted space available in the interface, this suggestion was discarded. It would be difficult to identify details via small illustrative icons.

Issue: It shows “all monuments” as the first page ** (1)

Suggestion 1: “Nearby monuments” should be the first page ** (2)

Suggestion 2: Maybe you can have a function “change settings” and they can choose if they prefer to see the nearby or all monuments first * (1)

Design Rationale: The second suggestion was adopted. This issue was affected by preferences, and it is an interesting point to investigate with different users’ profiles.

Issue: It is not possible to press and drag the map* (1)

Suggestion: Make this option available* (1)

Design Rationale: For technical reasons it was not possible to implement this feature. Additionally, the focus in the tests with users was not on wayfinding.

F) Directions

Issue: The directions page does not provide length in minutes between two sculptures* (1)

Suggestion: Provide information of length in minutes* (1)

Design Rationale: In the prototype, it was decided to have this information in the List section.

6.3.6 Discussion

The expert evaluation identified the main technical problems and issues during the user evaluation. Overall, experts were comfortable to share their opinions while evaluating the prototype. The presence of the researcher during the evaluations offered opportunities for dialogue about the prototype.

Certain suggestions made by the experts were not implemented due to technical limitations. Others were not modified in order to test the points with users in natural environments. At the end of this chapter, these issues are repeated and compared to results of the user evaluation.

6.4 User Evaluation

The objective of user evaluation was to examine the usability of the prototype and identify users’ preferences with regard to multimedia information delivery on mobile applications in outdoor contexts. In order to test user preferences for content presentation, two versions of the content following expert recommendations were included in the high-tech prototype. Both versions maintain the same layout but differ on text presentation, type of video and audio files

(size and discourse) and the presence of additional content. One version had a more complete set of multimedia features (Queen Victoria content) – tested by experts and another had fewer multimedia features (George IV content). Audio, pictures and video files available were diverse in length and type for every case. The Queen Victoria content had text with hyperlinks, informal audio with two speakers discussing about the monument, pictures of the monuments with extra information and a shorter video length. George IV content had a long text without hyperlinks, formal speaker in the audio file, pictures of the subject (George IV) and a long video of George IV's life. This offered room for researching overall user preferences for multimedia presentation (see pictures at 6.4.3.1 for details of each version).

6.4.1 User profiles

In April and May 2010, questionnaires were distributed across the university to identify possible participants for the study. The questionnaire covered seven questions about residence, familiarity with touch screen devices and mobile cultural guides. The reason for the questions was to have specific data about the participants, in case we needed participants with specific profile. Overall 50 questionnaires were delivered and only ten people did not give their contact to help in the study. Invitations were also sent to university e-mail service and posted on the Public Sculptures of Sussex website[43], Public Monuments & Sculpture Association[44] and the blog of the researcher[45]. Most of those participants were native speakers or advanced English speakers. In order to examine the influence of language skills on users' experience with the mobile app, invitations were sent to foreign students temporarily living in Brighton.

Overall thirty-two participants did the user tests in June and July 2010. The age range of the participants was between 18 to 71 years old. However, most of the participants were between 23 and 29 years old. This meant that the majority of participants either had touch-screen mobile phones or had used them before. According to the data, 50% of the participants used touch-screen mobile phones every day, 37.5% not frequently and 12.5% had never tried this kind of mobile phone before. Participants who used this type of phone every day were younger than the ones who had never used them or do not use them frequently.

[43] http://www.publicsculpturesofsussex.co.uk/
[44] http://www.pmsa.org.uk/
[45] http://mobileguideincontext.blogspot.com/

The data was diversified when looking at nationality. Participants were from three main continents: Europe (56%), South America (25%) and Asia (19%). Considering 28% of the participants were from UK, it was relevant to have this diverse set of participants to identify possible cultural differences in the study. Equally, the number of people who were living in Brighton was a factor that could influence on the results. When looking for participants to do the study, the questionnaires were used to balance the invitations in this regard. Sixty percent of participants had been living in Brighton for more than three months, including the British participants. Forty percent were visitors or were in Brighton for less than three months (Figure 39).

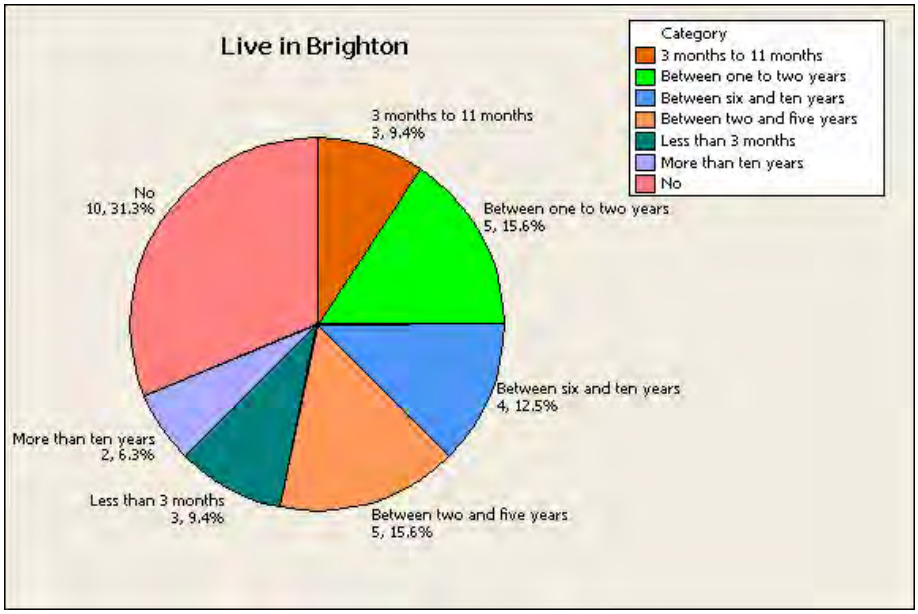


Figure 39: Participants who live in Brighton

Not so many English students answered the invitations and few visitors who did the study considered themselves not to be fluent English speakers. Only twenty percent of the participants were intermediate level students of English, and the remainder were native or advanced English speakers. Even with small number of intermediate English level participants (6) it was possible to spot some differences. Different reasons brought participants to do the study. Some were very interested in the technology, others in the cultural heritage content. Participants with different backgrounds gave distinct views during the study. For example, users involved in art (illustration, music, media and cultural heritage) were more likely to explore the application and access more functions. Others from the HCI and computer science

fields paid more attention to the functionality and coherence of actions on the application (Figure 40).

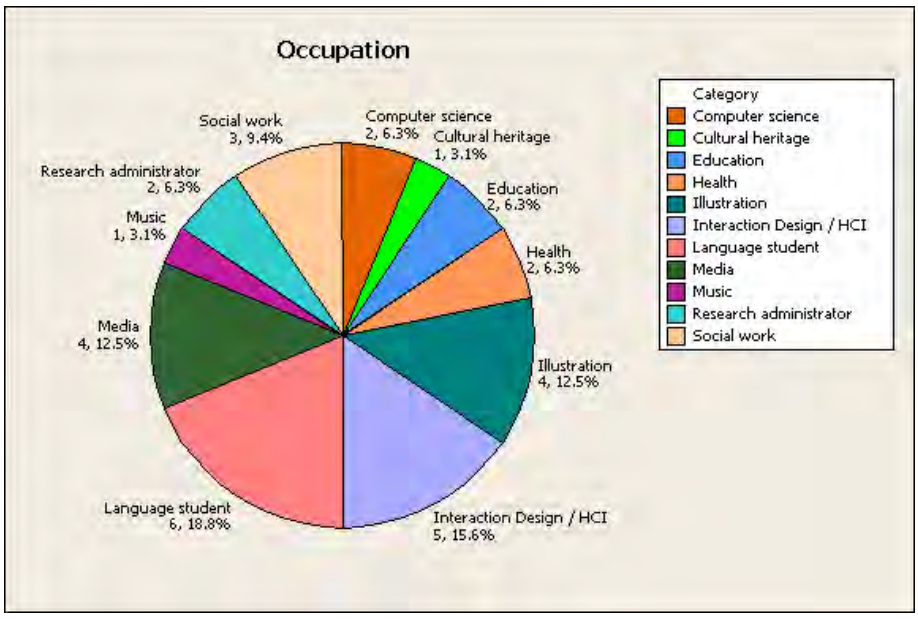


Figure 40: Occupation

Participants' interest in the content, like their occupation, was also relevant. Seventy percent of the participants were interested in the theme of the application. The number of participants who have used audio guides and video guides before also confirmed their interest in those types of apps. Eighty percent of the participants had used audio guides before in museums or galleries (72%) or city tours (8%). This shows they wanted to find out more about the exhibitions they attended. On the other hand, only 18% of participants had tried video guides before. There are not so many video guides available in museums and city guides (Chapter 3). This result opened the opportunity to research fresh participants' views on using video in outdoor settings.

The last information requested in the questionnaire was their time availability for doing the tour. Seventy two percent of the participants (27 participants) declared they had one to two hours and fifteen percent (5) between fifteen minutes and half an hour to do the tour. The latter participants (in majority) were not familiar with touch screen devices. Additionally, two of them did the tour in the evening time after sightseeing Brighton. They had to leave Brighton

after the tour and affirmed they were tired. Predominantly, users expected to spend one to two hours taking part in a tour using the mobile phone.

6.4.2 Method

Participants followed a short sculpture tour using a touch-screen mobile phone to access the application. The application was available on the mobile phone via mobile broadband in the Internet browser. It was launched in full screen format and ready for the users to access at the beginning of the study. As described above, the application had a map with points of interest[46] and two versions of content. The first sculpture, Queen Victoria, the text had hyperlinks, pictures of the statue and in the audio content a conversation took place about the sculpture. The second, George IV, had a scroll text, pictures of George IV and a formal audio narrative with one speaker about George IV life.

The researcher asked participants to go to one of the monuments from their current position. Eighteen participants started the tour seeing "Queen Victoria statue" and the remainder "George IV statue" to counterbalance any effect of content access order (Tullis & Albert 2008). In the first part of the tour, participants were free to access any content that sparked their interest. In the second part of the tour, the researcher motivated them, if necessary, to look at any information that they hadn't accessed before. The researcher marked down the sequence of multimedia content accessed during the tour on a form. The researcher accompanied the participants and asked them to use the think aloud technique (Love 2005:64; Preece 2007). When any silences occurred the researcher gently gave reminders that she was interested in what they were thinking. Questionnaires were filled in before and after the tour. Before the tour, demographic information and consent for the study were requested. After the tour, participants answered questions related to prototype interface design and their preferences for media. Observational data was also gathered during the tours. Participants wore a video head camera, which recorded their interaction with the prototype and any sound occurring on the tours. The observation data was analysed supported by the notes the researcher took during the tours. The use of a notepad was vital to gather information in case any problems might happen with the video recording.

[46] Web address of the prototype used in the user test: http://www.cmis.brighton.ac.uk/users/hcdspc10/mo.html

6.4.3 Data analysis

The data was analysed using descriptive statistical methods and qualitative methods. Basic statistical analysis was carried out to analyse the data from the questionnaires - demographic data, semantic scales and design preferences. Tables and cross tabulation were applied to compare the results among participants and the use of the system. The restricted number of participants in the study was not enough to ensure the validity of the statistical analysis. Besides, these results did not give us enough evidence of essential elements for designing mobile guide applications. Writing on design evidence, Lawson (2006: 64) highlights that "we normally measure and express quantities by counting using a numerical system. This leads us to believe that all numbers behave in the same way and this is quite untrue". The same author emphasises what designers really need is to have a feel for the meaning behind the numbers rather than precise methods of calculating them. (p.71). In agreement with Lawson ideas, a qualitative approach was applied in most of the process.

The data analysis was based on data transformation (3.2.3.4.b). The transcriptions of the video observations, important notes taken during the fieldwork and suggestions given by participants while they were answering the questionnaires were considered. Research questions were established to guide the analysis, such as:

- What are relevant issues to consider when developing mobile guide applications to be used in outdoor cultural heritage settings?
- What are the preferences for media usage and why?
- How much will users access text, audio, video and hyperlinks in front of the monuments?
- How important is it for them to access text, audio, video and hyperlinks in mobile guides?
- How satisfied will they be with the content delivered and why?
- Is there any difference in interaction or preferences among diverse users profile?
- Do the environment and time availability have an impact on the experience of accessing content in outdoor settings?

These questions were kept in mind while the data was classified and codified. The main independent variables were: age, residence, level of English, familiarity with touch screen mobile devices, previous experience with mobile tour guides, time availability and environmental factors. Some variables were added during the process, such as occupation and interest in cultural heritage sites. These showed their relevance as the material was analysed, resulting in new connections to be examined. Independent variables were used to investigate differences in participants' interaction with the application.

Dependent variables, the issues we aimed to measure, were primarily the use of multimedia features on the mobile phones in outdoor settings. In the same way, new dependent variables emerged from the analysis while the researcher was looking for issues that would answer the research questions. Relevant issues were classified into sets of codes. The principal set of issues emerging from the data were: the use of multimedia features, consistency of use, multi task usage, touch-screen interaction and wayfinding issues. Additionally, content interest, user preferences, outdoor constraints and technology drawbacks were evaluated. The set of codes were combined with the independent variables to answer the research questions. Not all the variables had an influence on the experience of the participants: these are therefore not explored in depth.

While carrying out the video observation, a table was used to identify which features participants accessed during the tour and in which order functions were accessed. Only the first stage of the experiment was examined at this level, i.e. in other words, the stage participants were able to choose functions they wanted. Some questions arising from this data, such as the number of features they access in the first monument visited, which functions they accessed more and the relation of environment constraints to the choices made.

The transcriptions of the videos, observation analysis and coding were assisted by the qualitative software Nvivo 8. The quantitative analysis was mainly generated using the statistics package Minitab 16.

6.4.4 Findings

The findings are divided into Primary multimedia features and Secondary multimedia features. This classification is organised according to the use of features during the tour. For instance, Primary multimedia features were more accessed than Secondary multimedia features. Additionally, content access vs. user profile, as well as issues suggested by experts for the final prototype were identified in the user evaluation and compared. The issues were described according to the strength of evidence presented in the qualitative and quantitative data. We considered the frequency with which issues were repeated during the analysis (evidence). In addition to this, particularities that stand out in the data were counted, such as suggestions not mentioned for many participants that opened opportunities for further exploration. The qualitative results are assigned and in certain situations supported by the quantitative analysis.

The issues are presented in the following format:

Issue: Content should not lead people to see things in the environment that no longer exist without showing visual information to illustrate the item. Strength of evidence: **** (4)

As in previous sections (e.g. Chapter Four), the strengths of evidence are accompanied by a symbol - * - to signify how often that issue was mentioned or identified in different users' opinions and/or behaviour.

6.4.4.1 Primary multimedia features

In this session, findings referring to text, hyperlinks, pictures, audio, video and map are described. First an outline of the main results is given for every feature and later on suggestions are discussed with regard to the main issues identified.

A) Text

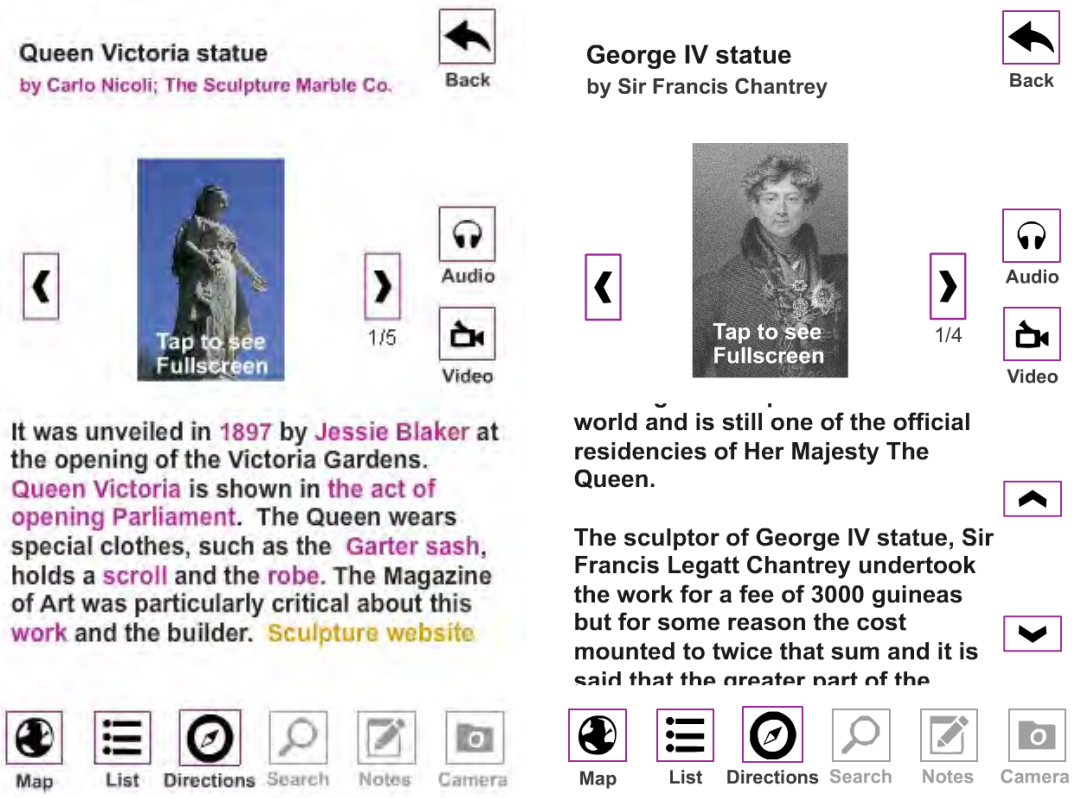


Figure 41: Text in the app

As can be seen above, in the prototype design, the text did not have the same presentation in both sculptures contents (Figure 41). Half of the participants started the tour by reading the text of the monuments. Others scanned the text and accessed other features. They also used their fingers to follow the text and found the typeface of George IV text was quite small to read. It was an interesting issue since the typeface was the same as Queen Victoria text. Users who identified this as a problem were over 47 years old and did not use touch-screen phones frequently. It might be because they are not used to reading large amounts of texts on phones.

Issue (01): When the block of the text does not fit onto one screen, the typeface is considered smaller than when the text has a single block that fits on the screen.
Strength of evidence (SE): *** (3)

In spite of this, the evaluation of the type size for the whole system was satisfactory. Eighty percent of the participants, using a scale of one to ten, marked a high score (7-10) for this item. The common factor for the ones who gave a lower mark was as mentioned above.

The text of George IV was also difficult to follow, according to users. The main reasons were the use of arrows to scroll the text and the uneven transition of the text. Touch screen device users expected some functions that are common to certain types of mobile phones. They expected to scroll the text when tapping on it, zoom in with double tap or press and drag to scroll the test. Novice users of this technology were lost in the text and mentioned that they needed to memorise the last word read before scrolling the text.

Issue (2): It is difficult to follow George IV text. SE: ****** (6)

When asked for choose the presentation of the text, ten participants (31 %) preferred to scroll the text instead of having hyperlinks. Two of them were older than 50 years old, did not have a technological background (education and social sciences). This may indicate they do not want to press so often on the screen because they are apprehensive or not familiar with it. It was the first time they used touch screen phones.

Issue (3): Participants who are older than 50 years old were apprehensive about pressing on/scrolling the screen. SE: ** (2)

Additionally, two participants preferred to read the text under noisy conditions.

Texts are good to read rather than audio, because when you are outside with a lot of noise audio doesn't serve the purpose. Participant 21

Issue (4): Participants preferred to read the text instead of listen to the audio in noisy conditions. SE: ** (2)

Suggestion 1: Offer information through audio/verbal mode. SC: N/A

B) Hyperlinks

Twenty two participants (69%) reported they prefer to have hyperlinks on the text than scroll it. They mentioned they did not want to read long texts in front of the monuments, so that, with hyperlinks they can choose what they want to know more.

In spite of this, eleven participants did not try the hyperlinks in the first stage of the experiment. Besides, external hyperlinks and links to the system were rarely selected. Participants from South America and Asia accessed links much later in the tours or did not access this function at all (90%). They were in majority visitors and spent a day in Brighton. United Kingdom participants read the hyperlinks more often (80%). They were residents of Brighton and were particularly familiar with the subjects. Visitors did the tour after a day of sightseeing or between touristic activities. They looked for basic information and wanted to move on. On the other hand, residents, who had some familiarity with subject, searched for additional information in the hyperlinks.

Issue (5): Participants reported they prefer to have hyperlinks in the text than to scroll it. SE: ********** (22)
Issue (6): Internationals spending the day in Brighton did not access links to the same extent as locals. SE: ****** (6)

The scarce access of this function in the first part of the tour might be related to unintuitive presentation of hyperlinks. Participants commented that most of the time they saw the highlighted words but did not realised that there was a hyperlink in the first place. In their understanding, the colours were used to emphasise the words. Their suggestions were to use standards from the early stages of the WWW, i.e. underline words and make them blue.

I thought that the hyperlinks were just important keywords. I did not expect information to pop up. I expected underlining as we know. It is a mobile device, which is a big difference isn't it? Participant 24

I thought that you liked to have pink and you just wanted to highlight not as hyperlinks but just as something that you wanted to highlight, put a stress on it. I'm sure if it was green or blue not the same colour as the rest, then I could go for it. But I also like the design, I'm not sure if you change these, maybe I was stupid. Participant 29

Additionally, twelve people did not access the external hyperlink in orange. The ones who accessed mentioned it the colours were very flashy and that is why they clicked on the words. Some of them mentioned that they did not realise it was an external link despite the word

“website”. Suggestions were given to make this function more transparent, such as add an icon -  beside the word highlighted.

The external hyperlink guided visitors to “Public Sculptures of Sussex website”. It is not a mobile tailored website and it is cumbersome to navigate on it. As a result, just very few participants rolled over this webpage and identified the pictures of Queen Victoria. This problem might have an implication in their satisfaction with external hyperlinks. It was possible to notice that participants were unsatisfied (64%) with this option more often than with the regular hyperlinks on the system (27%).

Issue (7): When accessing text participants did not always identify coloured words as hyperlinks. SE: ********** (11)
Issue (8): When accessing external hyperlinks users do not have the patience to look for content in a webpage that is not tailored to mobile devices. *** (3)

Further dissatisfaction occurred when users wanted to return to and from the app. This issue was identified in the expert evaluation previously and it was not possible to fix it for technical reasons. User evaluation confirmed the relevance of this issue. Fifteen participants complained and did not know how to return to the app. They preferred to have a back button on the screen, so that a web/ app protocol could be followed. The back button also worked as an escape button. When users felt lost or did not know what to do, they looked for ways to return to the previous screen.

Issue (9): It is not clear how to go back to the app from external links. SE: ********** (15)

C) Pictures
Accessing the picture gallery during the tour was considered a secondary activity. When visiting the first sculpture, 18 participants (56%) did not interact with the picture gallery. Otherwise, it is evident they saw the first picture on the way to the sculpture or in front of the monument.

(Figure 42). Some of the participants used the pictures of the statue to localise themselves. They said:

It's that the one isn't it? I saw the photograph and that confirmed it. Resident

Issue (10): Pictures of the statue assisted users in way finding situations. SE: ********** (14)

When asked their preference for having pictures of the subject or the sculpture on the app, 14 participants (41%) would like to have both kinds of pictures for every sculpture. They justified their choice affirming that one picture of the statue was enough to recognise it, and more pictures of the subject were necessary to give context and make the history alive. Besides, participants suggested having ancient pictures of the sculpture, when it was unveiled or pictures that showed the surroundings in the past. One participant, who described herself as very enthusiastic about sculptures, mentioned she would like to have the date information on the screen.

Issue (11): Participants would like to have both kinds of pictures for every sculpture. SE: ********** (14)
Issue (12): Participants with high interest in the theme wanted to see the date of the picture SE: * (1)

The rest were divided in their choices . Eleven participants (34%) opted for the subject picture and 8 participants (25%) opted for the sculpture picture. The ones who preferred the subject mentioned they were able to see the real sculpture on the spot; consequently they do not need illustration. However, in the observation studies it became clear that even those participants also used the pictures to identify the statue. The choice for pictures of the statue was justified by the theme of the tour. Sculpture pictures are related to what they see and they also allowed users to see more details of the sculpture on the screen. Particularly in the case of George IV, the sculpture was very high, so a picture of the sculpture would help to get a better view of the details. Some participants even passed by this statue and did not notice it.

Figure 42: Pictures in the app

I don't need more pictures of the statue, because I can see it. But it would be nice to see other pictures of the subject so that I learn more about it. Especially if it is a statue, I'd like to see what the person really looked like in real life. Participant 6

Maybe this is George IV: would be nice have a picture of the statue. Participant 7

Issue (13): Users passed by a high monument and did not notice it. SE: ***** (5)

In addition to pictures of the Queen Victoria statue, there was a picture of a plaque. This picture had an "info button", which displayed the text of the real plaque on the screen. Four participants did not see the replica of the text on the system. Eleven participants accessed this information in the first part of the tour because they were in front of the plaque and wanted to read what was written down on the real plaque in a legible form. In the second part of the tour, when asked to find the text about the plaque, participants looked for it on the text, audio and search sections: rarely did they tap on the pictures icon. On the other hand, participants who explored the system more, and had previously seen the pictures recognised where it was the replica of the text. The "info button" on the thumbnail pictures was not so obvious. In addition, it was not possible to select it from the thumbnails picture view. This was not the first

picture of the Queen Victoria content: for this reason the info “tap to see full screen” was not in sight. This presentation of information confused users, because they had to go to full screen mode and then select the “info button” to see the replica of the text.

Issue (14): The icon “info button” on the thumbnail pictures did not indicate the availability of the text replica. SE: *** (3)

In general, participants were very satisfied to have this information in the app, affirming it was difficult to read the text on the real object. Only five respondents were dissatisfied with this function. Participants also expected to have “the info button” for other pictures.

Issue (15): Participants would like to have an “info button” available for all the pictures containing extra info such as: dates and labels. SE: ** (2)

Seeing pictures in full screen mode, according to the questionnaire results, is an extremely important function. (Table 25).

	I didn’t try	Not essential	Neutral	Essential
Pictures in full screen mode	___	1	3	28
Audio	___	2	4	26
Subtitles	8	3	2	19
Video	2	9	5	16

Table 25: Important functions

It is worth mentioning that even though they rated this function as very relevant in the questionnaire, they did not access full screen pictures very often. In the first part of the tour, just eleven participants tapped to see the pictures in full screen. This may be because certain participants did not identify the possibility of seeing full screen pictures, despite the message: “Tap to see full screen”. This message was present in the first thumbnail picture. Sometimes, participants tapped on the arrows to change the pictures, and did not always notice the message or were confused about it. This is exemplified by participant 31 - *In the first photo you have to tap to see full screen and in the others you don’t.*

Issue (16): It is not obvious how to see full screen pictures SE: *** (3)

According to the previous expert evaluation (6.3) users would have problems in returning from the full screen mode. Experts pointed out this issue but carried out this action at the first attempt, intuitively. Hence, the researcher was not sure if participants might do this task intuitively or would need a "back button". Eight participants (25%) did not know how to go back from the full screen mode. Two of them have the same mobile phone used in the experiment – HTC Hero – and they used the "back key" of the phone to go back. Their mental model was to go back using the key and not the touch screen phone. Six were not familiar with touch screen phones. Those were from arts, health and social backgrounds. None of them were from a technological background. Even though they did not know how to go back, only two asked the researcher how to proceed. Those participants found it easy to "explore the system by trial and error" (they rated 8 to 10 on the semantic scale) but not to the same extent as the item "easy to learn the system" (6-8). Overall, it could be said it is an intuitive task; however, the "back button" should be available when the target group is not familiar with the technology or confident about trying new functions.

Issue (17): Users who were not familiar with the technology did not know how to go back from pictures in full screen mode. SE: ******** (8)

With these photographs I'm wondering how to get back to the main page. I'm just assuming that it is the back button. It is probably me not knowing the functionality of the phone. To go back pressing the screen I would be looking for some kind of back arrow or something on the screen. As I didn't have that on the screen my inclination was to press that (back button on the phone). The second choice, do that (press on the picture to go back). A back button on the photograph would be better for sure. Participant 15

Do you know what I would do? In all the pictures, to make it easier I would put the back icon in the corner of the pictures because then you can click anywhere and it makes it more consistent. Everyone would tap on the corner to go back. Participant 32

D) Audio

In the prototype, two audio files were available (Figure 43). The first was the Queen Victoria audio that was recorded by two British speakers having a conversation about the sculpture. The

second was delivered by one speaker with an American, international accent telling the history of George IV.

It was clear the audio was an option expected on mobile cultural guides. Audio was the second most important feature chosen by users as a feature to have on mobile guides. Having eyes free was the main justification for this must-have feature. Two participants did not find it important to have audio. They mentioned that it was very difficult to listen to the audio with environmental features such as noise, traffic and density of people. They also indicated their preference for video, because they could have the visual and not only the audio stimulus. These participants were international and marked the subtitles as a very essential feature.

Others were neutral about this option (4). These were older, between 31 -57 years old. They also read more and their satisfaction with the texts was very high. They were also more satisfied with GIV audio, which was a more traditional way to deliver information. It could be said that those participants were neutral about audio features and were more attracted by a traditional way to deliver information (text).

Issue (18): Participants were disturbed by environmental noise while listening to the audio file. SE: ** (2)
Issue (19): Older participants were more attracted by text than audio files. SE: ****(4)

Eighty percent of the participants tried the audio files in the first part of the tour. The twenty percent who did not try the audio files were also not familiar with touch screen mobile phones; however, most of them had used audio guides in museums and galleries. The tour was very short: as a consequence, novice users might find it difficult to overcome the technology barrier. In this case, a help function or information on how to use the app would benefit these users.

Issue (20): Users that are not familiar with touch screen phones did not try the audio files in the first part of the tour. SE: ******* (7)

Seventy percent of the participants were satisfied with the length of both audio files. Each audio was approximately two minutes and twenty seconds. In general, participants listened to the audio files until the end. Few participants (2) would like to have more audio files divided by subject information and sculpture information. One participant who found the audio files rather long shared her views, saying the time to appreciate the monument is shorter than listening to the whole audio file. If it were an attraction with more details to notice, it would justify the length of the audio files.

I think I've would have liked the audio to be shorter because It takes a long time to listen to it and doesn't take this much to look at the monument. Although it is useful information, interesting I wouldn't spend so much time looking at the monument. Specially if it is not something big and grand, but I might want to listen to it in some other time, so if it was like in a separate file. A bit more information, just a bit shorter - a minute in a half could be good enough. If it is like a monument, if it's something bigger, like a complex of things, yes, because I have time but now I have to move to the other sculpture. I have text here, although I prefer listening to the audio than to read the text. But having text is useful I would think. Participant 6

Issue (21): The length of the audio is satisfactory. SE: ********** (11)

Issue (22): Time to listen to the audio is longer than the time to appreciate the monument. SE: * (1)

Issue (23): More audio files might be available by theme – sculpture description and subject description. SE: ** (2)

While listening to the audio, they explored other sessions on the app or followed the instructions written down on the audio screen to appreciate the monument. In the first case, the audio file did not stop when they accessed other parts of the system. This was an error: nevertheless they appreciated the possibility to have multi task functions on the app – listening to the audio while accessing other functions. The only problem was when they wanted to stop the sound and needed to return to the audio page to select this function.

Issue (24): Users should be able to interact with other parts of the system while listening to the audio. SE: ********** (10)

Issue (25): When accessing audio files in outdoor settings using a mobile phone, visitors might want to stop the audio when they are in a different session of the app. SE: ******* (7)

Participants found several problems in the playback controls. Playing the audio as soon as the user selects the audio function was one issue recommended by experts. However, there was evidence in the previous fieldwork that participants needed more time to put on the headphones before playing audio. Six participants were confused and thought the audio file was not working or loading. Most of them did not feel uncomfortable about pressing the play icon, some of them that were already wearing their headphones hesitated before pressing but accomplished the action. Perhaps it occurred because there was only one file; if more files were presented they would have noticed the necessity to press play.

Due to Internet access on the mobile phone, sometimes users had to wait to load the audio file. Some of them were very impatient and pressed several times on the play button. The app did not give any feedback, consequently the researcher had to intervene with the experience and reload the application.

Issue (26): Users did not press play to start the audio if they were already wearing the headphones. SE: ****** (6)
Issue (27): Users were not advised to wear the headphones before listening to the audio files, so that they prefer to put on the headphones and then press play to start audio files. SE: ********** (12)
Issue (28): The audio bar did not display visually that it was loading the audio file. SE: ********** (12)
Issue (29): Audio file did not start when the user pressed play. SE: ********** (12)

Ten participants who were not familiar with the device did not know how to increase the volume of the audio. The volume controls were essential as the playback buttons and fundamental on the mobile phone screen. Participants who were owners of HTC Hero devices did not have problems in interacting with the volume controls.

Issue (30): Participants who were not familiar with the device did not know how to increase the audio volume. SE: ********** (10)

In addition, some participants listened to the audio and explored the system on their way to the monuments. The researcher had to attract their attention several times while crossing the streets or merely walking in crowded places. Problems with traffic and crowded environments also appeared in the previous study with a mobile device. (see Chapter Four). Traffic also resulted in noise. Eight participants who found the environmental noise were also unsatisfied with QV audio whereas three participants in the same situation were unsatisfied with GIV audio. The location of the Queen Victoria statue is between two main roads, making the traffic more intense, which results in a noisy environment most of the time.

Issue (31): Participants might be at risk (traffic safety) were distracted when interacting with the app. SE: ****** (6)
Issue (32): Participants who were in noisy environments were also not satisfied with audio files. SE: ********** (11)

Even though noise disturbed them, they were immersed in the mobile phone experience and did not take their eyes from the mobile screen. To motivate users to look at the monuments, we added a suggestion in the audio screen: “While you listen to the audio move closer to appreciate the monument”. Twenty-one participants (67%) followed the suggestion. A few touched the monuments as well. It was pertinent to notice that the George IV statue was very high, so participants followed the instructions to get closer, but after a few seconds some distanced themselves to see the overall statue. Instructions clearly need to be given in a tailored way depending on the type of the monument. In the Queen Victoria statue, the expression in the statue shows her looking down. Users had the sensation “the sculpture” was looking at them. Sensations that visitors have standing in front of a monument might change according to their place. Perhaps audio or text suggestions should be given to lead visitors to stand in the best spot to appreciate the monument.

Participants who did not follow the instructions (twelve) were mostly internationals (seven), non-native speakers (seven), did not use touch screen phones frequently and did not live in Brighton (three) or lived in Brighton less than two years (five participants). UK visitors followed the suggestions more often and touched the monuments. Perhaps they are more interested in

the sculptures and cultural heritage than internationals. They know more about the history and have background knowledge about the place, so that they can build on this knowledge. A further point was that the word “appreciate” was reported to be unclear. They suggested “see the details” was clearer than “appreciate”.

Issue (33): Text suggestions on the audio screen motivate users to look at monuments instead of looking at the screen. SE: ********** (21)
Issue (34): Instructions should be given according to the size of the monument. SE: **** (4)
Issue (35): Internationals did not follow the suggestions to move closer to appreciate the monument in the same extent as native/national visitors. SE: ******* (7)

Additionally, in the Queen Victoria audio, speakers mentioned the presence of George IV statue across Queen Victoria statue. Participants that listened to it, motivated by the audio looked at the George IV statue. This implies that the audio instructions were effective way in suggesting interaction with surroundings.

Issue (36): Participants noticed another sculpture in the surroundings because of motivation by the narration. SE: **********(25)

Thirteen participants (60%) did not make their choice between the American/International and British accent in the audio guide. In their opinion, it did not have an impact on their experience. The ones who chose the British accent (25%) had a more advanced level of English or were locals and justified their preference for accents that are native to the country where they are. Eleven participants (35%) opted for the American/International accent. In the majority they were language and university students. In their opinion this audio type was clearer to understand. In addition these participants were in the country to improve their understanding of British accent. The use of the same English accent in the mobile guide content of the place where the guide is accessed helps to bring history alive.

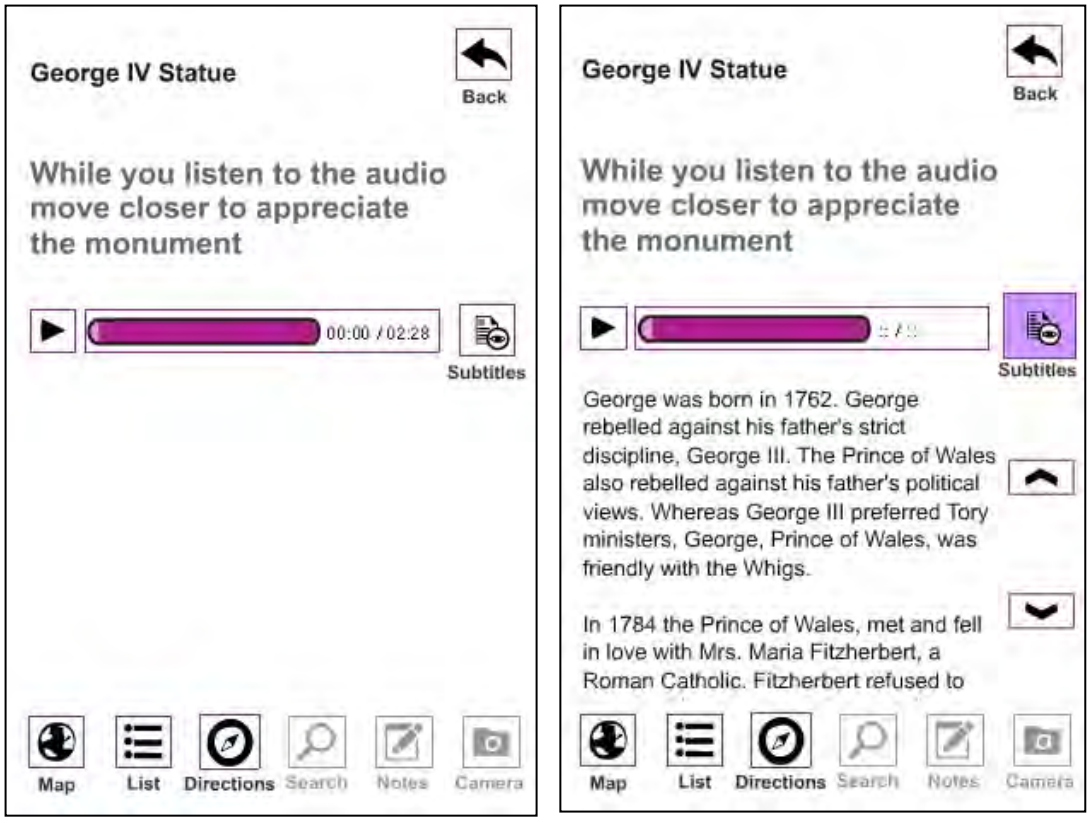


Figure 43: Audio and Subtitles in the app

Issue (37): The majority of participants did not show any preference for English accent type. SE: ********** (13)

On the other hand, the preference for accent might be related to the way the content was delivered in the audio guide. When we look at their options and how they justified their opinion, they frequently mentioned the mode it was presented. Seventeen users preferred the audio with two speakers and fourteen with one speaker. Native speakers, for the most part (8 – 90%), opted for the first situation. Intermediate level speakers favoured the second option. The responses of advanced level speakers answers were balanced. Participants from Asia also chose the first option: this might be because they were from countries whose second language is English. (Table 26).

	One speaker	Two speakers	Both	All
Asia	1 (17%)	5 (84%)	0	6
Europe	6 (67%)	3 (33%)	0	9
South America	6 (75%)	2 (25%)	0	8
United Kingdom	1 (11%)	7 (78%)	1 (11%)	9
All	14	17	1	

Table 26: Preference of audio per nationality

Participants who chose the first option were entertained by it. The two speakers gave life to the history of the sites. Moreover, they put themselves in the same situation as the speakers – they were looking at the monuments and appreciating them. Furthermore, the dialogue gave two perspectives on the subject content. Without the barrier of the language they could appreciate and understand the speakers' points of view. By contrast, intermediate English speakers found the first audio confusing and demanding. They were not so familiar with the colloquial English words and accent in the audio. Additionally, they found it difficult to pay attention to two speakers with distractions of the environment such as background noise from the audio file and noise setting. The option for one speaker was also justified by the content. Participants with intermediate English were not in England for a substantial amount of time: some of them were tourists, while others were living in England for about six months. Most of them were visiting Brighton for the day. The second audio option was straightforward and was not based on the opinions of the speakers. (Table 27).

I think that the dialogues are not the most appropriate for this occasion. Maybe a simple text read would be more appropriate. International participant

I preferred the two speakers although not quite as clear as the sole (American?) speaker. Probably have information given by the sole speaker though - he discussed all of George IV's life whilst the two speakers only talked about the statue - Because I knew the history it's not so important for me - but could be more interesting for those who don't know. Native speaker and local

Audio - two speakers - It has humour. They had similar observations to those that you have while you are in front of the object. They discuss aspects in a quite pertinent way. How they are feeling about that. Two people talking allow us different views than one voice telling what it is. Native speaker and local

Issue (38): Participants who are not fluent in English have difficulties in understanding conversations in the audio session. SE: ***** (5)

Issue (39): Native participants prefer audio files that add novelty and excitement to their background information. SE: ******* (7)

Issue (40): Audio file should not be recorded on the spot, because of city noise. SE: ******* (7)

Occasionally users' choices were also related to the content delivered or the credibility of the speakers. George IV audio was an overview about the figure of George IV and history. In the Queen Victoria audio the speakers had an informal conversation about the sculpture. Therefore, native speakers were more attracted by the conversation that did not have a historical background. On the other hand, internationals wanted to know more about the famous figure portrayed. Beyond that, credibility was also a topic that called the attention of participants. It was very relevant for them to know who the speakers were, so that they could trust them. When there was a narrator, it was not so relevant to know who the speaker was, as the text was not based on narrator's beliefs. Participants with a background in the Arts raised the issue of credibility. According to participants, this information should be available in the beginning of the audio file or accessible to see any time they wanted.

Issue (41): When the audio files contain opinions and beliefs of the speakers, credit should be given. SE: ******* (7)

I don't like the conversation. I'd like to have only one man speaking and explain more scientifically. Participant 16 International

The podcast with two speakers – in my opinion the traffic on the record disturbs me as well. It should be recorded in a studio. I have the noise of the traffic and the noise of the traffic of the video. Participant 26

I don't like (QV): it's like an interview. It gives you the notion that it is not professional, different style. Casual kind of interview, it might be good for video or maybe radio but not for this. Participant 29 – International

	One speaker	Two speakers	Both	All
Native speakers	1 (11%)	7 (78%)	1 (11%)	9
Intermediate	5 (83%)	1 (17%)	0	6
Advanced	8 (47%)	9 (53%)	0	17
All	14 (44%)	17 (53%)	1 (3%)	32

Table 27: English level versus audio preference

E) Subtitles

Only eight people accessed the subtitles in the first part of the tour, while others (eight) did not try the subtitles at all. Some of them did not notice the icon. The icon was not evident and after pressing play users followed the instructions on the audio screen or looked at the statues. Native speakers (70%) either did not try the subtitles or found them less essential than non-native speakers. The same occurred between International and UK visitors. Overall seventeen non-English speakers rate this function as essential. Twelve participants who found the subtitles essential found the environment was a little noisy. A similar situation occurs when we look at density of people. Fifteen participants marked it essential to have subtitles in crowded settings. The use of subtitles, according to our data, is essential for non-English speakers but also when the environment is not propitious to listening to the audio without interference of noise and density of people.

Issue (42): Participants did not notice the subtitle icon. SE: ********** (10)

Issue (43): When accessing video/audio files in outdoor noisy and crowded settings, internationals and non English speakers found it essential to have subtitles. SE: ********** (17)

When accessing the subtitles, a few participants (3) found it difficult to follow the subtitles while listening to the text. They agreed with participants' opinions about the George IV text, which had a similar configuration. The text did not scroll according to the user needs. A large portion of text changed when users pressed on the arrows to see further text. Users wanted more control of the text.

The scroll of the subtitles is so quick. What kind of jump is that? It jumps a lot. (He has to remember what the last line that he read is). Participant 12

Issue (44): User cannot scroll the text in his pace. SE: *** (3)

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F) Video

The use of video in outdoor settings is a cumbersome activity. Zhang (2007) points out certain technology constraints of mobile devices and wireless networks with regard to multimedia based mobile content. These include long latency while transmitting multimedia data over networks, mobile device decoding power, media formats and memory capacity. Some of these factors were also identified in the evaluation of the prototype. The videos in the application were streamed over mobile network and occasionally participants had to wait for watching it. (Figure 44). Consequently, they asked the researcher if the situation was normal and what they should do. Some of them tapped several times on the play button, which restarted the process every time they tapped. Users familiar with the technology tried to forward the video, but were not successful. Likewise in the audio session, participants who were not familiar with the device had difficulties finding the volume controls that were not on the screen. Participants also had problems in understanding how the playback controls appeared by tapping on the screen. This action was learned by trial and error.

Issue (45): Participants had to wait to see the video and did not know if it was loading the video or if the app had crashed. SE: ********** (16)

Issue (46): Users unfamiliar with technology did not know how to forward the video. SE: ***** (5)

Issue (47): When accessing videos in outdoor settings using a mobile phone, visitors should not stop watching or miss some parts of the video because they cannot find the volume controls of the video. SE: ***** (5)

Issue (48): Users did not know that tapping on the screen would cause video controls to appear on the screen. SE: ** (2)

Apart from the functional factors, six participants who had previous experience with touch screen devices turned the screen to landscape position to watch the video. Others waited for the video starts to turn the device. The videos were set up on landscape. The inclination to turn the device to landscape position even before the video starts is evidence that participants expect to have video in the landscape mode.

Issue (49): Users with experience with touch screen devices were used to seeing videos in landscape format SE: ****** (6)

Figure 44: Video

For participants video was the least important feature to have in mobile guides. Nine people did not find video important. Two people did not access video in the overall tour. However, in the questionnaire answers, it is true to say that seven users did not try the George IV video and three did not try the Queen Victoria one. Participants who did not try the Queen Victoria video watched the George IV video before or did not watch any video in the tour. Those who did not

try the George IV video watched Queen Victoria previously. This shows they were curious to see the videos but were not totally satisfied to try it on the subsequent sculpture. The same did not happen with audio content, in which all participants had a goal. A few watched just one video. Aditionally, not all the participants watched the video until the end. Particularly in the case of George IV video, which is more than four minutes long, fourteen people judge it excessive in length. Eight users (25%) did not watch it. The Queen Victoria video was 2 min long and ten people (30%) indicated it was long, although only three people did not watch it.

Issue (50): When accessing videos in outdoor settings using a mobile phone, visitors should not have to abandon the video because of the video length. SE: ********** (14)

None of the participants had previous experience with mobile city video guides. However, five participants had experience with museum video guides. However these participants did not access more videos on the tour than others. In general, the sample gave a fresh view of participants' opinions of using video in multimedia outdoor guides.

According to the sample studied, twenty-seven participants (85%) had never watched videos on mobile phones. Similarities of choices were found among eight participants who also did not mark video as an essential feature to have on mobile guides. Seven (87%) preferred to have text with hyperlinks than read a long text on the mobile phone screen and appreciated having audio content. Additionally, they chose to see by default nearby monuments on the map (63%) and would not give more than 30 min (50%) or 2 hours (50%) to do the tour. Their profile indicates preferences for straightforward ways to deliver content and fast access. Five participants (63%) were internationals and did not live in Brighton. Therefore they did not have as much time in the same manner as residents. The older participants in the experiment were part of this group. Five (63%) were between thirty-five years old and seventy one years old. Perhaps the use of video on mobile phones is a new trend and they are not used to it. On the other hand, reading the text in front of the monuments was their first attitude in front of the sculpture. (Table 28, 29).

Issue (51): Users did not find it essential to have video in the multimedia guides, preferring to see text with hyperlinks than a long text on the screen. SE: ******* (7)

Issue (52): Users did not find essential to have video in the multimedia guides prefer to see the nearby monuments first on the map. SE: ***** (5)

Issue (53): Users did not find it essential to have video in the multimedia guides, findimg it essential to have audio files. SE: ****** (6)

Issue (54): Visitors and international users found it more important to have audio than video in outdoor settings. SE: ***** (5)

	Live in Brighton	Age	English level	Video guide	Time availability	Essential Video	Essential Audio option
P03	yes	25	Advanced	No	15min to 30 min	2	5
P08	yes	71	Native speaker	No	1h to 2 hours	0	4
P10	yes	23	Advanced	No	15min to 30 min	1	2
P19	No	35	Advanced	No	1h to 2 hours	2	5
P23	No	55	Pre-Intermediate	No	15min to 30 min	1	3
P25	No	46	Native speaker	No	1h to 2 hours	2	5
P26	No	46	Native speaker	No	1h to 2 hours	1	3
P28	No	26	Advanced	No	15min to 30 min	0	4

Table 28: Participants who did not find video an essential feature

Issue (55): Older users accessed text more often than video in outdoor settings. SE: ****** (6)

George IV video was focused on George IV's life and the Queen Victoria video was mainly about the symbolism of a picture of Queen Victoria. When asked, users said they preferred to have information about the subject in the video content. They also mentioned that the Queen Victoria video encouraged them to observe the details on the sculpture.

When you are standing in front of the statue she is looking at you. When you look from far she looks more ponderous. What the comment in the video said about the painting gave a different aspect of her and how she gave in the middle distance now I can appreciate better about this statue because of the video. It is only if you stand away from her staring at you. Participant 31

			Access in the field			
	Text	**First page map**	**Text GIV**	**Text QV**	**Video QV**	**Video GIV**
P03	Text with hyperlinks	Nearby	0	0	0	0
P08	Full text	Nearby	1st	1st	0	0
P10	Text with hyperlinks	Nearby	0	0	0	0
P19	Text with hyperlinks	all monuments	1st	0	0	0
P23	Text with hyperlinks	Nearby	1st	1st	0	0
P25	Text with hyperlinks	Nearby	1st	1st	3rd	0
P26	Text with hyperlinks	all monuments	1st	1st	7th	4th
P28	Text with hyperlinks	all monuments	1st	1st	0	0

Table 29: Participants that did not access video in the field

Issue (57): Participants preferred the George IV video instead of Queen Victoria video, because the last was focused on one picture of the Queen. They found it more interesting to find out about George IV's life. SE: **** (4)

Issue (58): Video based on pictures of the subject can lead participants to compare and see details they would not see without this visual stimulus SE: * (1)

Figure 45: Map in the app

G) Map

Wayfinding was not the major concern of this field study. However, participants relied on the map to find the points of interest and gave suggestions for presentation improvement (Figure 45). The main improvements suggested were based on their experience using paper maps, web maps and maps on mobile devices. Nine participants were frustrated because they wanted to scroll the map to see the overview of the area. The same occurred with participants needing to zoom in and out of the map. They had previous experience with Google maps and IPhone applications, hence expected the same model of interaction.

Scroll is very important for me like in Google Maps - zoom in out. Participant 2

I would expect to zoom in by double tapping. I know with my iPhone I can expand the view. Participant 31

Issue (59): It is not possible to scroll the map. SE: ********* (9)

Issue (60): It is not possible to zoom in/ out of the map. SE: ******* (7)

Besides, users identified the lack of actions such as rotating the phone to align the map to the direction they were heading and, like Google Maps, a dot moving on the map according to their pace. The prototype did not update to their current location because of technical limitations. Users were aware of this drawback: despite this they mentioned the importance of this feature. All of these users were familiar with Google maps and maps on mobile devices.

Does it know my current location? I was expecting something like Google maps. This thing does not know which way I am facing. Participant 25.

Issue (61): Map does not switch direction according to the user's location. SE: ********* (9)

Issue (62): Map does not update graphically according to user's location. SE: ********** (13)

Additionally participants found the dots representing the points of interest very small and difficult to select. All the dots had vibration feedback which made it easier to select with confidence. Nevertheless, they were apprehensive that they might select two dots at the same time.

Issue (63): The icons on the map were very small . SE: **** (4)

Participants observed the graphic presentation of the map as well. The main dots on the map were not identified by five participants as representing points of interest in the multimedia guide. According to them, it was very subjective and did not give any identification that it was an icon. Two participants mentioned they would like to know what they were selecting before selecting it.

I'm coming to the statue and I don't know what to do. Should I press on that? (She points to the dots) Participant 8

Issue (64): It is not possible to know what the dots are before selecting them. SE: ***** (5)

Following the same line of thought, participants wished not only to know which points of interest they would see after selecting the dot icons, but also to access information about them when they were on the map. They preferred to have options to select the directions, audio, video and text before going to the content page.

What I'm trying to do is. If you held press down on it, held on, it would be nice if brought a menu. She says: Ah to say locate me take me to this monument. Like in the Google map that you hold down and it is says direct me to here. Participant 4

I would like to have options on the map. Click on the map and see if it has an audio. Listen about it while you walk to there. Participant 7

Issue (65): The app does not show options to access features available from the map screen. SE: ***** (5)

The map displayed on the prototype did not show the sea, green areas and cardinal points. Some users missed those natural landmarks. It is interesting to see that these participants were not visitors; they had lived in Brighton for more than one year.

My orientation is very graphic so if I see this dot and a green area I try to associate myself on the space. I wish in the map I had the pavilion so I could. Participant 2

Issue (66): Map does not show cardinal points, sea and green areas. SE: *** (3)

Figure 46: Directions

In the high tech prototype tested by experts the section “map” had three options “nearby, all and directions” in the same screen. Thus, to access “directions” was necessary to access “map” first. According to experts the “directions” should be accessed any time, not only when they were in the map section of the app. The suggestion was followed given a section for “directions” and another for “map” (Figure 46).

Those options made users confused and they did not know what to select “map” or “directions” when looking for locations.

Sometimes I'm not sure where I am. Because you have the map and the directions, maybe it should be under to the same thing. I don't know. Participant 7

Issue (67): Map and Directions were different sections on the app: as consequence this confused users when looking for locations. SE: *** (3)

6.4.4.2 Secondary Multimedia Features

The prototype had functions that did not work fully. Participants were advised of these constraints and encouraged to share their views of envisioning those features. Therefore, video observations and extra information provided by users gave a picture of how certain functions *should* work. Considerations about the list of points of interest, search engine pertinence and opportunities to take notes and share their views on social networks were considered here.

A) List

Thirteen participants used the list (Figure 47). Eleven were residents of Brighton for about one year, one had been living in Brighton for three months and the other was a local. They knew the spot and accessed the list to find out how many monuments were available in the App and how long it would take to arrive to the next monument. Visitors usually used the map and directions, while locals used the map. The former were new in the city, so they needed directions. Locals, despite being familiar with the city, did not remember or notice the presence of sculptures in the route. On the other hand, residents, in majority students, frequented the city centre more often than locals.

The ones who used this function appreciated its presence, however a few suggested having a function "take me there" from the list, similar to *route* in directions. Moreover, participants would have liked a brief explanation and a picture of the point of interest before selecting it, similar to the suggestions received on the map. The list did not update the user's locations, which cause frustration for certain participants.

If you are in this list, you want to find where that one is. Can you have a link map that shows where it is and a picture…? I just have tried them to see which one it is. Participant 4

Issue (68): Residents accessed the list more often than visitors and locals. SE: ********** (10)
Issue (69): Participants used the list to see what the next point of interest is. SE: **** (4)
Issue (70): The "route"/ "take me there" function is not available from the list. SE: **** (4)
Issue (71): The list does not show a link for a picture and a preview of the content. SE: ** (2)

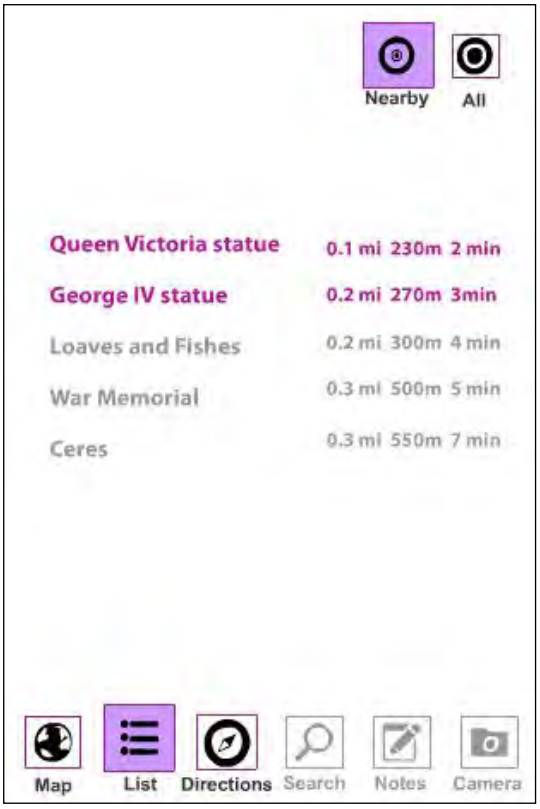

Figure 47: List

B) Search

Seven participants gave their opinions about this search engine. Three participants used the search to look for specific points of interest e.g. statues, plaques and landmarks. Two did not know what to search for and suggested the use of categories such as: streets, statues, and buildings. Two would like also to retrieve the results from the Internet. Another one suggested having the results displayed with directions ("take me there" function).

What is the search about? It's not highlighted I'm not sure If I suppose to click on it now. To find monuments, sculptures if I know a name. It should be in the home page. I want to see fountains in Brighton and it can show me the map with all the fountains. And I can also to see the list, fix my direction to go there. You need anyway in the middle of that. Because if I am tired I can say I want to find building ... beaches. Participant 10

But the search one I don't really know what can I search for or maybe if I know a particular place that I want to see that can be the search, but if the search is just to search out the sculptures if may is not listed and go for the search. If it is a general app I don't want to get a lot of the results, personally I don't use the search on a mobile phone I try to find to find from a list. Participant 11

Issue (72): Participants searched on the search engine for known points of interest SE: *** (3)

Issue (73): Participants did not know what to search for. SE: ** (2)

Issue (74): Search results did not have the option “take me there”. SE: ** (2)

Issue (75): Search results did not display a link to go to explore websites about the theme - Wikitude. SE: ** (2)

C) Notes

Ten participants shared their opinion about the icon “notes” in the app (Figure 48). They identified “notes” as a label for private notes about their experience and points of interest visited. When accessing the “notes” screen they saw comments from other participants and a link to share the comments. In this context, they suggested “comments” or “share” a better label for this function. Two affirmed they would not use this function as they have other resources to take notes (apps and paper/pencil). Four participants found it essential to have the “share” function and mentioned they would use it to share comments with their friends in social networks.

Social media - post photo and update to post in the same time. Share on the Internet than information about the monument. What do people say about this sculpture? Participant 22

Is it possible to share it? I want to share in Facebook or send by e-mail. I prefer to have "share" as the name of the icon. You can share and you can add comments as well. Then you see there is for sharing and then a space to comment. Resident

Issue (76): Users appreciate the possibility of sharing their thoughts and publishing in social media apps. SE: **** (4)

Issue (77): The label “notes” for sharing content in social networks was not clear: users interpret it as a function for adding private notes. SE: *** (3)

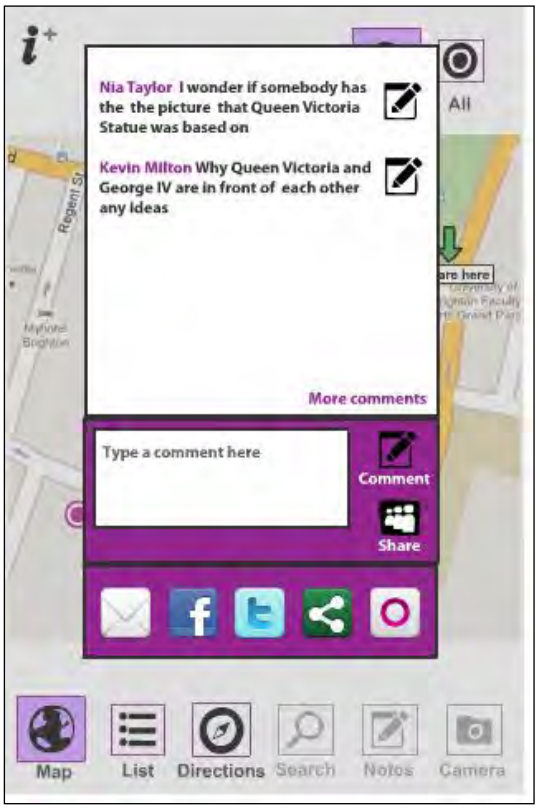

Figure 48: Notes

D) Camera

Four Visitors took pictures during the tour. Locals and residents did not show any interest in registering what they saw. Only one resident took a picture of Queen Victoria statue, because it had a traffic cone in its head. One participant made a relevant comment for integrating the "notes" with "camera" function. Nowadays, the comments are not just text but can be accompanied by pictures to be shared.

For me this icon as camera for me is no sense because why is there. You go to share, it means that you have the permission and now you are the author, you can say something, you can write something. In that sense is better to have the icon camera on the share page. You enter in a space that gives you permission to write something, share something. It is not written just but pictures too. Participant 29

Issue (78): Visitors took more pictures than residents and locals. SE: **** (4)

Issue (79): The app did not integrate "notes" to "camera", so users were not able to share a comment and a picture in the same post. SE: * (1)

6.4.4.3 Content access vs. User profile

Users' mental models reflect on the way they use the mobile phones in outdoor settings. As described in the sections above, previous experience with touch-screen mobile devices, familiarity with settings, background knowledge and age were the main effects upon their experience interacting with multimedia features surrounded by outdoors constraints. Similarly those elements also influenced how content was perceived and accessed.

Participants accessed about four features (4.5 median) to gather information in the first part of the tour. They prioritised: text (56%), audio (28%), picture gallery (13%) and looked at the pictures in full screen mode (9%). The George IV picture gallery was more often viewed than the Queen Victoria picture gallery, users were more attracted to a picture of the subject rather than the statue.

Participants with backgrounds in art and cultural heritage accessed more functions than others: eight features (8.5 median), in the tour.

Three participants verified the location of the sculpture but did not access any information in the first part of the tour. They declared themselves not interested in the subject. Ten participants, below the median (4.5), did not live in Brighton or lived in Brighton for less than three months. In their opinion, it is not necessary to have this quantity of content. They wanted to know basic information (date, who, when). As soon as they found what they were looking for they moved to the next point of interest. Nine of those participants were internationals: the content in their opinion was too much to follow and they felt tired by the end of the tour . They were asked to access more information in the second part of the tour. A clue of tiredness was observed when participants (5) sat down to follow the content.

Issue (80): In the tour participants accessed in average four features to retrieve information. SE: ********** (18)

Issue (81): Participants accessed more text than other features to retrieve information. SE: ********** (17)

Issue (82): Participants with backgrounds in art and cultural heritage accessed more features than other participants. SE: ********* (9)
Issue (83): Participants with no interest in the subject did not access any feature without being requested. SE: *** (3)
Issue (84): Internationals users were overwhelmed by accessing all the information available on the app SE: ****** (6)

Participants (14) who accessed fewer features than the average did not use touch screen mobile phones every day. It might be because they were not familiar with the device or not confident in its use. Evidence of it was when they interacted with the touch screen device during the tour. Several of them pressed instead of tapping to select functions. This problem occurred mainly with participants over fifty years old who had never used touch screen phones before.

Interaction with touch screen devices in outdoor settings was also tricky for other participants. The screen was sometimes dirty, because of the fingerprints on the screen. Participants cleaned the screen on their t-shirts or asked the researcher to clean it. Because of the environmental light, these marks disturbed even more the user's vision. Therefore, they often looked for places with shadows. Additionally, there was evidence that participants had more difficulties in seeing dark backgrounds than light ones in these conditions. Maybe due to dark colours, backgrounds retreat more than light ones, which makes typefaces looks smaller than they really are (Evans & Thomas 2008). Some suggestions were given to solve this problem. For instance, displaying an option to adjust the screen brightness.

Five participants who accessed a low number of features thought the audio and text had the same content. In this case, the audio or the text should tell users to access other content available.

Actually I don't read the content. It just I don't bother to read much, because maybe it wasn't so interesting for me. Maybe if it was like an ancient fountain. I would read why is an ancient fountain? Participant 10

Video is too much and text, too much information. The principal is the sculpture. Video/text all together for someone like me who understands [only] a bit of English is too much. The principal gets lost, the sculpture. Participant 23

For me it's ok. I think for tourists I am not sure if they would stop in front of the monument and want to know everything about it. Maybe they just want to know why this monument is here, just that. Maybe short information would be great. Because most of the time when you are with a guide, you want to walk around and you just need to stop 2 or 3 min in front of the monument. You don't have to take a long time in front of a place to explore the city. Participant 30

Now the sunshine came out. Can you see your screen? He uses the hands to protect the mobile from the sun. Participant 4

Issue (85): Participants who did not use touch screen phones frequently accessed fewer functions than the ones who did SE: ********** (14)

Issue (86): Older participants pressed the icons instead of tapping. SE: *** (3)

Issue (87): SE: Different media features were identified to have similar content by participants. ****

Issue (88): Mobile device screen was difficult to see under strong light conditions. SE: ********* (9)

Other environmental issues also affected the experience, such as noise, traffic and density of people already discussed above (Audio section). Environmental issues had their role in the trial, but the way in which the mobile device guided participants also had an impact on their experience with content. Some users expected to have a linear guide to explore the area. They mentioned the importance of being guided by the mobile device. For them, it would be easier if the mobile guide led them not just to the locations but also to the highlighted points of interest in a linear order. The suggestions provided on this point included chronological order, personal guide (avatar) and a planned route based on the location.

It is interesting to have the chronological order, like George IV should be before Queen Victoria. It is good to see the sculptures by linear chronological orde . It is possible to understand better the history. Participant 26

Issue (89): Users expected a linear guided tour. SE: **** (4)

The need for linearity also appeared when participants were reading the George IV text. This text mentioned characteristics of the sculpture and also information about other sculptures connected to it. It was confusing for users to read information about other points of interest in the middle of the George IV text. Consequently, they were distracted by these details and had to restart the text. The use of hyperlinks in Queen Victoria text solved this problem of noise in the text.

I would like to know first about the sculpture, then where it was before and after that information about the War memorial. My attention is on George IV: if I want to know more I would like to have a hyperlink, and then it's clear that I'm not in this information anymore. Participant 26.

Where are the hundred names? Oh sorry is in the War Memorial. Participant 24 was reading George IV text.

Issue (90): References to diverse points of interest in the main text confuse the users. SE: ***

A comparison of those issues as well as their relevance to the design of outdoor mobile guides is provided in the Results chapter.

6.4.5 Expert issues vs. User issues

Issues recognised by experts are compared here to the frequency they occurred during the evaluation with users. Eleven issues not applied previously in the design of the prototype had been mentioned by experts.

Issues	**Expert S/E**	**User S/E**
1. The navigation bar is always available. It can distract the user.	*	**
2. IPhone users will try to pinch instead of tap to select full screen picture	*	*
3. It is not clear that by tapping on the picture the user will go back from full screen mode	****	********
4. The audio does not play after tapping on “audio button”	**	******

5.Difficult to see the continuation of the transcription/subtitle text	*	***
6. It is not evident why links are in different colours	**	**********
7. It is not clear how to go back to the app from external links	***	**********
8. It is not clear that the icons are monuments in the map	**	*****
9. Its shows “all monuments” as the first page. What is the better option?	**	All:********* Nearby:********** *********
10. It is not possible to press and drag the map	*	*********
11. The directions page does not provide length in minutes between two sculptures	*	**

Table 30: Expert issues not implemented

In general, the presence of navigation bar (1) did not distract the users. Two participants mentioned its relevance in all the pages. One agreed with experts and found it unnecessary to have the navigation bar when accessing the content. For the other, it was not clear the bar worked with all the pages. Both were used to touchscreen phones everyday (IPhone users). They can be considered as expert users.

I don't need the navigational bar when I go to the content. Buttons in the navigation bar distract me. Participant 22

What I am concerned with here is: it is very good to have a line above these icons. Then all those icons would be detached from the current page. I expect to have them under line to tell me that these icons are working with the entire app not just with this current page. Participant 29

Only one iPhone user would like to pinch instead of tap (2) to see full screen picture. She also mentioned using the double tap to change the picture mode. The other participants (11) did not have problems changing the picture mode. On the other hand, they were more often frustrated when trying to scroll and drag the map and text.

Participants not familiar with technology had more difficulties in returning from full screen pictures (3). This was discussed in section 6.4.3.1.3. However six users agreed with experts.

Twelve users had to restart the audio file to put on the headphones before listening to the audio (4). This issue is explained in section 6.4.3.1.4.

Problems following the subtitles (5) are covered in section 6.4.3.1.5.

Hyperlinks were not easy to identify in the text (6). This issue is discussed in section 6.4.3.1.2.

Users familiar with the mobile device used it in the study to find out how to go back from external links (7). This was a relevant issue and it was discussed in section 6.4.3.1.2.

It was not clear that dots represented monuments on the map (8). This issue was discussed in section 6.4.3.1.7.

Twenty-three participants preferred to see "Nearby monuments" in the map as the first mode (9). Some similarities were found in this group, discussed in the end of section 6.4.3.1.6. Participants with previous experience with touch screen phones – IPhone users mainly – expected to press and drag/scroll the map (10). This issue was discussed in section 6.4.3.1.7.

The points of interest in the tour (11) were localised a short walk from the start point. Two participants would like to see the route, in directions, with the distance between the current point and the next point of interest to be visited.

I want to see how to get there. Here should have how long do I have to walk or if I have to take a bus, which bus should I take and where? Participant 11

The suggestions made by experts were clarified by the user's evaluation. Questions such as "tap to play to start audio" (4), hyperlinks transparency (6), back from external links and full screen picture mode (7; 8), icon transparency in the map (8) and press and drag to move the map (9) were issues highlighted by users. These issues are extremely relevant to the design of cultural mobile apps for outdoor settings.

6.4.7 Discussion

Interesting facts are not only the ones that had high scores in the prototype evaluation. The qualitative analysis of videos and questionnaires highlighted issues present in designing multimedia mobile guides for use in outdoor settings. To summarise the findings, first the

higher score of strengths of evidence will be discussed followed by the low scores highlighted in the evaluation.

Few high score issues were related to technology and problems not possible to solve in the prototype development. Problems with Internet connection such as loading audio and video files, coming back from external links and the location tracker functions were primary in this category. Following these, it was the impossibility of scrolling the map, switching it according to the route taken and zooming in/out the map. These were features users expected to have in the guide based on their background using desktop applications and mobile applications.

Other higher score issues were more relevant to multimedia mobile interface and content design. For instance, the lack of volume controls on the screen, visibility of hyperlinks and instructions of how to go back from full screen pictures. In the first case, participants who were familiar with the type of the device did not mention this issue. Secondly, more evidence in the hyperlinks presentation was requested based on the user's technology background. Although the hyperlinks were in different colours, as in certain Webpages, participants needed more evidence of it on mobile devices. Thirdly, coherence of controls was expected in all the pages of the app. In this case, the majority were not frequent users of touch screens. They often relied on the back button of the phone when they did not know how to proceed. Returning to the previous state of the system offered them confidence. However, they had difficulties to get back from full screen, by trial and error they learnt how to do this action. Certain actions appeared to be instinctive and intrinsic to the context. It was also true when participants by instinct turned the screen to landscape to see a video.

Multitasking was also a trend observed in this study. Participants appreciated being able to listen to the audio and at the same time interact with other functions on the system. The text was recognised as the feature that requested more users' attention. Occasionally users had to restart reading the text in order to focus. They also identified the importance of messages to lead participants to see other parts of the system or observe carefully points of interest.

Although international and visiting participants were sometimes overwhelmed with content and diverse ways of presenting it, it was found relevant to have diversity of choices. Availability of multimedia choices is not only related to a participant's profile but also with environmental context. Environmental issues were observed with participants in the field but were not possible to duplicate in the lab tests. Text was preferred when there was noise in the surroundings. Audio was supported by the use of subtitles in the same conditions. Additionally, audio was more strongly indicated when participants wanted to explore the environment with visually, observing the details of the sculpture or when light conditions were not proper to visualise the screen. Video was suitable for before or after the tour, in their words, to be accessed in a comfortable place. Overall, participants watched the video not more than two minutes.

The length of the tours and the quantity of sections visited was proportional to the familiarity with the content, language skills and time availability. Locals and UK residents spent more time in the tour and accessed more functions than Internationals and/or visitors.

Participants who did not easily identify how certain functions worked requested the presence of a help system. In their opinion this should include information on: how to backtrack from full screen pictures, explaining the colour words were hyperlinks, how to close the application and interact by tapping instead of pressing on the screen.

The presence of hyperlinks was positively identified as a factor to improve their experience. Text with hyperlinks was considered more organised and easier to understand than the other option.

For the most part, the users' evaluation gave references on how to use multimedia features on mobile devices in outdoor settings. The presence of diverse ways to deliver information was essential to cater for the public of touristic and historical places. Tourists, locals and residents do not always have the same language, background and time available to visit the places. The use of tailored systems would facilitate and customise those applications. However, it is not straightforward to develop applications for a very mixed public. In the second part of the study

international visitors were requested to interact more with the system. In real situations, they would not access those functions, as was attested in the first part of the tour. Moreover, it was valuable for residents and locals to have more options to explore the system. Likewise, subtitles were relevant for those without advanced English. Native and advanced speakers were not uncomfortable with the presence of this feature. Ideally, a system that has equilibrium of essential functions, for the clusters identified in this study, is the best option.

6.5 Conclusion

This chapter described the evaluation studies of the mobile guide prototype, including the methods, data analysis and findings for the expert evaluation followed by the user evaluation. Additionally, the issues brought up by experts and users were classified according to the strength of evidence and confidence levels during the evaluation.

Throughout, it was clear to see the variety of users' characteristics present in this study. A balance of essential issues for this diverse public should be utilised for developing mobile applications for outdoor settings. The environmental context played an important role in user experience. It affected the use of multimedia in outdoor settings in conjunction with user characteristics, such as residence, language skills and familiarity with technology. These issues would not have been possible to identify in lab tests. On the other hand, questions relating to interface design were more often distinguished by experts in the lab evaluation.

The next chapter shows a framework of elements identified in this thesis that influenced the user experience when visiting historical places in outdoor settings. These elements were identified during the field work sessions, which aimed to gather requirements for designing and developing the prototype and prototype evaluation study. In addition, we present a toolkit with a list of recommendations to help designers developing multimedia outdoor mobile guides.

7 Results

7.1 Introduction

The research reported in the six preceding chapters had two major outcomes:

- frameworks of factors illustrating users' experience with mobile guides
- list of design recommendations.

The main factors involved in the activity of being guided by a mobile device to access information in outdoor settings were illustrated via three frameworks organised by a) look and feel, b) context and c) content. Factors were collected during the preliminary research and the evaluation phase with user studies. Subsequently, the factors identified in the prototype evaluation (Chapter 6) were extracted from the frameworks and modelled in a wheel of relationships centred on user characteristics. In this wheel it was possible to identify relations between user characteristics and look and feel, content and context elements. A further three wheels that indicate 90 recommendations for the design of outdoor mobile guides accompany the relationship wheel.

7.2 Framework of factors

The frameworks presented here were a work in progress during the period of this research. The first version of the frameworks may be found in Chapter 4 – Design Research Activities, which grouped elements identified in the field studies. In the versions presented here the elements identified during the Evaluation phase were added and coloured in orange.

Influential factors were organised in three frameworks to facilitate visualisation, i.e. look and feel, content and context factors (see Fig 51). The look and feel framework illustrates syntactic elements that helped or disturbed users in accessing content. The second framework has essential elements to deliver and understand content meaning. The third framework highlights surrounding elements relating to users' interaction with the device such as users (audience), information sources (booklet, devices) and ambience (environment and way finding situations).

The frameworks have some similar elements that cross boundaries. This occurred because these were observed from diverse points of view and were related together. It was clear that more factors associated to multimedia issues were added in this last version of frameworks. This was to be expected, as the focus of the evaluation study was to test a prototype mobile guide and identify how multimedia elements on mobile phones should be designed to deliver cultural heritage information (Figure 49, 50 e 51).

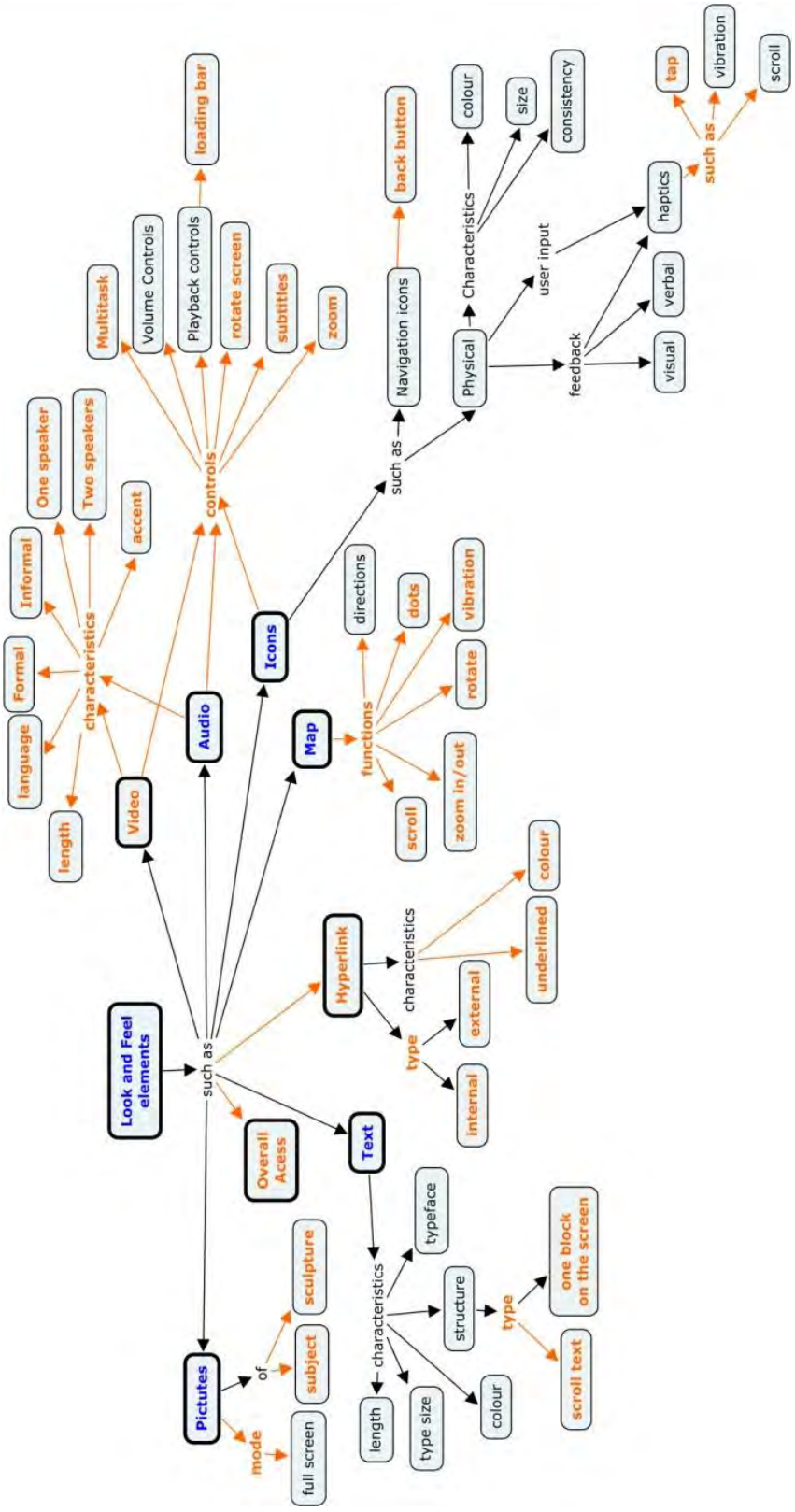

Figure 49: Framework 1 - Look and Feel elements

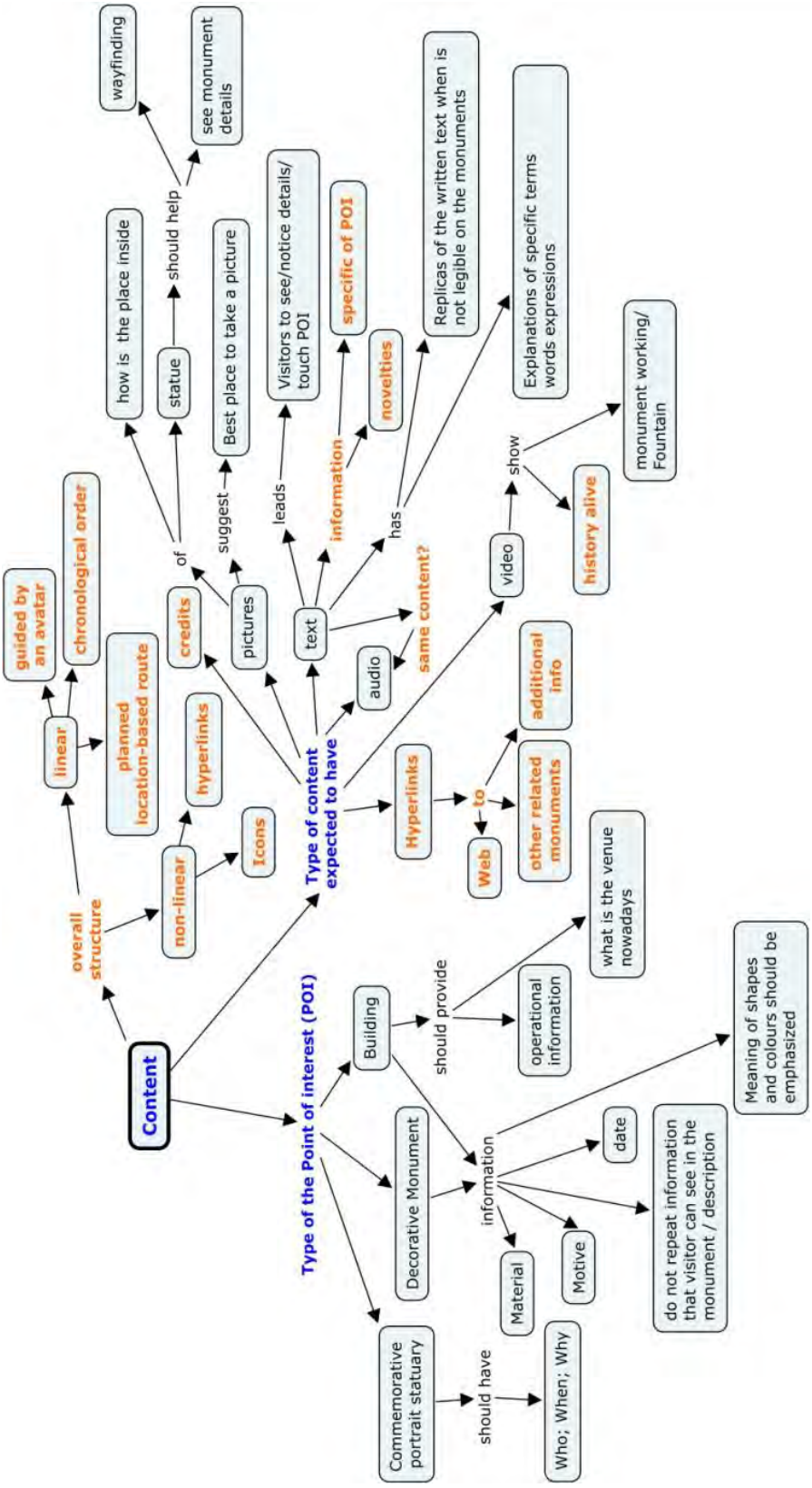

Figure 50: Framework 2 - Content elements

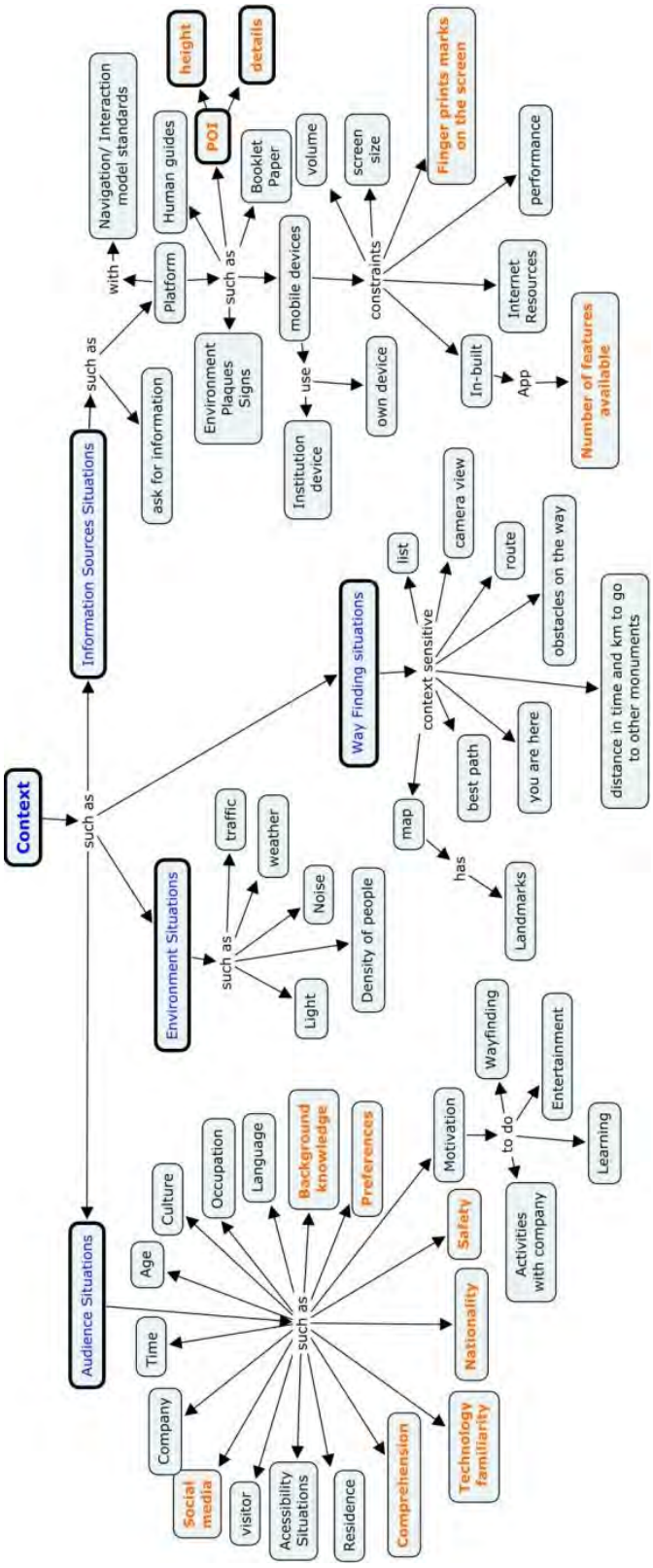

Figure 51: Framework 3 - Context elements

Following the identification of influence factors, there was a need to develop a tool to enable a designer to consult how these factors might affect the user's experience with mobile guides. First of all, it was necessary to integrate the frameworks to be consulted in a manageable way. It was observed that audience situations (in Framework 3) were the relationship key. Audience situations (user characteristics) were connected to all other factors in the frameworks; therefore these elements were extracted from the "Context framework" and centralised in a model to integrate the three frameworks. Although user characteristics belong to context instances, they also affected look and feel elements and content interpretation. (Figure 52).

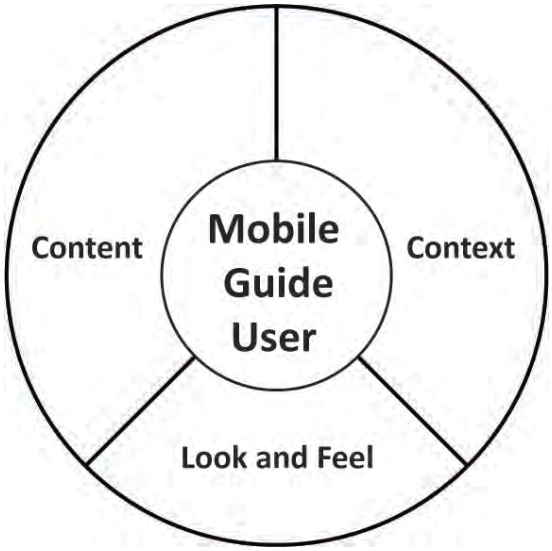

Figure 52: User centred design mobile guide integration model

From this model, a design tool kit was developed to enable designers to consult recommendations based on the influence factors.

7.3 Design tool kit

In the integration model (Fig 52) user characteristics were connected to three categories of look and feel, content and context elements. Each category provided recommendations to design mobile outdoor guides. Not all the factors presented in the frameworks appeared in the design toolkit, only the ones that appeared in the prototype evaluation (Chapter Six). Factors observed in the prototype evaluation emerged from user tests and generated the most reliable and trustworthy recommendations.

A toolkit was created in the form of four graphic wheels to help designers consult the design recommendations. The toolkit has four wheels and a list of 90 recommendations. The main wheel shows the relationship of factors. The Look and Feel wheel, Content wheel and Context wheel indicate the design recommendations. I am going to show later how they work with the four examples given in the Introduction chapter.

The main wheel is a detailed version of the integration model (Figure 53). It points out the relationships between user characteristics and the look and feel, content and context factors. A code system was applied. Every category has a colour – User (orange); Look and feel (pink); Context (green) and Content (blue) and the wheels are divided into smaller categories labelled with letters in alphabetic order. User factors are labelled with uppercase letters to distinguish them from other categories' elements which have lowercase letters. From the user elements in the centre, it is possible to identify the relationships between of user characteristics and other factors.

As illustrated in Figure 53 - A-age is accompanied by a c l m in pink. This means that user's age might affect how audio (a), text (c), icons (l) and video (m) should be displayed on the mobile guide phone screen. From this relation A – Age and a-audio; c-text; l-icon and m-video, a number of recommendations are available for consultation in the other wheels. In this case, as all the relations (low-case letters) are in pink the wheel to consult is the Look and Feel wheel.

The look and feel (Figure 54), content (Figure 55), and context (Figure 56) wheels are divided into categories and display the specific number of the recommendation accompanied by an uppercase letter. The upper case letter indicates the user characteristics present in the Relationship wheel. Therefore, when a designer wants to consult the recommendations directly without consulting the Relationship wheel, s/he will know which of the user characteristic (uppercase letter) relates to certain recommendations (i.e. the opposite relation to that described above). In the example above, the recommendation available for A-age connected to c-text is 1A. This recommendation is displayed in the Look and Feel wheel, text (c). The description of this recommendation is available in a list (7.3.1).

Figure 53: Relationship wheel

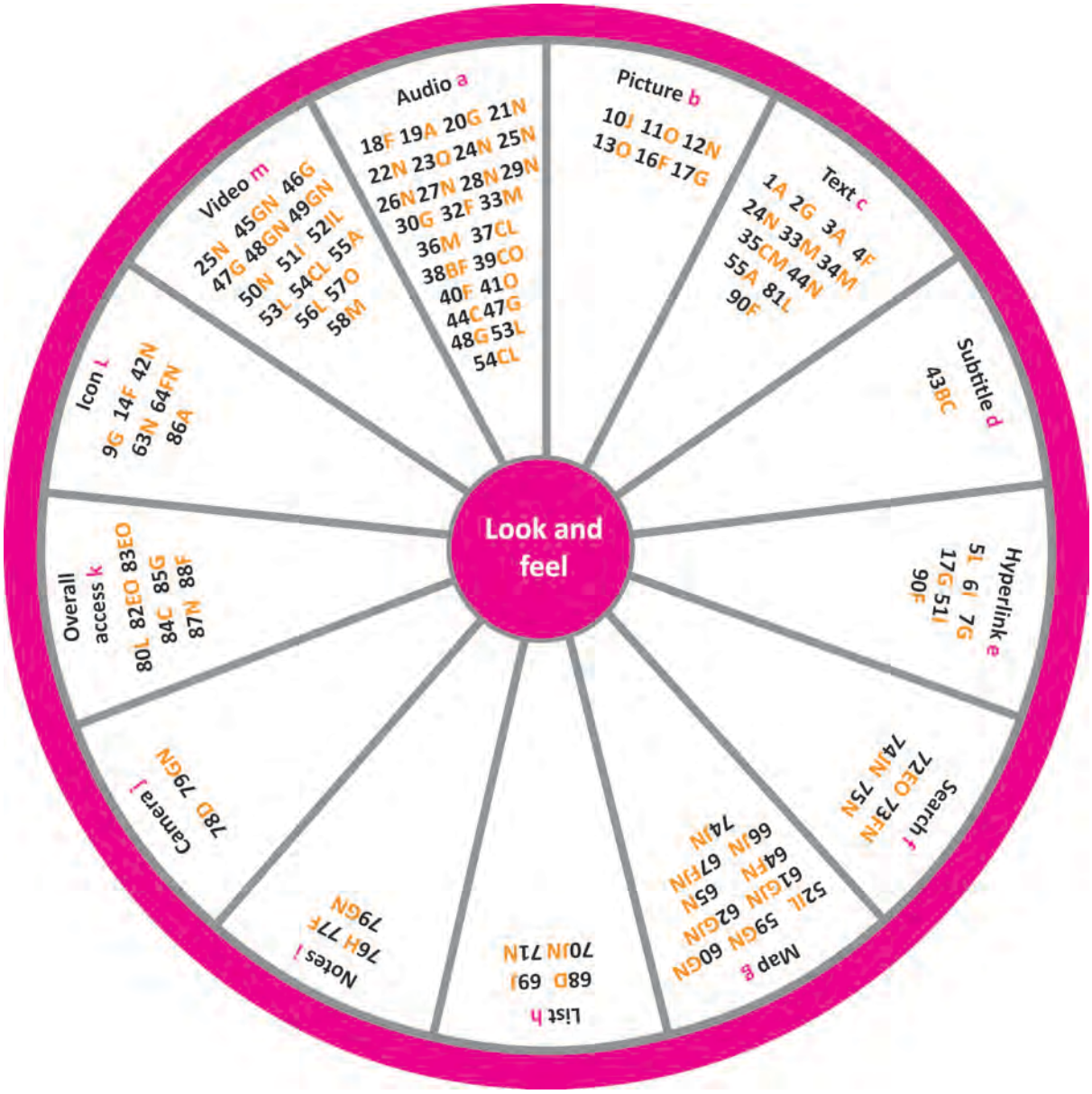

Figure 54: Look and feel wheel

Figure 55: Content wheel

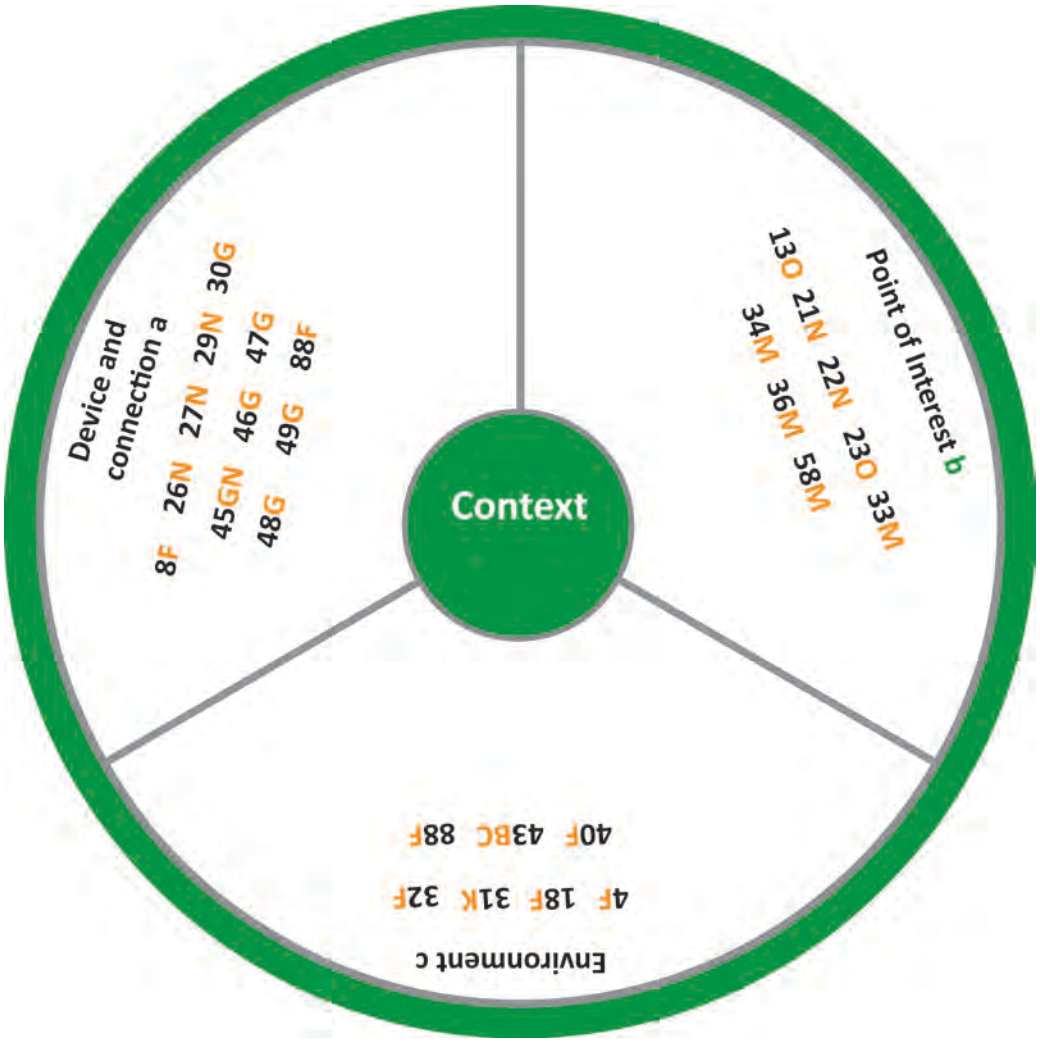

Figure 56: Context wheel

In the first chapter (Introduction) a set of questions were given as an example of some concrete issues designers might come across when designing outdoor mobile cultural guides. The answers for these questions are shown here as examples for better understanding the use of the design toolkit.

Question 1: Should photographs of the POI (sculptures, monuments) be displayed on the app interface even though users will be able to see it “in the flesh” for themselves?

How to consult the wheels: Designers may consult the Relationship wheel (orange) to look for the relationship between the use of pictures (b) and other issues. They can recognise it by the

number of times the letter (b) is in the relationship wheel. For more specific information they can look at the Look and Feel wheel (pink wheel) to identify the number of the recommendations related to the use of pictures - 10J (way finding); 11O 13O (Interest); 16F (comprehension); 17G (familiarity with technology. After that, they select the recommendation that suits their question and consult the list (Appendix I, section 7.3.1, Figure 57).

Answer: Yes, pictures of the POI help in wayfinding situations and help the user to recognise the POI when it is higher than the user´s field of vision. (See Evaluation chapter – 6.4.4.1-C).

R10 - Use pictures to help users to recognise POI they are looking for. SC: High Recommendation

R11 - Use pictures of the POI to help in way finding and pictures of subject to give context and illustrate history. SC: High Recommendation

R13 - Use pictures and other features, audio, to call user's attention to details of a POI that is very high SC: Recommended

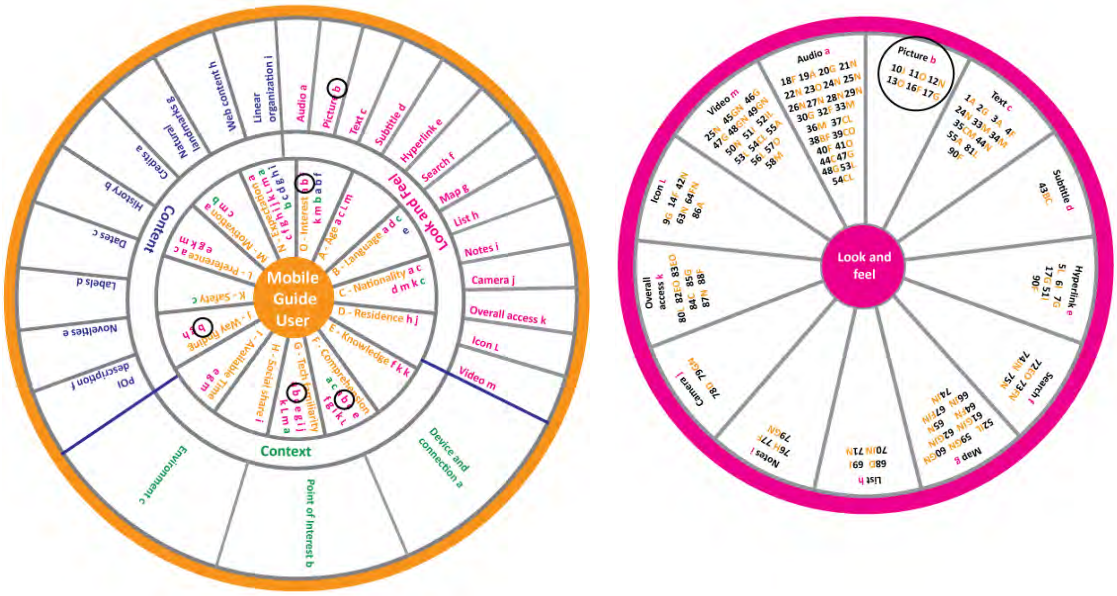

Figure 57: Question 1

Question 2: What is the maximum length of video people can watch in outdoor settings?

How to consult the wheels: Designers will identify the letter – m – for video and identify user issues related to video files. They may pick - Expectation (N) – as a possible recommendation to answer this question. After that, in the Look and Feel wheel they will select the recommendations numbers that are accompanied by the letter (N) and consult those in the list. Although the recommendations focused on the user´s expectation are very diverse, there is one – 50N – that fits on this question (Figure 58).

Answer: According to the research findings users watched the videos for less than two minutes. (See Evaluation chapter – 6.4.4.1-F).

R50 - The length of the video should be less than 2 min. SC: High Recommendation

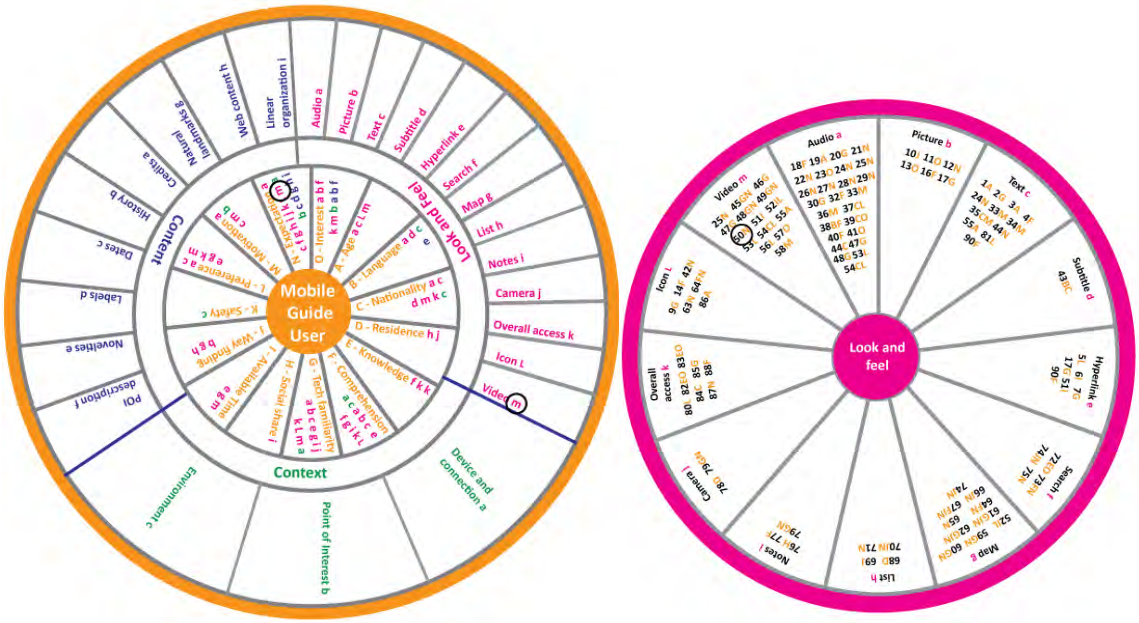

Figure 58: Question 2

Question 3: Should users be able to interact with other parts of the system while listening to the audio?

How to consult the wheels: In order to answer these questions designers may consult the Look and Feel wheel first. They will check the – Audio (a) – and will find several recommendations of how to use audio. They can check one by one in the list of recommendations or they might prefer to consult the Relationship wheel for a more specific search. As the question may be related to Expectation (N), Technology familiarity (G) or Preference (L), they can read the recommendations accompanied by those letters. They will find the answer to this question in the group of recommendations related to Expectation (N). They also may notice that some recommendations are repeated for different multimedia features (24 N and 25 N), making clear the connections between features (Figure 59).

Answer: Yes, the audio of the current file should stop if another audio file is accessed. Additionally, users should be able to access the playback buttons whenever they want. (See Evaluation chapter – 6.4.4.1-D).

R24 - When visitors listen to the audio, if they access another function the audio should not stop just in case they access features that have sound. SC: High Recommendation

R25 - Audio playback functions should be available on all the screens when an audio file is on. When accessing audio files in outdoor settings using a mobile phone, visitors might want to stop the audio when they are in a different session of the app. SC: Recommended.

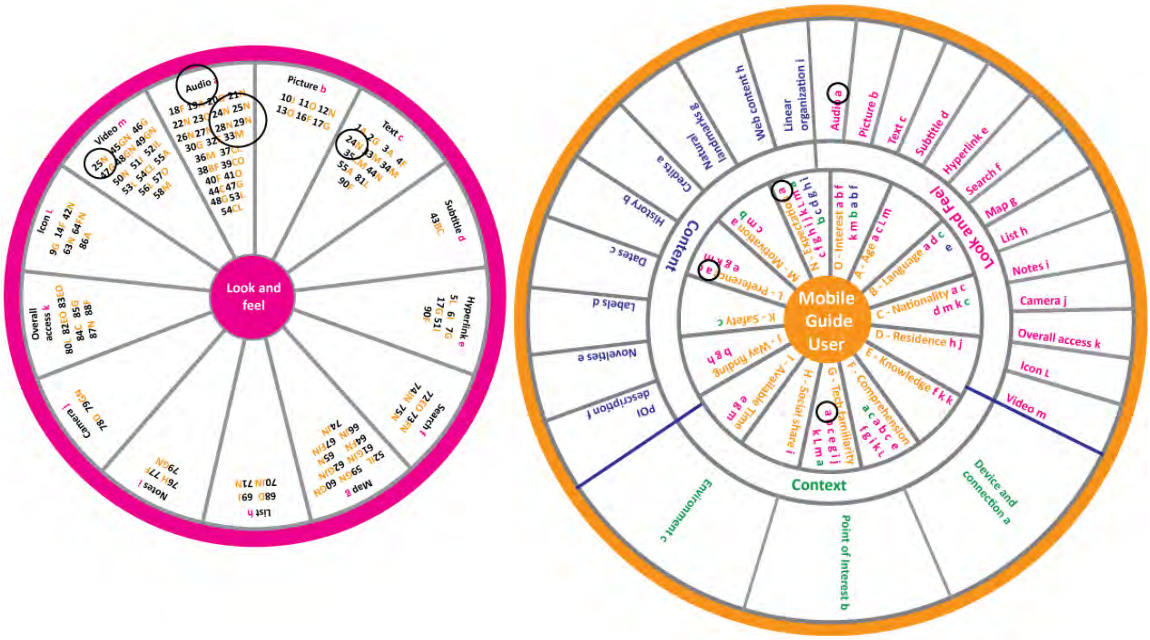

Figure 59: Question 3

Question 4: Are dialogues an appropriate style for delivery of audio content?

How to consult the wheels: As in question 3, designers can check the issue Audio (a) on the Look and Feel wheel to find recommendations and issues pertaining to content delivery using audio. Each recommendation has a number identifying the issue and a set of orange capital letters that indicate the User issues that are listed in the inner circle of the orange relationship wheel.

In reverse, the designer can also consult the inner circle of the Relationship wheel first and identify recommendation sets based on User issues using the colour coded lower-case letters listed beside each heading. For example: a designer wants to know if the user issues Language (B), Interest (O), Nationality (C) and Comprehension (F) would interfere with delivering content through audio dialogues. First s/he can identify those issues in the Relationship wheel to check whether audio is listed as an issue under each heading. Using the capital letters for each of the

user issues from the relationship wheel, s/he can then consult the three other wheels to identify specific issues and recommendations (Figure 60).

Answer: The differences between native and non-native speakers were identified as an issue that affects audio delivering. A more formal way of delivering audio content, with mainly one speaker was preferred by non-native speakers. On the other hand, an informal conversation, a dialogue with two speakers, pleased native speakers. Based on the interviews, this happened because the two speaker conversations added novel facts to native speakers' background information. In addition, they did not have difficulties in understanding the speakers' accent, which was a major issue for non-native speakers. One way to facilitate understanding for non-native speakers is to deliver subtitles with audio files. (See Evaluation chapter – 6.4.4.1-D). Additionally, participants in the evaluation study gave their opinion about audio files recorded in studio and in outdoor settings. In their opinion, the audio should be recorded in a studio setting, because the noise from the audio record can mix with current environment noise and confuse listeners. Dialogues recorded in outdoor settings were difficult to understand in situ.

R38 - Provide a straightforward way to deliver audio content. Participants who are not fluent in English have difficulties in understanding dialogues in the audio sessions. SC: Recommended.

R39 - Two speakers having a conversation and giving their opinions about the subject is one way to deliver audio content for native speakers. Native participants prefer audio files that add novelty and excitement to their background information. SC: Medium Recommendation.

R43 - Provide subtitles for users following the content. When accessing video/ audio files in outdoor noisy and crowded settings, internationals and non-English speakers found it essential to have subtitles. SC: High Recommendation.

R40 - Audio should be recorded in a studio and subtitles should be available to follow the audio file. Audio file should not be recorded on the spot, because of city noise. SC: Medium Recommendation.

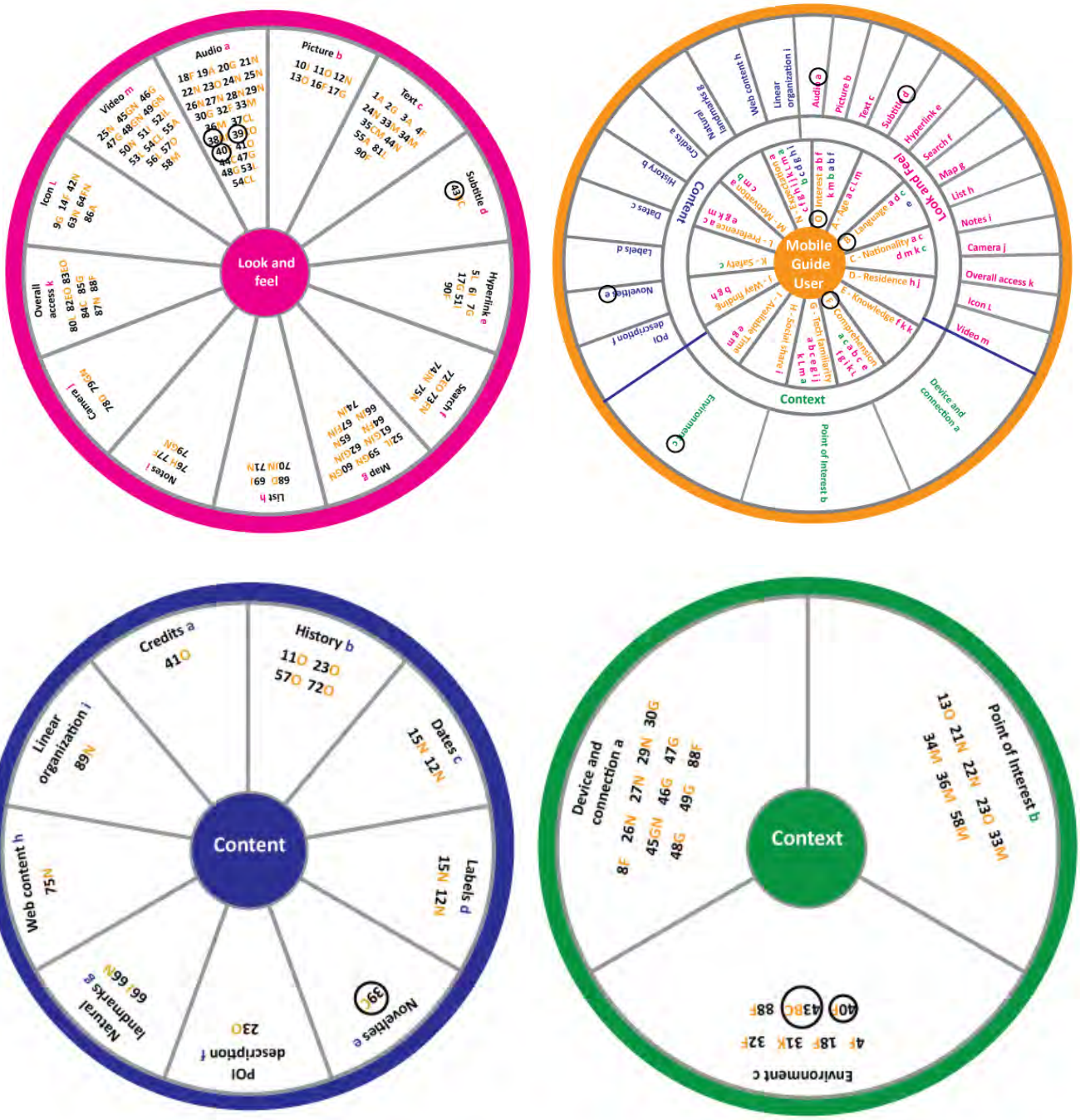

Figure 60: Question 4

7.3.1 Design recommendations list

Ninety design recommendations were identified in the prototype evaluation. The recommendations were displayed in a list. Recommendations were described accompanied by strength of confidence, issues rated by evidence and factors relationship code. Issues are rated according to the number of times they appeared in the evaluation studies, indicating the strength of evidence. The strength of confidence was given by the researcher indicating the extent to which that recommendation is trustworthy based on what was observed in the field. Some recommendations have a low level of confidence, because there was low indication of their validity, which gives opportunities for future works. Recommendations with strength of confidence over 10* are highly recommended; 5-10* medium recommended and 1-4* recommended.

Example

R55: Present different ways to deliver information in the same guide: older people are not always patient, have available time or know how to view videos on mobile phones.

SC: Medium recommended **** (6)**

Issue (55): Older users accessed text more often than video in outdoor settings.

SE: **** (6)**

Relation: Age (A) x text (c) x video (m)

Recommendations are described in a clear manner to identify the number of recommendation (55); strength of confidence (SC), the issue (55), strength of evidence (SE), relation of user characteristics (A- Age) and elements (c- text; m-video);

The list of design recommendations for outdoor mobile guides is displayed in ascending order.

R1 - Make the type size bigger than 14pt in long texts or fit the text on one screen. SC: Recommended ** (2)

Issue (01): When the block of the text does not fit in one screen, the typeface is considered smaller than when the text has a single block that fits on the screen. SE: *** (3)

Relation: Age (A) x text (c)

R2 - Use the same interaction model of the device in the app. SC: Recommended ** (2)

Issue (02): It is difficult to follow George IV text. SE: ****** (6)

Relation: Technology familiarity (G) x text (c)

R3 - The text should be shown in one block of text. SC: Recommended **(2)

Issue (03): Participants who are older than 50 years old were apprehensive to press on/scroll the screen. SE: ** (2)

Relation: Age (A) x text (c)

R4 - Offer information through audio/verbal mode. SC: Recommended ** (2)

Issue (04): Participants preferred to read the text instead of listening to the audio in noise conditions. SE: **(2)

Relation: Comprehension (F) x text (c) x environment (c)

R5 - Use hyperlinks to facilitate of users to read text in outdoor settings. SC: Medium Recommendation ******* (7)

Issue (05): Participants reported they prefer to have hyperlinks on the text than scrolling. SE: ********** (19)

Relation: Preference (L) x hyperlinks (e)

R6 - Hyperlinks should be available for users who are familiar with the content of the subject and want to know more about it. SC: Recommended *** (3)

Issue (06): Internationals spending the day in Brighton did not access links to the same extent as locals. SE: ****** (6)

Relation: Available time (I) x hyperlinks (e)

R7 - Make it blue, underline the words, or add an icon (jump) near the hyperlink. SC: Recommended ****(4)

Issue (07): When accessing text not always participants identify coloured words as hyperlinks. SE: ********** (11)

Relation: Technology familiarity (G) x hyperlinks (e)

R8 - Lead users to websites that have a mobile version. SC: Recommended ** (2)

Issue (8): When accessing external hyperlinks users do not have patience to look for content in a webpage that is not tailored to mobile devices. SE: *** (3)

Relation: Comprehension (F) x Device and connection (a)

R9 - Use the back button on the interface to go back SC: Medium Recommendation ******(6)

Issue (9): It is not clear how to go back to the app from external links. SE: ********** (15)

Relation: Technology familiarity (G) x icon (L)

R10 - Use pictures to help users to recognise POI they are looking for. SC: High Recommendation ********** (12)

Issue (10): Pictures of the statue assisted users in way finding situations. SE: ********** (12)

Relation: Way finding (J) x Pictures (b)

R11 - Use pictures of the POI to help in way finding and pictures of subject to give context and illustrate history. SC: High Recommendation ********** (14)

Issue (11): Participants would like to have both kinds of pictures for every sculpture. SE: **********(14)

Relation: Interest (O) x Pictures (b) x History (b)

R12 - Show information date and label on the pictures. SC: Recommended *(1)

Issue (12): Participants with high interest on the theme wanted the date of the picture SE: * (1)

Relation: Expectation (N) x Pictures (b) x Content – date (c) and Label (d)

R13 - Use pictures and other features, audio, to call user's attention to details of a POI that is very high SC: Recommended *****(5)

Issue (13): Users passed by a high monument and did not notice it. SE: ***** (5)

Relation: Interest (O) x Pictures (b) x POI (b)

R14 - User should be able to select this function on thumbnails mode and full screen mode. SC: Recommended ** (2)

Issue (14): The icon “info button” on the thumbnail pictures did not indicate the availability of the text replica. SE: *** (3)

Relation: Comprehension (F) x Icon (L)

R15 - Participants expect to see the same amount of information in every part of a system or sub-system (pictures section). SC: Recommended ** (2)

Issue (15): Participants would like to have an “info button” available in all the pictures containing extra info such as: dates and labels. SE: ** (2)

Relation: Expectation (N) x labels (d) x dates(c)

R16 - Add a message “tap to see full screen” in all the pictures of the picture gallery. SC: Recommended ** (2)

Issue (16): It is not evident how to see full screen pictures SE: *** (3)

Relation: Comprehension (F) x pictures (b)

R17 - Add a back button in every full screen picture. SC: Recommended ** (2)

Issue (17): Users who were not familiar with the technology did not know how to go back from pictures in full screen mode. SE: ******** (8)

Relation: Technology familiarity (G) x pictures (b) x hyperlinks (e)

R18 - The system should present information in diverse media type (text, video) not only audio so that in noise conditions users might access information to the same extent. SC: Recommended ** (2)

Issue (18): Participants were disturbed by the environmental noise while listening to the audio file. SE: **(2)

Relation: Comprehension (F) x Audio (a) x environment (c)

R19 - The system should present information in diverse media type (text, video) not only audio so that in noise conditions users might access information in the same extent. SC: Recommended ****(4)

Issue (19): Older participants were more attracted to access text than audio files. SE: **** (4)

Relation: Age (A) x audio (a) x text (c)

R20 - Information on how to use the app should be available to users. SC: Medium Recommendation ******* (7)

Issue (20): Users who are not familiar with touch screen phones did not try the audio files in the first part of the tour. SE: ******* (7)

Relation: Technology familiarity (G) x audio (a)

R21 - Two minutes to three minutes are ideal for users listening to audio files. SC: High Recommendation ********** (11)

Issue (21): The length of the audio is satisfactory. SE: ********** (11)

Relation: Expectation (N) x Audio (a) x POI (b)

R22 - The length of the audio file should be suitable to the average time spent to appreciate the monument. SC: Recommended * (1)

Issue (22): Time to listen to the audio is longer than the time to appreciate the monument. SE: * (1)

Relation: Expectation (N) x Audio (a) x POI (b)

R23 - Make available major number of audio files with different themes that users can choose. SC: Recommended

Issue (23): More audio files might be available by theme – sculpture description and subject description. SE: ** (2)

Relation: Interest (O) x Audio (a) x history (b) x POI (b)

R24 - When visitors listen to the audio, if they access another function the audio should not stop just in case they access features that have sound. SC: High Recommendation ********** (10)

Issue (24): Users should be able to interact with other parts of the system while listening to the audio. SE: ********** (10)

Relation: Expectation (N) x Audio (a) x Text (c)

R25 - Audio playback functions should be available on all the screens when audio file is on SC: Recommended ******* (7)

Issue (25): When accessing audio files in outdoor settings using a mobile phone, visitors might want to stop the audio when they are in a different session of the app. SE: *******(7)

Relation: Expectation (N) x Audio (a) x Video (m)

R26 - The audio should auto play when the user is wearing the headphones and there is only one file available. If more than one file is available user should be required to press the play button. SC: Medium Recommendation ******(6)

Issue (26): Users did not press play to start the audio if they were already wearing the headphones. SE: ****** (6)

Relation: Expectation (N) x Audio (a) x Device and Connection (a)

R27 - Time availability to put on the headphones is necessary. SC: High Recommendation ********** (12)

Issue (27): Users were not advised to put on the headphones before listening to the audio files, so that they prefer to put on the headphones and then press play to start audio files. SE: ********** (12)

Relation: Expectation (N) x Audio (a) x Device and Connection (a)

R28 - User should press play to start the audio file and the audio bar has to show it is loading. SC: High Recommendation ********** (12)

Issue (28): The audio bar did not show visually that the audio file was loaded. SE: **********(12)

Relation: Expectation (N) x Audio (a)

R29 - If it is a web app the speed of Internet connection should be high. In case of technology problems visual feedback should be provided to users – Add the word “Downloading”. SC: High Recommendation ********** (12)

Issue (29): Audio file did not start when pressed play. SE: ********** (12)

Relation: Expectation (N) x Audio (a) x Device and Connection (a)

R30 - It should have the volume controls on the touch screen of the phone SC: High Recommendation ********** (10)

Issue (30): Participants who were not familiar with the device did not know how to increase the audio volume. SE: ********** (10)

Relation: Technology familiarity (G) x Audio (a) x Device and Connection (a)

R31 - Alerts should be given to users when crossing streets. SC: Medium Recommendation ****** (6)

Issue (31): Participants might be under risky (traffic safety) were distracted when interacting with the app. SE: ****** (6)

Relation: Safety (K) x Environment (c)

R32 - Offer subtitles or other ways to deliver information available in the audio file. SC: High Recommendation **********(11)

Issue (32): Participants who were in noisy environments were also not satisfied with audio files. SE: ********** (11)

Relation: Comprehension (F) x Audio (a) x Environment (c)

R33 - Mobile guides should display messages to motivate users to look at monument piece. SC: High Recommendation **********(21)

Issue (33): Text suggestions on the audio screen motivate users to look at monuments instead of looking at the screen. SE: ********** (21)

Relation: Motivation (M) x Audio (a) x Text (c) x POI (b)

R34 - It should be given suggestions to move further away when monuments are high and better observed by distance. SC: Recommended ****(4)

Issue (34): Instructions should be given according to the size of the monument. SE: **** (4)

Relation: Motivation (M) x Text (c) x POI (b)

R35 - Change the word “appreciate” to “see the details” in the text SC: Recommended **(2)

Issue (35): Internationals did not follow the suggestions to move closer to appreciate the monument in the same extent as native/national visitors. SE: ******* (4)

Relation: Motivation (M) x Nationality (C) x Text (c)

R36 - Audio may lead participants to direct their sight to monuments and surroundings details. SC: High Recommendation ********** (25)

Issue (36): Participants noticed another sculpture in the surroundings because of audio speaker’s incentive. SE: ********** (25)

Relation: Motivation (M) x Audio (a)

R37 - Although the American accent was preferred by Internationals, it is indicated to use in audio and video the accent of the region where the guide is accessed. SC: Medium Recommendation ******** (8)

Issue (37): The majority of participants did not show any preference for English accent type. SE: ********** (13)

Relation: Nationality (C) x Audio (a)

R38 - Provide a straightforward way to deliver audio content. SC: Recommended ** (2)

Issue (38): Participants that are not fluent in English have difficulties to understand conversations in the audio session. SE: ***** (3)

Relation: Language (B) x Audio (a)

R39 - Two speakers having a conversation and giving their opinions about the subject is one way to deliver audio content for native speakers. SC: Medium Recommendation ********(8)

Issue (39): Native participants prefer audio files that add novelty and excitement to their background information. SE: ******* (7)

Relation: Nationality (C) x Audio (a) x Novelties (e)

R40 - Audio should be recorded in a studio and subtitles should be available to follow the audio file. SC: Medium Recommendation ******* (7)
Issue (40): Audio file should not be recorded on the spot, because of city noise. SE: ******* (7)
Relation: Comprehension (F) x Audio (a) x Environment (c)

R41 - The credit should be given in the beginning of the audio file or accessible to request any time users want. SC: Recommended **(2)
Issue (41): When the audio files contain opinions and believes of the speakers, credit should be given. SE: ******* (7)
Relation: Interest (O) x Audio (a) x Credits (a)

R42 - Place the subtitle icon near the play button. All the functions active should be together on the interface. SC: Recommended ** (2)
Issue (42): Participants did not notice the subtitle icon. SE: ********** (10)
Relation: Expectation (N) x Icon (L)

R43 - Provide subtitles for users follow the content. SC: High Recommendation ********** (15)
Issue (43): When accessing video/ audio files in outdoor noisy and crowded settings, internationals and non English speakers found it essential to have subtitles. SE: ********** (17)
Relation: Nationality (C) x Subtitles (d) x Environment (c)

R44 - The text should scroll smoothly and easy to control. SC: Recommended ** (2)
Issue (44): User cannot scroll the text in his pace. SE: ***(3)
Relation: Expectation (N) x Text (c)

R45: While the video is loading provide feedback to users e.g. add a message “downloading”. SC: High Recommendation **********(16)

Issue (45): Participants had to wait to see the video and did not know if it was loading the video or the app crashed. SE: ********** (16)
Relation: Expectation (N) x Video (m) x Device and Connection (a)

R46 - Provide feedback when users want to forward the video. SC: Recommended *****(5)
Issue (46): Users unfamiliar with technology did not know how to forward the video. SE: ***** (5)
Relation: Technology familiarity (G) x Video (m) x Device and Connection (a)

R47 - Volume controls should be present on the screen. If they are used to the phone controls this option is not absolutely necessary. On the other hand, when watching the videos participants are looking at the screen, so it is easier to change the volume if the controls are on the screen. SC: Recommended *****(5)
Issue (47): When accessing videos in outdoor settings using a mobile phone, visitors should not stop watching or miss some parts of the video because they cannot find the volume controls of the video. SE: ***** (5)
Relation: Technology familiarity (G) x Video (m) x Audio (a) x Device and Connection (a)

R48 - Provide help information. SC: Recommended ** (2)
Issue (48): Users did not know how to see the video without the controls on the screen. SE: ** (2)
Relation: Technology familiarity (G) x Video (m) x Audio (a) x Device and Connection (a)

R49 - Program videos to be shown in landscape format. SC: Medium Recommendation ****** (6)
Issue (49): Users with experience with touch screen devices were used to see videos in landscape format SE: ****** (6)
Relation: Technology familiarity (G) x Video (m) x Device and Connection (a)

R50 - The length of the video should be less than 2 min. SC: High Recommendation **********(12)

Issue (50): When accessing videos in outdoor settings using a mobile phone, visitors should not abandon the video because of the video length. SE: ********** (14)
Relation: Expectation (N) x Video (m)

R51 - Present different ways to deliver information in the same guide, people are not always patient or have available time to see videos in outdoor settings SC: Medium Recommendation ******* (7)
Issue (51): Users did not find essential to have video in the multimedia guides also prefer seeing text with hyperlinks than a long text on the screen. SE: ******* (7)
Relation: Available time (I) x Video (m) x Hyperlinks (e)

R52 - Present different ways to deliver information in the same guide, people are not always patient or have available time to see videos in outdoor settings SC: Recommended ***** (5)
Issue (52): Users did not find essential to have video in the multimedia guides prefer to see the nearby monuments first on the map. SE: ***** (5)
Relation: Available time (I) x Video (m) x Map (g)

R53 – Audio files should be preferred than video files, people are not always patient or have available time to see videos in outdoor settings SC: Medium Recommendation ******(6)
Issue (53): Users did not find essential to have video in the multimedia guides find essential to have audio files. SE: ****** (6)
Relation: Preference (L) x Video (m) x Audio (a)

R54 - visitors and international participants prefer audio files. SC: Medium Recommendation *****(5)
Issue (54): Visitors and internationals users found more essential to have audio than video in outdoor settings. SE: ***** (5)
Relation: Nationality (C) x Video (m) x Audio (a)

R55 - Present different ways to deliver information in the same guide, old people are not always patient, have available time or are know how to see videos on mobile phones. SC: Medium Recommendation ****** (6)
Issue (55): Older users accessed more often text than video in outdoor settings. SE: ****** (6)
Relation: Age (A) x Text (c) x Video (m)

R56 - Although users did not value access to a video in the field, it is important to have a video file, so users may choose to watch it before or after the tour in a comfortable place. SC: Recommended ***(3)
Issue (56): Video is not essential to have in multimedia guides. SE: ******** (8)
Relation: Preference (L) x Video (m)

R57 - Video content should be focus on history and subject life. SC: Recommended **** (4)
Issue (57): Participants preferred George IV video to the Queen Victoria video, because the last one was focused on one picture of the Queen. They found it more interesting to learn about George IV's life. SE: **** (4)
Relation: Interest (O) x Video (m) x History (b)

R58 - Multimedia content should lead participants to see more details on POI. SC: Recommended ** (2)
Issue (58): Video based on pictures of the subject can lead participants to compare and see details they would not see without this visual stimulus SE: ** (2)
Relation: Motivation (M) x Video (m) x POI (b)

R59 - Users should be able to scroll the map. SC: Medium Recommendation *********(9)
Issue (59): It is not possible to scroll the map. SE: ********* (9)
Relation: Expectation (N) x Map (g)

R60 - Users should be able to zoom in/out of the map. . SC: Medium Recommendation ******* (7)
Issue (60): It is not possible to zoom in/ out of the map. SE: ******* (7)

Relation: Expectation (N) x Map (g)

R61 - Map should align to face the direction user is going to. SC: Medium Recommendation ********* (9)

Issue (61): Map does not switch direction according to the user's location. SE: ********* (9)

Relation: Expectation (N) x Map (g)

R62 - The map should have a location tracker. SC: High Recommendation ********** (13)

Relation:

Issue (62): Map does not update graphically according to user's location. SE: ********** (13)

Relation: Expectation (N) x Map (g)

R63 - Use additional feedback – vibration/colour. SC: Recommended *** (3)

Issue (63): The icons were very small in the map. SE: **** (4)

Suggestion 1: The space between icons should be enough to tap without tapping on another function by mistake. SC: N/A

Relation: Expectation (N) x Icon (L)

R64 - Display a preview of the monument on the map e.g. illustrative icons. SC: Recommended ** (2)

Issue (64): It is not possible to know what the dots are before selecting them. SE: ***** (5)

Relation: Comprehension (F) x Expectation (N) x Icon (L) x Map (g)

R65 - Options such as: directions and audio, video, text content should be available for selection on the map. SC: Recommended ***** (5)

Issue (65): The app does not show options to access features available from the map screen. SE: ***** (5)

Relation: Expectation (N) x Map (g)

R66- Map should display natural landmarks and cardinal points for way finding purpose. SC: Recommended ***(3)

Issue (66): Map does not show cardinal points, sea and green areas. SE: *** (3)

Relation: Expectation (N) x Way Finding (J) x Map (g)

R67 - Directions should be contemplated on the map section. SC: Recommended *** (3)

Issue (67): Map and Directions were different sections on the app, as consequence it confused users when looking for locations. SE: *** (3)

Relation: Comprehension (F) x Way Finding (J) x Expectation (N) x Map (g)

R68 - List should be a feature available when residents are part of mobile guide target group. SC: High Recommendation ********** (11)

Issue (68): Residents accessed the list more often than visitors and locals. SE: ********** (11)

Relation: Residence (D) x List (h)

R69 - It should update the distance and order of points of interest in the list. SC: Recommended *** (3)

Issue (69): Participants used the list to see what next point of interest is. SE: **** (4)

Relation: Way Finding (J) x List (h)

R70- A link to the map/directions should be provided from the list. SC: Recommended ****(4)

Issue (70): It is not available the “route”/ “take me there” function from the list. SE: **** (4)

Relation: Expectation (N) x Way Finding (J) x List (h)

R71- Show in the list a picture and the first statement of the content. SC: Recommended ** (2)

Issue (71): The list does not show a link for a picture and a preview of the content. SE: ** (2)

Relation: Expectation (N) x List (h)

R72 - Users should be able to type the name of any point of interest they are interested on in the search engine. SC: Recommended *** (3)

Issue (72): Participants searched on the search engine for points of interest they have previous knowledge. SE: *** (3)

Relation: Previous Knowledge (E) x Interest (O) x Search (f)

R73 - Show a list of words based on categories: sculptures, buildings, nearby monuments. SC: Recommended ** (2)

Issue (73): Participants did not know what to search for. SE: ** (2)

Relation: Comprehension (F) x Expectation (N) x Search (f)

R74 – Display search results with a link for map and directions to the point of interest. SC: Recommended ** (2)

Issue (74): Search results did not have the option “take me there”. SE: ** (2)

Relation: Way Finding (J) x Expectation (N) x Search (f) x Map (g)

R75 - The results should be retrieved from the App and Internet e.g. Wikipedia.SC: Recommended **(2)

Issue (75): Search results did not display a link to go to explore websites about the theme - Wikitude. SE: ** (2)

Relation: Expectation (N) x Search (f) x Web content (h)

R76 - Mobile guides should have a function to share thoughts in social networks. SC: Recommended ****(4)

Issue (76): Users appreciate the possibility of sharing their thoughts and publishing in social media apps. SE: ****(4)

Relation: Social share (H) x Notes (i)

R77 - “Comments” or “Share” is a better label to publish public comments than “notes”. SE: Recommended *** (3)

Issue (77): It was not clear the label “notes” for sharing content in social networks, users interpret it as a function to add private notes. SE: ***(3)

Relation: Comprehension (F) x Notes (i)

R78 - The feature “camera” should be available to please visitors to the city but also to register unexpected situations that might occur during the tour. SC: Recommended **** (4)
Issue (78): Visitors took more pictures than residents and locals. SE: ****(4)
Relation: Residence (D) x Camera (J)

R79 - The “camera” function should be integrated to “notes”. SC: Recommended ** (2)
Issue (79): The app did not integrate “notes” to “camera”, so users were not able to share a comment and a picture in the same post. SE: * (1)
Relation: Technology Familiarity (G) x Expectation (N) x Notes (i) x Camera (J)

R80 - It is not relevant to have more than four options to access content in outdoor mobile guides. SC: High Recommendation ********** (18)
Issue (80): In the tour participants accessed in average four features to retrieve information. SE: ********** (18)
Relation: Preference (L) x Overall access (k)

R81 - Text is a must-have way to display content in a mobile guide, followed by audio files. SC: High Recommendation ********** (17)
Issue (81): Participants accessed more text than other features to retrieve information. SE: ********** (17)
Relation: Preference (L) x text (c)

R82 - Mobile guide should have an amount of information to satisfy experts and novices in the field. SC: Medium Recommendation ********* (9)
Issue (82): Participants with background in art and cultural heritage accessed more features than other participants. SE: ********* (9)
Relation: Interest (O) x Overall access (k)

R83 - Mobile guide content should engage users to access cultural information, calling their attention to content. SC: Recommended ***(3)

Issue (83): Participants with no interest in the subject did not access any feature without being requested. SE: *** (3)
Relation: Interest (O) x Overall access (k)

R84 - Connect information delivered among diverse features. Hence, International users will follow indications to access information. SC: Recommended ******(6)
Issue (84): Internationals users were overwhelmed to access all the information available on the app SE: ****** (6)
Relation: Nationality (C) x Overall access (k)

R85 - Encourage users to access information on the app through visual clues. SC: High Recommended ********** (14)
Issue (85): Participants did not use touch screen phones frequently accessed less functions than the ones that did SE: ********** (14)
Relation: Technology Familiarity (G) x Overall access (k)

R86 - Give use instructions as soon as the app starts and provide a help system for this function. SC: Recommended *** (3)
Relation:
Issue (86): Older participants pressed the icons instead of tap. SE: *** (3)
Relation: Age (A) x Icon (L)

R87 - Connect information delivered among diverse features to encourage users to explore content available on the app. For example “listen to the audio to know how the life was in the Royal Pavilion”. SC: Recommended ****(4)
Issue (87): Participants identified different media features to have similar content. SE: **** (4)
Relation: Expectation (N) x Overall access (k)

R88 - Give the option to adjust the brightness screen or to change the background and text colour. SC: Recommended *********(9)

Issue (88): Mobile device screen was difficult to see under light environments. SE: ********* (9)

Relation: Comprehension (F) x Device and Connection (a)

R89 - Give a planned route based on chronological order. SC: Recommended **** (4)

Issue (89): Users expected a linear guided tour. SE: **** (4)

Relation: Expectation (N) x Linear organisation (n)

R90 - Use hyperlinks for extra information. SC: Recommended *** (3)

Issue (90): References to diverse points of interest in the main text confound the users. SE: *** (3)

Relation: Comprehension (F) x Text (c) x Hyperlinks (e)

One of the main questions of this thesis is: How should cultural and tourist guides present information and provide interaction for tourists and city residents in outdoor settings? Designers of such systems may consult this toolkit to help answering this question.

7.3.1.2 Highest rated recommendations

Seventeen recommendations were rated with high strength of confidence, twenty-four were considered medium recommendations and forty one were only recommended, indicating the need for more tests to confirm or disconfirm them (Table 30). A full list of recommendations organised by strength is available in Appendix I.

Rate	Recommended
High	10, 11, 21, 24, 27, 28, 29, 30, 32, 36, 43, 45, 50, 68, 80, 81,85
Medium	9, 13, 14, 15, 16, 17, 18, 19, 20, 26, 31, 37, 39, 40, 49, 51, 53, 54, 55, 59, 60, 61, 62, 82,84,88
Recommended	1,2,3,4,5,6,7,8,12,22,23,25,34,,35,38,41,42,44,46,47,48,52,56,57,58,63,64,65,66,67,69,70,71,72,73,74,75,76,77,78,79,83,86,87,89,90

Table 30: Recommendations by strength

High recommendations highlight the importance of functionality in outdoor settings and paid special attention to user's profile and motivation. Outdoor constraints generated recommendations such as amount of time suitable to spend in front of monument listening to the audio files and watching video files (2 min).

Another valuable criterion to consider was the average number of functions accessed naturally by users in the tours, identified as four. Due to noise environments and the presence of non-native speakers as visitors of such places, subtitles are a necessary function. Additionally, volume controls were often requested during the tours affirming the necessity to find them on the visual interface screen. Device and connection constraints also appeared in this investigation as a crucial factor. For instance, provide satisfactory Internet speed connection, visual feedback of video and audio load bars process and stop audio files to run when other audio content is accessed. In addition, audio and text messages are recommended in order to boost user's interest to content and direct their sight to environment and real art object.

Medium recommendations are more specific to content deliver and usability issues. They specially indicate directions for ways to deliver the content through multimedia functions. Besides, several usability recommendations were gathered to improve mobile guide usability. When choosing the best format to deliver content it is recommended to use text with hyperlinks, pictures and audio files. A native speaker should record the audio files in a studio. Different levels of content should be available to satisfy audience with diverse expertise. From the usability point of view, users expect to see the same amount of information in the sections of the system. For example, if one picture has extra information, the others also should have it. A help system should be available to demonstrate interaction models and functions present on the system. For instance, novice users of touch screen phones will learn how to use them. Functions such as location tracker, zoom in/out and scroll map and text are expected by expert users and recommended to facilitate visualise content and way finding. Additionally, for safety issues it is recommended to have visual or audio alerts for traffic attention.

Recommendations with low strength of confidence are suggested to designers but need more testing to assure their validity. Recommendations for designing "search, notes and share" were

generated by a few observations in the evaluation study. Not so many participants accessed them. These suggestions are often similar to medium and high recommendations but were originated from different issues: that is why they are presented. More tests are required to assure their validity in those specific contexts, illustrated by the issues and factors relation.

7.4 Discussion

The results of this study were appeared gradually during the research stages. Preliminary research offered requirements to design a prototype of a cultural heritage mobile guide. Following this phase, experts and users evaluated the prototype in order to generate design recommendations. Context, content and look and feel elements were identified as influence factors for user experience in cultural heritage settings. These were organised in three frameworks per each category offering an overview of factors to bear in mind while designing mobile guide applications. Factors related to the use of mobile devices to illustrate cultural heritage objects in outdoor settings were highlighted in the prototype evaluation resulting in an integration model. Therefore, the integration model grouped context, content and look and feel factors that had an effect on user's experience with the prototype mobile guide. From this model, a toolkit was developed to help designers to identify the main factors and their interrelation on the user's experience. Additionally, the interrelations of factors indicated recommendations to design mobile guides. Some of them were specific to cultural heritage settings, others more general to developing outdoor mobile guides. To aid designers in identifying the most relevant recommendations, these were organised by strength of evidence as well. Seventeen recommendations were high recommended. Twenty-four were recommended with medium strength of confidence. Forty-one recommendations were identified as relevant but need more tests to assure their validity.

This toolkit of user's experience with mobile guides in outdoor settings offers possibilities to identify the main factors that might influence users' experience and the main recommendations to overcome them in the final design. These results were based on field work undertaken in Brighton, with specific monuments and sculptures. Users' profiles were very varied and field works were not applied in the same season. This made it difficult to compare the field experiments against each other but offered a way to confirm and discover

more influence factors on this activity during the research process. In other settings, probably other factors may emerge affected by different users' profile, geography and environment situations. In the end, it is also worth saying that the seventeen high level recommendations and most of medium level recommendations are more general and may be applied to a broad range of outdoor mobile guides, not only those delivering cultural heritage content.

7.5 Conclusion

This chapter has showed the results of this thesis work, delivering ninety recommendations to design outdoor mobile cultural guides. Moreover, it offered a toolkit to help designers to consult these recommendations and identify factors that might influence the user experience with such systems. Furthermore, three frameworks were presented containing factors identified as influences on the overall user experience in outdoor cultural heritage settings. In these three frameworks, content, context and look and feel factors were gathered from users' experiences with diverse sources of information – human guides, paper based guides and mobile device guides.

In the next and final chapter, the conclusions of the thesis are described, intensifying the contributions of the thesis and suggesting further work.

8 Conclusions, reflections and further work

8.1 Introduction

In this chapter the contributions of the thesis and further work are underlined. The two main research questions proposed at Chapter 1 – Introduction (1.3) were answered in the process of this research and they are summarized in this section.

1. How do visitors perceive, handle and interact with graphic representations and multimedia resources on location-aware mobile cultural guides in outdoor settings?

   To answer this question several tests with users in the field (Chapter 4) provided an understanding of how visitors consume cultural heritage mediated by different media. Additionally, a diagram of activity and factors (4.2.4) resulted from those field work activities.

2. How should cultural and tourist guides present information and provide interaction for tourists and city residents in outdoor settings?

   I created a tool (7.3) to understand, explain and make predictions of how users might be affected by diverse factors in outdoor settings and how designers may use those factors collected and translate into look and feel elements on mobile interfaces.

In order to assess the research process the structure of this chapter is based on the topics proposed by Nieveen (1999) and Zimmerman et al (2007) for evaluating and reporting Design Research. Therefore the whole research process is evaluated here, emphasising findings and contributions to knowledge.

8.2 Evaluating and reporting design research

In Chapter 2 – Methodology (2.2.1.1**)** - the process of reporting and evaluating Design Research was described by Nieveen (1999) and Zimmerman et al (2007). They suggested certain criteria to evaluate this practice such as: process, practicability and extensibility; relevance; invention;

consistency; and effectiveness. These served as a guide in reporting contributions and evaluating the process of this research.

Process, Practicability and Extensibility - Each step of this thesis was documented and analysed carefully. In Chapter Two a description of Design research methodology, user centred design methods applied in this research, and how it was applied is available. The research was structured based on the main phases of Design Research methodology – preliminary research, prototyping phase, assessment phase and reflection and documentation. These steps were expanded to be suitable for investigating the nature of using a mobile cultural guide in outdoor settings. In the preliminary research literature review, competitor analysis and design activities with users served as the basis for developing a prototype mobile guide, which later on was tested by experts and users to generate design recommendations. As a result of field studies to gather requirements and evaluate the mobile guide prototype, factors that affected user experience were grouped together, resulting in a framework. This framework of factors was organised as a design toolkit (Results, Chapter Seven). Hence, designers may consult this tool to know which factors may affect user experience and which recommendations they may follow to design outdoor mobile cultural applications.

The research process is divided into sequential steps to facilitate other researchers to follow. For instance, the same steps may be followed to develop a mobile app with another theme, instead of cultural heritage sculptures guide, natural landmarks or services mobile guide. Methods for gathering requirements and analysing data may serve as a model to be followed in similar research. Designers also may use the toolkit to understand the environmental constraints of being guided by a mobile device. For designers of cultural heritage mobile apps, the toolkit offers specific recommendations for context, content and look and feel elements. All the recommendations present in the toolkit are focused on user characteristics. Additionally, designers may select recommendations to follow based on their evidence and confidence given. This assures designers to follow the high rated recommendations and indicate the need for more tests for the lower rated recommendations. Hence, this work offers ways to further research in the field.

Relevance – Academic research and manufacturers guidelines, heuristics and patterns were reviewed and served as the basis for the prototype design. Nokia Patterns inspired prototype design elements and served as our main guide, being clearer and providing practical examples. (Appendix A). An alignment chart was made to compare content and functionalities of commercial outdoor mobile guide apps (Appendix B). This gave an overview of what is being produced and what can be improved in the field.

In parallel with background research, design activities with users were accomplished to complete background review and understand the real constraints and user needs in outdoor cultural heritage settings. Several factors were identified in the design activities that were not present in the literature reviewed. For example the type of content users expect to access in front of diverse kind of monuments – sculpture, architectural and commemorative monuments.

Content requirements were gathered mainly from the paper-based guide study. It was attested that participants accessing the same content of the paper-based guide on a mobile device did not notice or suggest content issues to the same extent. Technology was a distraction when evaluating content information. Moreover, it is important to undertake more than one activity to identify different types of requirements, give strength to requirements gathered, and assure their application on the prototype design.

The relevance also appeared after evaluating the prototype design. Multimedia functions were not the focus of most reviewed studies. Therefore, evaluation studies with the prototype were valuable to map ways of delivering text, audio, video, pictures and hyperlinks on mobile devices. Recommendations of how to use multimedia features and which factors might influence user access in the field offered an overview to the activity and directions for designers of mobile guide systems. The results are valuable for outdoor mobile apps, in general, but also have specific recommendations for accessing cultural heritage information.

Furthermore, lessons were learned about preparing the field tests. For example, participants with company preferred to do the field test without the presence of the researcher and

communicate more during the tours. On the other hand, participants alone did not apply the think aloud technique when the researcher was not with them. In the first field test participants were invited to have a cream tea in exchange for their views after the tour. This provided a comfortable atmosphere for them to answer the questionnaire and share their ideas. However, it was time consuming to be with each participant until they finish the tea and the questionnaire. The questionnaire was long, in this study, had demographic questions and questions related to user´s experience. In the later field tests, demographic questions were answered before the tour and later their experience was reported. This speeded up the process and did not fatigue participants.

Invention – The design toolkit is the main invention resulting from this research, along with the methodology applied and the mobile guide prototype. The mobile guide prototype was not a final and complete application. It contained only two POI and scarce content. It was a tool to apply the user requirements gathered and generate design recommendations for mobile outdoor guides. It can be used to illustrate design recommendations present in the toolkit. Prototype specification may serve as a technical base for other projects.

After reviewing the literature review, no scientific work was found that applied Design research methodology to developing mobile cultural guides. In this work, Design research was adapted to fulfil relevant characteristics of the project such as: outdoor settings, technology constraints and user centred methodologies. This method is general and can be followed by outdoor mobile apps designers. In order to consider the nature and constraints of the activity, the design toolkit will assist designers to make better content and look and feel element choices in outdoor contexts.

The toolkit was created predicting possibilities of extension in the future. All the factors are labelled with a letter and they are distinguished by colour. Each colour wheel starts with the first letter of the alphabetic – a – to give room for future factors that might be found and added to the model. New inventions will bring new factors. Interfaces driven by voice, for example, will imply new situations and maybe constraints to be thought of. The toolkit will have its validity even with new inventions. Technical constraints such as Internet connection might not

exist, but questions related to users' characteristics will be a constant issue. The toolkit is focused on user characteristics that do not change so fast as technology inventions. Thus more implications might emerge but those found in this research will continue to be relevant and factors to consider.

Consistency – All components of this research are connected to each other. This is illustrated in the Chapter 2 - Methodology. Literature review, field work and competitor analysis generated the background for prototype design. This was tested by experts, modified with expert suggestions and tested by users in the field. All influence factors collected in the field work with users were structured in three frameworks – Content, Context and Look and feel. From these, the factors that appeared in the prototype evaluation were modelled in a toolkit displaying design recommendations for outdoor mobile cultural guides. The ones who were not selected for the toolkit need more testing with mobile devices to assure validity.

Effectiveness – The intervention was effective because the objectives were achieved applying the Design research methodology. The objective was to generate design recommendations for developing outdoor mobile cultural guides, focusing on the multimedia features. Not only were multimedia features covered in the design recommendations but also content and context issues that affected in the activity. These issues were analysed resulting in frameworks of factors and a design toolkit to consult for design recommendations. The refinement of user centred design methods were also achieved throughout the process. Three field studies contributed to this.

8.3 Final considerations and further work

This research relates to work in MobileHCI (Section 3.4), on cultural guides (Section 3.3 and 3.5), and user interface design (Section 3.4). It examined few models and frameworks of mobile interaction context, such as the ones proposed by Savio & Braiterman (2007); Grun (2005) and Parsons et al (2007). Additionally, patterns, principles and design issues in mobile apps were analysed (Roth 2002; Ballard 2007; Colazzo et al 2005). Those approaches are relevant to research field, they improve the use of technology in mobile guides (Section 3.3.4.2) and

provide guidelines for identifying general factors that might affect the user experience. Otherwise, those did not exploit content presentation and look and feel elements in outdoor contexts. This thesis aims to fill this gap offering design recommendations (Section 7.3.1) for applying and developing content, presenting multimedia information in mobile guides according to diverse environment and user situations. Moreover, those recommendations are available for designer's consultation in a Design toolkit (Section 7.3) by user experience, content, context and look and feel factors. This model was created only with factors that influenced the user experience with mobile guides.

Furthermore, the use of the Design research process (Section 2.2) in the design of mobile guides is not a common practice. Lessons were learned about how to conduct this type of research and apply coherent methods. Design research was an effective methodology to follow in this work. It was possible to accomplish the established objectives in the beginning of the process and answer the research questions (Section 8.1). Besides, if designers are interested in the process, a detailed methodology and user centred methods are available in this study.

This research indicates directions to go further and investigate issues that were not so clear in the final activities (Section 7.3.1.2). By assigning strength of evidence ratings to issues, and strength of confidence ratings to recommendations, it was possible to verify the gaps of this study and extend it in the near future.

The design tool kit represents the main results of this research. In the future, we expect them to be used as a paper based or digital tool by designers. As a result, in the future the design toolkit can be evaluated by designers and improved as a mobile app design tool.

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Appendices

Appendix A: Background requirements – Literature Review

The first table shows requirements extracted from literature review. It includes suggestions, recommendations, guidelines, principles and patterns from Cultural heritage, Design, HCI and Mobile HCI field. Those requirements inspired the development of the Prototype design (Chapter 5).

The second table covers selected user interface guidelines and patterns from three manufactures – Apple, Android and Nokia. Those were applied to the Prototype design (Chapter 5).

Background requirements

Number	Requirements
1.	People with high education and income, middle age and female are more likely interested and motivated to visit cultural places.
2.	Personality is also a factor that affects choice of leisure.
3.	Media, particularly television and relatives and friends suggestions have an impact in formation of destination image.
4.	Organised tours involve visitors in information bubble, restrict time to know the pace of the local visited and are short in time to see all the attractions included in the itinerary.
5.	Visitors of cultural heritage exhibitions are satisfied when their expectation are met, the service has quality and worth costing.
6.	Positive mood reduces the effect of perceived quality on satisfaction.
7.	Visitor's satisfaction should be evaluated in various phases of the experience.
8.	Cultural tourism brings economic benefits to local people as well assists them knowing about their own city.

9.	Locals sometimes do not support tourism because of drawbacks, such as: violence, density of people and waste.
10.	To support tourism, locals should be involved in the cultural activities, as well as be aware of tourism actions.
11.	Web pages and mobile apps are consulted to get information of points of interest, restaurants, accommodation, consult directions, and save the paths on a destination.
12.	When locals contribute with information to cultural interactive systems they create a sense of ownership and attachment to the cultural setting.
13.	Learning, entertainment and experience are considered the main outcomes of heritage interpretation that affects the visitor's satisfaction.
14.	When visitors notice the importance to use technology to help to understand the exhibition, they are very supportive to use those
15.	When visitors do not use their own devices to access the content, training should be provided to learn how to interact with the dedicated device.
16.	When developing mobile applications five dimensions should be considerate in the project: spatial, contextual, conceptual, temporal mobility and mobility of technology.
17.	Engaged visitors learn better in exhibitions.
18.	Learning is greatly voluntary. It depends of visitor's motivation and interest to learn.
19.	Visitor's interest is situational and they may learn more in those occasions.
20.	Pre-knowledge and preparation before tours might affect the outcome (engagement, learning) of the visit.
21.	Allow users to choose content and content originality affects user satisfaction and interest on subjects presented through mobile guides.
22.	Availability of basic and hierarchical information might facilitate information retrieve. Choices to investigate and access more information should be available in mobile guides.
23.	Mobile guides that provide social interaction, incentive visitors to share what they learnt with peers and increase engagement.
24.	Images of the past may reinforce the theme of the app (game).
25.	Users expect flexibility and efficiency to access content in outdoor settings. e.g. short tour route; allow users choose the path to follow and short texts.

26.	Location based system should consider user's context and flexibility to display information. E.g. show historical buildings on the screen even though they are not open.
27.	Visitors may take a while to understand how to use GPS on the phone. Therefore, instructions should be available in the app.
28.	When developing location-based services, ways to facilitate interaction between services and information presentation should be considered.
29.	Mobile guides incentive users to discover sites they were not aware before.
30.	Restricted battery, screen visibility in a sunny day and the application speed may interfere on the user's experience with mobile guides.
31.	Users find more interesting and meaningful consult open source information available on the WEB linked than in isolation.
32.	The use of sensors on mobile phones enhances user input and interaction with digital and physical maps.
33.	The more people tried 2D bar codes in an app more they were apt to trust and recommend the app for others.
34.	Content might be displayed on the screen based on time spent in front of the exhibit and number of times user visited it.
35.	Augmentations give an added value to the visitor of historical sites.
36.	Cross-platform projects intensify the visitor's experience supporting social interaction and providing pleasure.
37.	Related elements should be placed closer to reinforce meaning and reduce the complexity of the design. It should be applied with the principle of similarity.
38.	Use similar colours, sizes and shapes on interface elements that are similar or to create units of meaning.
39.	When design involves simple and recognised patterns, consider removing or minimising the elements of design that can then be supplied by viewers. When designs involve more complex patterns, consider the use of transitional elements to assist viewers in finding or forming the patterns.
40.	The grounds should continue behind the figure.
41.	The figure seems closer with a clear location in space, whereas the ground seems

	farther away and has no clear location in space. The use of brightness and contrast levels can be applied on pop-up menus, pull down menus and windows to make this effect.
42.	Elements bellow a horizon line and closer to the bottom are more likely to be perceived as figures (focus).
43.	Symmetry should be applied to give a sense of harmony to the design. It can be violated to warn people or call user's attention.
44.	Elements that are not related should have a gap between then and evidence that they are not part of the same group on the screen.
45.	Minimise the number of elements in a design. Favour symmetrical compositions when efficiency of use is the priority and asymmetrical composition when interestingness is the priority.
46.	Users can understand abbreviated text and concepts, and this can be exploited and used to save space on small-screens.
47.	Arrange elements in graphs and displays such that end points of elements form continuous, rather than abrupt lines.
48.	Proximity and similarity principles work in the same extent with visual and haptic perception.
49.	Location-based systems provide fragmented information that is completed by user's perceptions of their surrounds.
50.	People visit locations based on their background interest or recommendations by friends. Mobile systems may show suggestions based on previous user's activity.
51.	Users look for information on the mobile screen of their current locations.
52.	Similarity of representations on the screen and surroundings are essential to show users they are in the correct location.
53.	Strive for consistency */Consistency and standards** - Similar actions should be requested in similar situations avoiding misunderstandings and doubts. Shapes, colours, fonts, menus and so on should be consistent throughout the layout. It is also in accordance of the Gestalt principle of continuity. Mainly in the mobile field is suggested to follow platform conventions, as users are accustomed with certain interaction actions.
54.	Match between system and the real world**- Use real world conventions making information appear in natural and logical order.

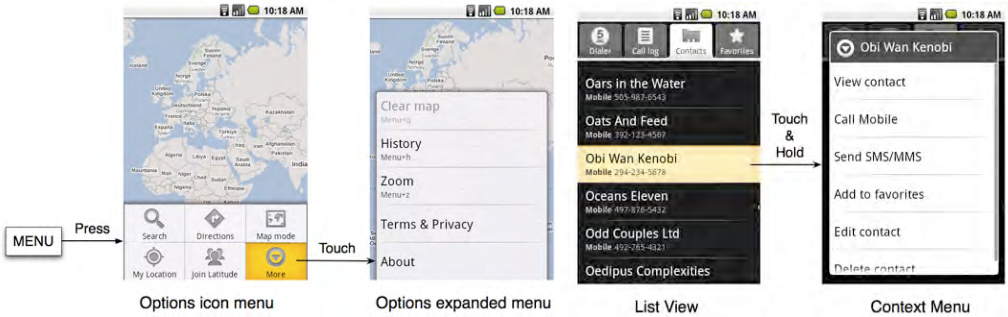
55.	Carter to universal usability*/ Flexibility and efficiency of use**- Design for plasticity, recognising different user profiles (novice and experts; internationals and nationals; disabilities). Add possibilities of content change.
56.	Offer informative feedback* /Visibility of system status**- keep users informed of what is happening during the interaction by feedback. Visual presentation is a way to show changes explicitly.
57.	Design dialogs to yield closure*- Sequences of actions should be organised with beginning, middle and end. It is also in accordance of the Gestalt principle of continuity and closure.
58.	Prevent errors*/ Error prevention** - Design the system to prevent errors in the interaction cycle.
59.	Permit easy reversal of actions*/ Help users recognise, diagnose, and recover from errors** - Minimise actions to recover errors and show errors messages in a plain language.
60.	Support internal locus of control*/ User control and freedom** - Experienced users appreciate to be in control of actions. Support undo and redo in case users want to go back to previous state of the system.
61.	Reduce short-term memory load*/ Recognition rather than recall** - Humans have limited capacity of information processing in short-term memory – seven plus or minus two chunks.
62.	Avoid making users to remember information/action from one screen to be used in another screen. The interaction should be clear for users. Training should be provided for complex sequence of actions.
63.	Aesthetic and minimalist design**- Important actions should be privileged. Irrelevant information should not be part of the visual interface.
64.	Help and documentation** - Provide a source of information for users to easily look for actions that they are not sure about or do not know how to proceed.
65.	Users do not want to spend time learning new ways to interact with unless those are faster than previous methods applied before.
66.	The public of mobile devices is very diverse, so that devices should accommodate different user's needs.
67.	Flexibility should be provided in sharing/downloading information through different platforms and supports.

68.	Content and activities must be desired and requested.
69.	Ease of use is paramount. Many interactions must be intuitive and rapid. User interaction should be simplified, minimising the interaction elements displayed on the screen and avoiding visually demanding navigation.
70.	Mobile phones will not be limited to the processing capabilities of the device. It can work as personal identity, wallet, ticket, entrance key, activator and personal display. Specialised multi-purpose with diverse range of features is currently requested by users.
71.	Small devices afford displaying one app at time due to small screen size.
72.	One handed operation is preferential and thumb-operated.
73.	Personal device implies security in data entered and stored.
74.	Considerate the duration of the user experience with the device (batteries).
75.	Design of apps should consider inconsistent connectivity. Designers should take in consideration what happens to the user if he gets disconnected.
76.	Considerate the requirement of the task to choose the hardware and technology.
77.	Limited processing power (usually 400MHz) and memory spaces imposes on developers some restrictions.
78.	The same content can be used for different purposes and for different contexts of use.
79.	Long text is not appropriate on the screen; it requires scrolling to be read. Substitute an audio file for a long text. Visitors want to look at the exhibits and not to read long texts. A text to be read is different for a text conceived to be heard.
80.	Large images are not indicated.
81.	The navigation and structure of the content should be designed for mobile applications.
82.	The use of location awareness systems should take into account: Location accuracy; Location-mediated control and, or user control; Localisation and time-based media (updates according to location).
83.	The navigation and structure of the content should be designed for mobile applications.

84.	Users should be welcomed in the app being guided through the system. e.g. annotation.
85.	Users should know how to hide and see controls, to interact with content, in touch screen phones.
86.	A design to be successful must meet basic needs before it can satisfy higher-level needs.
87.	The resultant design should satisfy users on physio (body and senses), psycho (emotions and thoughts), socio (relationships) and ideo (values) levels.
88.	Consider user's diversity: individual differences; preferences; context and experience overtime.
89.	Consider the subjective nature of the experience. What, how and why people interact with products should be examined while designing products.
90.	Tap on the screen to hide and show controls.
91.	First time user should be advised of what to do with annotations.
92.	Level of personalisation might be achieved retrieving previous user's information added to the system.
93.	Settings should be available for facilitating user's preferences – font size, colours, and screen orientation.
94.	ICT should be used when conventional media is not sufficient to deliver the indented information or when ICT can provide a better understanding of the subject before, during or after the visit.
95.	Content should be designed according the user preferences, and based on user research.
96.	ICT media must relate clearly to the places, objects or events in the real world that are its subject.
97.	The content should be presented in a lively, interesting and accessible way.
98.	Sustainability and environmental impacts of ICT should have a rational planning to avoid unrealistic expectations or unanalyzed side-effects of tourist development.
99.	It would usually be beneficial for users to be able to stop, replay and rewind content, especially if the system is to be used outdoors or on the move.

100.	Add the provision of multilingual programs is a good alternative in considering user needs where it is appropriate and necessary.
101.	The hardware and the equipment can improve or dismiss visitor's attention.
102.	The impact on visitors that use or do not use the technology.
103.	Scores give to requirements strength of confidence and evidence.

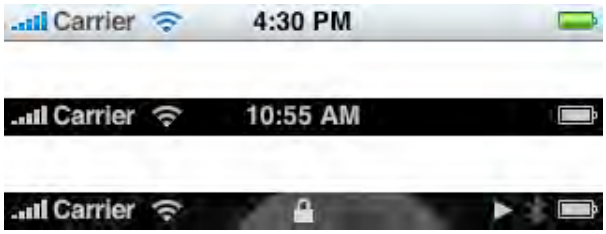
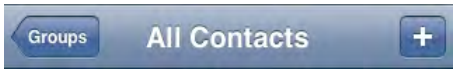
Manufacturer User Interface requirements

GUIDELINES	
Android Best Practices guidelines	
Notifications	
	Notifications should let the user easily get back to the previous activity.
	Don't take over the BACK key unless you absolutely need to – the back key is used constantly in the operational system to user know where he is. The user can return to a task by choosing the icon for its root activity the same way they started the task. Once inside a task, the BACK key goes to previous activities in that task.
	Use the notification system — don't use dialog boxes in place of notifications - Users are used to dealing with notifications and can pull down the notification shade at their convenience to respond to your message.
Menu	
	Option menu can be accessed by the hard key. Context menu are accessed by touch and hold the screen.  Options icon menu Options expanded menu List View Context Menu
	Separate selection-specific commands from global commands. Put any commands that are global to the current activity in the Options menu or place them fixed in an activity screen; put commands that apply to the current selection in the Context menu.

	Place the most frequently used operations first on the menu to avoid scrolling.
	Don't put commands only in a Context menu because users can see easier the option menu.
	Selecting an item in the content should perform the most intuitive operation - Selecting a media icon or filename executes "Play".
	When a user does touch & hold on an item, the Context menu should contain the name of the selected item.
	Put only the most important commands fixed on the screen. By putting commands in menus, you free up the screen to hold more content. On the other hand, fixing commands in the content area of an activity makes them more prominent and easy to use. When quick access to the command is important and going to the menu would be tedious or slow. Example: Next/Previous buttons or Zoom In/Out buttons in an image viewing application. Dialogs and wizards. Example: OK/Cancel buttons.
	Use short names in the Options icon menu.
	A dialog should not have an Options menu. A dialog box is recognisable by being smaller than full-screen, having zero to three buttons, is non-scrollable, and possibly a list of selectable items that can include checkboxes or radio buttons. When the user presses the MENU button, if there is no Options menu, the system currently does nothing.
	Dim or hide menu items that are not available in the current context. In Options menu - disable the menu item, which dims the text and icon, turning it gray. In Context menu - hide the menu item. This makes the menu shorter so the user sees only available choices (which also reduce any scrolling).
Icons	
	Creating a unified look and feel throughout a user interface adds value to your product.
	Use vector shapes where possible – it can be scaled up without loss of detail.
	Menu icons can use a variety of shapes and forms and must be scaled and positioned inside the asset to create consistent visual weight with other icons.
Apple iOS Best Practices guidelines	
	Controls should look tappable.
	App structure should be clean and easy to navigate. iOS provides the navigation bar for drilling down through hierarchical content, and the tab bar for displaying different peer groups of content or functionality.

	User feedback should be subtle, but clear.
	Focus on the primary task. Analyze what's needed in each screen.
	Minimise the number and prominence of controls to decrease their weight in the UI.
	Consider subtly customising controls so that they integrate with your app's graphical style.
	Consider fading controls after people have stopped interacting with them for a little while.
	Put the most frequently used (usually higher level) information near the top.
	Make the path through the information you present logical and easy for users to predict In most cases, give users only one path to a screen.
	Make the main function of your application immediately apparent.
	Be consistent with the usage paradigms of the built-in applications.
	In all your text-based communication with users, use terminology you're sure that your users understand.
	Balance any request for input by users with what you offer users in return.
	Make it easy for users to input their choices.
	Allows people to make the fewest possible gestures to do what they want.
	When appropriate, make it easy for people to interact with others and share things like their location, opinions, and high scores.
	Avoid including settings in your application if you can.
	Let users set the behaviour they want by using configuration options in your application.
	Offer configuration options in the main user interface or (in iPhone apps) on the back of a view.
	Incorporate a brand's colours or images in a refined, unobtrusive way.
	Avoid taking space away from the content people care about.
Text	
	Be sure to correct all spelling, grammatical, and punctuation errors.

	Keep all-capital words to a minimum.
	Think like a newspaper editor, and strive to convey information in a condensed, headline style. Give controls short labels, or use well-understood symbols.
Images	
	Ensure that your launch images and application icon are high quality.
Layout display	
	In all orientations, maintain focus on the primary content.
	Think twice before preventing your application from running in all orientations.
	On iPhone, anticipate users' needs when you respond to a change in device orientation.
Elements	
	Give tappable elements in your application a target area of about 44 x 44 pixels.
Animation	
	Add animation cautiously, especially in applications that do not provide an immersive experience.
	Use animation consistently throughout your app.
Gestures	
	Avoid associating different actions with the standard gestures users know.
	Use complex gestures as shortcuts to expedite a task, not as the only way to perform a task.
	In general, avoid defining new gestures.
Solutions	
	Focus your solution on the needs of 80 percent of your users.
Functionality	
	Save the current state when stopping
	Display an attractive screen that describes the problem and suggests a correction.
	If only some of your application's features are not working, display either a screen or an

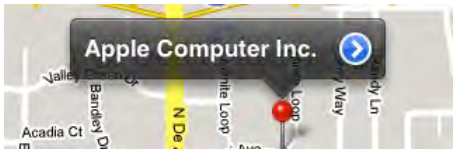
	alert when people activate the feature.
Status bar – full screen 	
	Think twice before hiding the status bar if your application is not a game or full-screen media-viewing application.
	Consider hiding the status bar (and all other app UI) while people are actively viewing full-screen media.
	When appropriate, display the network activity indicator.
Navigation bar 	
	Use the title of the current view as the title of the navigation bar.
	Make sure it's easy to read the text in the navigation bar.
	Use a toolbar instead of a navigation bar if you need to offer a larger set of controls, or you do not need to enable navigation.
	Avoid crowding a navigation bar with additional controls, even if there appears to be enough space.
	Use system-provided buttons according to their documented meaning.
	Avoid altering the back button's appearance or behaviour.
	Take into account the automatic change in navigation bar height that occurs on device rotation.
Toolbar 	
	Use a toolbar to give people a selection of frequently used commands that make sense in the current context.

	Maintain a hit target area of at least 44 x 44 pixels for each toolbar item.
	Try to avoid mixing plain style (borderless) and bordered toolbar items in the same toolbar.
	On iPhone, take into account the automatic change in toolbar height that occurs on device rotation.
Tab bar  	
	Don’t use a tab bar to give users controls that act on elements in the current mode or screen.
	In general, use a tab bar to organise information at the application level.
	Consider badging a tab bar icon to communicate unobtrusively.
Table view	
	Provide a list of options from which users can select.
	Display hierarchical information.
	Display conceptually grouped information.
	Display information that is indexed to facilitate lookup.
	Always provide feedback when users select a list item.
	Consider animating the changes users make to list items to provide feedback and strengthen the user’s sense of direct manipulation.
	If table content is extensive or complex, avoid waiting until all the data is available before displaying anything.
	Consider displaying “stale” data while waiting for new data to arrive.
	If the data is slow-loading or complex, provide users with a signal that processing is continuing.
	Avoid variable row heights in a plain table.
	As much as possible, ensure that your text labels are succinct to avoid truncation.

Web View

Avoid using a web view to create an application that looks and behaves like a mini web browser. People expect to use Safari on iOS to browse web content, so replicating this broad functionality within your app is not recommended.

Detail Disclosure Button



Typically, you use a detail disclosure button in a table view to give users a way to see more details or functionality related to a list item. However, you can also use this element in other types of views to provide a way to reveal more information or functionality related to an item in that view.

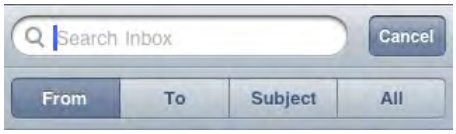
Info Button

On iPhone, use an Info button to flip the screen and reveal more information.

Progress View

Use a progress view to provide feedback to people on a task that has a well-defined duration, especially when it's important to show them approximately how long the task will take.

Search Bar



Use a search bar to enable search in your application. Do not use a text field because it doesn't have the standard appearance users expect.

You can customise the appearance of a search bar by specifying one of the standard-color background styles: Blue (This is the default gradient that coordinates with the default appearance of toolbars and navigation bars.); Black

Standard Buttons

Button	Name	Meaning
	Action	Open an action sheet that allows users to take an application-specific action
	Camera	Open an action sheet that displays a photo picker in camera mode
	Compose	Open a new message view in edit mode
	Bookmarks	Show application-specific bookmarks
	Search	Display a search field
	Add	Create a new item
	Trash	Delete current item
	Organize	Move or route an item to a destination within the application, such as a folder
	Reply	Send or route an item to another location
	Stop	Stop current process or task
	Refresh	Refresh contents (use only when necessary; otherwise, refresh automatically)
	Play	Begin media playback or slides
	FastForward	Fast forward through media playback or slides
	Pause	Pause media playback or slides (note that this implies context preservation)

The guidelines presented here contributed to develop the prototype design (chapt XX). More details and a complete set of guidelines from both platforms can be finding at:

Apple:
http://developer.apple.com/library/ios/#documentation/UserExperience/Conceptual/MobileHIG/Introduction/Introduction.html

Android: http://developer.android.com/guide/practices/ui_guidelines/index.html

In addition to the guidelines presented above, Mobile design patterns from Nokia supported the development of the prototype design (Chapter 5). Here is presented the description of some patterns.

A complete list of patterns and more details can be found at: http://wiki.forum.nokia.com/index.php/Category:Mobile_Design_Patterns

Nokia patterns		Inspired prototype design elements
	Flying icon menu - Nowadays it is used in every touch mobile. Whenever we touch the main icon or the menu on the screen it will get opened. Flying icons does mean that icons are scrolling on the display are by finger touch. Flying menu is like rotating application which needs user response about selecting some options from the list of available icons.	Navigation bar
	Sub menu list - Whenever we touch the main icon or the menu a list of sub menu appear on the screen to ask user about some more options,	List of sculptures
	Applying focus - A means of indicating which object, element or control has focus within an application (and is therefore ready to be manipulated in some way).	List of sculptures Icons navigation bar
	Name: contextual prompt - A modal view containing a group of options, actions or information directly related (and contextual to) the focussed or active mode, object or view.	Directions
	Drop down menu - A form of contextual menu allowing selection of (only) one item from a list. Drop-down menus get their name from the common desktop usage in which the list displays downwards into the view.	Directions
	Fly out menu- A list of clickable links or sub menu that appears when focus is on a particular menu item is known as a fly-out menu.	Search Share
	Live scrolling - The Live Scrolling Design Pattern, also known as Continuous Scrolling or Infinite Scrolling, is a way of displaying and loading data in incremental manner.	George IV content
	Paging - A systematic technique of arranging content of a long page over a number of numbered WebPages.	Slideshow pictures
	Master detail design - It is a method to represent data by using two separate views: one to show the available items, and another to show the details of a single item.	Map List
	Grid menu - A series of list items are arranged in one or more horizontal rows and/or vertical columns to form a grid menu.	Main and Contextual Navigation bar
	List menu - A list menu is often used as a substitute for a grid menu when the numbers of items is more. Some users prefer the list menu to the grid menu, hence the type is kept customisable, in many cases.	Sculptures list
	Progress and wait indication - Indicators used to represent an active process. A progress indicator indicates the progression of a task, while a wait indicator simply indicates that a process (of undetermined length) is still	Video page Audio page

	ongoing.	
	Scalability - Scalability refers to the ability of the application to adapt to different screen sizes and orientations.	Pictures Video page
	Scroll bars - Scrollbars are components/tools for scrolling or sliding content on the screen. The default or the built-in scrollbars are the conventional long rectangular scrollbars, preferably used with contrasting colors. However, today with many innovative design patters flowing out, there are varieties of scrollbar designs available. A use of good scrollbar makes the application have a more attractive user interface.	Text
	Scrolling – It is defined as sliding text, images, videos, etc on a webpage, application or a document, which cannot be fully shown on the screen at time.	Text
	Search widget - Search in mobile is very essential. There are so many examples at which we need to search the word. E.g. finding name from the contact list, finding the song from long mp3 list, finding the required word from the long assay.	Search
	Slider control - Search in mobile is very essential. There are so many examples at which we need to search the word. E.g. finding name from the contact list, finding the song from long mp3 list, finding the required word from the long assay.	Multimedia players
	Sorting - A means of re-ordering a list based on a chosen parameter.	List of nearby sculptures
	Specifying of detecting location - A means of prompting the user to specify their location and/or auto-detect and display it (typically using GPS or triangulation).	You are here icon Map List
	Teaser menu - While designing web pages with lot of content, the space constraints pose a big challenge to the designer, as they want to show all/most of the content, yet are not able to do so. In such cases it is important to design the web page in such a way that the most important/relevant content gets displayed on the main page, while there is some mechanism of letting the user know that there is additional content available which they can view if they wish to.	Know more link in the content page
	Web browser styles - A web browser is a medium by which user can open web pages in mobile. Mobile browser should capable enough that it gives better web browsing experience like computer. In touch mobile web browser contains touch keyboard and address bar for entering address. A web browser should contain zooming slider, back button to go in the previous webpage and	Web pages connected to the app

	refresh button. Also it should contain the search field, tabs, bookmark and home page buttons.	
	Direct Manipulation – Direct manipulation (or touch) devices allow the user to navigate and interact with the UI through actual manipulation of on-screen controls ex: pressing, clicking or dragging. Manipulation can occur with a thumb or finger.	Overall app
	Gestures - Many newer devices include sensors, which enable the use of gestures. Instead of simply interacting with the on-screen user interface or physical controls; gestures involve interacting with the whole device ex. tilting, blowing on or shaking the device. Gestures are not obvious for the user, and must be either discovered easily, or communicated clearly.	Rotate the video screen
	Pinching and expanding - Most often used within the context of photography or mapping, this action consists of pressing the display while moving the thumb and index finger closer or farther apart. Doing so causes the object below the finger to contract or enlarge.	Pictures
	Double taps - While popular on the web, double taps can be problematic on mobile devices as they can decrease the efficiency of single taps. Every time the user taps the screen, the device has to wait a few moments to see if there will be a second tap. If the second tap does not materialise, the system continues with the action but to the user; this unnecessary delay can be troubling—especially on a device which may already be prone to delays due to network latency.	Overall app – single taps
	Long and short taps- Simple taps are the most common and intuitive touch action and also mimic the mouse click behaviours we are used to on the desktop. Taps of different durations may however be used to prompt different actions. Once an object has been selected (i.e. focussed) using a simple (short) tap, a longer tap (i.e. a sustained press action) can then be used to reveal contextual options.	Overall app - Short taps
	Grids- A series of list items arranged in one or more horizontal rows and/or vertical columns to form a grid.	Navigation bars
	Vertical lists - A vertically aligned list of data. Each list item can be standalone or paired with additional content such as an icon or short description.	List view

Appendix B: Alignment Chart – Brighton city based apps

App name	BrightonEngland	Brighton Cool places travel guide	Brink guide	Brighton offline city map with POI	My Holiday Let	AHI's offline Brighton	YesCitiz Brighton	Genius Map Brighton	Walk Brighton
Price	Free	£1.79	£1.79	£2.99	Free	£0.59	£2.39	£0.59	Free
Category	POI guide	POI guide	POI guide	POI guide	Guide plus Advertisement	User generated content Guide	User generated content Guide	Location based guide	Location based guide
Developers	Creative Commons/ Travelto series	Puking publishing/ Emma Gregg (local)	Brink media	Aplus Software	My Holiday let apartments	AHI's technology	Newscape Technology	OpenStreet map	Electric Map Company
Year	2009	2010	2010	2010	2011	2010	2011	2010	2009
Multimedia									
Text	x	x	x		x	X (Add)	X (few)		
Pictures		x	x		x	X (add)	X (few user generated content)		
Picture Gallery	x								
Video									
Audio									
Static Map	x								x
Content									

Wikitravel				x					
Wikipedia	x								
Wonderlane[47]									
Authored content		x	x		x				
Expert knowledge		x							
App name	**BrightonEngland**	**Brighton Cool places travel guide**	**Brink guide**	**Brighton offline city map with POI**	**My Holiday Let**	**AHI's offline Brighton**	**YesCitiz Brighton**	**Genius Map Brighton**	**Walk Brighton**
C H Monuments - Pictures									
Royal Pavilion	x	x	x		x				
West Pier	x								
The Brighton Palace Pier	x	x			x				
Kings Road Arches	x	x							
Theatre Royal	x								
Kings Road bandstand	x	x							
Brighton Museum		x			x				
Duke of York's Cinema		x							
Brighton			x						

[47] Wonderlane Flickr photostream - http://www.flickr.com/search/?q=brighton&w=71401718%40N00

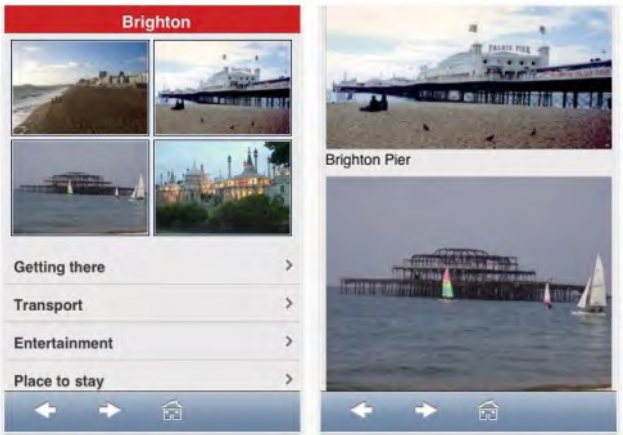
Fishing Museum									
George IV statue	X								
Victoria Fountain	X (label: large Brighton Fountain)								
Peace statue							x		
C H Monuments - text									
Royal Pavilion	x	x	x		x				
West Pier	x								
Brighton Palace Pier	x	x			x				
Kings Road Arches		x							
App name	**BrightonEngland**	**Brighton Cool places travel guide**	**Brink guide**	**Brighton offline city map with POI**	**My Holiday Let**	**AHI's offline Brighton**	**YesCitiz Brighton**	**Genius Map Brighton**	**Walk Brighton**
Theatre Royal	x	x							
Brighton Museum	x	x			x				
Duke of York's Cinema		x							
Brighton Fishing Museum			x						
George IV sculpture									

Victoria Fountain									
Peace statue							x		
Open hours		x							
Contact info		x	x						
Prices		x	x						
Rating guide			x						
Interactive elements									
Back icon	x	x	x	x		x	x		
Current location icon		x	x	x		x	x		x
Website POI link		x	x	x			x		
Search		x	x	x			x	x	
Interactive Map		x	x	x	x	x	x	x	
Google earth view		x					x	x	
Help		x	x			x			
POI Wheel spinnining		x							
List	x	x	x			x	x		
Favourites		x		x				x	
Add POI						x	X(residents mode)	X (add roads to the map)	
App name	**BrightonEngland**	**Brighton Cool places travel guide**	**Brink guide**	**Brighton offline city map with**	**My Holiday Let**	**AHI's offline Brighton**	**YesCitiz Brighton**	**Genius Map Brighton**	**Walk Brighton**

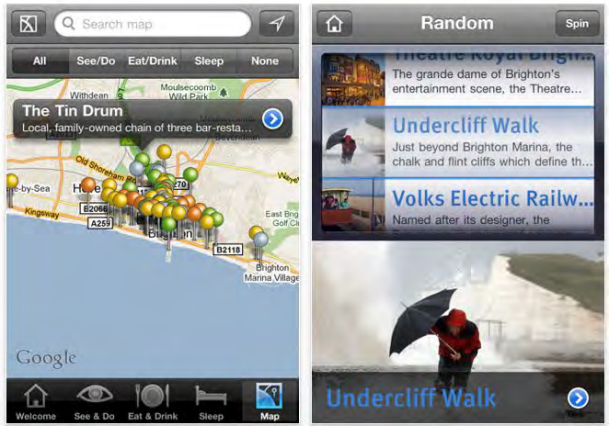
				POI					
Log in							X (it does not work without a login)		
Share					X (postcards by e-mail)		X(Facebook)	X(address by e-mail)	
Rate system							x		
Highlights									
	Extense content	Indication of Rainy days activities and kids activities	Categories named after activity verbs. Category Tourist trap and services (e.g. repairs) but currently empty. Shows the location on the map with content.	Long list of attraction but do not give any content offline only location is available.	User can send a post card through e-mail with pictures provided by the app or using your won pictures.	User can save pictures to the POI a use as a travel diary	Ask user if you live in Brighton or you are a tourist. If you live in Brighton you have options to add information. If you are a visitor you can choose categories to be shown e.g. hotel Display content in several languages	Send the address pinned by e-mail.	Shows visually the distance of POI from the current location. E.g what can be seen in 5 min walk.

Appendix C: Visual Reference – Commercial Mobile apps

Brighton city based apps

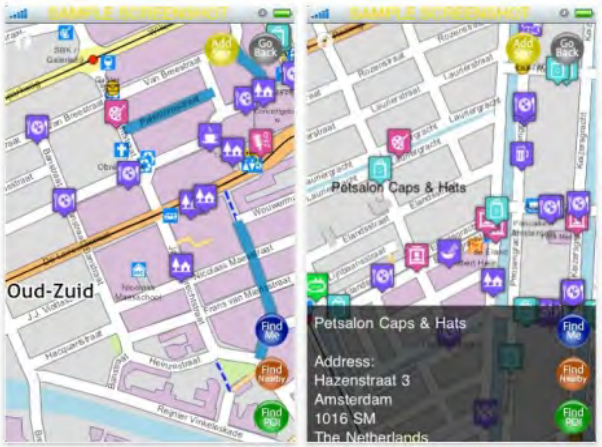


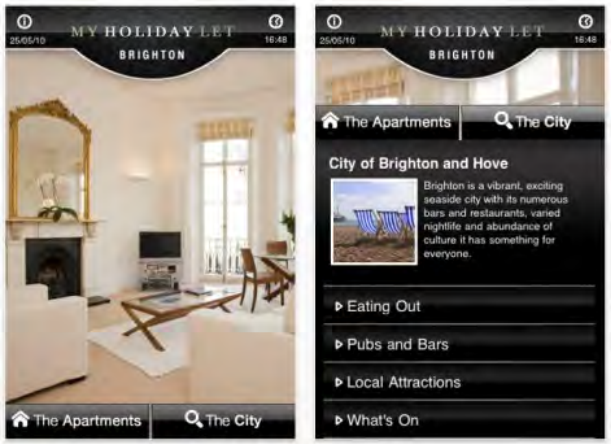
BrightonEngland (1)

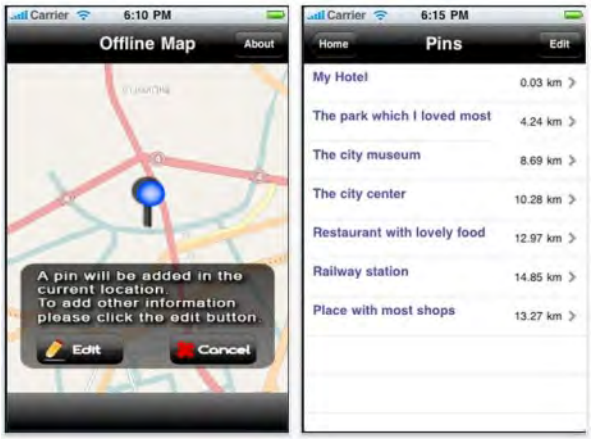


Brighton Cool places travel guide (2)

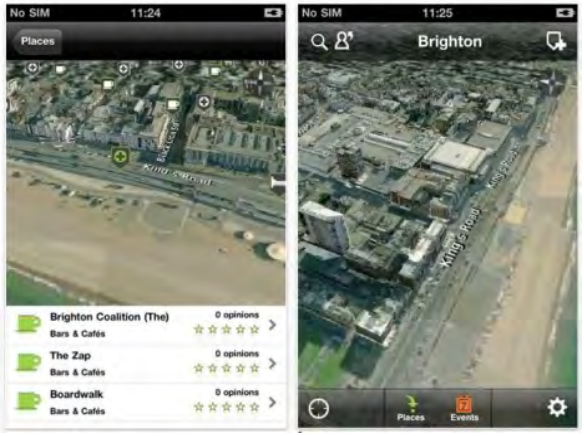
Brink guide (3)





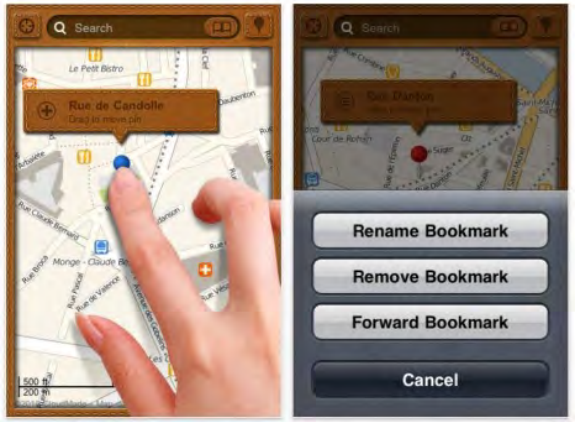


Brighton offline city map with POI (4)



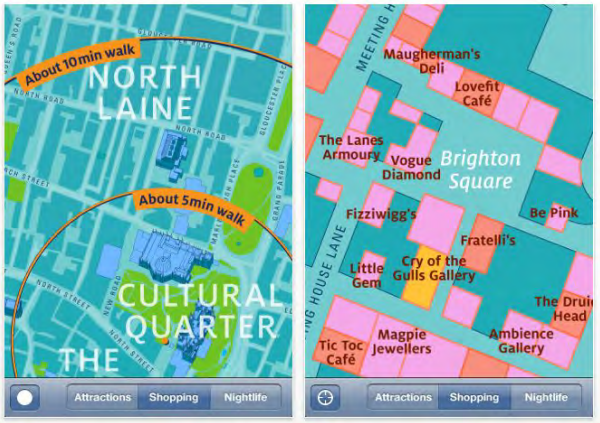
YesCitiz Brighton (7)

My Holiday Let (5)



Genius Map Brighton (8)

AHI's offline Brighton (6)

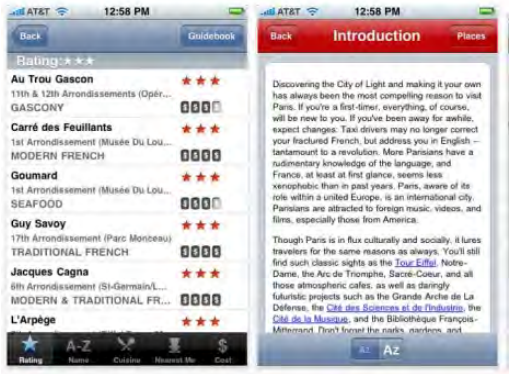


Walk Brighton (9)

Popular travel and tourism mobile apps

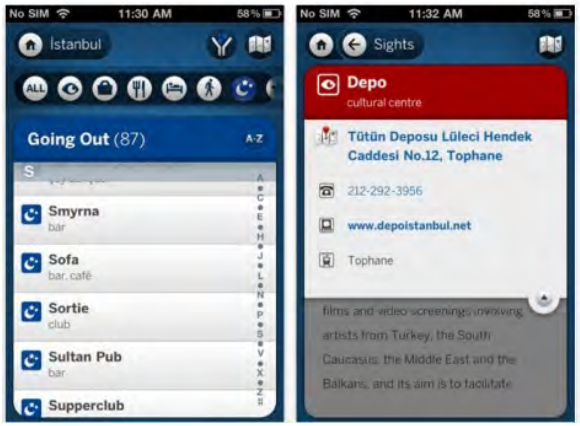
Layer (10)

Wikitude (11)



Frommer's (12)

Sprice (13)



Lonely Planet (14)

Schmap (15)

Appendix D: Questionnaire (Fieldwork2)

Sculpture tour – Questionnaire

Date:_____ Time started: _____ Time finished: _____

Section I: Personal Information

1. In which age group are you?

( ) 19 and under ( ) 20 – 29 ( ) 30 – 39 ( ) 40 – 49 ( ) 50 – 59

( ) 60 +

2.Gender:

( ) Male

( ) Female

3. Where were you born?

( ) Abroad. In _____ (country)

( ) In UK. In _____ (city)

4. Where do you live?

( ) Abroad. In _____ (country)

( ) In UK. In _____ (city)

5. Is it your first time in Brighton?

( ) Yes

( ) No. It is my _____time in Brighton

( ) No. I live in Brighton for _____

6. In terms of your interest in art and cultural heritage, how would you characterise yourself?

( ) Little interested ( ) Very interested

( ) Interested ( ) Specialist. _____

Part 2: To be completed after the tour

1. With respect to sculpture tour and the booklet, please indicate (circle) the extent to which you agree or disagree with the following statements:

SD = Strongly Disagree D = Disagree N = Neutral A = Agree SA = Strongly Agree					
The map was easy to follow	SD	D	N	A	SA
I asked other people for further information	SD	D	N	A	SA
It was easy to find the sculptures	SD	D	N	A	SA
It was easy to identify how far you were from the next sculpture on the map	SD	D	N	A	SA
It would be easy to follow the tour with company	SD	D	N	A	SA
The photos were useful to identify the sculptures	SD	D	N	A	SA
The images helped me to see better the sculptures details	SD	D	N	A	SA
The text was too long	SD	D	N	A	SA
The type size was too small to read	SD	D	N	A	SA
The language of the text was complicated	SD	D	N	A	SA

2. With respect to sculpture tour and the booklet, please answer the following questions

How long did you think you took to complete the tour?

( ) 15 – 30 min

( ) 30– 45 min

( ) 45 min- 1h

( ) More than 1hour

2. Do you think it was easy to use the booklet outside?

( ) Yes ( ) No

3. **If No**. *Please indicate (circle)* which of the following factors contributed for made it difficult to use?

Traffic	not at all	a little	a lot
Noise	not at all	a little	a lot
Density of people	not at all	a little	a lot
Too sunny	not at all	a little	a lot
Too rainy	not at all	a little	a lot

Any further explanation?

4. Which information was essential to you in the booklet?

5. Did you need additional information to understand the references of the texts? Can you give examples?

6. What do you remember of the tour?

7. Do you think that there is anything else that should be in the booklet?

8. What would you think of having this content on a mobile phone?

9. Do you think that the use of multimedia (video, audio, links) would improve your experience? Why?

10. Would you like to see the other sculptures today? Any further explanation?

Any other comments?

Appendix E: Questionnaire (Fieldwork3)

University of Brighton

Participant number: _____

Public Monument trail study

I'm a research student from University of Brighton and I have been looking at the expectations of visitors underneath to cultural and historical guides and the role that visitor experiences could play in design of mobile guides.

The aim of this questionnaire is to find out about your views regarding mobile guides. We will use this information to develop mobile guides that meet the needs of the people who will be using it.

All the information you provide is confidential and will not be used for other purpose.

About you

1. In which age group are you?

( ) 19 and under ( ) 20 – 29 ( ) 30 – 39 ( ) 40 – 49 ( ) 50 – 59

( ) 60 +

2. Gender:

( ) Male

( ) Female

3. Where were you born?

( ) Abroad. In _____ (country)

( ) In UK. In _____ (city)

4. Where do you live now?

( ) Abroad. In _____

( ) In UK. In _____

5. Is it your first time in Brighton?

( ) Yes

( ) No. I live in Brighton

( ) No. I _____

6. Have you ever used touch screen devices (phone, IPod touch, PDA) before?

( ) No

( ) Yes. I used/have a(n)

_____

7. Have you ever used an audio guide and/or video guide before?

( ) Yes. I used _____ in ( ) city ( ) museum ( ) Other (*please specify*)

_____

( ) No

8. In terms of your interest in art and cultural heritage, how would you characterise yourself?

( ) Little interested ( ) Very interested

( ) Interested ( ) Specialist.

_____

Please continue to next page…

About the system

1. With respect to the mobile guide, please indicate the extent to which you agree or disagree with the following statements:

	Strongly disagree				Strongly agree
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					
	1	2	3	4	5

	Strongly disagree				Strongly agree
1. It was easy to find the sculptures					
2. It was easy to identify how far you were from the next sculpture on the map					

3. The texts about the statues were too long					
4. The type size was too small to read					
5. The language of the text was complicated					
6. The images were useful to identify the sculptures					
7. The images helped me to see better the sculptures details					
8. It would be easy to follow the tour with company					
9. I asked other people for further information					
	1	2	3	4	5

2. Do you think it was easy to use the Wikitude interface to do the tour?

( ) Yes ( ) No

If No. *Please indicate (circle)* which of the following factors made it difficult to use?

Traffic	not at all	a little	a lot
Noise	not at all	a little	a lot
Density of people	not at all	a little	a lot
Too sunny	not at all	a little	a lot
Too rainy	not at all	a little	a lot
Too cold	not at all	a little	a lot
Other (please specify)			

Please continue to next page…

3. With respect to the mobile interface, please rate your satisfaction.

		1 2 3 4 5 6 7 8 9 10										NA
Organisation of information	confusing										very clear	
Identifying the monuments on the map	difficult										easy	
Identifying the monuments on the camera view	difficult										easy	
Using the list view to see what is around	never										always	
Zoom icon	useless										essential	
"You are here" icon	unhelpful										helpful	
The link "more information"	useless										essential	
The podcast about the sculptures	useless										essential	

4. How long did you think you took to complete the tour?

( ) 15 – 30 min ( ) 30– 45 min ( ) 45 min- 1h ( ) More than 1hour

5. Did you understand all the references in the texts?

( ) Yes ( ) No

Would you like to give some examples?

6. What do you remember of the tour?

7. Do you think that the use of multimedia (audio, links) assists you in understanding the content better?

( ) Yes ( ) No

8. Do you think that the use of video would assist you in understanding the content better?

( ) Yes ( ) No

Any further comments?

Thanks for your views!

Appendix F: Consent form (Fieldwork and Evaluation sessions)

UNIVERSITY OF BRIGHTON

Brighton Sculpture Trail

I agree to take part in this research which is part of a project to develop mobile guides in cultural heritage settings.

I am aware that I will be required to do a short sculpture trail in Brighton and answer *questions about the experience.*

I understand that participants will be video recorded so the data can be analyzed in detail by the researcher. The videotapes will be only shown to members of the research team. The only exception to this is that if you give your permission, we may use portions of the videos and photographs in academic conferences or publications. They will be kept safe during the research and destroyed following the analysis.

I understand that I am free to withdraw from the study at any time without giving a reason and without incurring consequences from doing so.

Name (please print) ……

Signed ……..

Date ……..

Appendix G: Requirement selection – field studies

Booklet study

Wiki study

Field studies - Requirements	SE	SC	Situation	Reason
Text				
(R01) (R17) The system should display brief information (text) of POI.	********* *******	*******	**S(x) NS( )**	
Hyperlinks				
(R25) The links should have clear names according to their function.	****		**S(x) NS( )**	**More info was substituted by PMS website**
(R02) (R15) The system should make available explanations of terms, words, expressions and so on in hyperlinks.	**********	*****	**S(x) NS( )**	**This was the format applied to George IV section**
(R54) The system should have more information of the subject in case users want to know more about it.	*****		**S(x) NS( )**	**External hyperlinks are available in the prototype.**
Typeface				
(R20) The typeface should be at least 10pt.	**********		**S(x) NS( )**	**Proportional type size of booklet and wikitude text was kept in the prototype.**
(R21) The background and the text should have a good contrast.	**********		**S(x) NS( )**	**White background and high contrast of the text (pink and black) was displayed in the prototype app.**
Pictures				
(R07) (R22) The system should have visual information that provides clues where the monument is; e.g. visible background showing elements around it.	********* **********		**S(x) NS( )**	**The pictures displayed on the prototype were taken considering the landmarks displayed in the background.**
(R22) (R08) The system should display pictures of the monument to support participants to see better the monument details.	**********		**S(x) NS( )**	**Close pictures of the monuments were displayed in the prototype app.**

(R10) The content should engage visitors with the monuments, not substitute the experience with the real object.	******		**S(x)** **NS( )**	**Pictures of real subjects (George IV) were included in the prototype app to test engagement.** **TP**
(R11) When displaying websites with pictures on the app, a mobile version should be available.	**	**	**S(x)** **NS( )**	**Pictures on the app were resized to be shown in full screen. External links were not projected for it.** **TP**
(R12) The system should add new information to the experience, such as pictures of inside the buildings.	*****		**S(x)** **NS( )**	**Pictures inside the monuments were added to the prototype app.**
Podcast – Audio files				
(R14) **The audio should not demand so much attention of the user in outdoor settings.**	*****		**S(x)** **NS( )**	**In the prototype a audio version was recorded to supply this requirement.** **TP**
(R15) **The audio should be recorded by one speaker and in a studio.**	*****	***	**S(x)** **NS( )**	**In the prototype a audio version was recorded to supply this requirement.** **TP**
(R17) **The system should display visual information on the screen while the podcast is playing.**	*****	**	**S(x)** **NS( )**	
(R20) **The system should allow users to see the transcription of the audio on the screen, in case they cannot hear it because of the environment noise.**	*****		**S(x)** **NS( )**	
(R22) **The podcast should not start playing before users press play.**	****	*	**S(x)** **NS( )**	**TP**
Requirements from field studies	**SE**	**SC**	**Situation**	**Reason**
Navigation				
(R1) The system should display the last information accessed on the screen. (e.g. next monument/map)	**********		**S(x)** **NS( )**	**The prototype did not change screen without user's interferences**
Immersion				
(R26) The system should engage users with monuments and history.	*********		**S(x)** **NS( )**	**"Get closer to appreciate the monument" was added to the audio screen.**
Company				
List				
(R30) The information of how far the monument is essential. The system should show closest monuments to participants in an ascendant way when a	******	******	**S(x)** **NS( )**	

list view is available.				
(R31) The list view is essential to make participants aware of how many monuments are around and to access content.	**********	**********	**S(x)** **NS( )**	
Map				
(R34) The map should display a way to retrieve directions to go to a point of interest.	**********		**S(x)** **NS( )**	
(R35) T**he system should provide a trajectory traced from the current location to the target location.**	*******		**S(x)** **NS( )**	
(R36) Icon "You are here" is relevant to show user's current location. It should be updated regularly.	**********		**S(x)** **NS( )**	**It was added to the prototype but not updated so often because of technical issues**
(R38) (R39) When open overlays on the map don't hide the surroundings it is cumbersome for way finding. Users should be able to open and close overlays (icons/labels of the monuments) on the map easily.	**		**S(x)** **NS( )**	**This issue was solved given users control to hide the labels and overlays as they wished.**
(R40) The map should display the POIs for a particular tour.	******		**S(x)** **NS( )**	**Public monuments and sculptures were contemplated in the prototype.**
(R7) The map should show main natural or artificial landmarks in the city to help in way finding.	******	****	**S(x)** **NS( )**	**Green areas and the main landmarks (Pavilion) were in the map prototype.**
(R11) The icons representing the points of interest should be placed in an accurate position on the map that matches with the real world monuments.	*******		**S(x)** **NS( )**	**Icons were accurate place on the map.**
Environment				
(R47) Information should be available on the system to be accessed after the tour. In case of environment conditions disrupt the experience.	*****		**S(x)** **NS( )**	**The prototype was online so users could access it after the tour.**
(R48) (R13) The system should display visual and verbal information, so that users can make their choices of which	**********		**S(x)** **NS( )**	**Transcriptions were added to audio files in the prototype.**

representation is suitable to environment and weather conditions.				
(R49) (R12) The system should advise users when is required attention to cross the streets.	**********		**S(x)** **NS( )**	**Pedestrian paths were added to the map in the prototype.**
(R50) The route of the tour should privilege ways in participants do not have to cross several streets. It requires attention and accidents may happen.	***		**S(x)** **NS( )**	**The route of the tour was reduced and participants had to cross only one road. Additionally, they signed a consent form about the traffic risks and the researcher followed them for safety reasons.**
(R14) The system should be able to display basic information clearly, so that, it will not be cognitively demanding in outdoor environments.	*********		**S(x)** **NS( )**	**The size of the text was reduced in the prototype.**
Learning the system				
(R28) Consider previous user's experience with touch screen mobile phones. Use modes of interaction that may be intuitive for a wide range of users.	***		**S(x)** **NS( )**	**When developing the prototype user interface, clear and intuitive elements were displayed. Certain interactions, were tested to unveil the possibilities of applying it. Such as "tap on the full screen image to go back to previous state".** **TP**
(R29) When testing apps with users, designers should consider solving usability and functionality crucial problems. Therefore, new interesting issues might emerge from the user tests for improvement.	**********		**S(x)** **NS( )**	**The usability of the system was evaluated by the experts before user's tests.**
Content				
(R19) The system should display replicas of the written text and the informative plaques of the monuments	******		**S(x)** **NS( )**	**A replica of a text displayed in a plaque was included in the prototype app.** **TP**
(R03) The information should be displayed in a more narrative way.	****	*	**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content Expert Evaluation**
(R51) The basic information should work as an anchor to instigate user's interest.	*****		**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content**

				Expert Evaluation
(R52) The content should be able to engage users in the beginning of the text, because they might lose their focus of attention in detriment of the options available to interact with.	*****		**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content Expert Evaluation.** **The size of the text was reduced in the prototype.**
(R53) Users should be able to see essential information straight away; consequently they do not have to search for it in the whole text.	*********		**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content Expert Evaluation.**
(R55) (R16) The system should not display information that users can see anyway. It should engage users not describe what they can see.	*********		**S(x)** **NS( )**	**Redundant information was excluded in the prototype content.**
(R56) The system should have available an audio sample of the text, or at least the name of the monuments. Hence, international users can learn to pronounce some words.	****		**S(x)** **NS( )**	**Audio files are available in the prototype app.**
(R24) Who; when; why are the main questions that should be covered of commemorative portrait statuary.	**********		**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content Expert Evaluation.**
(R25) Information about material, date, and style are extremely relevant when exploring the sculpture piece.	**********		**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content Expert Evaluation.**
(R26) The date and the motive should be clear when the system display information about commemorative monuments.	**********		**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content Expert Evaluation.**
(R27) Consider on the system the knowledge that users probably have about the subject. For example Wars.	****		**S(x)** **NS( )**	
(R18) (R30) The system should make indications to look at the monument from diverse spots. Encourage users to move around the monument.	**********		**S(x)** **NS( )**	**Information was displayed on the screen in order to incentive users to get closer to monuments in the prototype app.**

(R31) When the monument is decorative the meaning of shapes and colours should be emphasised on the system.	********		**S(x)** **NS( )**	**The content was modified to boost user's interest in the prototype. Content Expert Evaluation.**
(R33) The system should help users to relate various aspects of the piece to others.	**********		**S(x)** **NS( )**	**Audio guide related two monuments in the prototype.**
(R3) The system should have information of monuments on the way or offer the user possibilities to retrieve this info in somewhere else – websites.	***************		**S(x)** **NS( )**	**Certain monuments on the way were added on the tour such as Pavilion.**
(R4) The system should show operational information about the places that users are passing by. When the monument is in or on a building, the system should provide information of what the venue's present/past function.	******		**S(x)** **NS( )**	**Opening times , operational information, what the building is nowadays were added to the prototype**

Appendix H: Expert Evaluation form

University of Brighton

Researcher: Heloisa Candello

Research Supervisors: Dr Lyn Pemberton and Richard Griffiths

Cognitive Walkthrough evaluation - Mobi App

Dear Expert,

Mobi is a web app to help visitors and residents of Brighton to know more about the sculptures and monuments in situ. Users will have the app available in **a touch screen mobile phone (e.g. 320x480 pixels screen size). Users will tap on the graphic interface to require information**. Our main objective is to analyse their interaction with the elements on the screen. We would like to have your assistance to improve it before testing with users. The prototype is not fully functional. You will notice that not all the audio, video files and links (in gray) are available. We appreciate if you could follow the cognitive walkthrough below and fill the form with your comments and suggestions. Please feel free to give us more feedback as well, of any kind. This should take approximately 20 - 30 minutes.

After the evaluation, please send this form back to me heloisacsp@gmail.com ; hcdspc10@brighton.ac.uk

The data collected in this form might be used in publications but it will be always anonymous. We will provide you a digital copy of the final thesis.

Thank you very much for your help.

Set up Information:

Please access the prototype from the webpage:

http://www.cmis.brighton.ac.uk/users/hcdspc10/mobi.html

We would like you to access the prototype on-line. In case you don't have Flash Player installed in your computer please download it from the link below:

http://www.adobe.com/shockwave/download/flash/trigger/en/3/index.html

Once you have accessed the file please follow the walkthrough worksheet, answer the questions and give your opinion about the system.

Your Details:

Company:

Contact Information:

Field of Expertise:

Human-Computer Interaction (HCI) ☐ Mobile HCI ☐ Information Visualisation ☐

Information Design ☐ Heritage Interpretation ☐ Mobile learning ☐

Years of Experience in the Field:

1 to 5 ☐ 6 to 10 ☐ more ☐

Task: Finding information about one monument in the tour.

Typical users: Visitors, short and long term residents that want to know more about the city (Brighton – UK)

Device: Touch screen mobile phones (e.g. HTC Hero 320x480)

The 1 – 10 steps to complete the task are given below. The 11- 20 steps are in the next page.

Please answer for each step **yes** or **no** the A to D questions and insert your comments and suggestions on the following columns.

A - Will the action be sufficiently **evident** to the user?

B - Will users **know what to do**?

C- Will users understand how to do it?

D- Will users understand from feedback whether the action was correct or not?

Steps	Tasks	A	B	C	D	Comments	Suggestions
	Find the nearest monument from where you are Click on the nearest "monument" icon from the "you are here" icon - green arrow						
	See the content of this						

	monument Click on the square “Queen Victoria”						
	See the pictures available Click on the “arrows” to see the pictures						
	See the “picture of the plaque” in full screen Click on the “picture of the plaque”						
	See the text of the plaque Click on the “text” icon						
	Can back to the picture Click on the “plaque thumbnail” (Intention: can back to the full screen mode)						
	Can back to the content of the monument Click on the “full screen picture”						
	Listen to the audio Click on the “audio” icon						
	Pause the audio Click on “pause” icon						
	See the text of the audio Click on the “text” icon						
	Go back to the audio page Click on the “text” icon again (Intention: go back to the previous state – audio page)						
	Watch the video Click on the “video” icon (Intention: go to the video page)						

Please answer for each step **yes** or **no** the A to D questions and insert your comments and suggestions on the following columns.

A - Will the action be sufficiently evident to the user?

B - Will users know what to do?

C- Will users see how to do it?

D- Will users understand from feedback whether the action was correct or not?

Steps	Tasks	A	B	C	D	Comments	Suggestions
	Go back to the content page Click on the “back” icon (Intention: can back to the content page)						
	See the information of who is Jessie Blaker Click on “Jessie Blaker” hyperlink and read the text (Intention						
	Go back to the previous state (content page) Click on “the box” (Intention: make the box disappear)						
	Go to additional information, website about the subject Click on the “more” icon – small black button with the cross (Intention: go to the webpage about the subject)						
	Go back to the app using the “browser controls” (Intention: go back to the app)						
	See the monuments nearby Click in the “icon nearby” monuments from the map page						
	See the directions between Queen Victoria and Ceres Select Queen Victoria in the “current location” and “Ceres”in the Select Monument. Click in “Route”						
	Go back to the map Click in the map button						
Other Comments							

Thanks for your contribution

Appendix I: List of Design Recommendations by strength

List of Recommendations by strength

Recommended

R1 -Make the type size bigger than 14pt in long texts or fit the text on one screen. SC: Recommended (**)
Issue (01): When the block of the text does not fit in one screen, the typeface is considered smaller than when the text has a single block that fits on the screen. SE: ***
Relation: Age (A) x text (c)

R2 - Use the same interaction model of the device in the app. SC: Recommended (**)
Issue (02): It is difficult to follow George IV text. SE: ******
Relation: Technology familiarity (G) x text (c)

R3 - The text should be shown in one block of text. SC: Recommended (**)
Issue (03): Participants that are older than 50 years old were apprehensive to press on/scroll the screen. SE: **
Relation: Age (A) x text (c)

R4 - Offer information through audio/verbal mode. SC: Recommended (**)
Issue (04): Participants preferred to read the text instead of listen to the audio in noise conditions. SE: **
Relation: Comprehension (F) x text (c) x environment (c)

R6 - Hyperlinks should be available for users that are familiar with the content of the subject and want to know more about it. SC: Recommended (***)
Issue (06): Internationals spending the day in Brighton did not access links in the same extent as locals. SE: ******
Relation: Available time (I) x hyperlinks (e)

R7 - Make it blue, underline the words, or add an icon (jump) near the hyperlink. SC: Recommended (****)

Issue (07): When accessing text not always participants identify coloured words as hyperlinks. SE: **********

Relation: Technology familiarity (G) x hyperlinks (e)

R8 - Lead users to websites that have a mobile version. SC: Recommended (**)

Issue (8): When accessing external hyperlinks users do not have patient to look for content in a webpage that is not tailored to mobile devices. SE: ***

Relation: Comprehension (F) x Device and connection (a)

R12 - Show information date and label on the pictures. SC: Recommended (*)

Issue (12): Participants with high interest on the theme missed the date of the picture SE: *

Relation: Expectation (N) x Pictures (b) x Content – date (c) and Label (d)

R22 - The length of the audio file should be suitable to the average time spent to appreciate the monument. SC: Recommended

Issue (22): Time to listen to the audio is longer than the time to appreciate the monument. SE: *

Relation: Expectation (N) x Audio (a) x POI (b)

R23 - Make available major number of audio files with different themes that users can choose. SC: Recommended

Issue (23): More audio files might be available by theme – sculpture description and subject description. SE: **

Relation: Interest (O) x Audio (a) x history (b) x POI (b)

R25 - Audio playback functions should be available on all the screens when audio file is on SC: Recommended (*******)

Issue (25): When accessing audio files in outdoor settings using a mobile phone, visitors might want to stop the audio when they are in a different session of the app. SE: *******

Relation: Expectation (N) x Audio (a) x Video (m)

R34 - It should be given suggestions to move further away when monuments are high and better observed by distance. SC: Recommended (****)

Issue (34): Instructions should be given according to the size of the monument. SE: ****

Relation: Motivation (M) x Text (c) x POI (b)

R35 - Change the word “appreciate” to “see the details” in the text SC: Recommended (**)

Issue (35): Internationals did not follow the suggestions to move closer to appreciate the monument in the same extent as native/national visitors. SE: *******

Relation: Motivation (M) x Nationality (C) x Text (c)

R38 - Provide a straight forward way to deliver audio content. SC: Recommended (**)

Issue (38): Participants that are not fluent in English have difficulties to understand conversations in the audio session. SE: *****

Relation: Language (B) x Audio (a)

R41 - The credit should be given in the beginning of the audio file or accessible to request any time users want. SC: Recommended (**)

Issue (41): When the audio files contain opinions and believes of the speakers, credit should be given.SE: *******

Relation: Interest (O) x Audio (a) x Credits (a)

R42 - Place the subtitle icon near the play button. All the functions active should be together on the interface. SC: Recommended (**)

Issue (42): Participants did not notice the subtitle icon. SE: **********

Relation: Expectation (N) x Icon (L)

R44 - The text should scroll smoothly and easy to control. SC: Recommended (**)

Issue (44): User cannot scroll the text in his pace. SE: ***

Relation: Expectation (N) x Text (c)

R46 - Provide feedback when users want to forward the video.SC: Recommended (*****)
Issue (46): Users unfamiliar with technology did not know how to forward the video. SE: *****
Relation: Technology familiarity (G) x Video (m) x Device and Connection (a)

R47 - Volume controls should be present on the screen. If they are used to the phone controls this option is not extremely necessary. On the other hand, when watching the videos participants are looking at the screen, so it is easier to change the volume if the controls are on the screen. SC: Recommended (*****)
Issue (47): When accessing videos in outdoor settings using a mobile phone, visitors should not stop watching or miss some parts of the video because they cannot find the volume controls of the video. SE: *****
Relation: Technology familiarity (G) x Video (m) x Audio (a) x Device and Connection (a)

R48 - Provide help information. SC: Recommended (**)
Issue (48): Users did not know how to see the video without the controls on the screen. SE: **
Relation: Technology familiarity (G) x Video (m) x Audio (a) x Device and Connection (a)

R52 - Present different ways to deliver information in the same guide, people are not always patient or have available time to see videos in outdoor settings SC: Recommended (*****)
Issue (52): Users did not find essential to have video in the multimedia guides prefer to see the nearby monuments first on the map. SE: *****
Relation: Available time (I) x Video (m) x Map (g)

R56 - Despite of users did not value to access a video in the field; it is important to have a video file, so users can possible to watch it before or after the tour in a comfortable place. SC: Recommended (***)
Issue (56): Video is not essential to have in multimedia guides. SE: ********
Relation: Preference (L) x Video (m)

R57 - Video content should be focus on history and subject life. SC: Recommended (****)

Issue (57): Participants preferred George IV video instead of Queen Victoria video, because the last one was focused on one picture of the Queen. They found more interesting knowing of George IV's life. SE: ****

Relation: Interest (O) x Video (m) x History (b)

R58 - Multimedia content should lead participants to see more details on POI. SC: Recommended (**)

Issue (58): Video based on pictures of the subject can lead participants to compare and see details they would not see without this visual stimulus SE: **

Relation: Motivation (M) x Video (m) x POI (b)

R63 - Use additional feedback – vibration/colour. SC: Recommended (***)

Issue (63): The icons were very small in the map. SE: ****

Suggestion 1: The space between icons should be enough to tap without tapping in other function by mistake. SC: N/A

Relation: Expectation (N) x Icon (L)

R64 - Display a preview of the monument on the map e.g. illustrative icons. SC: Recommended (**)

Issue (64): It is not possible to know what the dots are before selecting them. SE: *****

Relation: Comprehension (F) x Expectation (N) x Icon (L) x Map (g)

R65 - Options such as: directions and audio, video, text content should be available for selection on the map. SC: Recommended (*****)

Issue (65): The app does not show options to access features available from the map screen. SE: *****

Relation: Expectation (N) x Map (g)

R66- Map should display natural landmarks and cardinal points for way finding purpose. SC: Recommended (***)

Issue (66): Map does not show cardinal points, sea and green areas. SE: ***

Relation: Expectation (N) x Way Finding (J) x Map (g)

R67 - Directions should be contemplated on the map section. SC: Recommended (***)

Issue (67): Map and Directions were different sections on the app, as consequence it confused users when looking for locations. SE: ***

Relation: Comprehension (F) x Way Finding (J) x Expectation (N) x Map (g)

R69 - It should up to date the distance and order of points of interest in the list. SC: Recommended (***)

Issue (69): Participants used the list to see what next point of interest is. SE: ****

Relation: Way Finding (J) x List (h)

R70- A link to the map/directions should be provided from the list. SC: Recommended (****)

Issue (70): It is not available the “route”/ “take me there” function from the list. SE: ****

Relation: Expectation (N) x Way Finding (J) x List (h)

R71- Show a picture and the first statement of the content. SC: Recommended (**)

Issue (71): The list does not show a link for a picture and a preview of the content. SE: **

Relation: Expectation (N) x List (h)

R72 - Users should be able to type the name of any point of interest they are interested on in the search engine. SC: Recommended (***)

Issue (72): Participants searched on the search engine for points of interest they have previous knowledge. SE: ***

Relation: Previous Knowledge (E) x Interest (O) x Search (f)

R73 - Show a list of words based on categories: sculptures, buildings, nearby monuments. SC: Recommended (**)

Issue (73): Participants did not know what to search for. SE: **

Relation: Comprehension (F) x Expectation (N) x Search (f)

R74 – Display search results with a link for map and directions to the point of interest. SC: Recommended (**)

Issue (74): Search results did not have the option “take me there”. SE: **

Relation: Way Finding (J) x Expectation (N) x Search (f) x Map (g)

R75 - The results should be retrieved from the App and Internet e.g. Wikipedia.SC: Recommended (**)

Issue (75): Search results did not display a link to go to explore websites about the theme - Wikitude. SE: **

Relation: Expectation (N) x Search (f) x Web content (h)

R76 - Mobile guides should have a function to share thoughts in social networks. SC: Recommended (****)

Issue (76): Users appreciate to have the possibility to share their thoughts and publish in social media apps. SE: ****

Relation: Social share (H) x Notes (i)

R77 - “Comments” or “Share” is a better label to publish public comments than “notes”. SE: Recommended (***)

Issue (77): It was not clear the label “notes” for sharing content in social networks, users interpret it as a function to add private notes. SE: ***

Relation: Comprehension (F) x Notes (i)

R78 - The feature “camera” should be available to pleasure visitors of the city but also to register unexpected situations might occur during the tour. SC: Recommended (****)

Issue (78): Visitors took more pictures than residents and locals. SE: ****

Relation: Residence (D) x Camera (J)

R79 - The “camera” function should be integrated to “notes”. SC: Recommended (**)

Issue (79): The app did not integrate “notes” to “camera”, so users were not able to share a comment and a picture in the same post. SE: *

Relation: Technology Familiarity (G) x Expectation (N) x Notes (i) x Camera (J)

R83 - Mobile guide content should engage users to access cultural information, calling their attention to content. SC: Recommended (**)

Issue (83): Participants with no interest in the subject did not access any feature without being requested. SE: ***

Relation: Interest (O) x Overall access (k)

R84 - Connect information delivered among diverse features. Hence, International users will follow indications to access information. SC: Recommended (**)

Issue (84): Internationals users were overwhelmed to access all the information available on the app SE: ******

Relation: Nationality (C) x Overall access (k)

R86 - Give use instructions as soon as the app starts and provide a help system for this function. SC: Recommended (**)

Relation:

Issue (86): Older participants pressed the icons instead of tap. SE: ***

Relation: Age (A) x Icon (L)

R87 - Connect information delivered among diverse features to encourage users to explore content available on the app. For example “listen to the audio to know how the life was in the Royal Pavilion”. SC: Recommended (**)

Issue (87): Different media features were identified to have similar content by participants. SE: ****

Relation: Expectation (N) x Overall access (k)

R88 - Give the option to adjust the brightness screen or to change the background and text colour. SC: Recommended (**)

Issue (88): Mobile device screen was difficult to see under light environments. SE: *********
Relation: Comprehension (F) x Device and Connection (a)

R89 - Give a planned route based on chronological order. SC: Recommended (**)
Issue (89): Users expected a linear guided tour. SE: ****
Relation: Expectation (N) x Linear organisation (n)

R90 - Use hyperlinks for extra information. SC: Recommended (**)
Issue (90): References to diverse points of interest in the main text confound the users. SE: ***
Relation: Comprehension (F) x Text (c) x Hyperlinks (e)

Medium

R5 - Use hyperlinks to facilitate of users to read text in outdoor settings. SC: Medium Recommendation (*******)
Issue (05): Participants reported they prefer to have hyperlinks on the text than scroll it. SE: **********
Relation: Preference (L) x hyperlinks (e)

R9 - Use the back button on the interface to go back SC: Medium Recommendation (******)
Issue (9): It is not clear how to go back to the app from external links. SE: **********
Relation: Technology familiarity (G) x icon (L)

R13 - Use pictures and other features, audio, to call user's attention to details of a POI that is very high SC: Recommended (*****)
Issue (13): Users passed by a high monument and did not notice it. SE: *****
Relation: Interest (O) x Pictures (b) x POI (b)
R14 - User should be able to select this function on thumbnails mode and full screen mode. SC: Recommended (**)
Issue (14): The icon "info button" on the thumbnail pictures did not indicate the availability of the text replica. SE: ***

Relation: Comprehension (F) x Icon (L)

R15 - Participants expect to see the same amount of information in every part of a system or sub-system (pictures section). SC: Recommended (**)

Issue (15): Participants would like to have an “info button” available in all the pictures containing extra info such as: dates and labels. SE: **

Relation: Expectation (N) x labels (d) x dates(c)

R16 - Add a message “tap to see full screen” in all the pictures of the picture gallery. SC: Recommended (**)

Issue (16): It is not evident how to see full screen pictures SE: ***

Relation: Comprehension (F) x pictures (b)

R17 - Add a back button in every full screen picture. SC: Recommended (**)

Issue (17): Users that were not familiar with the technology did not know how to go back from pictures in full screen mode. SE: ********

Relation: Technology familiarity (G) x pictures (b) x hyperlinks (e)

R18 - The system should present information in diverse media type (text, video) not only audio so that in noise conditions users might access information in the same extent. SC: Recommended (**)

Issue (18): Participants were disturbed by the environment noise while listening to the audio file. SE: **

Relation: Comprehension (F) x Audio (a) x environment (c)

R19 - The system should present information in diverse media type (text, video) not only audio so that in noise conditions users might access information in the same extent. SC: Recommended (****)

Issue (19): Older participants were more attracted to access text than audio files. SE: ****

Relation: Age (A) x audio (a) x text (c)

R20 - Information of how to use the app should be available to users. SC: Medium Recommendation (*******)

Issue (20): Users that are not familiar with touch screen phones did not try the audio files in the first part of the tour. SE: *******

Relation: Technology familiarity (G) x audio (a)

R26 - The audio should auto play when the user is wearing the headphones and there is only one file available. If more than one file is available user should be required to press the play button. SC: Medium Recommendation (******)

Issue (26): Users did not press play to start the audio if they were already wearing the headphones. SE: ******

Relation: Expectation (N) x Audio (a) x Device and Connection (a)

R31 - Alerts should be given to users when crossing streets. SC: Medium Recommendation (******)

Issue (31): Participants might be under risky (traffic safety) were distracted when interacting with the app. SE: ******

Relation: Safety (K) x Environment (c)

R37 - Despite American accent was preferred by Internationals, it is indicated to use in audio and video the accent of the region where the guide is accessed. SC: Medium Recommendation (********)

Issue (37): The majority of participants did not show any preference for English accent type. SE: **********

Relation: Nationality (C) x Audio (a)

R39 - Two speakers having a conversation and giving their opinions about the subject is one way to deliver audio content for native speakers. SC: Medium Recommendation (********)

Issue (39): Native participants prefer audio files that add novelties and excitement to their background information.SE: *******

Relation: Nationality (C) x Audio (a) x Novelties (e)

R40 - Audio should be recorded in a studio and subtitles should be available to follow the audio file. SC: Medium Recommendation (*******)

Issue (40): Audio file should not be recorded on the spot, because of city noise.SE: *******

Relation: Comprehension (F) x Audio (a) x Environment (c)

R49 - Program videos to be shown in landscape format. SC: Medium Recommendation (******)

Issue (49): Users with experience with touch screen devices were used to see videos in landscape format SE: ******

Relation: Technology familiarity (G) x Video (m) x Device and Connection (a)

R51 - Present different ways to deliver information in the same guide, people are not always patient or have available time to see videos in outdoor settings SC: Medium Recommendation (*******)

Issue (51): Users did not find essential to have video in the multimedia guides also prefer seeing text with hyperlinks than a long text on the screen. SE: *******

Relation: Available time (I) x Video (m) x Hyperlinks (e)

R53 – Audio files should be preferred than video files, people are not always patient or have available time to see videos in outdoor settings SC: Medium Recommendation (******)

Issue (53): Users did not find essential to have video in the multimedia guides find essential to have audio files. SE: ******

Relation: Preference (L) x Video (m) x Audio (a)

R54 - Audio files are preferred by visitors and international participants. SC: Medium Recommendation (*****)

Issue (54): Visitors and internationals users found more essential to have audio than video in outdoor settings. SE: *****

Relation: Nationality (C) x Video (m) x Audio (a)

R55 - Present different ways to deliver information in the same guide, old people are not always patient, have available time or are know how to see videos on mobile phones. SC: Medium Recommendation (******)

Issue (55): Older users accessed more often text than video in outdoor settings. SE: ******

Relation: Age (A) x Text (c) x Video (m)

R59 - Users should be able to scroll the map. SC: Medium Recommendation (*********)

Issue (59): It is not possible to scroll the map. SE: *********

Relation: Expectation (N) x Map (g)

R60 - Users should be able to zoon in/out the map. . SC: Medium Recommendation (*******)

Issue (60): It is not possible to zoon in/ out the map. SE: *******

Relation: Expectation (N) x Map (g)

R61 - Map should align to face the direction user is going to. SC: Medium Recommendation (*********)

Issue (61): Map does not switch direction according to the user's location. SE: *********

Relation: Expectation (N) x Map (g)

R62 - It should have a location tracker. SC: High Recommendation (**********)

Relation:

Issue (62): Map does not up to date graphically according to user's location. SE: **********

Relation: Expectation (N) x Map (g)

R82 - Mobile guide should have an amount of information to satisfy experts and novices in the field. SC: Medium Recommendation (*********)

Issue (82): Participants with background in Art and cultural heritage accessed more features than other participants. SE: *********

Relation: Interest (O) x Overall access (k)

High

R10 - Use pictures to help users to recognise POI they are looking for. SC: High Recommendation (**********)

Issue (10): Pictures of the statue assisted users in way finding situations. SE: **********

Relation: Way finding (J) x Pictures (b)

R11 - Use pictures of the POI to help in way finding and pictures of subject to give context and illustrate history. SC: High Recommendation (**********)

Issue (11): Participants would like to have both kinds of pictures for every sculpture. SE: **********

Relation: Interest (O) x Pictures (b) x History(b)

R21 - Two minutes to three minutes are ideal for users listen to audio files. SC: High Recommendation (**********)

Issue (21): The length of the audio is satisfactory. SE: **********

Relation: Expectation (N) x Audio (a) x POI (b)

R24 - When visitors listen to the audio, if they access another function the audio should not stop just in case they access features that have sound. SC: High Recommendation (**********)

Issue (24): Users should be able to interact with other parts of the system while listening to the audio. SE: **********

Relation: Expectation (N) x Audio (a) x Text (c)

R27 - Time availability to wear the headphones is necessary. SC: High Recommendation (**********)

Issue (27): Users were not advised to wear the headphones before listening to the audio files, so that they prefer to wear the headphones and then press play to start audio files. SE: **********

Relation: Expectation (N) x Audio (a) x Device and Connection (a)

R28 - User should press play to start the audio file and the audio bar has to show it is loading. SC: High Recommendation (**********)

Issue (28): The audio bar did not show visually that it was loaded the audio file. SE: **********

Relation: Expectation (N) x Audio (a)

R29 - If it is a web app the speed of Internet connection should be high. In case of technology problems visual feedback should be provided to users – Add the word “Downloading”. SC: High Recommendation (**********)

Issue (29): Audio file did not start when pressed play. SE: **********

Relation: Expectation (N) x Audio (a) x Device and Connection (a)

R30 - It should have the volume controls on the touch screen of the phone SC: High Recommendation (**********)

Issue (30): Participants that were not familiar with the device did not know how to increase the audio volume. SE: **********

Relation: Technology familiarity (G) x Audio (a) x Device and Connection (a)

R32 - Offer subtitles or other ways to deliver information available in the audio file. SC: High Recommendation (**********)

Issue (32): Participants that were in noisy environments were also not satisfied with audio files. SE: **********

Relation: Comprehension (F) x Audio (a) x Environment (c)

R33 - Mobile guides should display messages to motivate users to look at monument piece. SC: High Recommendation (**********)

Issue (33): Text suggestions on the audio screen motivate users to look at monuments instead of looking at the screen. SE: **********

Relation: Motivation (M) x Audio (a) x Text (c) x POI (b)

R36 - Audio may lead participants to direct their sight to monuments and surroundings details. SC: High Recommendation (**********)

Issue (36): Participants noticed another sculpture in the surroundings because of audio speaker’s incentive. SE: **********

Relation: Motivation (M) x Audio (a)

R43 - Provide subtitles for users follow the content. SC: High Recommendation (**********)

Issue (43): When accessing video/ audio files in outdoor noisy and crowded settings, internationals and non English speakers found essential to have subtitles. SE: **********

Relation: Nationality (C) x Subtitles (d) x Environment (c)

R45: While the video is loading provide feedback to users e.g. add a message “downloading”. SC: High Recommendation (**********)

Issue (45): Participants had to wait to see the video and did not know if it was loading the video or the app crashed. SE: **********

Relation: Expectation (N) x Video (m) x Device and Connection (a)

R50 - The length of the video should be less than 2 min. SC: High Recommendation (**********)

Issue (50): When accessing videos in outdoor settings using a mobile phone, visitors should not abandon the video because of the video length. SE: **********

Relation: Expectation (N) x Video (m)

R68 - List should be a feature available when residents are part of mobile guide target group. SC: High Recommendation (**********)

Issue (68): Residents accessed the list more often than visitors and locals. SE: **********

Relation: Residence (D) x List (h)

R80 - It is not relevant to have more than four options to access content in outdoor mobile guides. SC: High Recommendation (**********)

Issue (80): In the tour participants accessed in average four features to retrieve information. SE: **********

Relation: Preference (L) x Overall access (k)

R81 - Text is a must have way to display content in a mobile guide, followed by audio files. SC: High Recommendation (**********)

Issue (81): Participants accessed more text than other features to retrieve information. SE: **********

Relation: Preference (L) x text (c)

R85 - Encourage users to access information on the app through visual clues. SC: High Recommended (**********)

Issue (85): Participants did not use touch screen phones frequently accessed less functions than the ones that did SE: **********

Relation: Technology Familiarity (G) x Overall access (k)