ENHANCING USERS' EXPERIENCE WITH SMART MOBILE TECHNOLOGY

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Abstract

The aim of this thesis is to investigate mobile guides for use with smartphones. Mobile guides have been successfully used to provide information, personalisation and navigation for the user. The researcher also wanted to ascertain how and in what ways mobile guides can enhance users' experience.

This research involved designing and developing web based applications to run on smartphones. Four studies were conducted, two of which involved testing of the particular application. The applications tested were a museum mobile guide application and a university mobile guide mapping application. Initial testing examined the prototype work for the ‘Chronology of His Majesty Sultan Haji Hassanal Bolkiah’ application. The results were used to assess the potential of using similar mobile guides in Brunei Darussalam’s museums. The second study involved testing of the ‘Kent LiveMap’ application for use at the University of Kent. Students at the university tested this mapping application, which uses crowdsourcing of information to provide live data. The results were promising and indicate that users' experience was enhanced when using the application.

Overall results from testing and using the two applications that were developed as part of this thesis show that mobile guides have the potential to be implemented in Brunei Darussalam’s museums and on campus at the University of Kent. However, modifications to both applications are required to fulfil their potential and take them beyond the prototype stage in order to be fully functioning and commercially viable.

Acknowledgement

First and foremost I would like to dedicate my wholehearted thanks to “Allah Subahanahu wa ta’ala” for the strength to complete this research. I would also like to thank my sponsor, the Ministry of Education under the Government of Brunei Darussalam for giving me the opportunity to continue my studies.

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CHAPTER 1
Introduction

Mobile technology is defined as the technology used for cellular communication. Mobile code division multiple access (CDMA) technology has evolved rapidly. A standard mobile device has gone from being no more than a simple two-way pager to being a mobile phone, GPS navigation device, an embedded web browser and instant messaging client, as well as a handheld game console (TechInfoPoint (2015).

It is the fastest growing platform to date and continues to provide new experiences for users. Besides using mobile technology to connect users and communicate globally, it has evolved a further use in making mobile guide applications. These guide applications use mobile internet or a mobile data connection to allow users to go online and acquire information easily. The kind of information includes navigation, guides, reviews and personalisation.

Institutions such as museums have installed this type of mobile technology. For almost six decades (Othman, Petrie, and Power 2011), mobile guides have been utilised in museums to enhance user experience. Conventional types of technology

that have been used in museums include handheld guides, smartphone tours as well as iPods and mp3 players.

In recent years, mobile technology used in museums is no longer limited to just guiding the visitors and has been improved upon to enhance the user experience to make it more engaging. Many museums throughout the world have implemented the latest mobile technology to attract visitors to their institutions. From simple tour guides additional features have been incorporated such as social interactivity and games.

This thesis discusses the users' experience in museum and university environments using mobile technology. The reason for using the university as a platform was to gauge whether the users' experience was enhanced using the mobile technology.

In addition, usability scale and user interface satisfaction instruments were used to assess the quality of the developed mobile guides. Quality in this context implies ease of use and user satisfaction of the mobile guide applications that were developed.

1.1 What is a Mobile Guide?

A mobile guide is a portable device that provides multimedia information. This includes images, videos or text. Usually mobile guides are closely associated with users' physical location and objects in the users' immediate surroundings (Kjeldskov et al. 2005). A dictionary definition of the term 'mobile' simply means 'capable of moving or of being moved readily from place to place' (thefreedictionary.com 2011). Proctor has classified and described mobile guides as follows:

- **Pocketable** (phones, personal media players, gaming devices) *and* **portable** devices (tablets and eReaders);
- **Smartphones** that run apps and access the Internet, *and* older **cellular phones** that do nothing more than make voice calls and send text messages;
- **Podcasts** of audio and video content, *and* other **downloadable content**, including PDF's and eBooks;

- **Mobile websites**, optimised for the small screen and audiences on the go, *and* **'desktop' websites**, designed for large, fixed screens but which are increasingly visited by mobile devices.

(Proctor 2013)

Figure 1.1
Samsung and iPhone smartphones (image courtesy of Samsung and Apple)

1.2 Motivation and Rationale

The main focus of this thesis is to investigate mobile guides. This includes the development, usability, satisfaction and users' experience of the mobile guides. The mobile guides were developed specifically for smartphones such as the popular Samsung and iPhone smartphones (Figure 1.1). A web application and web map application were used to produce the mobile guides, which run on the smartphones web browser. The two places used as subjects for this study were the Brunei Museum in Brunei Darussalam and the University of Kent campus in the United Kingdom. Although the two spaces are different in terms of usage both of these sites can benefit from using mobile guides.

Mobile guides in the traditional sense have been used in museums for a number of decades while mobile technology was introduced a decade ago (Othman, Petrie and Power 2011). However, Near Field Communication (NFC) tags and Quick Response

(QR) codes have been used for less than ten years in these environments. Initially, the study focused on developing a museum mobile guide for the Brunei Museum in Brunei Darussalam. This museum has never utilised any mobile technology. Therefore, the researcher was motivated to develop a mobile guide for the museum to enhance users' experience in the museum. For this pilot study the mobile guide web application that was developed used content based on the 'Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah' (Chronology of His Majesty Sultan Haji Hassanal Bolkiah). A typical user and mobile guide interaction can be seen below in the Museum of Modern Art, New York (Figure 1.2). This personal access to information and other data is often a satisfying and beneficial experience for the user.

Figure 1.2
A visitor using a mobile guide in MoMA (image courtesy of Dexigner)

The other study in this research utilised the University of Kent as a space. Some universities in England have implemented their own university mobile guides such as Newcastle University and University of Oxford. Selected screenshots of these mobile guides are shown in Figures 1.3 and 1.4 respectively.

The purpose of this research was to develop a mobile guide to enhance users' experience on the University of Kent campus especially among students. Therefore a web map application called 'Kent LiveMap' was developed which initially gave information specifically related to parking in the University of Kent. The prototype that was developed is a web based application which will run on any mobile phone browser which is different from the way mobile guides are used at other universities. The crowdsourcing aspect was another unique part of this application as users themselves are able to provide information.

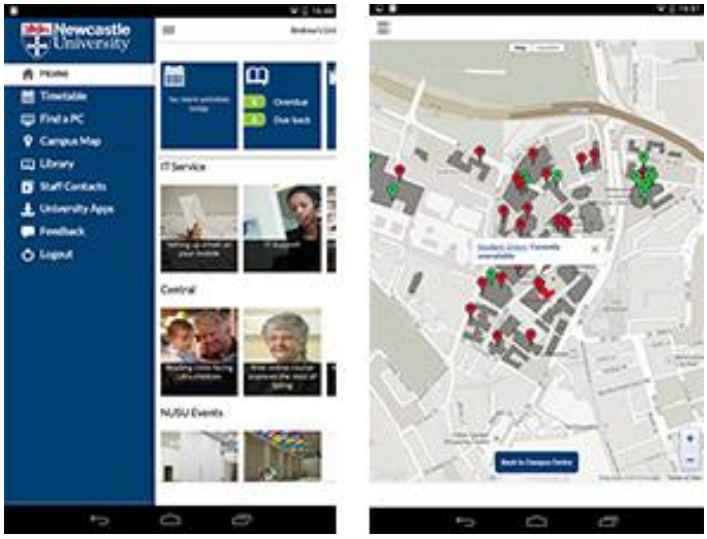


Figure 1.3
Screenshot of Newcastle University Guide (image courtesy of Google Play)

Figure 1.4
Screenshot of University of Oxford Guide (image courtesy of Google Play)

1.3 Research Questions

The two principal research questions and other relevant questions that the researcher aims to answer are:

1. How can a map with dynamic real time data be generated through crowdsourcing?
   1.2 Can crowdsourcing of information offer reliable data?
   1.3 Is crowdsourcing of information sufficient to develop a viable application?
2. How can Kent LiveMap enhance users' experience on campus?
   2.2 What different types of information can Kent LiveMap deliver?

1.4 Thesis Overview

The rest of the thesis outline is as follows:

Chapter 2 presents a literature review of the background related to the study. Topics were chosen which related directly or indirectly to the four applications that were to be developed as part of this research study. This chapter is divided into a number of sub-sections which focus on the features of mobile guides used in museums, types of visitor to museums, the mobile web, mobile map applications, parking problems and solutions, crowdsourcing, near field communication (NFC) tags, quick response (QR) codes, analysis and conclusions.

Chapter 3 discusses mobile audio guides and the development of an audio guide by the researcher. It is based on a study of mobile audio guides using smartphones. The focus is on an audio guide, which was developed specifically for visually impaired students at the University of Kent.

Chapter 4 discusses mobile guides used in treasure hunts and similar information trail activities. The focus is on another development by the researcher. This information guide was developed for a Scavenger Hunt at the University of Kent using smartphones.

Chapter 5 discusses the study based on a web application called 'Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah'. This chapter is

divided into sub-sections including the method used for testing the application, design features, results, analysis, discussion and conclusions. The focus is on a pilot study used to test a web application prototype. The results of this study, which were limited in scope, were used as a learning experience so that the mistakes and errors arising from this study can be avoided in the future and acquired knowledge can be built upon.

Chapter 6 discusses the 'Kent LiveMap' application, which is a web map application that uses crowdsourcing of information to obtain live data. As in previous chapters it is divided into sub-sections including the method of testing used, results, analysis, discussion and conclusions. The focus of this study was improving the methodology and developing relevant questionnaire instruments to provide more reliable results.

Chapter 7 discusses the future development of the two mobile guides developed and tested for the purposes of this thesis. The focus is on amendments and addition of features to the Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah mobile guide and the Kent LiveMap mobile guide. The various potential uses of Kent LiveMap are also explored.

Chapter 8 discusses the conclusions of this thesis. It addresses the research questions that provided the basis for the Kent LiveMap application. It also focuses on what was achieved through the research programme, acquired knowledge in the area of mobile guide research as well as the limitations of the research that was carried out.

CHAPTER 2
Literature Review

2.1 Introduction

The work presented in this research programme identifies a number of topics in relation to mobile guides and the related technologies currently being practised. The topics explored are; ‘features of museum mobile guides’, ‘types of visitor in museum environments’, ‘mobile web’, ‘mobile map applications’, ‘parking problems, systems and solutions’, ‘crowdsourcing’ and ‘near field communication (NFC) and quick response codes (QR Codes)’ These particular topics were reviewed to establish guidelines for the development and study aspects of this research.

The literature review is presented in the following order:

- **Section 2.2** – This section discusses the features of museum mobile guides. These features are classified into three aspects, namely: tour guide, social interaction and play-game aspects. Cited examples and explanations are given for each of the three aspects. Additional features which can enhance users’ experience such as the use of storytelling and incorporating mixed and

augmented reality games into mobile guides are discussed in the 'missing features' section.

- **Section 2.3** – This section discusses the types of visitors to museums and their reasons for visiting museums. Visitors are classified and categorised into distinct groups based on their behaviour traits and motives for visiting museum environments.
- **Section 2.4** – This section discusses the 'Mobile Web' and the increasing importance of accessing the Internet using mobile devices. The types of applications used in the mobile web realm are outlined and the differences between mobile web applications and mobile applications are highlighted.
- **Section 2.5** – This section discusses Mobile Map applications and the common mapping applications available on the Apple, Android and Windows platforms.
- **Section 2.6** – This section discusses various Parking applications and seeks to address parking related problems and issues. A review of smart parking systems available in the market and their respective features is undertaken so as to be able to use the ideas and principles for developing a mobile parking application as part of this research study.
- **Section 2.7** – This section discusses crowdsourcing with particular emphasis being placed on crowdsourcing information. The various models of crowdsourcing and their essential differences are explored. Mobile crowdsourcing of information is discussed further in this section, as this will be the primary method used to obtain data for the LiveMap application being developed as part of this research study.
- **Section 2.8** – This section discusses Near Field Communication (NFC) and Quick Response (QR) code technology. A brief comparative study of both technologies is undertaken and usage of these technologies in museum environments and the tourism sector is outlined.
- **Section 2.9** – This section provides an analysis of the literature review and summarises the conclusions.

2.2 Features of Museum Mobile Guides

Usage of mobile technology in museum environments can be classified as having three main aspects, namely: tour guide, social interaction, and play-game aspects.

2.2.1 Tour Guide

The standard usage of mobile technology in museum environments employs the tour guide feature. This feature includes information, navigation and personalisation to varying extents.

Information - Information is retrieved about the artefacts in the museum using a smartphone. The information obtained may contain text, graphics, video or audio. Some museums do not provide complete information on all of their exhibits; therefore mobile technology can be used as an alternative way of obtaining such information. A previous study conducted in the Lapworth Museum, explored whether mobile technology can deliver information-centred experiences (Naismith and Smith 2009). By using the Hypertag Magnus Guide (Figure 2.1), the authors concluded that it was both convenient and easy for visitors to obtain information regarding the exhibits.

Figure 2.1
Screenshot of the Hypertag Magnus Guide

Navigation - Mobile tour guide applications often provide map navigation in museum environments, which enable visitors to easily find the exhibits they wish to see. It also helps them to route themselves if they're lost inside the museum. The navigation maps are either static or GPS (Global Positioning System) enabled. Static maps are similar to paper or board-based maps where the user will find their location

manually. However, with a GPS enabled map, a smartphone will automatically detect where the user is currently located. One example of simple map navigation that has been successfully used in museums is the iMuse mobile guide (Fevgas, Tsompanopoulou, and Bozanis 2011). This guide provides a pre-defined tour with route and exhibition information within the particular room or rooms that the visitor is interested in (Figure 2.2).

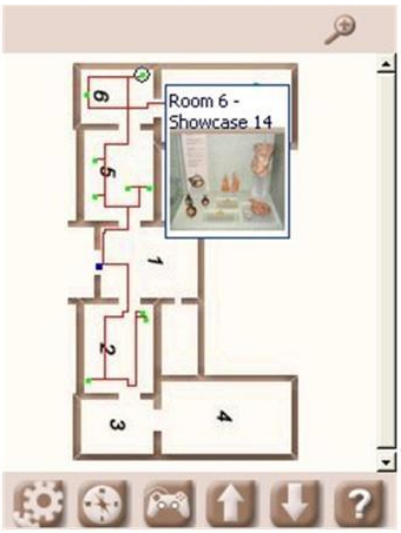


Figure 2.2
Screenshot of the iMuse navigation section

Personalisation - Phone-based tour guide applications can be personalised. Personalised tour guides enable the user to pre-define the mobile based on their interests. The personalisation can be setup in advance at home or on-site. The Cultural Heritage Information Personalisation (CHIP) interactive tour guide is an example of a mobile guide where users are able to personalise their preferences (Figure 2.3). Visitors can set which artefacts they want to see before arriving at the museum. Once the individual has finished selecting various artefacts the application will generate a map indicating the location of the relevant artefacts. Another example of personalisation can be found in the iMuse mobile tour application (Figure 2.4). This is a highly sophisticated guide where visitors can select what they want to view and this will generate a map that shows the location of the query (Fevgas, Tsompanopoulou, and Bozanis 2011) (Roes et al. 2009). Both of these examples show the effectiveness of tour guide applications, which allow visitors to rapidly find their way around in museum environments based on what they want to see.

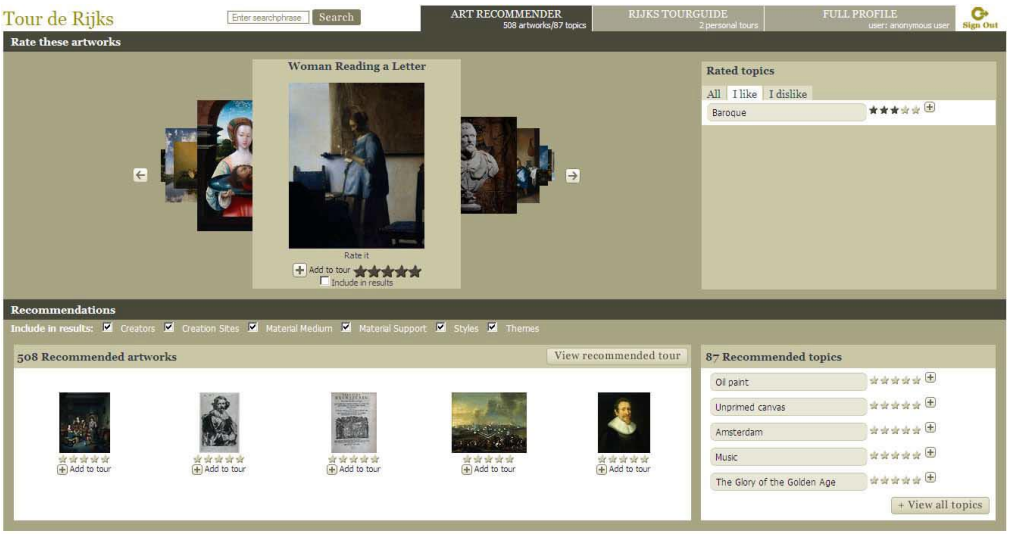


Figure 2.3
Screenshot of the CHIP tour guide selection section

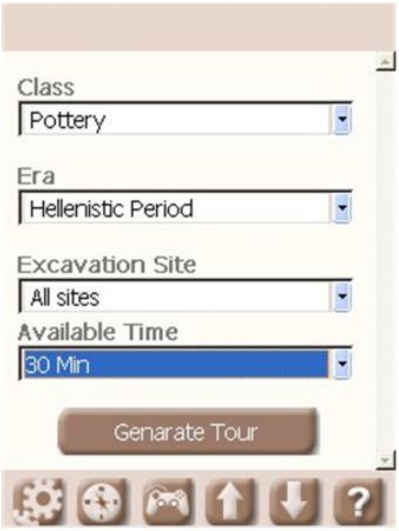


Figure 2.4
Screenshot of the iMuse personalised tour section

2.2.2 Social Interaction

The second aspect of mobile technology usage in museum environments is social interaction. Visiting the museum is often a personal and memorable experience but it is also significant to have social interaction as it will help other visitors share knowledge or opinions of the various exhibits and artefacts. This social approach to sharing knowledge can be achieved by leaving imprints, rating or voting, tagging individual artefacts, sharing emotions, or by giving reviews and comments.

Imprints - Imprint systems use mobile technology to enhance visitor experience in museum environments. Leaving imprints can develop a fun aspect in which visitors can express their creativity based on the exhibit they are viewing and experiencing. Imprints provide social awareness, as visitors are able to view existing imprints. Based on surveys, 95% of visitors surveyed left imprints (Boehner et al. 2005). This demonstrates that imprint systems can be successfully developed to enhance social presence. Notably, 73% of visitors made their own imprints rather than using the default (Boehner et al. 2005). A typical imprint drawing page is shown in Figure 2.5. The imprint system has proven to be one of the most successful methods in engaging users to participate in what museum environments have to offer.

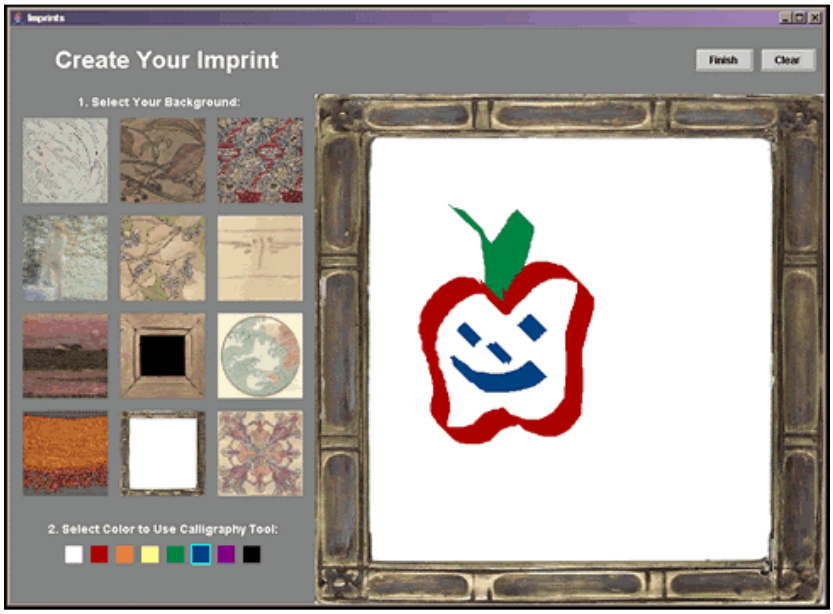


Figure 2.5
Screenshot showing an Imprint drawing page

Rate or Vote - Rating or voting on exhibits in museum environments using mobile technology has been in use for almost a decade. By letting the visitor rate and vote, popular exhibits can be discovered. A ‘Rate’ or ‘Vote’ is a system where users communicate through score; thus by having a score system, the mobile device can automatically recommend the most popular exhibits for visitors to see. The CHIP interactive tour guide, tested in the Rijksmuseum in Amsterdam, utilises a star rating system (Figure 2.6) which automatically recommends highly rated artefacts to the visitor (Roes et al. 2009). Other than rating of the artwork itself, users are allowed to rate the creator, creation site, material medium, material support, style and themes.

By these ratings, visitors can identify famous artists, favourite material types, painting styles and themes (Hage et al. 2010). Socially, visitors interact with each other by rating or voting for their favourite exhibits and artefacts. This feature saves time by providing the highest ratings for popular exhibits and is a useful tool for visitors to museum environments.

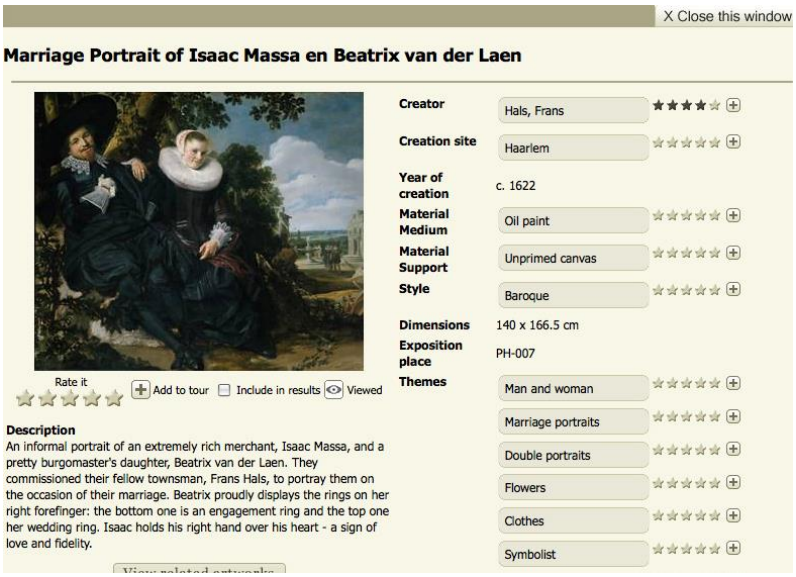


Figure 2.6
Screenshot showing the CHIP rating section

Tagging - Social tagging is a feature in mobile technology, which allows the visitor to label the exhibits based on their own judgement. For example, a museum exhibiting a porcelain plate decorated with flowers, visitors can tag it with suitable words of their own choice, such as plate, porcelain, flower or china based on what they thought about that particular exhibit. MobiTags is an example of a social tagging system that has been implemented in museum environments to help visitors interact with exhibitions and individual exhibits. MobiTags allows visitors to add their own labels as well as existing tags, which they think, might be appropriate. MobiTags also employs a voting interface based on available tags to show which labels are the most appropriate choice for the exhibits (Figure 2.7). This entire tagging system helps visitors to find an artefact based on appropriate labels, which are later mapped to their location (Cosley et al. 2009). Tagging not only speeds up the process of finding artefacts but it also enriches visitor activities by allowing them to contribute their own labels.

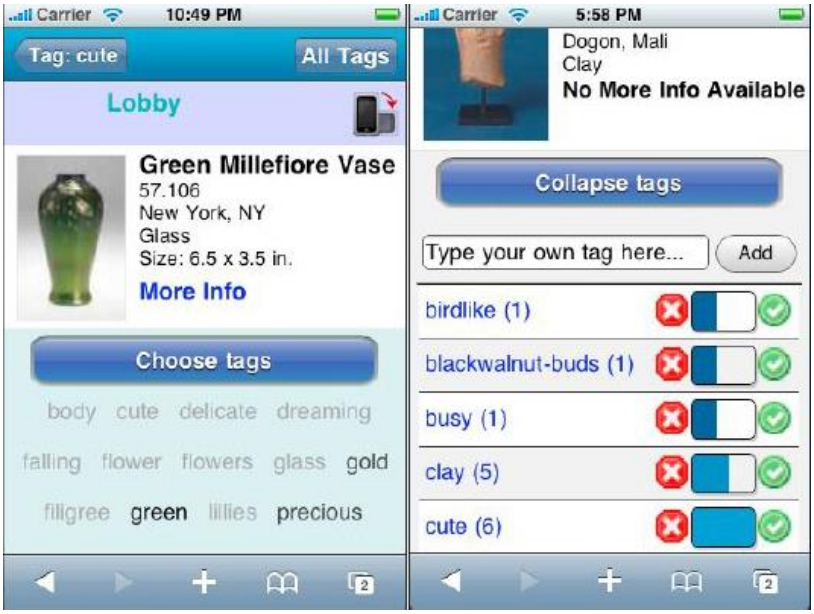


Figure 2.7
Screenshot of MobiTags, which allows the user to leave tags and vote for appropriate tags

Emotions - Visitors may experience certain emotions towards a particular exhibit or artefact that they view and touch in a museum environment. With emotion mobile applications, the visitor can share their emotions by stating how they feel about the exhibit they see. For example, if a visitor appreciates a colourful painting, they can select a 'happy' icon as their emotion to reflect their feelings. A visitor can also check other people's emotions about particular exhibits. Judging emotions using technology is not an easy task. One common way of assessing visitor emotions is by using emotion icons or emoticons (Meschtscherjakov, Weiss, and Scherndl 2009). This requires manual input by a user to enter how they feel at the time of examining and interacting with an exhibit. Typical emotions expressed through icon input are 'happy', 'sad', 'surprise', 'anger' and 'disgust' (Figure 2.8).

Figure 2.8
Emoticons expressing user emotion

Another example of assessing emotions using mobile applications is through the use of images and text to describe a particular emotion. This way of assessing emotions has been pilot tested using a system called Aurora (Gay et al. 2011). Users are asked to tap an empty photo box and select a single photo to represent how they feel. Additionally the user can type their emotion based on the image used (Figure 2.9). The findings of the research by Gay et al. showed that this was a tool that encouraged social awareness, emotion sharing and socially supportive behaviour.

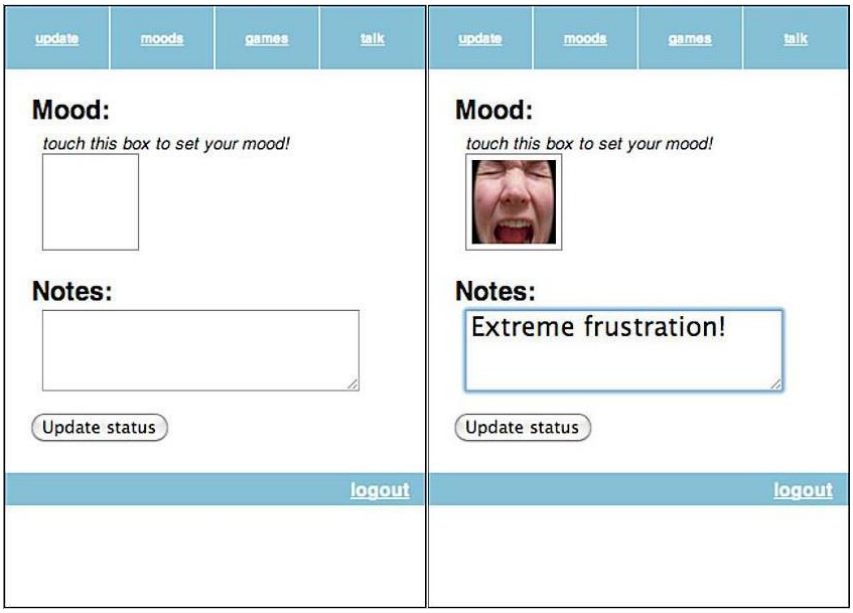


Figure 2.9
Screenshot of Aurora system showing a user inserted image and caption

Review and Comment features - Another common social interaction feature that can be implemented using mobile technology in museum environments is the adding of a review or comment for a particular artefact. While this is similar to storytelling and expressing an emotion visually, adding a review or comment is more concise and text based only. Instead of a visitor elaborating a story, he or she may comment briefly on an artefact by stating, “There are two cute dogs in the painting” or express an emotion by stating “I hate this painting”. Using the review and comment feature of a mobile guide application can increase social interaction in museum environments regardless of mobile platform.

2.2.3 Play and Game features

Additionally in museum environments, play and game features can be incorporated into mobile guide applications. These features enhance the individual users learning process and create a fun experience during their visit. Two examples of play and game features used in museum environments are educational games and scavenger or treasure hunts.

Education - One of the goals of museums is to educate visitors with regard to knowledge about particular artefacts. Museums provide educational information to the visitor so that they are aware of and understand the various exhibitions. Cicero is a mobile guide application, which illustrates this educational aspect well. It supports six types of individual games, namely: quiz, association, details, chronology, hidden, and memory. Each of the games has a different style of testing the visitor. For example, the quiz game consists of multiple choice questions, association games (Figure 2.10) allow the user to associate images of a particular exhibit with words and the chronology game involves arranging artwork chronologically (Ghiani et al. 2008). Based on an evaluation of the Cicero system, the adaptation features of education were judged as being interesting, stimulated learning, entertaining and improved user attention.

Figure 2.10
Screenshot of Associations game used in the Cicero System

Zydeco is another example of a mobile guide that has been applied in museum environments (Figure 2.11). It is an inquiry-based learning system that explores the museum. The system provides a new learning experience for visitors using a mobile device and keeps track of all users' input. Zydeco allows the user to collect data, take pictures, record audio and utilises a virtual tool to generate data (Kuhn et al. 2010). The aim of Zydeco is to deliver an arranged education experience with outlined learning goals.

Figure 2.11
Screenshots of Zydeco showing data collection linked to photo and audio

Scavenger or Treasure Hunt - A scavenger or treasure hunt is usually held outside a building. This exciting activity has now been implemented in museum environments to increase the fun aspect of the visit. Recently, the National Museum of Scotland implemented a treasure hunt game called 'Capture the Museum'. The format of the game follows a typical scavenger or treasure hunt but with the additional aspect of conquering exhibits. Visitors use their smartphones to scan the various exhibits and then answer questions relating to the exhibits. The team who captures the most exhibits gains territory (Figure 2.12). This is a stimulating way of achieving visitor interaction which makes the museum not just a place to educate but one that has its own play aspect (White 2013).

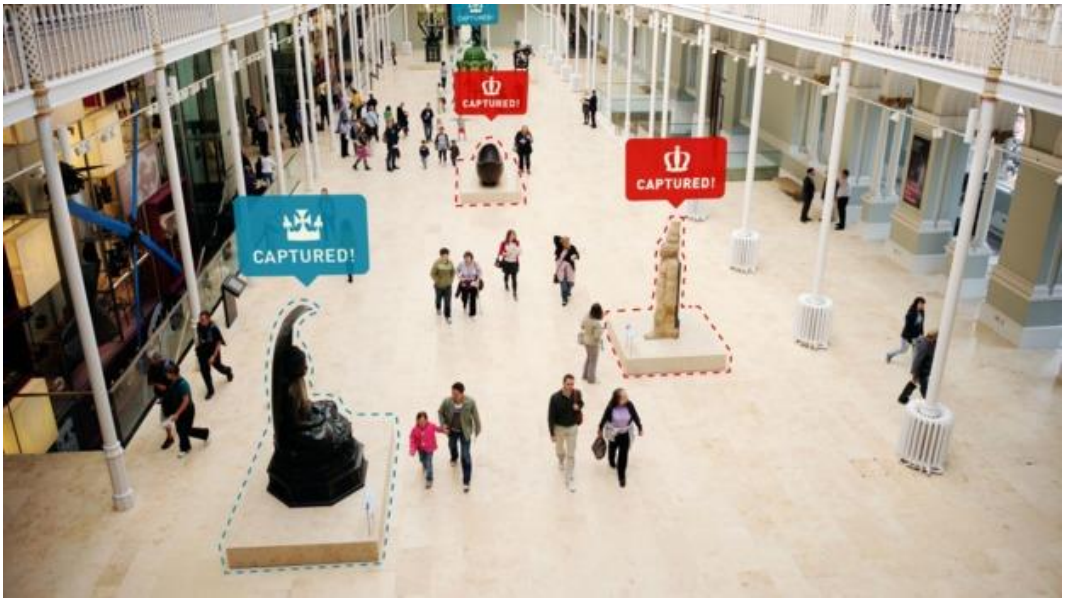


Figure 2.12
Image showing exhibits which have been captured - National Museum of Scotland

2.2.4 Missing Features

Mobile technology currently offers many features for museum environments that contribute to a more enjoyable and beneficial experience for the visitor. However, there are still more aspects and features that can be implemented to enhance the visitor experience further. Mobile guide applications provide significant amounts of information, navigation and personalisation. Yet, there are still gaps in the social and play or fun aspects of using mobile phones in museum environments. This section will discuss some of these 'missing features', which can be useful additions to the current arsenal of features in existing mobile guides.

Storytelling - Storytelling is a social feature, which could be implemented in museum environments using smartphones. Visitors could share their experiences about things that had intrigued them. For example, if a visitor wishes to share a unique experience at a museum he recently visited, he could do so by sharing his adventure via smartphone. Moreover, this can improve the social aspect of visitors' experiences (Fisher, Twiss-Garrity, and Sastre 2008).

Mixed and Augmented Reality games - As mobile technology use in museum environments is on the rise, technologies such as near field communication (NFC) are being used as a medium to support museum environments in enhancing the

visitor experience. NFC has been incorporated into mixed and augmented reality games and based on evaluation it has proved to be a promising technology (Blöckner et al. 2009). NFC is a novel technology in which the user can easily tap or wave NFC tags with their smartphone and retrieve information (Figure 2.13). Based on research findings, mobile mixed reality games offer a unique experience for users (Coulton, Rashid, and Bamford 2006).

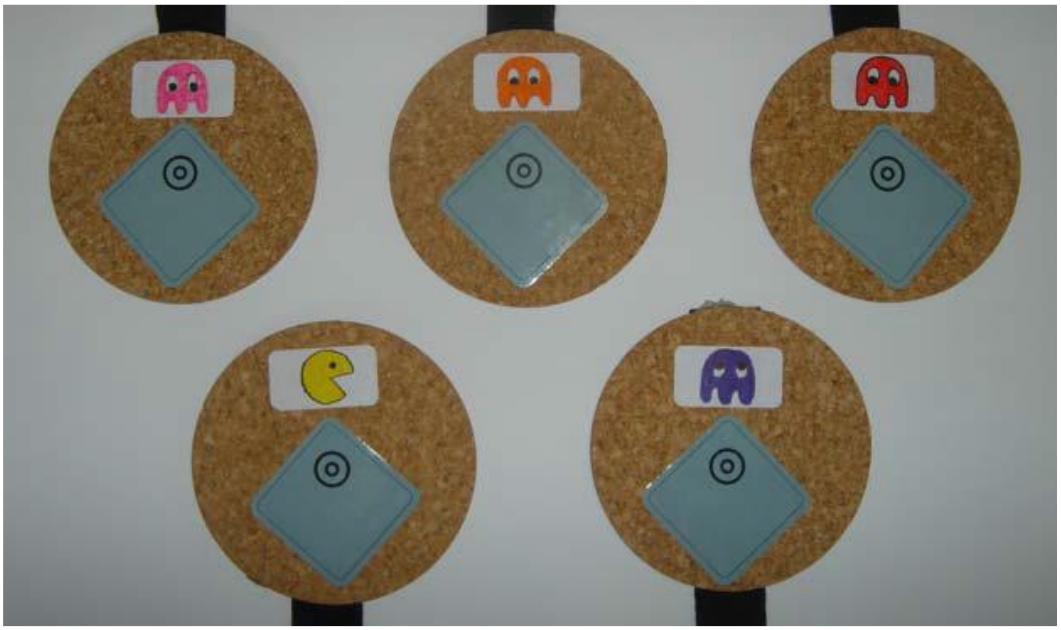


Figure 2.13
Traditional Pacman game using NFC tags

Whack-a-mole is a mixed reality game that has been adapted using NFC tags (Figure 2.14). The game involves players using a smartphone to read information via NFC tags. If a player taps or waves his smartphone on the appearing mole he will obtain points which are then accumulated with each mole 'whacked' (Broll et al. 2011). Mixed reality games employing NFC tags can be adapted and utilised in museum environments e.g. to see whoever can answer a question about a painting quicker.

Figure 2.14
Playing 'Whack-a-mole' using NFC tags

Another mixed reality game that uses NFC tags is an NFC matching game. This is a traditional matching game, which has been digitalised using a smartphone. Any player~~s~~ who manage to match a card, which is installed with an NFC tag, will get points (Sarmenta 2012). This tangible and casual NFC game demonstrates a novel way of implementing mixed reality games using NFC Tags. This type of game can be adapted and implemented in museum environments with an educational focus.

2.3 Types of visitor in museum environments

Although the primary reasons for visiting museums are for education and knowledge, each visitor has his or her own reason for visiting. A well-known museum researcher John H. Falk categorised visitors based on visitor targets. The five types of visitors were classified as 'Experience Seekers', 'Explorers', 'Facilitators', 'Professionals/Hobbyists' and 'Rechargers' (Falk 2009). This classification is not mutually exclusive meaning that groups of people might change from one category to another, for example one day they visit the museum as an 'explorer', and the next visit is as a 'facilitator'. Visitors may also represent a mixture of these categories such as the 'experience seeker' who is also a 'professional/hobbyist'. Types of visitor need to be recognised in museum

environments so that suitable mobile guides can be developed for museums, hence the importance of visitor classification.

Figure 2.15
Types of visitor found in museums by John H. Falk

The various types of visitor (Figure 2.15) are discussed in more detail in the following section to understand what the different needs of visitors are and how best to implement suitable technology in the form of mobile guides based on visitor requirements.

2.3.1 Experience Seekers

Experience Seekers are visitors who are motivated to visit a museum to witness the most important artefacts and to create memorable experiences. This category of people is made up mostly of tourists. As they are most likely to be on a tight schedule they tend to focus on exhibitions that they think are essential for them during their visit. This category also includes local people who are attracted to new exhibitions that capture their interest. Visitors in this category often require guidance in the form of maps to navigate them during their visit.

2.3.2 Explorers

Explorers are curiosity-driven visitors who are known to value education and known to feel amazed and challenged by artefacts and exhibits. Their main target is to find something that will attract their attention and improve their knowledge. They tend to look for new information and new theories throughout their visit. To meet their goals, they will read labels and other information about artefacts that intrigue them. Explorers usually come alone or separate themselves from the group. They want to

explore alone at their own pace and without any rigid tour or audio guides. Falk suggested that explorers might use an audio or tour guide if it is flexible and if there is freedom of choice (Falk 2009).

2.3.3 Facilitators

Facilitators are those who visit museum environments with others such as friends, families, relatives or children. They are the social type of visitors. They focus on enabling the experience and learning with others in the accompanying social group. Their primary goal is to ensure that the people in the group enjoy themselves and accomplish their own goals at the museum. Parents, for example are facilitators for their children. They show, guide and educate their children during their visit to a museum. If the acquaintances of the facilitator are not interested or fail to meet set goals, the museum can be classified as an environment for socialising and building relationships.

2.3.4 Professionals and Hobbyists

Professionals and Hobbyists visit museums because of a certain interest or to see a particular artefact. They are visitors who think the museum is a most important destination. This group of people consider themselves to be knowledgeable as it relates to their field of expertise and are unlikely to read the wall labels or information provided, as they would prefer to use their own interpretations. Their aim is to see and seek specific exhibitions. They may also attend lectures or workshops organised by the museum and enjoy talking to the experts and learning behind the scenes.

2.3.5 Rechargers

Rechargers are often visiting museums specifically to relax in a peaceful atmosphere. Most of them are not interested in the exhibitions. They are primarily seeking a contemplative and restorative experience. They are the ones who most probably just sit in an exhibition room and listen to the ambience of background music. They are unlikely to borrow or use any mobile guide or other aid provided in the museum.

By knowing the type of visitors in museum environments we can make informed decisions as to what type of mobile technology guides are suitable for individual visitors and for the various groups of people visiting museums. The classification of visitor types discussed is particularly useful as it allows applications to be built to cater to many different needs and which will ultimately enhance the visitor experience. The need for highly specific applications is apparent when we understand the psychology and various attributes of the different types of visitor found in museum environments.

2.4 Mobile Web

The mobile web refers to the use of browser-based internet services from handheld mobile devices, such as smartphones or feature phones, through a mobile or other wireless network. Traditionally access to the World Wide Web has been via fixed-line services on laptop and desktop computers (EQMEDIA n.d.).

However, the Web is becoming more accessible by portable and wireless devices. In January 2014 the time of mobile access to the Internet exceeded desktop use in the USA (O'Tool 2014).

2.4.1 Mobile Web application versus Mobile or Native application

In the mobile realm the terms mobile web application (Mobile Web app) and mobile application (Mobile app) or native application (Native app) are all frequently used and must be defined for clarity to avoid confusion.

Mobile applications (Mobile apps) and Native applications (Native apps) are synonymous. The term native app is the preferred usage and these are applications that are found on mobile devices and are accessed through icons on the device. Native apps are installed by downloading from an application store (such as Google Play Store or Apple's App Store). They are developed specifically for one platform, and can take full advantage of all the device features.

Mobile Web applications (Mobile Web apps) are more commonly referred to as Web apps. Web apps are not real applications; they are really websites that, in many ways,

look and feel like native applications, but are not implemented as such. They are run by a browser on mobile devices and are typically written in HTML5. Web apps are similar to standard websites that run on laptops or desktops but are designed specifically for smaller portable devices such as smartphones and tablets (Figure 2.16).

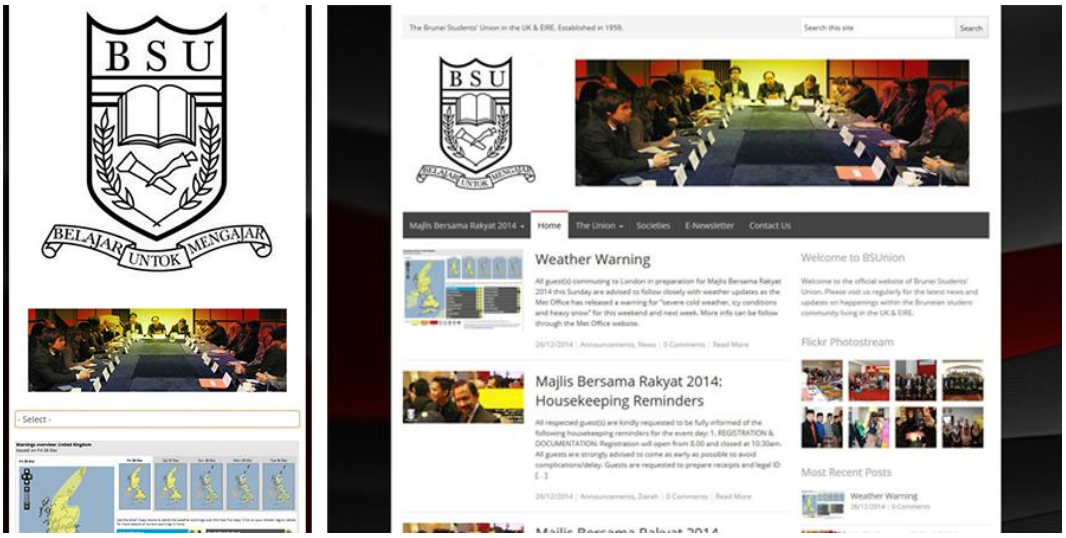


Figure 2.16
Screenshots of the Brunei Student Union's Website on a smartphone (Left) and on a desktop or laptop (Right)

Web apps and native apps each have their advantages and disadvantages. In terms of device features, although web apps can take advantage of some features, native apps have access to all device-specific features including GPS, camera, gestures and notifications. A native app is best if your app must work when there is no connectivity. Web apps are considerably more discoverable than native apps as content is a lot more discoverable on the web than in an app. Maintaining a native app can be complicated, not only for users but also for developers whereas maintaining a web app is as simple as maintaining a web page. If platform independence is important this is better achieved with a web app than a native app.

In summary, web apps and native apps are ways to cater to the needs of the mobile user. There is no unique best solution and each type of app has its strengths and weaknesses (Budiu 2013).

The distinction between web apps and native apps is anticipated to become increasingly blurred, as mobile browsers gain direct access to the hardware of mobile devices, and the speed and abilities of browser-based applications improve (EQMEDIA n.d.).

2.5 Mobile Map Applications

Mobile map applications are built to run maps on portable devices. The resulting mapping applications can be used either as a web app or a native app (mobile app). Using the mobile web, the web app will run on a mobile browser. However, as a native or mobile app it will run directly once the map application is installed to a mobile device. Ready-made map providers have developed mobile map applications including Google Maps, OpenStreetMap and Bing Maps.

Google Maps is a mapping mobile app developed by Google for the Android and iOS operating systems; it uses Google Maps for its information (Figure 2.17). OpenStreetMap (OSM) is a collaborative project to create a free editable map of the world (Figure 2.18). OSM is considered a prominent example of volunteered geographic information and is supported by a non-profit organisation. Bing Maps is a web mapping service provided as part of Microsoft's Bing suite of search engines.

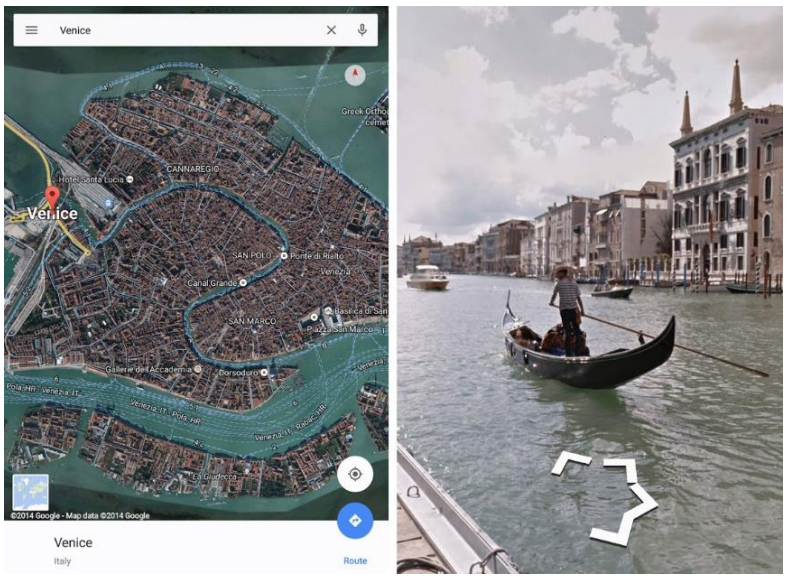


Figure 2.17
Screenshots of Google Maps showing satellite view (Left) and street view (Right) (image courtesy of Google Play)

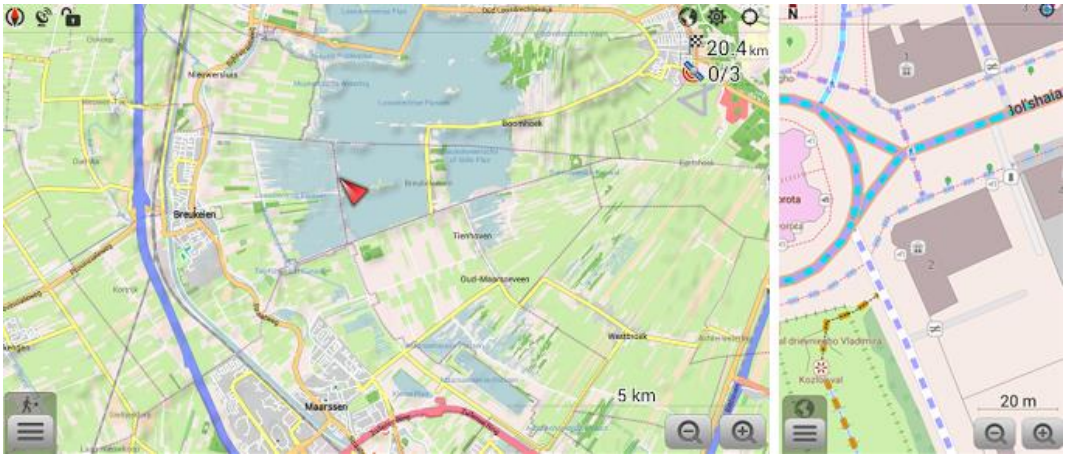


Figure 2.18
Screenshots of OpenStreetMap showing landscape mode (Left) and portrait mode (Right)

2.6 Parking problems, systems and solutions

Availability of parking spaces or lots is a problem which can be encountered anywhere in the world. Population growth leading to an increase in the number of vehicles on the road has resulted in insufficient parking lots (Idris, Tamil, et al. 2009). This issue has been reviewed extensively by researchers to alleviate and solve parking problems. Various parking systems and solutions are discussed which deploy a range of technologies. Some of the key ideas and principles are reviewed for the purpose of possible implementation in developing a mobile parking application.

2.6.1 Smart Parking Systems

Smart parking systems have been implemented in the United States, Europe and Japan. A typical smart parking system provides information such as parking location, whether a parking lot is fully occupied, whether parking lots are still available and offers the flexibility to pay for parking online. Five major aspects of smart parking systems are outlined below:

2.6.1.1 Parking Guidance and Information System (PGIS)

This system provides direction towards a free parking space within the parking facilities. However, the availability and location of the parking space are unknown to the users before they reach the parking facilities.

2.6.1.2 Transit based information system

This system includes transit information services for diverse transport types. Information is provided to assist drivers to their destinations as well as helping them to find available parking spaces in car parks.

2.6.1.3 Smart Payment system

This system is implemented to facilitate payment for parking. This is to overcome the conventional payment methods that usually delay the payment process. Smart payment systems reduce overall costs and staffing requirements for payment handling.

2.6.1.4 E-Parking

This system provides an alternative way of enquiring about the availability of parking spaces as well as giving the option to reserve parking spaces. E-Parking allows access using text messages (SMS) or through online enquiry. Incorporating a payment mechanism to the electronic enquiry component can easily be done.

2.6.1.5 Automated Parking

This system involves the use of a computer-controlled mechanism, in which operated machines automatically locate vehicles into allocated spaces. It is efficient as it utilises the maximum parking space available (Liu et al. 2012). This system also enhances safety for both the driver and vehicle as parking is operated automatically. However, as a downside, automated parking systems require major investment for construction as well as operation (Idris, Leng, et al. 2009).

2.6.2 Parking mobile applications

Parking mobile applications allow users to find parking spaces using their smartphones. Some of the features of parking mobile applications include finding directions to parking lots and spaces, parking payment, setting parking times, making reservations, checking parking rates and providing information about the parking area. Three popular parking mobile applications, which are currently being used, are outlined below.

2.6.2.1 ParkMe Parking

ParkMe Parking is a mobile application that can be downloaded using iTunes, Google Play Store and Windows mobile devices. This covers the Apple, Android and Microsoft platforms effectively giving freedom of access to any smartphone user. ParkMe Parking is free to users. The interface is shown in Figure 2.19. The main features allow drivers to; view informative maps of the parking areas they wish to use, check and compare parking rates, set parking times and gives real-time information on how many parking spaces are available as well as providing directions to the nearest drive way (*Google Play - ParkMe* 2014).

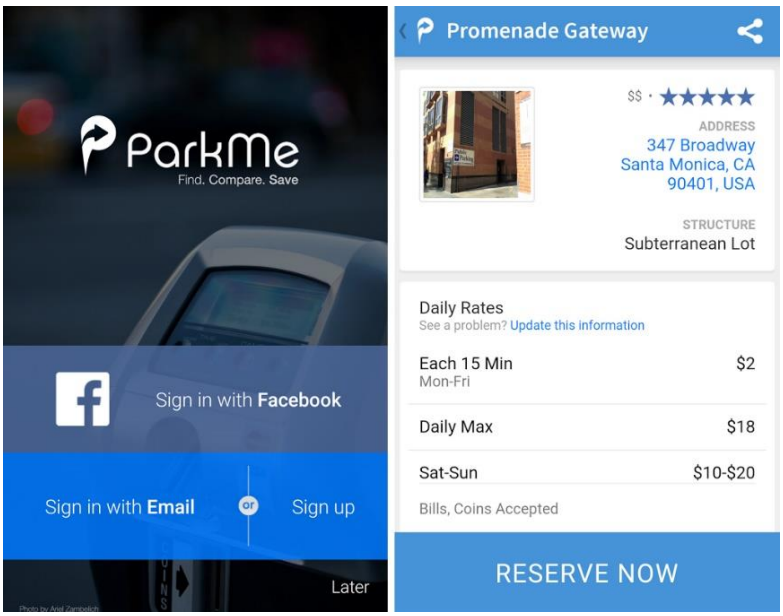


Figure 2.19
Screenshots of the ParkMe interface

2.6.2.2 Park Me Right

The Park Me Right mobile application is currently available on Google Play Store only. Hence it is limited to the Android platform at this time. This application can locate parked cars using an augmented reality feature or Google Maps. Other features include finding parking lots, automatic notification after parking, sharing your car position to friends and family, searching the nearest parking lot and parking meter calculations. The augmented reality feature uses the camera function of a smartphone where it will point to a marker location of the parked car (Figure 2.20). Sharing location can be forwarded using social networks such as Facebook, Twitter, Foursquare or through SMS (*Google Play - Park Me Right:Free Car Locator* 2014).

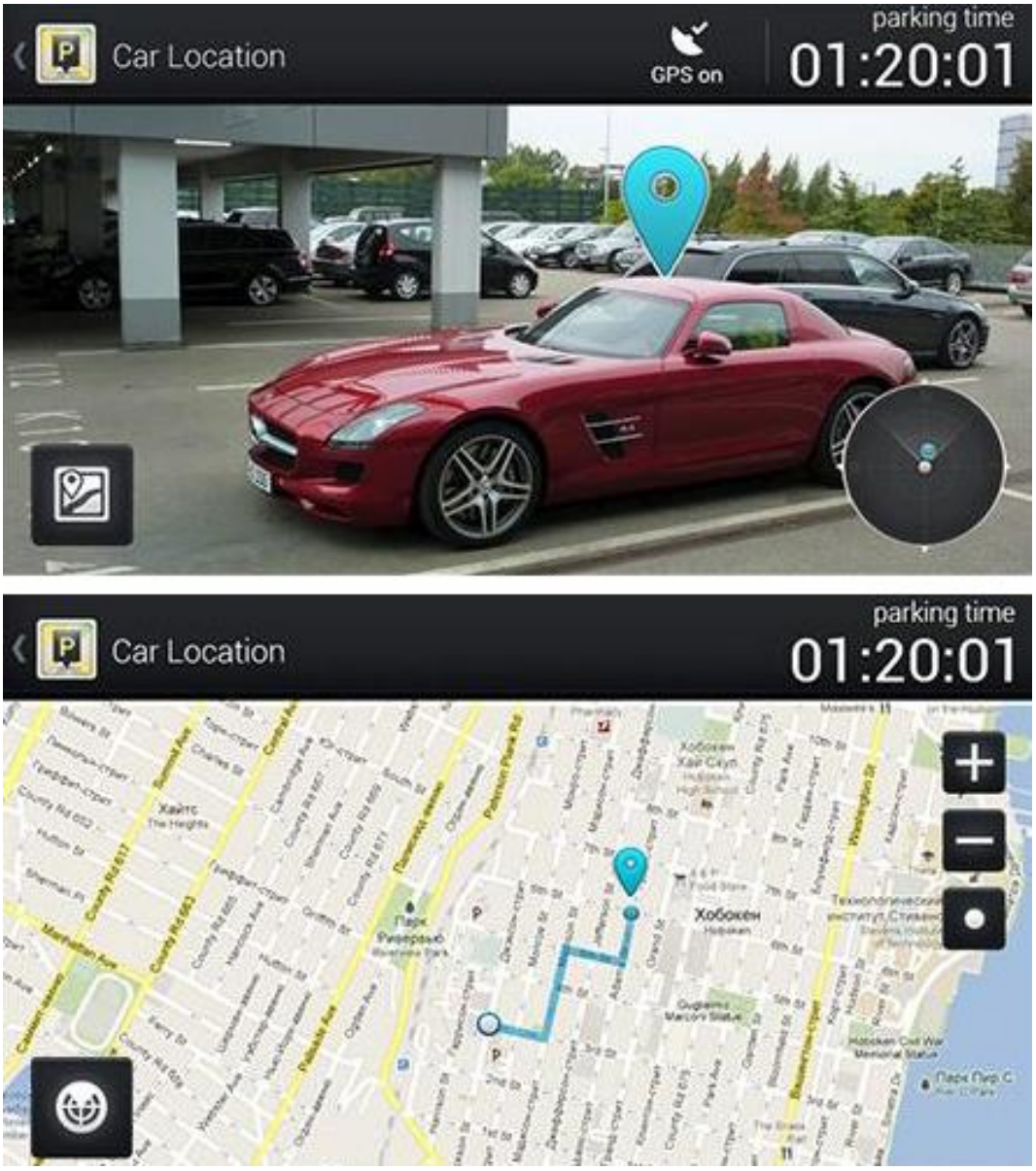


Figure 2.20
Screenshots of the Park Me Right application (image courtesy of Google Play)

2.6.2.3 Parkopedia

The Parkopedia mobile application can be downloaded using iTunes, Google Play Store and over any Windows smartphone. This application can find the current location of the user and allows entering of an address (Figure 2.21). The features include; obtaining directions straight to the parking space, checking parking availability in real-time, confirming opening hours, prices, payment method and the application allows users to narrow their parking choices by using filters (*Google Play - Parkopedia Parking* 2014).

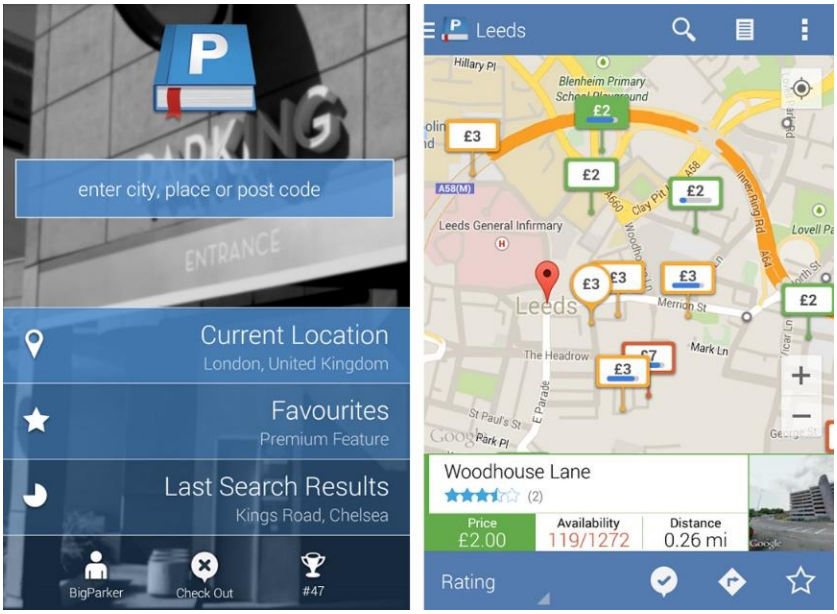


Figure 2.21
Screenshots of the Parkopedia interface (image courtesy of Google Play)

2.7 Crowdsourcing

Crowdsourcing is the practice of obtaining needed services, ideas, or content by soliciting contributions from large groups of people, especially from the online community rather than from traditional employees or suppliers (Merriam-Webster.com n.d.). A well-known example of crowdsourcing is the Wikipedia project. Rather than using traditional ways of hiring writers and editors, Wikipedia uses people to contribute information of their own (DailyCrowdsource.com n.d.).

The principle of crowdsourcing is that more heads are better than one. By canvassing a large crowd of people for ideas, skills or participation, the quality of content and idea generation will be superior. However, for the purposes of this research, it is apparent that there are still problems on how to implement crowdsourcing when designing smart parking systems and applications. In this context crowdsourcing requires participation from the users of the system; therefore motivation is a key factor in getting users to participate. If there are sufficient incentives the user will be motivated to participate in crowdsourcing of the necessary information.

2.7.1 Crowdsourcing Models

Various models of crowdsourcing exist depending on the skills, services, ideas and content required. Prevalent crowdsourcing models are outlined below.

2.7.1.1 Crowdsource Design

This crowdsourcing model seeks crowds of designers to do any work related to design. This includes designing logos, advertisements, videos as well as product design. The client will normally provide information relating to the work required, their budget and the deadline. Three popular crowdsource design websites are DesignCrowd (Figure 2.22), CrowdSpring and Freelancer.

Figure 2.22
Screenshot of DesignCrowd website

2.7.1.2 Crowdfunding

Crowdfunding is a crowdsourcing model that involves raising funds by getting crowds of people to donate money for a project or cause. Two popular crowdfunding methods are rewards-based crowdfunding and helping a business directly. Rewards-based crowdfunding, as the name implies, gives the donator incentives such as pre-purchase products. Kickstarter is a leading rewards-based crowdfunding website (Figure 2.23). Helping a business directly entails providing funds only. Donators are not allowed to invest or become shareholders of the company they are funding.

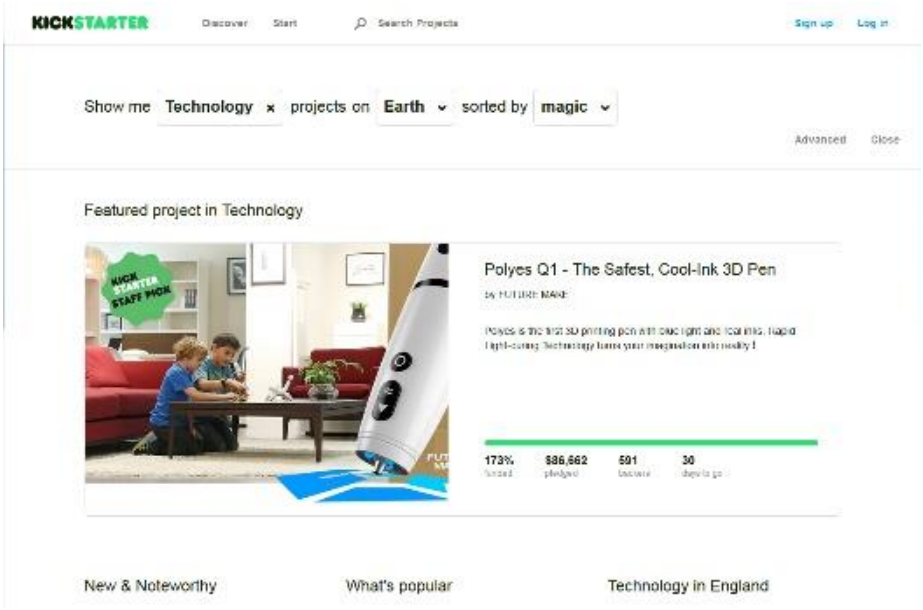


Figure 2.23
Screenshot of Kickstarter website

2.7.1.3 Macrowork and Microwork

Crowdsourcing tasks usually occur on the micro or macro scale. Macrowork is defined as large amounts of work that require specialised skills to do the work. Elance is an online staffing platform, which falls into the macrowork category. This website allows businesses to post jobs, search for freelance professionals and solicit proposals (Figure 2.24).

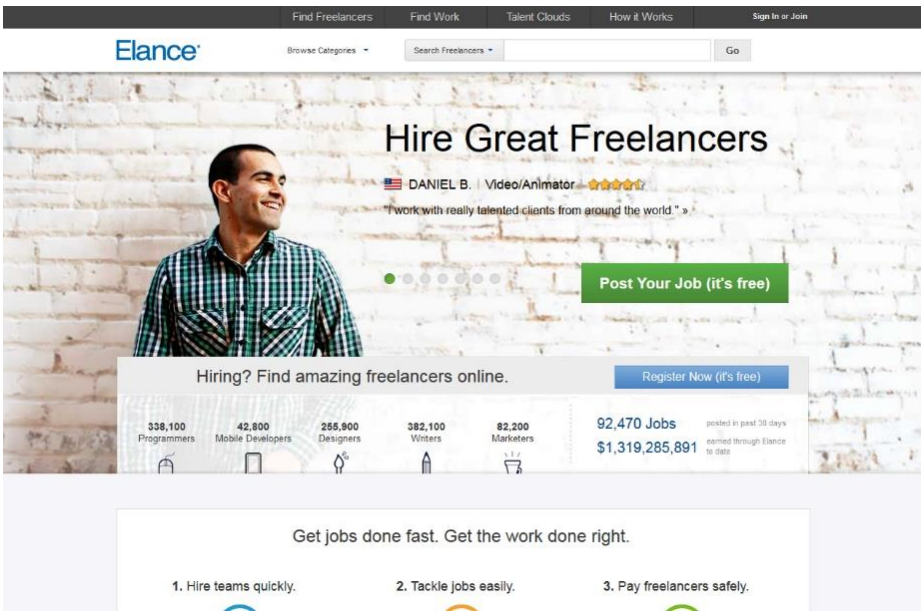


Figure 2.24
Screenshot of Elance website

Microwork on the other hand is defined as a series of small tasks, which together comprise a large unified project, and are completed by many people over the Internet. Microwork is considered the smallest unit of work in a virtual assembly line (Janah 2010). It is most often used to describe tasks for which no efficient algorithm has been devised and requires human intelligence to complete tasks reliably (Grant 2010; Janah 2009). Amazon Mechanical Turk (MTurk) is a crowdsourcing internet marketplace that gives individuals and businesses access to a diverse, on-demand, scalable workforce and gives workers a selection of thousands of tasks to complete whenever it's convenient (Figure 2.25).

Figure 2.25
Screenshot of Mechanical Turk website

2.7.1.4 CrowdSearching

Crowdsearching is a crowdsourcing model that uses geographic location to accomplish specified tasks. The Hipkey by Hippih is an example of a product utilising geographic location to locate and find items, pets or people. It is a crescent shaped alarm (Figure 2.26) that connects over Bluetooth to iOS devices to trigger visual, audible or vibrating alerts from the Hipkey as well as the device. It is used in conjunction with its iOS app to set its multiple ranges and modes and is recharged via MicroUSB (Hippih n.d.).

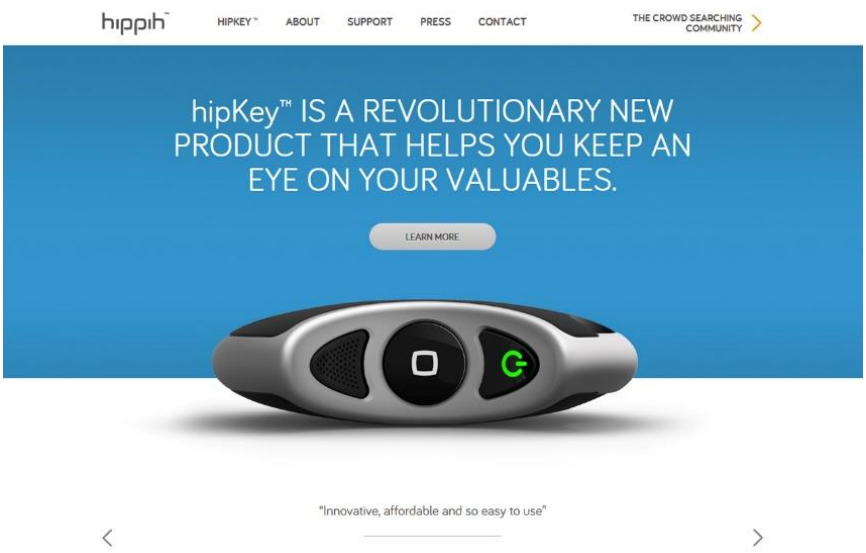


Figure 2.26
Screenshot of Hippih website

2.7.1.5 Crowd Voting

Crowd voting is one the most popular models of crowdsourcing. It leverages the community's judgement to organise, filter and stack-rank content such as newspaper articles, music and movies. The Internet offers various mechanisms to perform voting. Coca Cola has used crowd voting for new bottle designs, Domino's Pizza for submitting new pizza ideas (Figure 2.27) and some have called the Reality TV show 'American Idol' the largest crowd voting ever conducted.

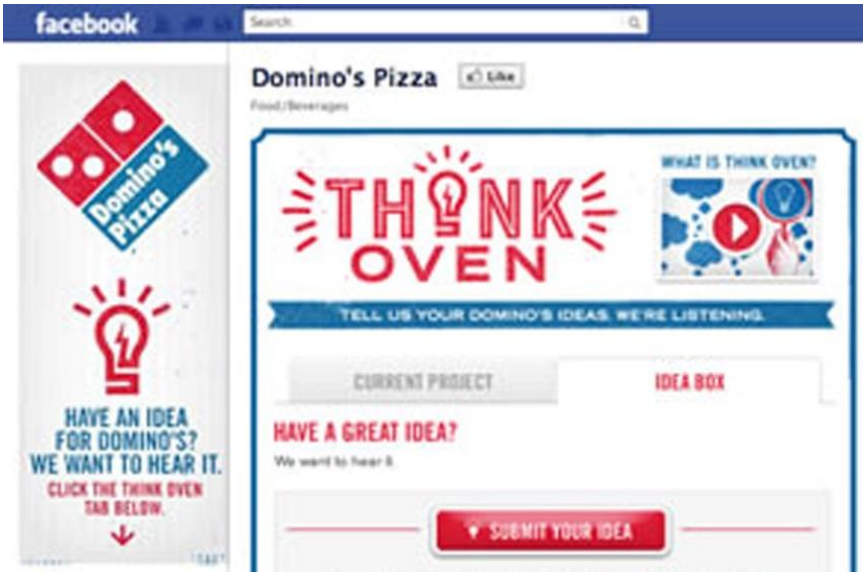


Figure 2.27
Screenshot of Domino's Pizza using facebook to crowd vote

These and other websites employ crowd voting in order to gain community opinions. The feedback serves as a low-cost alternative to conducting extensive market research when developing new product names, ideas or products themselves (Bunskoek 2014).

2.7.2 Mobile Crowdsourcing

Mobile crowdsourcing involves crowdsourcing activities, irrespective of the model employed, that take place on smartphones or mobile platforms. It is characterised by GPS technology and allows for real-time data gathering.

Mobile crowdsourcing has become an increasingly popular method of providing large amounts of real-time data to improve daily life. This growth in mobile crowdsourcing can potentially be used in the design of smart parking apps. A case study on how to develop such a system has been outlined by Xiao Chen, Elizeu Santos-Neto and Matei Ripeanu (Chen, Santos-Neto, and Ripeanu 2013).

Smartphones offer a great platform for extending existing web-based crowdsourcing applications to a larger contributing crowd, making contributions both easier and omnipresent. Access is either by web-based applications or new applications (Chatzimilioudis et al. 2012).

Waze is the world's largest community-based traffic and navigation app (Figure 2.28). It provides real-time traffic and road info, saving everyone time and gas money in their daily commute (Waze 2009). The application plays a major role in alerting other drivers by reporting if there are police on site, accidents, road hazards or traffic jams.

Figure 2.28
Screenshot of the Waze application

TaskRabbit (Figure 2.29) uses mobile crowdsourcing to outsource household errands and skilled tasks to trusted people in the community (DailyCrowdsource.com n.d.) (Keifer 2010).

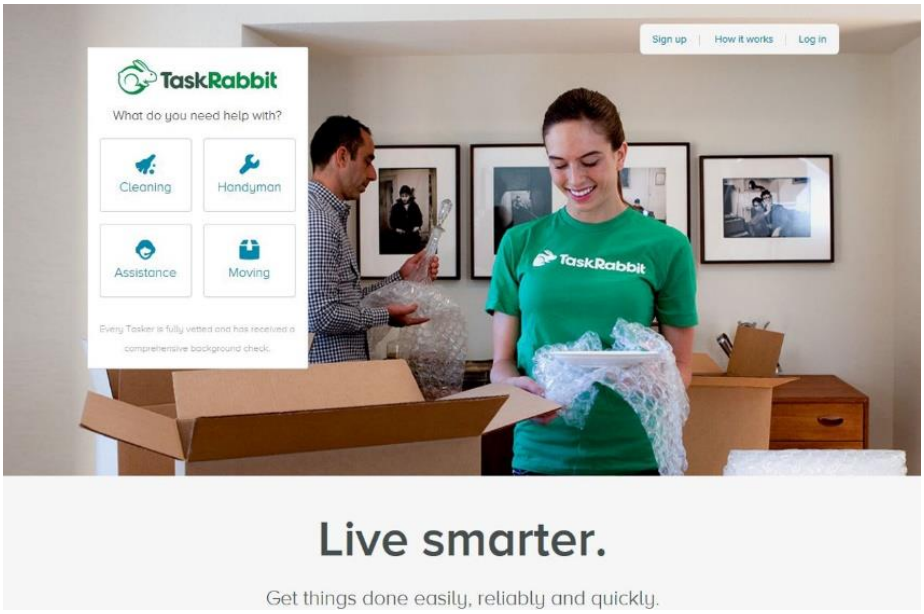


Figure 2.29
Screenshot of TaskRabbit website

2.7.3 Motivation to Crowdsource

Researchers have investigated user motivation and human willingness in crowdsourcing. Based on previous studies, people's motivations are various and depend on the specific crowdsourcing project. Some of the reasons put forward as to why people contribute to crowdsourcing are outlined in the table below (Tokarchuk, Cuel, and Zamarian 2012).

REASON	EXPLANATION
Reciprocity and expectancy	People contribute to the community or tend to help because they are expecting others will do the same for them when needed.
Reputation	People contribute to increase their prestige and to be well regarded by others.
Competition	People contribute to show that they can achieve more than others can. In some cases, this factor is strictly related to reputation building efforts.
Self-esteem and learning	People contribute to the community to grow as individuals, either in terms of their own self-perception or to increase their knowledge.
Altruism	People act out of pure sympathy for others, with no expectation of reciprocity.
Fun and personal enjoyment	People tend to contribute more when they have fun doing so.
Implicit promise of future monetary reward	People typically act to increase their own human capital and market themselves.
Money	People receive direct compensation.

2.8 Near Field Communication (NFC) and Quick Response Codes (QR Codes)

Near Field Communication (NFC) and Quick Response Codes (QR Codes) are forms of contactless communication (nearfieldcommunication.org). Both of these technologies store small amounts of information such as a web address URL or ID. However, the way in which they function is different (RapidNFC 2014). These technologies are defined, compared and a brief survey of their uses in museum environments and tourism is discussed.

2.8.1 Near Field Communication

Near Field Communication or NFC is short-range wireless communication utilising radio waves. The term is used in most cases for a specific set of protocols that enable two electronic devices, one of which is usually a portable device such as a smartphone to establish radio data communication with each other by bringing them closer than, typically 10 cm (4 in) from each other.

The open platform NFC technology was developed by a collaboration of Philips, Sony and Nokia in 2004. It builds on the earlier Radio Frequency Identification (RFID) technology, which is a form of one-way, close-range wireless communication. NFC allows two-way communications and can operate in three different modes:

Reader/Writer – The NFC enabled device reads or writes to a supported tag.

Peer-to-Peer – The NFC enable device exchanges data with a compatible device.

Card Emulation – The NFC enabled device acts as a tag or contactless card for an existing NFC reader.

NFC enables users to share business cards, make transactions and access information from smart posters with a simple touch. Data can be retrieved by tapping NFC enabled smartphones on NFC tags that store the data (NFC-Forum n.d.).

Figure 2.30
Samples of NFC tags and logo

These NFC tags (Figure 2.30) are passive data stores which can be read, and under some circumstances written to, by an NFC device. Present and anticipated applications include contactless transactions, data exchange and simplified setup of more complex communications such as Wi-Fi (NFC-Forum n.d.).

2.8.2 Quick Response Codes

A Quick Response or QR Code (Figure 2.31) is a type of matrix barcode or two-dimensional barcode. A barcode is a machine-readable optical label that contains information about the item to which it is attached. Initially, QR Codes were designed for the automotive industry in Japan but nowadays they are used extensively in consumer advertising. A QR Code can be used to store a URL, website login and code payment (Naraine 2012; Grove 2011). Information is retrieved from a QR Code by scanning the QR Code with a smartphone. The smartphone must have a QR Code application installed so that the QR Code can be scanned and read.

Figure 2.31
Sample of a QR Code

2.8.3 Near Field Communication versus Quick Response Codes

A comparison of the relative merits of NFC and QR codes are published on the RapidNFC website. The pros and cons of these technologies are summarised under eight categories, namely: user experience, cost, size, product integration, print and customisation, availability in mobile phones and, programming and security. The outcome for each category is outlined in the table below (RapidNFC 2013).

CATEGORY	NFC	QR CODE	WINNER
User Experience	Works immediately without additional software. Tap an NFC tag from the home screen and the web link or command will launch automatically.	Smartphone requires an app in order to scan it. To scan the code the user must first access the app and align the camera to the code.	NFC. Offers a more slick and intuitive user experience.
Cost	NFC tags cost around 20 pence each (BND 0.45) for an order of 1,000 tags.	QR Code only costs as much as the print and can be included within existing print media at no extra cost.	QR Code.
Size	NFC tags are usually 10-30 mm in diameter and are very thin at just 10-20 microns (0.01-0.02 mm).	QR code must be at least 20 mm by 20 mm to ensure they can be scanned without error.	No winner. Similar size.
Product Integration	NFC tags can be scanned without a direct line of sight and therefore it can be inside a product or hidden from view. Special on-metal tags must be used when the tag is placed within 5 mm of metal surfaces.	QR codes must be printed visibly onto each product. Special care must be taken when printing on 3D products.	NFC. Better for product integration.
Print and Customisation	NFC tags can be full colour custom print and can be hidden behind the printed media or within a product.	QR Codes must be visible and can only have limited customisation in order to maintain its performance.	NFC. Full colour customisation print and branding.
Availability in mobile phone	Not all smartphones are NFC enabled.	QR Code can be used by all existing smartphones.	QR Code.
Programming	NFC tags are easy to encode using a mobile app on NFC enabled phones. Only NFC tags are rewriteable.	QR codes can be freely generated from a wide range of websites.	No winner. Both easy.
Security	NFC tags have a fixed manufacture ID number and specialist tags can also support encryption to hide the programmed data.	QR Codes have no security.	NFC.

2.8.4 Usage of NFC Tags and QR Codes

NFC and QR Code technology has been applied in many different contexts and are both widely used. NFC smart posters are used in magazine advertisements, fliers, billboards and other physical mediums. NFC smart posters are favoured over many other digital forms of communication because NFC technology is typically a native feature of the consumer's mobile device. At the heart of each smart poster is an NFC tag, a small unpowered electronic device that holds a small amount of data such as a

web link, text or command. When an NFC enabled smartphone is placed in close proximity it powers the NFC tag and reads the information stored on it.

In terms of mobile guide usage NFC tags and QR Codes, are used extensively in museum environments and for tourism purposes. A brief survey of usage in this context is outlined below.

2.8.4.1 Museums

Implementation of NFC and QR code technology in museum environments is becoming increasingly popular and typically provides information such as text or URL's which automatically launch a video or web page related to artefacts, exhibits and other information which museums consider relevant to the visitor.

Museum of London – This was one of the first museums to launch a campaign utilising NFC tags. The project was supported by Nokia to equip them with the NFC tags and the statistics to measure their use. NFC tags are located next to artworks (Figure 2.32) or artefacts, which transmit web links to NFC enabled smartphones. The museum takes full advantage of current mobile technology and social media whereby visitors are encouraged to buy tickets for future exhibitions. They can also check in, follow or like the museum on sites such as Foursquare, Twitter and Facebook (Clark 2011b; MuseumOfLondon n.d.).

Figure 2.32
NFC tag being used in the Museum of London

The Bardo Museum – This museum in Tunisia launched the first NFC guide in Africa. The application was developed in partnership with Orange. Visitors can access complimentary information on what they want to see, audio commentaries as well as historical and geographic perspectives (Figure 2.33). Children are provided with a games section comprising discovery, mosaic and junior activities which means they can learn while having fun. The application can run in three languages namely, French, English and Arabic (LiveOrangeTV 2014).

Figure 2.33
NFC guide in the Bardo Museum

2.8.4.2 Tourism

NFC and QR Code technology has also been implemented widely in the tourism industry. Many studies relating to NFC and QR Code technology usage in the tourism industry are available. Both technologies have similar functionality and are able to obtain information, find locations and offer payment services.

Cityzi - In 2010, NFC trials were carried out in the city of Nice, France. The pilot study led to the development of an NFC application with the brand name 'Cityzi' (Clark 2010). Cityzi offers payment, transport and information services as well as loyalty points. The payment services offered allow consumers to make payment using their NFC enabled smartphone. For transport services users can access real-time travel information for all services calling at bus and tram departure points. QR

Codes were installed along with NFC tags across the local transport network (Clark 2009). Information services provide additional information and facts about the city of Nice. As a customer incentive loyalty points are accumulated when consumers use their NFC smartphone to make a purchase. In October 2011, Strasbourg adopted Cityzi making them the second city in France to use the NFC application and brand (Clark 2011a). The key logos and icons used by Cityzi are shown in Figure 2.34 (Clark 2010).

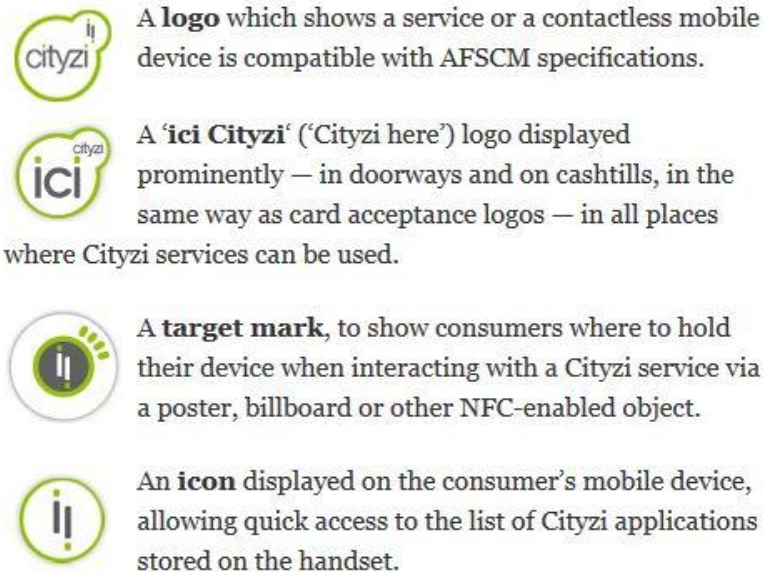


Figure 2.34
Cityzi NFC logo and icons

Clarion Hotel, Stockholm – This hotel in the Swedish capital engaged in the world's first pilot study using NFC phones (ClarionStockholm n.d.). The main goal of the pilot study was to get feedback from guests and employees using NFC phones for a variety services. Guests were able to use an NFC enabled phone as a key to enter their room (Figure 2.35) while another service allowed them to handle their check out process.

Figure 2.35
NFC enabled phone being used as a key at Clarion Hotel, Stockholm

2.9 Conclusions

The literature review focused on topics chosen by the researcher, to better understand the key ideas and principles to be drawn upon for the development of the mobile guide applications in this research study. The topics were researched, reviewed and arranged as follows:

- 2.2 Features of museum mobile guides
- 2.3 Types of visitor to museum environments
- 2.4 Mobile web
- 2.5 Mobile map applications
- 2.6 Parking problems, systems and solutions
- 2.7 Crowdsourcing
- 2.8 Near field communication (NFC) and quick response codes (QR Codes)

In particular, a review of literature relating to mobile guides used in museum environments and literature relating to smart parking applications and crowdsourcing was undertaken as these were relevant to the two applications that were developed and tested as part of the research study.

Mobile guide applications provide significant amounts of information, navigation and personalisation. The researcher concluded that there are still gaps in the social and play or fun aspects of using mobile phones in museum environments. The use of

storytelling and the incorporation of mixed and augmented reality games into mobile guides in the context of museum environments would enhance users' experience by adding to the visitor's degree of social interaction and personal enjoyment. These suggested additions could also be applied to mobile guide applications in the tourist sector. NFC, although novel, is a proven technology, which can be utilised to incorporate mixed and augmented reality games into existing mobile guide technology.

It is important to recognise the different types of visitor in museum environments so that suitable mobile guides can be developed for museums, hence the importance of visitor classification. If we clearly understand what the different needs of visitors are then we can implement suitable mobile guide technology based on visitor requirements and preferences.

From the literature review of the mobile web it is apparent that the Internet is being increasingly accessed through mobile devices such as smart phones, tablets and laptops as opposed to the traditional fixed line desktop access. The mobile web is catered to by web apps and native apps depending on the needs of the mobile user. It can be concluded that there is no unique best solution and each type of app has its strengths and weaknesses. The distinction between web apps and native apps is anticipated to become increasingly blurred, as mobile browsers gain direct access to the hardware of mobile devices, and the speed and abilities of browser-based applications improve. Developers will have more freedom in the future to develop across different platforms as this distinction lessens.

Mobile map applications were reviewed in brief and it is clear that existing applications are sophisticated and difficult to duplicate if information has to be sourced from scratch. However, ready-made map providers such as Google Maps, OpenStreetMap and Bing Maps offer efficient solutions as they provide accurate and up to date information.
Parking is a universal issue and the literature review shows the availability of novel smart parking solutions to help users get up to date information about where to park, availability of parking spaces and other parking related services offered by mobile

applications. The use of live data is crucial to the success of such applications and the issue of sourcing such data is highlighted in the crowdsourcing section. A novel aspect of the LiveMap application developed by the researcher is the crowdsourcing of information from users to keep the parking info up to date in real time. Crowdsourcing of information in this manner is cost effective but there is the issue of how to guarantee both the accuracy and supply of real time data from users of the LiveMap prototype.

NFC and QR Code technologies were reviewed, as they are relevant technologies for the researcher in the context of developing a mobile guide for use in the Brunei Museum and for developing the LiveMap parking application for student use in the University of Kent. From a comparative study of NFC and QR Codes it can be concluded that both technologies have their advantages and disadvantages. NFC tags and QR Codes are equally effective to programme while QR Codes are considerably more cost effective and more available in smartphones. However, NFC tags offer a better user experience, better product integration and better security. Both technologies have proved to be effective in various fields of application and have been successfully implemented in mobile technology used in museum environments and in the tourist industry.

The topics reviewed were specifically chosen by the researcher to provide relevant literature for the development of the museum mobile guide application and the development of the LiveMap parking application. The literature also provided background research for the audio tour guide and Scavenger Hunt application despite the fact that these applications were found to be unsuitable for testing.

CHAPTER 3

Other Development 1 - Audio Tour of University of Kent

3.1 Introduction

An audio tour or audio guide provides a recorded spoken commentary, normally through a handheld device, to a visitor attraction such as a museum. In this case a mobile audio guide was developed for use with a smartphone as a self-guided tour of the University of Kent. The mobile audio guide was developed and presented to the research supervisors during a progress meeting held in May 2014. The primary motivation for developing the audio guide was to enhance users' experience in the University. The only information available about the University at this time was in booklet form. This study was not carried forward beyond the development stage.

3.2 Objectives

The initial objectives for the mobile audio guide included design, development and testing of the guide. However, only development was undertaken. The main target

users for this guide were visually impaired students. However, the guide is suitable for use by others.

3.2.1 Who is the Mobile Audio Guide for?

The mobile audio guide was initially developed for visually impaired students. The audio was aimed to help visually impaired users find directions for lecture theatres and other key buildings on campus. The guide also provides textual directions for other users who wish to find their way around the university using a smartphone, whether staff, students or visitors to the University of Kent.

3.2.2 How does the Mobile Audio Guide application work?

The mobile audio guide is based on a standard mobile web application. NFC tags and QR Codes are used to store links to the relevant website. NFC tags and QR Codes are also embedded in smart posters for users to tap or scan (Figure 3.1 and Appendix 10). Once the link is transferred to the users' smartphone the front page of the website appears. After users click the current page the application will go to a direction page with the corresponding audio.

3.3 Motivation and Idea

The researcher was motivated to develop a mobile audio guide when in the same bus as a visually impaired student. The visually impaired student was using a GPS tracking system to navigate himself to the university. Audio instructions in the form of directions could help other visually impaired students on campus. However, it is not necessary to limit an audio guide to visually impaired users only. Audio can be used by anyone with normal hearing. The audio guide included text so that others who wished to read as well as listen to directions can also use it.

3.4 Prototype Design and Development

The information for the mobile audio guide was based on the content of a self-guided tour booklet provided by the University of Kent. For the prototype of the mobile audio guide, a sample of text from the tour booklet was used to demonstrate the application. The front cover of the booklet was used as an opening page for the mobile audio guide (Figure 3.2). A text sample containing directions was the basis

for the audio which was obtained using Google Translate. The Google Translate application was downloaded and added to the web page.

Figure 3.1
Smart poster for the Mobile Audio Guide

Figure 3.2
Screenshot of the Mobile Audio Guide user interface

3.5 Discussion

A working prototype of the mobile audio guide was developed thereby achieving the objective of having a mobile guide that provided audio for its users. However, this was in sample form only and no further research or development of the mobile audio guide was undertaken.

A fully developed mobile audio guide used in conjunction with smart posters would meet the needs of all potential users except for visually impaired students. Given that the initial motivation was to develop a mobile audio guide for visually impaired students this issue would have to be addressed if a full blown application was to be designed, developed and tested. A possible solution relies on the use of NFC technology. Though an emerging technology, NFC's powers of close-range object recognition (with NFC tag or device), identification and data exchange has the potential to build applications for non-visual and visually impaired users. Cutting-edge technologies are turning smartphones into assistive devices for the service of non-visual users across different areas (Bhattacharya 2014).

This mobile audio guide project was too constrained to justify taking the research further at this stage. The low number of visually impaired students and the technological challenges of applying NFC to solve this problem for the visually impaired were decisive. The application was rudimentary and straightforward and acted as a simple textual and audio guide based on existing information. The application did not have any novel features; however, the design and development process provided valuable experience for the researcher.

CHAPTER 4

Other Development 2 - Scavenger Hunt Application

4.1 Introduction

The ‘Scavenger Hunt’ application was designed and developed as part of the research study. The researcher developed and presented the application during a progress meeting with the research supervisors in May 2014. However, the study did not proceed with testing of the application. Initially, it was developed to study the fun and entertainment aspect of using a mobile guide with a smartphone at the University of Kent.

4.2 Objectives

The objectives of the research were to design, develop and test the scavenger hunt application for use with smartphones. The study sought to investigate whether using the application with smartphones enhances users’ experience in terms of the fun and play aspects of the scavenger hunt. The idea was to use NFC tags and QR codes to

obtain follow-up clues and riddles that lead users to other pit stops during the course of the scavenger hunt

4.2.1 Who is the Scavenger Hunt application for?

The scavenger hunt application was designed for the students and staff of the University of Kent. The aim was to educate students and staff about the university's history as well as providing the location of important buildings on campus. It was also an opportunity to promote novel technology through usage of NFC tags and QR Codes.

4.2.2 How does the Scavenger Hunt application work?

The scavenger hunt game is played using a standard mobile web application. The competitors tap an NFC tag or scan a QR code to obtain a Web URL which provides the question they need to answer. Once the question is successfully answered, the next riddle is given and competitors proceed to the next location to answer the next question and so on until all the questions are answered and the game completed. This scavenger hunt game is scored using a point's based system. The person who scores the highest is the winner or, in the case of a tie, the person who submits the last correct answer earlier will be declared the winner.

4.3 Motivation and Idea

The motivation for developing the scavenger hunt application for use with smartphones came from the interests of the researcher. Scavenger or treasure hunts have been successfully organised by Bruneian students in the University of Kent for a number of years. The inaugural competition in 2010 was called the 'BruKent Amazing Race' and has been organised on an annual basis since then. 'Lost in London' was another scavenger hunt competition (Figure 4.1) organised by Bruneian Students based in University College London (UCL). The researcher was motivated to implement the competition using smartphones based on his participation and involvement in organising previous competitions.

Figure 4.1
'Lost in London' treasure hunt organised by UCL (photo courtesy of BRUCL blog)

Other institutions have implemented scavenger hunt mobile games of their own. Notably, the Smithsonian American Art Museum developed a scavenger hunt application known as 'Pheon'. Pheon (Figure 4.2) was first introduced in 2010 at the Smithsonian (Righthand 2010).

Figure 4.2
Visitors' participating in the Pheon scavenger hunt

'MobHunt' is another example of a scavenger hunt mobile game. It was created as a tour around the Infolab21 building at Lancaster University. The game is simple in

essence and primarily provides a tour of the main buildings and facilities (Coulton, Rashid, and Bamford 2006). An interesting feature is the use of radio frequency identification (RFID) tags as shown in Figure 4.3 below. RFID technology is the precursor to NFC technology, the latter being practised extensively in mobile guide applications.

Figure 4.3
InfoLab21 MobHunt RFID tags

4.4 Prototype Design and Development

The first prototype design presented used an indoor location (Figure 4.4). Participants scan a QR Code at the starting point, which links to a webpage. The web page gives clues to find specific artwork. If the participant successfully finds the artwork, he or she needs to scan another QR Code to obtain the next riddle. However before proceeding, the participant has to answer a quiz style question to get to the next clue (Figure 4.5).

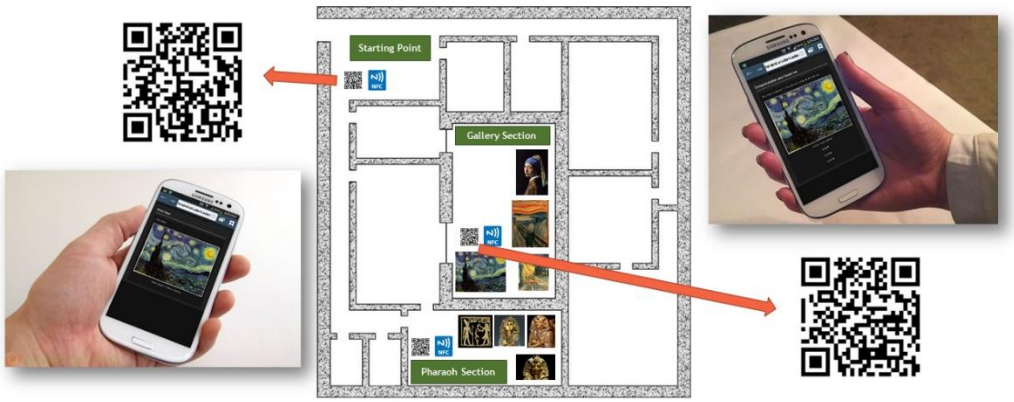


Figure 4.4
First prototype location plan for the Scavenger Hunt application

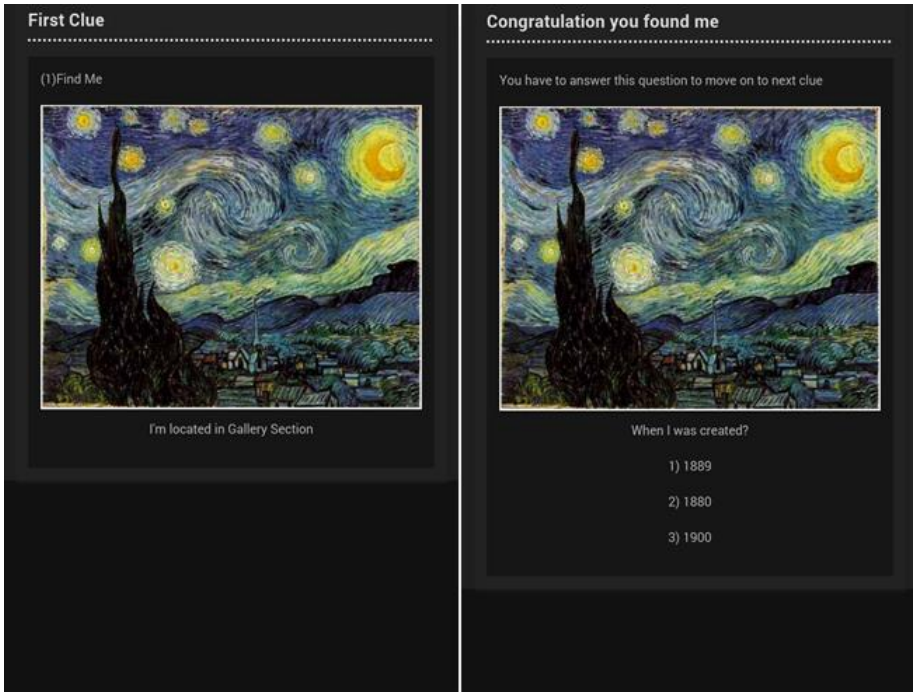


Figure 4.5
Screenshots of artwork and quiz question

The second prototype design used the university campus (Figure 4.6). Participants tap or scan a smart poster to obtain clues (Figure 4.7). The smart posters are embedded with NFC tags and QR Codes, which link the user to a web page. The starting webpage contains the first clue and the user enters their University of Kent Identity code (UKC ID) for a timestamp at the particular location. For this prototype four locations were set, namely; Jennison, Keynes, Woolf and Labyrinth with quiz style questions (Figure 4.8). The smart posters and user interface for the four locations can be found in Appendices 11.1 - 12.2.

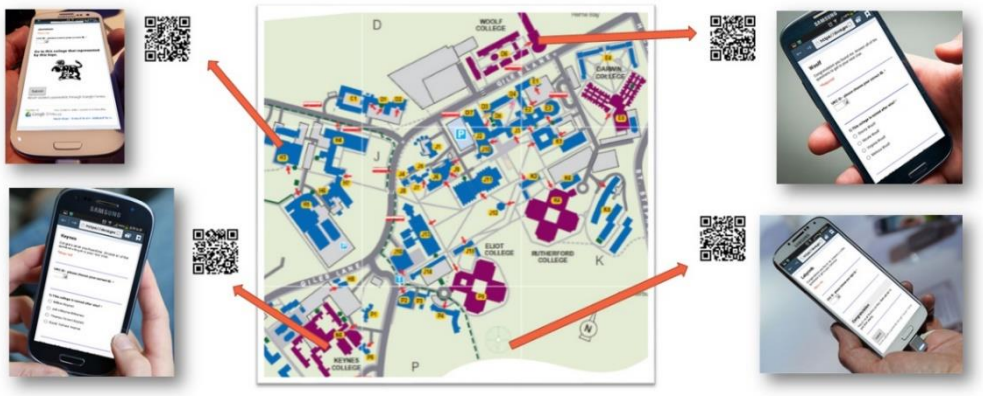


Figure 4.6
Second prototype location plan for the Scavenger Hunt application

Figure 4.7
Second prototype showing Scavenger Hunt Smart Posters

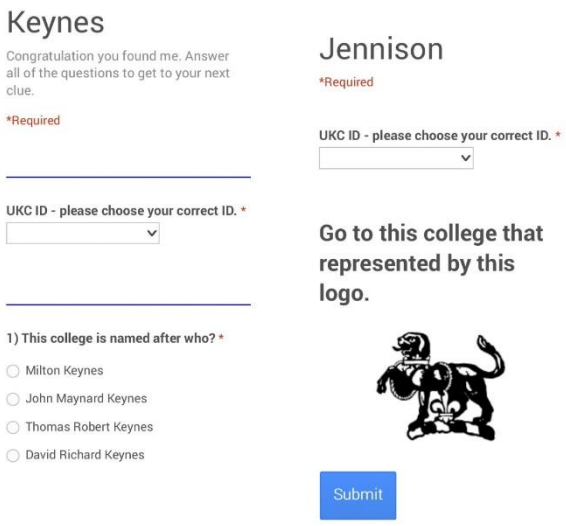


Figure 4.8
Screenshots of second prototype quiz questions

4.5 Discussion

The implementation of the two prototype designs was considered to be successful. However, further research and development was not undertaken as there were no novel aspects in this project. The ‘Scavenger Hunt’ application game for use with smartphones as it stands is limited and would benefit from various amendments and feature additions.

A crowdsourcing aspect could improve the application whereby participants during the live scavenger hunt could provide clues and hints for others if help is needed. Making the scavenger hunt more interactive for all would enhance users' experience. A game and play aspect could be built into the application where individuals or teams have to complete various game tasks, simulations or challenges during the course of the scavenger hunt as well as answering location questions and riddles. Bonus points or prizes can be awarded for these tasks making the scavenger hunt more entertaining and competitive. Participants can be readily motivated when such incentives are provided.

The research methodology was straightforward but lacked the sophistication required to take the development of the prototype designs further. The questionnaire lacked depth in terms of the responses sought and was not varied enough. The number of participants in the testing of the application was small and did not constitute a significant sample population to validate the results and outcome. Written consent from participants was overlooked although verbal consent was given.

CHAPTER 5

Study 1 – Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah

5.1 Introduction

Study 1 represents a pilot study of the original idea for this research programme. This study focuses on developing and testing a web application on a smartphone to present historical photos of His Majesty Paduka Seri Baginda Sultan Haji Hassanal Bolkiah to visitors in museum environments and similar institutions in Brunei Darussalam. The web application was designed to be viewed with any smartphone. It was designed and developed using Hyper Text Markup Language (HTML). NFC tags and QR codes were used to access relevant website information.

This study was carried out in the National Archives building of Brunei Darussalam using Samsung SIII (S3) and iPhone 3GS smartphones. One of the meeting rooms in the National Archives building was used to test the mobile guide web application.

Although the study focused on developing a mobile application for museum environments, it was not felt necessary to be in a museum as the purpose was to test the web application. The outcome of the testing was based on use of the web application pre-loaded with the chronology content.

5.2 Objectives

The primary objectives of this study were to design, develop and test the Kronologi KDYMM Paduka Seri Baginda Haji Hassanal Bolkiah (hereafter known as Kronologi SHHB) web application. Secondary objectives included testing the viability of a mobile guide using smartphones in museum environments, implementing the Kronologi SHHB web application in the Brunei Museum, Bandar Seri Begawan, Brunei Darussalam, enhancing users' experience, and determining the preference for NFC tags or QR codes. The study also aimed to obtain feedback and suggestions for improvement from the participants.

5.3 Method

5.3.1 Participants

Seven participants took part in this pilot study. They were employed by Brunei Darussalam's Museums department and held different posts including Archives Officer, Information Technology Officer and Curator. The participants consisted of two males and five females ranging from 27 to 56 years of age with a mean age of 38 years. All participants were familiar with browsing the Internet using their smartphones. Even though they each owned a smartphone, they were less familiar and aware of QR code programmes to be installed and whether their smartphone was NFC enabled or not. Therefore the participants were briefed on these aspects and the testing went ahead assuming the requirements were fully understood. Smartphones were provided during the testing period for those participants who wished to use them.

5.3.2 Design

The material used in the design of the Kronologi SHHB web application was acquired from the National Archives of Brunei Darussalam. Permission was given to use photographs with a watermark. Photographs of His Majesty Paduka Seri Baginda

Sultan Haji Hassanal Bolkiah, the current Sultan of Brunei were used as the subject for this web application. The material made available was organised chronologically based on the following decades; 1950s, 1960s, 1970s and 1980s. HTML was used to design this web application, as it was responsive to the various smartphone browsers in use.

The links for the web application were programmed to NFC tags using NFC programme writer. For the QR codes, Google URL shortener was used as it provides the QR code automatically after entering the link.

Figure 5.1 shows the information mounted onto a board for ease of testing with the various NFC tags and QR codes. The information was organised in chronological order based on four decades spanning the years 1950 – 1989.

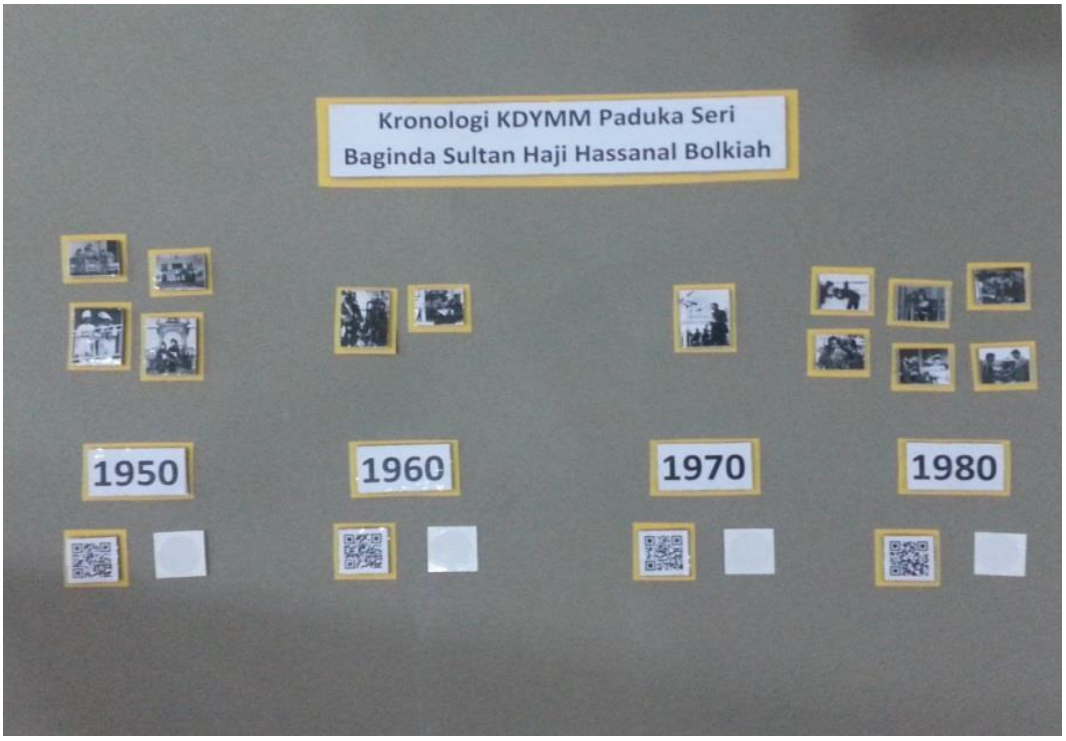


Figure 5.1
Board arrangement of NFC tags and QR codes

The text information for the web application was presented in the Malay language only as Bruneians were the targeted audience for the pilot study.

Figure 5.2
User Interface of 1950's Kronologi SHHB

Figure 5.2 shows the webpage for the 1950s decade. It consists of the title, 'Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah' with a subtitle of the year (1950-an) and three images, each of which links to a specific page with relevant information.

Figure 5.3
Screenshot of User Interface after clicking an image

Figure 5.3 illustrates the information shown in the user interface after clicking an image. The page contains a representative photograph, text information and social network options for adding comments. Users can comment and tweet using Facebook and Twitter respectively. The comments section is based on the Facebook social plugin. Users can log into their Facebook or Yahoo accounts to add a comment on the page. Another Facebook social plug-in allows users to 'like' the content of the page providing the user is logged-in to their Facebook account. There is a back link at the top and bottom of the page to access the previous page. '*Kembali'*, which means 'return' is the Malay word used to represent the back button.

5.3.3 Questionnaire

The questions used in this study were designed by the instructor and did not follow any previous studies. The full questionnaire can be found in Appendix 1. Seven questions (a - g) were asked comprising two demographic questions, two closed-ended questions, one open-ended question, one preference question and two suggestion questions. The information requested and questions given were as follows:

a) Name
b) Age
c) The *Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah* is easy to use? [if no state the reason(s)] **YES NO**
d) If you want to improve the user interface what would you suggest?
e) Which one is easier? Using NFC tags or QR codes?
f) Do you think the usage of smartphones will enhance visitors' experience in the museum? Give a reason(s).
g) Give suggestions to make the application more interesting.

These questions were asked to probe the following; whether the design layout of the interface was easy to understand, to determine any preference between using NFC tags and QR codes, whether using a smartphone to run the application enhances visitors' experience in museum environments and to offer suggestions on how to improve the web application.

5.3.4 Procedure

The instructor carried out a short presentation on the research study. This included details about NFC technology, QR codes and the sample interface of the guide based on the smartphone used. Eleven officers attended the presentation from the Museums department in Brunei Darussalam. Seven participants were recruited on the day of the presentation and took part in the pilot study. Each of the seven participants was briefed for two to three minutes on how to use the web application. NFC enabled smartphones and iPhones were made available to test the web application.

The sequence of the testing procedure for each participant was as follows:

1. **Briefing Session:** After the presentation was finished, the instructor carried out individual briefings. Each participant was asked to test the NFC tags, QR codes and the interface of the web application. No recordings were made during the testing period. Each participant was asked to test for no more than three minutes. Participants were shown how to use the NFC tags and QR codes prior to the testing, as they were not familiar with the technology provided.

2. **Instructions:** Each participant was instructed verbally to perform the required tasks.

3. **Interaction with NFC tags and QR codes:** Participants were asked to test both the NFC tags and QR codes. A Samsung SIII (S3) smartphone was used to tap the NFC tags and an iPhone 3GS was used to scan the QR codes. The participants were allowed to tap or scan any of the NFC tags or QR codes.

4. **Interaction with the web application:** Once the participants were satisfied with tapping an NFC tag or scanning a QR code, they were asked to browse the web page. They were then asked to click on the various images of photographs available and browse normally as they would for any other website.

5. **Questionnaire:** After performing the tasks, the participants were given a questionnaire to obtain feedback on what they experienced during the testing. Participant's feedback can be found in Appendices 2.1 - 2.3.

6. **Debriefing Session:** The instructor thanked the participants after completing and handing in the questionnaire sheet. Time was given for participants to ask questions and request explanations for matters relating to the testing procedure.

5.4 Results

5.4.1 Descriptive features of the sample

There were seven participants in this study with a mean age of 38 (SD =12.23). There were more female participants than male participants, five female participants and two male participants (Figure 5.4).

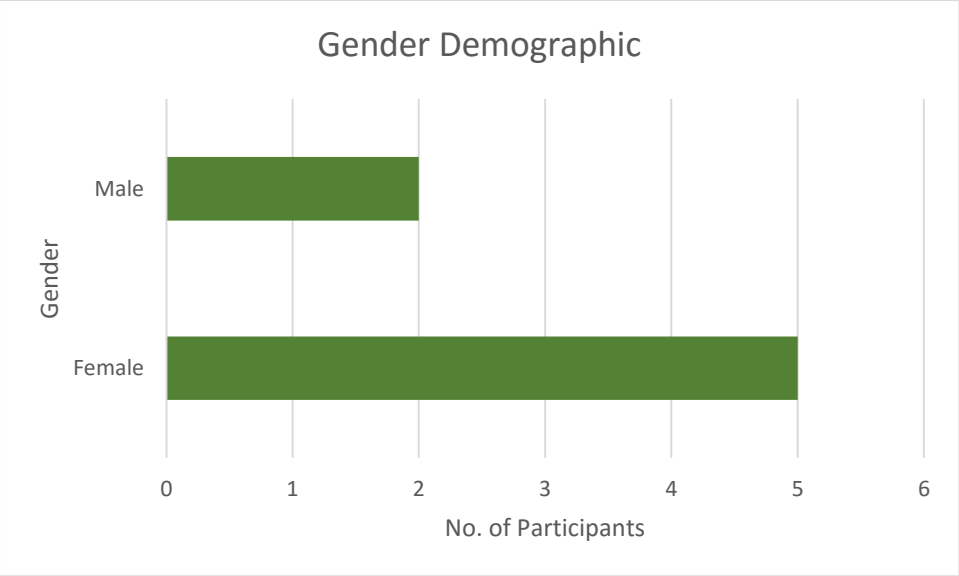


Figure 5.4
Graph of gender demographic

5.4.2 Closed-ended Question

The first question, question c was a closed-ended question asking whether the user interface is easy to use. Participants were required to simply answer yes or no. If the answer was no the participant was asked to give reasons. All seven participants answered yes to this question (Figure 5.5).

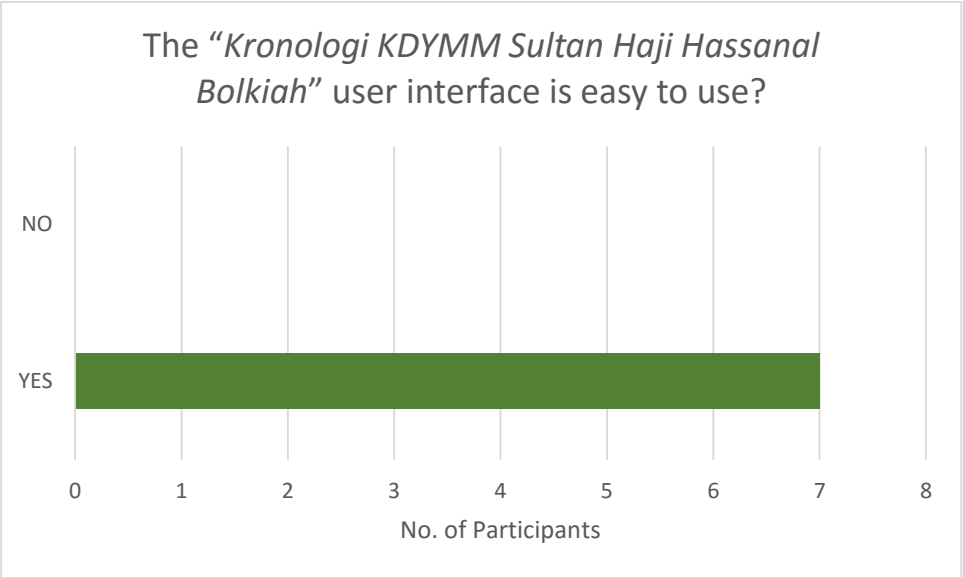


Figure 5.5
Graph of the ease of use of the User Interface

5.4.3 Open-ended Question

One open-ended question was given as part of question f. The first part was a closed-ended question, asking if using a smartphone will enhance visitors' experience in museum environments and was followed by the open-ended question asking for reasons. Six of the participants gave a positive response to the question. One of the participants did not give a yes or no answer to the first part, however reasons were given.

5.4.4 Suggestions

Questions d and g required suggestions to be made by the participants. Question d asked how to improve the user interface while question g asked how to make the application more interesting. Three participants responded to the question on how to improve the user interface. Five participants gave suggestions as how to make the application more interesting.

5.4.5 Preference

Question e related to the participant's preference for NFC tags or QR codes. Three of the participants preferred using NFC tags, two participants chose QR codes and two

stated that NFC tags and QR codes were both easy to use therefore not showing any preference for the two technologies used in the web application (Figure 5.6).

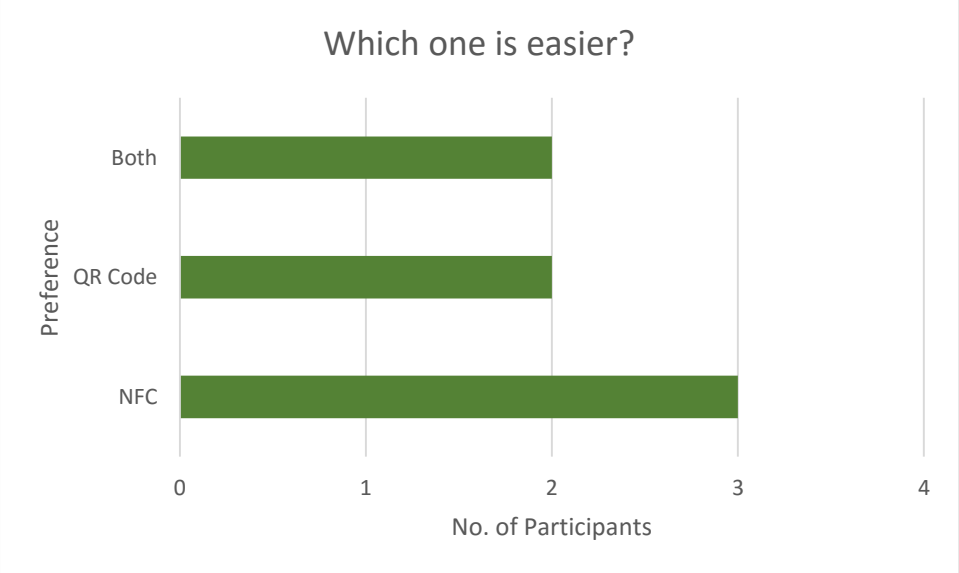


Figure 5.6
Graph of participant's preference

5.5 Analysis

5.5.1 Is the user interface easy to use?

Unanimously participants agreed that the user interface was easy to use. The positive response implies that the current user interface can be used for future prototypes of the web application.

5.5.2 Improvements to user interface

Three participants responded to question d. The three suggestions were to improve the load up page, to create a forum or chat room for discussion on the photograph images or video and to add language options.

The loading of the web application depends on the speed of the Internet connection. Slow loading can be attributed to the mobile Internet service providers in Brunei Darussalam of which there are only two. ICT infrastructure is not yet on par with countries in the region. This problem can only be addressed and rectified by the Internet service providers and the government of Brunei Darussalam. Forums and chat rooms are thought to be an unnecessary distraction given that Facebook and Twitter social network plugins are already built into the application. However, it is

possible to provide links in the form of buttons, which can direct the user to more detailed forums and discussions about the various photographic images and videos that could be provided. Language options make for a very useful suggestion and are thought to be both practical and necessary as museum environments attract visitors locally and worldwide.

5.5.3 Preference for NFC Tags or QR Codes

Two of the participants stated that both NFC tags and QR codes were easy to use. Three participants expressed a preference for NFC tags and two participants preferred QR codes (Figure 5.6). Based on these results the use of NFC tags was preferred. However, given that only seven participants took part in the testing it cannot be concluded that these results are significant. The sample size is too small.

5.5.4 Can smartphones enhance visitors' experience in the museum?

A majority of the participants responded positively to question f with each of the participants giving different reasons relating to enhancing the user experience. Reasons given included, that using a smartphone allowed an alternative way of obtaining information and the information could be easily reviewed in the home. Using smartphones could also benefit visitors who have a limited amount of time to browse exhibits, artefacts and exhibitions. The ability to give feedback in the form of comments on the photographic images is also seen as a plus. Although one of the participants did not give a yes or no answer, the reason given was positive as the participant stated that using a smartphone with the application allowed visitors to review and compare the information provided in different galleries.

5.5.5 Suggestions to make the application more interesting

Five participants responded to question g. The suggestions given by the participants were as follows: include audio and video, improve the interactivity of the application, include games, link the artefact to other relevant websites with published references and recognised international experts and institutions, and information included in the application should be different from the information on display.

5.6 Discussion

The findings show a positive response to using a smartphone with the Kronologi SHHB web application. However, the results obtained were insufficient and it is clear that the process and procedures used to evaluate the study should be revised. The questionnaire was limited to seven questions and included closed-ended questions, which limited the findings of the research. Any future questionnaire instruments should be designed with a comprehensive range of carefully thought out questions, which can elicit the key information being sought as well as collating useful opinions and suggestions about the application and the technologies it uses.

The sample size needs to be increased and replication of the testing with different groups of users should be undertaken. Other methods of testing including interviewing and recording participants would increase the reliability of the results obtained. Video recording while participants use a smartphone with the web application could also improve the study by providing an accurate and complete account of the testing period.

The following outline some of the shortcomings of the methodology used and the factors to be addressed:

1. **Methodology:** The methods used in the study need to be amended, for example briefing of participants on how to use NFC tags and QR codes was insufficient and should be revised. More tasks should be set and performed during the testing period. Participants should be interviewed and recorded in conjunction with use of a suitable questionnaire.

2. **Questionnaire:** Closed-ended questions should be avoided. For example, 'Do you think using a smartphone would enhance visitors' experience in the museum?' could be changed to 'What features can enhance visitors' experience in the museum using a smartphone?’

3. **Environment:** A meeting room in the National Archives building was used during the pilot testing. An empty room with a museum setting would have been more appropriate to run the testing.

4. **Equipment:** There was no recording equipment used during the testing. There should be recording equipment such as video cameras or audio recorders to keep records of the testing.

5. **Number of Participants:** The number of participants was low. Hence, the results of the testing were not significant. The number of participants should be increased to obtain more varied responses and reliable data.

6. **Permission:** Participants only gave verbal consent to the instructor. The instructor should provide a consent form to be signed by the participant, which would give permission for all testing and allow responses and results to be used for the purpose of the study.

In conclusion, the current methodology was ineffective. Statistically significant conclusions cannot be drawn from the limited results obtained. The methodology needs to be more rigorous and quantitative so that effective data analysis can be done. Further development of the Kronologi SHHB web application cannot be justified using the current methodology, as it is unsound and ineffective.

5.7 Conclusions

This study was undertaken to investigate the potential for using smartphone devices to run a prototype mobile guide application in Brunei Darussalam's museums. A pilot study was conducted with the Kronologi SHHB web application using Samsung and Apple smartphones. NFC tag and QR code technology was used during the testing process to investigate ease of use and any preferences for these technologies.

Based on the results and outcomes of the pilot study, it can be concluded that many issues arose because of the methodology used, which was deemed to be both

insufficient and unsuitable. Significant changes to the methodology need to be made for any future study. Despite the mistakes that were made during the course of the pilot study, it is felt that the existing study provides useful qualitative information, which can be used as a reference for future research. Suggestions and constructive comments given by the participants could also be considered for future prototype work.

CHAPTER 6

Study 2 – Kent LiveMap application

6.1 Introduction

Study 2 was undertaken as an amendment of an earlier study. This study still focuses on developing and testing a web application on smartphones. In this case, a map based Web application focusing on the University of Kent, Canterbury campus was designed and developed using Hypertext Markup Language (HTML) and OpenStreetMap navigation.

This study aims to measure the application systems usability, user interface satisfaction and seeks to address the research questions posed as the main basis for the research study. The target users of this application were the students, staff and visitors to the University of Kent. Parking on campus was one of the subjects of the study and the application was designed to give information about available car parks on campus in real time as well as being able to give information on live events on campus.

6.2 Objectives

The primary objectives of this study were to design, develop and test the Kent LiveMap application. A usability scale was devised to test the application as well as an instrument to gauge user interface satisfaction. These instruments were used to investigate whether or not the application will benefit users. Volunteers testing the application answered questions and provided feedback about the application.

6.3 Who is the Kent LiveMap application designed for?

The Kent LiveMap application is designed for the University of Kent, Canterbury. It aims to provide information to students, lecturers and visitors by presenting live data and information about the campus in an interactive way using mobile technology. The fundamental use of Kent LiveMap is to provide the students and lecturers with live information of current events on campus. Currently, the University of Kent's social networks (Facebook, Twitter and Instagram) are the only source of live information to the students and lecturers. However, this is restricting as not everyone has a social network account. Therefore, Kent LiveMap is anticipated to be inclusive and accessible.

Another target user group of Kent LiveMap are visitors to the university. Kent LiveMap can be of assistance to visitors such as family members during their visit. Besides providing live information, visitors can also access a map of the campus and navigate themselves to locations they want to go such as parking locations, lecture theatres and buildings of interest. Therefore, visitors can easily navigate the campus without getting lost.

6.4 What can the Kent LiveMap application be used for?

Kent LiveMap is designed not only to provide a map of the campus layout but also to provide the latest updates of the university's activities. The map layout contains markers, which the user can click and information will pop up and be displayed. The information for this study will focus on car park details in the university and provide the updated information based on the markers.

6.5 Method

6.5.1 Participants

Twelve participants took part in this study. They were all students of the University of Kent from different courses. The participants were comprised of four males and eight females whose age ranges from 18 to 25 years. Four of the participants are 18 to 20 years old and the remaining eight participants fall between 21 to 25 years of age. All of the participants owned at least one smartphone and therefore browsing the Internet using their smartphone's web browser was not a problem for them. Ten of the users owned iPhones, one owned a Samsung and one participant owned two smart phones, namely a Nokia and one plus one. In terms of familiarity with NFC and QR code technologies before the testing, three of the participants have used both technologies, seven participants have used QR codes only and two participants have not used the two technologies.

6.5.2 Design

The OpenStreetMap navigation service was used to develop the Kent LiveMap application. It is a free web-based editable map. OpenStreetMap was used in conjunction with Hypertext Markup Language (HTML) and Leaflet. Leaflet is an open-source JavaScript library for mobile-friendly interactive maps and was used to add map features such as markers, vector layers, image overlays and pop-ups.

The NFC tags and QR codes were programmed to link to the web map application. This was the same process used for study one. NFC programme writer was used to programme NFC tags and Google URL shortener was used to provide QR codes.

In study one, the NFC tags and QR codes were attached to a display board whereas in this study, a smart poster was printed with the relevant NFC tag and QR code label. The NFC tag was attached behind the NFC tag area. Figure 6.1 shows the smart poster used for this study (Appendix 8).

Figure 6.1
Kent LiveMap Smart Poster

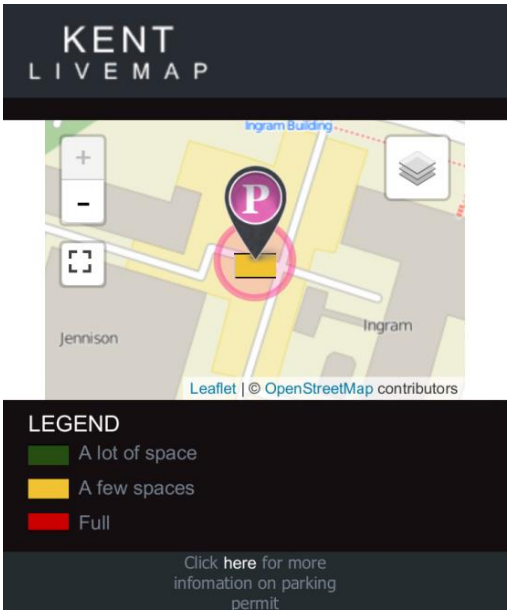


Figure 6.2
Kent LiveMap main page

Figure 6.2 shows the interface of Kent LiveMap (Appendix 9). The webpage features the header, the map based on OpenStreetMap, the legend of the map and a marker, which is linked to parking permit information.

The map, for the purposes of this study, focused on the Jenison Building at University of Kent and thus, the smart poster was designed specifically for the Jennison building. On the map, there is a marker that shows the available parking spots at the University of Kent. There are colour-coded, rectangular shapes below the marker notifying the availability of car parks. The map also features a legend with options to zoom in, zoom out and use the full screen. The types of parking permit legends are Pink Permit, All Permit Parking and Visitor Pay and Display Parking (Figure 6.3).

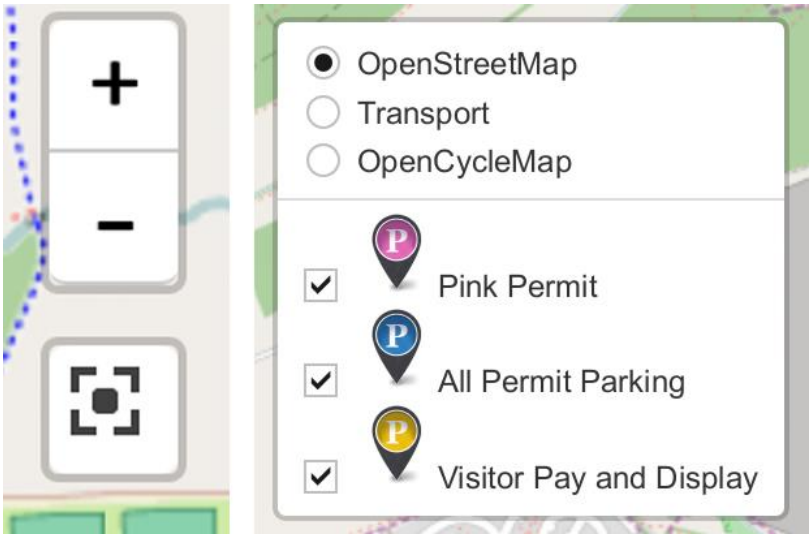


Figure 6.3
Zoom button, full screen button and legend

The marker will pop up 'infodata' when it is clicked (Figure 6.4) and immediately shows the name as well as availability of car parks. A Twitter plugin was embedded in the infodata as well. An option to submit the latest information in the form of a link is placed at the bottom of the infodata pop-up which was linked to a webpage that allows users to submit the latest parking information.

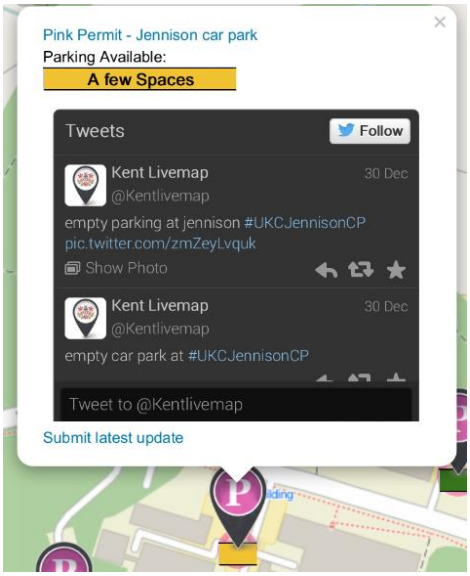


Figure 6.4
Screenshot of Kent LiveMap infodata

The colour coded rectangles below the marker shows three colours depending on the availability of parking. For example, if a specific car park is full it will display red, if a few spaces are left it will display yellow or if the car park is completely empty it will display green. A legend of the colour rectangles is placed on the main page of the Kent LiveMap application (Figure 6.5).

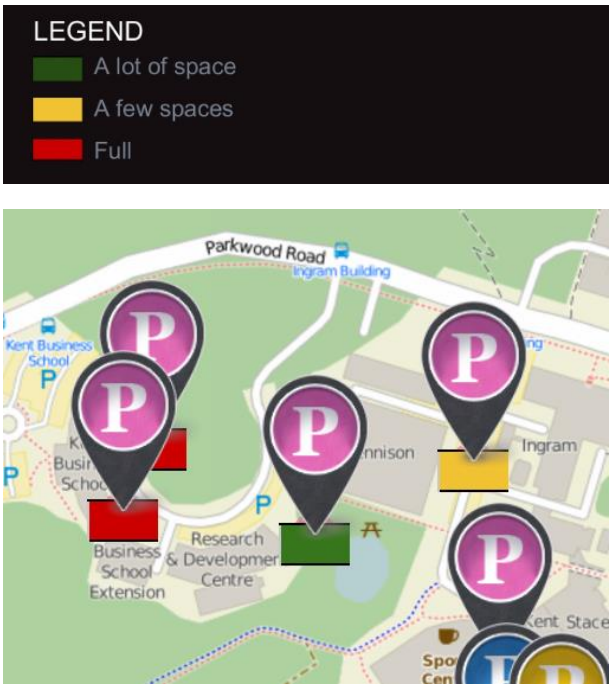


Figure 6.5
Legend for parking status (Above) and notification of parking status (Below)

At the top left of the map, there are zoom in, zoom out and full screen option buttons as well as a loading sign. Besides using the zoom in and zoom out buttons; pinching in and out of the screen will also achieve the same effect. Figures 6.6 and 6.7 show the maximum zoom in and maximum zoom out functions respectively. The full screen button enables the maximum screen size for the map and the same button is used to go back to the smaller-sized screen while the full screen mode is activated. The loading sign will only appear if it is currently loading the map (Figure 6.8).

Figure 6.6
Screenshot of maximum zoom in function

Figure 6.7
Screenshot of maximum zoom out function

Figure 6.8
Screenshot of loading button when map is loading

A comprehensive map legend can be found at the top right of the map. The features of the legend include the option to select the types of map layouts and parking permits based on user preferences. The types of maps available are the standard OpenStreetMap, transport (Figure 6.9) and OpenCycleMap (Figure 6.10).

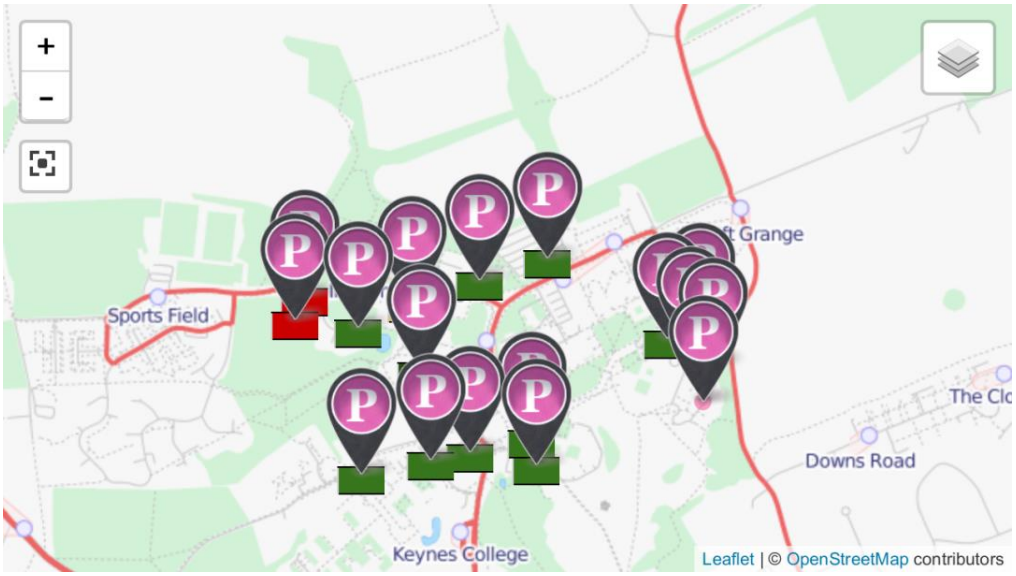


Figure 6.9
Screenshot of transport map

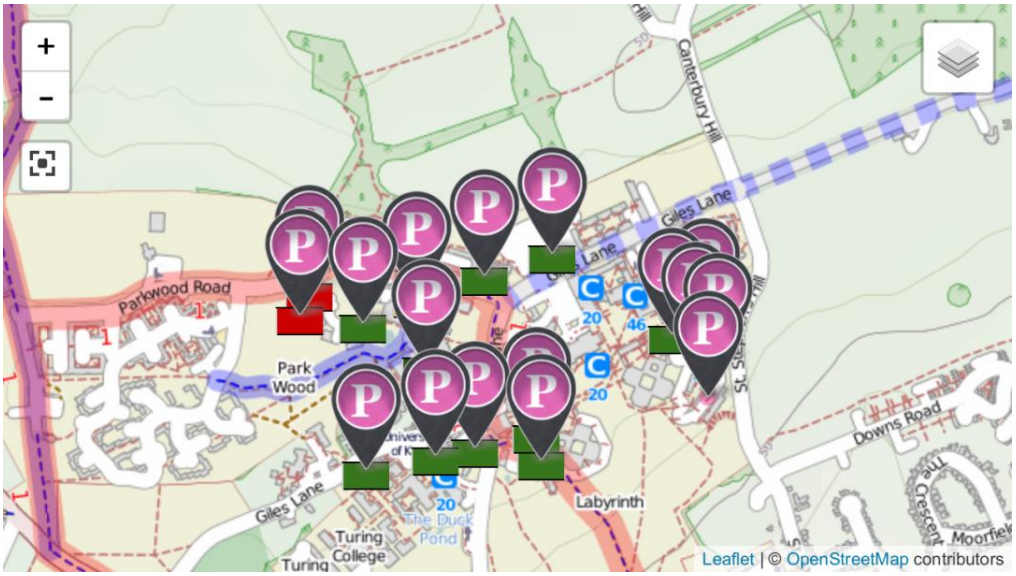


Figure 6.10
Screenshot of OpenCycleMap

The markers used in the Kent LiveMap application follow the three types of parking available, namely; Pink Permit coloured pink, All Permit Parking coloured blue and Visitor Pay and Display Parking coloured yellow (Figure 6.11).

Figure 6.11
Markers used in Kent LiveMap

6.5.3 Questionnaires

Three sets of questions were used in this study, namely, a System Usability Scale (SUS), a questionnaire for user interface satisfaction (QUIS) and open-ended type questions to address and elicit responses to the research questions.

6.5.3.1 System Usability Scale (SUS)

John Brooke created the System Usability Scale in 1986. This system has become an industry standard, with references in over 1300 articles. A SUS provides a ‘quick

and dirty', reliable tool for measuring usability. The benefits of using this system are as follows:

- It is a very easy scale to administer to participants
- It can be used on small sample sizes with reliable results
- It is valid – it can effectively differentiate between usable and unusable systems

(Usability n.d.)

The SUS questions used in the study consisted of ten questions with expected responses ranging from strongly agree, agree, normal, disagree to strongly disagree. The questions asked for Kent LiveMap are as follows:

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

The SUS instrument measures the usability of the system, which in this case means the usability of the Kent LiveMap application. An SUS score above 68 is considered above average and less than 68 is considered below average.

6.5.3.2 Questionnaire for User Interface Satisfaction (QUIS)

The Questionnaire for User Interface Satisfaction is a tool to measures users' satisfaction with specific aspects of the human-computer interface (*Questionnaire For User Interaction Satisfaction* n.d.). In testing Kent LiveMap, five groups of interface factors were measured. The groups of interface factors comprised:

1. Overall reaction to Kent LiveMap
2. Screen
3. Terminology and system information
4. Learning
5. Kent LiveMap capabilities

The full questionnaire was broken down into the following groups of specific aspects:

Group 1

OVERALL REACTION TO KENT LIVEMAP		0	1	2	3	4	5	6	7	8	9	
1.	poor											excellent
2.	difficult											easy
3.	frustrating											satisfying
4.	dull											stimulating
5.	inflexible											flexible

Group 2

SCREEN		0	1	2	3	4	5	6	7	8	9	
1. Reading characters on the screen	hard											easy
2. Highlighting simplified task	not at all											very much
3. Organisation of information	confusing											very much
4. Structure of screens	confusing											very clear

Group 3

TERMINOLOGY AND SYSTEM INFORMATION		0	1	2	3	4	5	6	7	8	9	
1. Use of terms throughout Kent LiveMap	inconsistent											consistent
2. Terminology related to task	never											always
3. Position of messages on screen	inconsistent											consistent
4. Prompts for input	confusing											clear
5. Kent LiveMap informs about its progress	never											always
6. Error messages	unhelpful											helpful

Group 4

LEARNING		0	1	2	3	4	5	6	7	8	9	
1. Learning to operate Kent LiveMap	difficult											easy
2. Remembering names and use of commands	difficult											easy
3. Performing tasks is straightforward	never											always
4. Help messages on the screen (Legend)	unhelpful											helpful

Group 5

KENT LIVEMAP CAPABILITIES		0	1	2	3	4	5	6	7	8	9	
1. Kent LiveMap speed	too slow											fast enough
2. Kent LiveMap reliability	unreliable											reliable
3. Kent LiveMap tends to be	noisy											quiet
4. Correcting your mistakes	difficult											easy
5. Designed for all levels of users	never											always

6.5.4 Procedure

Twelve participants were recruited for this study and were tested individually. Before testing, the participant was briefed about the process and procedures for testing. The test was conducted in the participant's home using a smartphone and webcam that was provided by the department along with the instructor's laptop. The task tests and interview took about ten to fifteen minutes per participant. After the interview the participants were given the questionnaires and also a consent form to ensure permission was given for the results to be used in the study.

The chronology for the procedure of the study for each participant was as follows:

1. **Briefing Session:** The instructor introduced himself and talked briefly about his background. Then, the instructor explained the process of the study. The participants were asked if they were familiar with NFC tags and QR codes and this was followed up with the instructor's explanation of what these technologies are and how they work. They were also informed that their actions and voices would be recorded during testing and that they were required to complete a series of questionnaires as well as a consent form (Appendix 4).

2. **Instructions:** The instructor gave verbal instructions. The instructor set the tasks and the participants were asked to perform the tasks. The participants were then asked to comment on the smart poster for Kent LiveMap.

3. **Interaction with NFC tags and QR codes:** Participants were asked to tap an NFC tag or scan a QR code. They were asked to use the Nexus 5 smartphone provided by the instructor.

4. **Interaction with Kent LiveMap:** Participants were asked to perform tasks on Kent LiveMap based on the instructions given by the instructor. The tasks set were as follows:

    a) Explore the interface layout of the page. (Text, structure and information)
    b) If you want to use **full screen mode** which button would you press?
    c) If you want to **zoom in** and **zoom out** which button would you press? Other than using the button how could you **zoom in** and **zoom out**?
    d) Do you know what the **pink**, **blue** and **yellow** markers represent?
    e) If you just want to see a specific parking permit only (such as **pink** permit only and hide the **yellow** and **blue** permits) what would you do?
    f) Do you know what the **red**, **yellow** and **green** colours mean on the map?
    g) If you want to know more details about a specific parking area what should you press?
    h) If you want to tweet about the parking information what would you press?
    i) If you want to provide the latest update on parking where should you press (not tweet)?

5. **Interview and Questionnaires:** After the interview, the participants were asked to answer the questionnaires provided. The three sets of questions comprising the questionnaire can be found in Appendices 3.1 - 3.3.

Participant's compilation answers for the Kent LiveMap interview can be found in Appendices 5.1 - 5.10.

6. **Signing the consent form:** Participants were asked to fill in the consent form as proof of permission to use their feedback for the study.

7. **Debriefing Session:** The instructor asked if the participants had any questions regarding the study and finally the instructor thanked the participants for taking part in the study.

6.6 Results

6.6.1 Descriptive features of the sample

There were twelve participants in this study with a mean age of 21 (SD = 0.90). There were more female participants than male participants, four of the participants were male and eight were female (Figure 6.12).

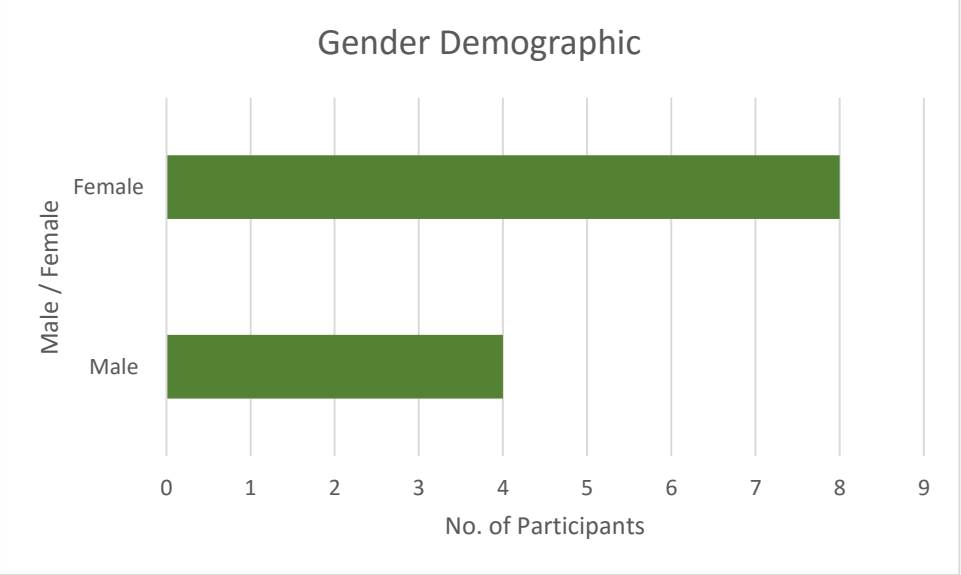


Figure 6.12
Graph of gender demographic

6.6.2 System Usability Scale (SUS)

The first questionnaire given was the System Usability Scale. The mean SUS score for Kent LiveMap was 81 (SD = 11.5). This mean was above the average score of 68 expected for standard SUS testing. Ten participants scored more than the expected 68 and two participants scored less than this average (Figure 6.13). A summary of all scores can be found in Appendix 6.

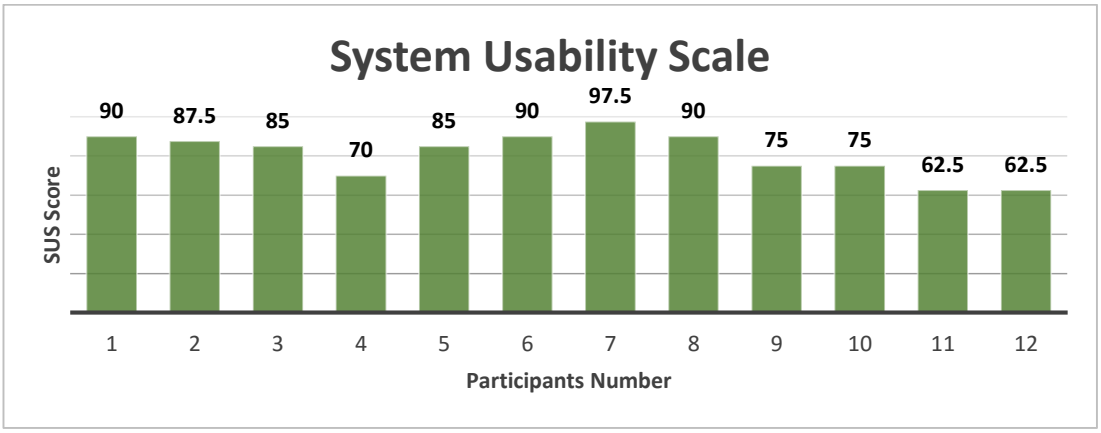


Figure 6.13
Graph of individual participant SUS scores

6.6.3 Questionnaire for User Interface Satisfaction (QUIS)

The Questionnaire for the User Interface Satisfaction was grouped into five categories. Each group measured different classifications. A summary of the means and standard deviations can be found in Appendix 7. The tables below show the scores for the group 1 (Overall reaction to Kent LiveMap) and group 2 (Screen) categories.

Group 1 Results

Question		Scores	SD
OVERALL REACTION TO KENT LIVEMAP			
Q1	*Poor - Excellent*	7.00	1.28
Q2	*Difficult - Easy*	7.67	1.07
Q3	*Frustrating - Satisfying*	7.33	1.56
Q4	*Dull - Stimulating*	6.17	1.95
Q5	*Inflexible - Flexible*	6.42	1.73

Group 2 Results

Question		Scores	SD
SCREEN			
Q1	Reading characters on the screen *Hard – Easy*	7.08	1.83
Q2	Highlighting simplified task *Not at all – Very Much*	6.92	1.31
Q3	Organisation of information *Confusing – Very Much*	6.92	1.62
Q4	Structure of screens *Confusing – Very Clear*	7.17	1.59

The tables below show the scores for the group 3 (Terminology and system information), group 4 (Learning) and group 5 (Kent LiveMap capabilities) categories.

Group 3 Results

Question		Scores	SD
TERMINOLOGY AND SYSTEM INFORMATION			
Q1	Use of terms throughout Kent LiveMap *Inconsistent - Consistent*	7.17	1.27
Q2	Terminology related to task *Never - Always*	7.00	1.28
Q3	Position of messages on screen *Inconsistent – Consistent*	7.50	1.00
Q4	Prompts for input *Confusing – Clear*	6.92	1.44
Q5	Kent LiveMap informs about its progress *Never – Always*	6.83	1.34
Q6	Error messages *Unhelpful - Helpful*	6.83	1.70

Group 4 Results

Question		Scores	SD
LEARNING			
Q1	Learning to operate Kent LiveMap *Difficult - Easy*	7.83	1.34
Q2	Remembering names and use of commands *Difficult – Easy*	7.42	1.93
Q3	Performing tasks is straightforward Never – Always	7.67	1.61
Q4	Help messages on the screen (Legend) *Unhelpful - Helpful*	7.83	1.27

Group 5 Results

Question		Scores	SD
KENT LIVEMAP CAPABILITIES			
Q1	Kent LiveMap speed *Too Slow – Fast Enough*	7.25	1.22
Q2	Kent LiveMap reliability *Unreliable - Reliable*	7.17	1.27
Q3	Kent LiveMap tend to be Noisy - Quiet	7.58	1.56
Q4	Correcting your mistakes *Difficult - Easy*	7.33	1.92
Q4	Designed for all levels of users *Never - Always*	7.17	1.34

6.6.4 Open-ended Questions

Open-ended questions were asked as part of the questionnaire process. These questions were asked based on the research questions posed for the purposes of this study. The first research question enquired how a map with dynamic real time data could be generated through crowdsourcing and consisted of two parts. Seven questions were asked based on the second research question, which related to how Kent LiveMap could enhance users' experience on campus (Appendix 3.3).

6.6.5 Opinions and Suggestions

One question concerning the participant’s opinion of the Kent LiveMap smart poster was asked during the interview. Participants were also asked to give suggestions as how to improve the smart poster.

6.7 Analysis

6.7.1 Demographic

The age of participants involved in the study ranged from 18 to 25 years. All of the participants were students of the University of Kent. Eight females and four males participated in the study. All of the participants owned at least one smartphone and one of them owned two smartphones (Figure 6.14).

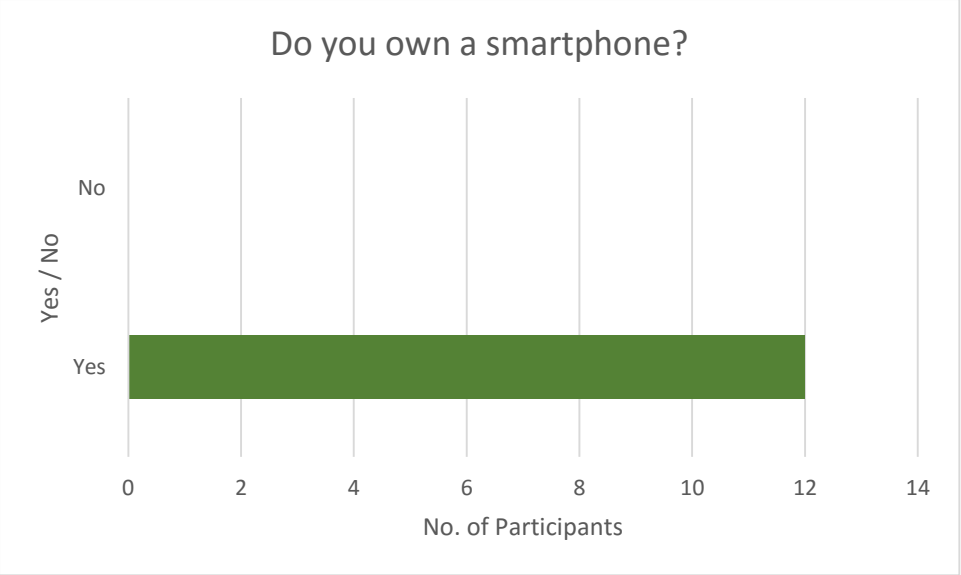


Figure 6.14
Graph of smartphone demographic

Three of the participants have used NFC and QR code technology before while seven have only used QR code technology. The remaining two participants have never used NFC or QR code technologies (Figure 6.15).

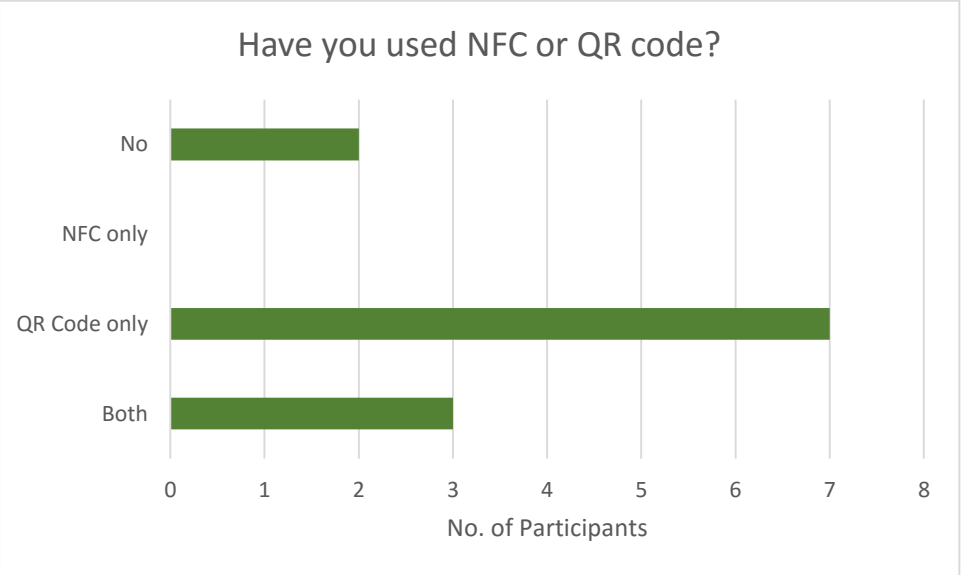


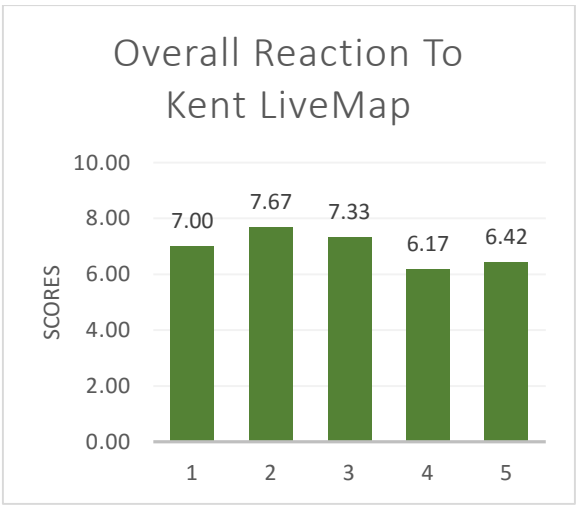
Figure 6.15
Graph of participants experience using NFC tags or QR codes

6.7.2 System Usability Scale

The mean score for the System Usability Scale on Kent LiveMap is 80.83 (SD = 11.5). Most participants chose agree or strongly agree on questions 1, 3, 5, 7 and 9. On the other hand, participants chose disagree or strongly disagree on 2, 4, 6, 8 and 10. Some of the participants chose a neutral or normal response on some of the questions. The highest score by a participant was 97.5 and the lowest score by two of the participants was 62.5. The mean score for the set of ten questions given is above the average standard of the System Usability Scale, which is set at 68, therefore it can be concluded that the Kent LiveMap application is a pass in terms of the standard system usability scale.

6.7.3 Questionnaire for User Interface Satisfaction

The Questionnaire for User Interface Satisfaction was scored from 0 to 9 across each of the five groups of interface factors being measured. The average for each interface factor is 4.5, which represents the middle aspect of the particular rating. The scores for the QUIS instrument were all above average. The group 1 results for overall reaction to Kent LiveMap are shown in Figure 6.16. The overall average score for this category was 6.92. The highest score in this category was the *'difficult to easy'* rating where the participant's average score was 7.67 and the lowest score was the *'dull to stimulating'* rating where the participant's average score was 6.17.

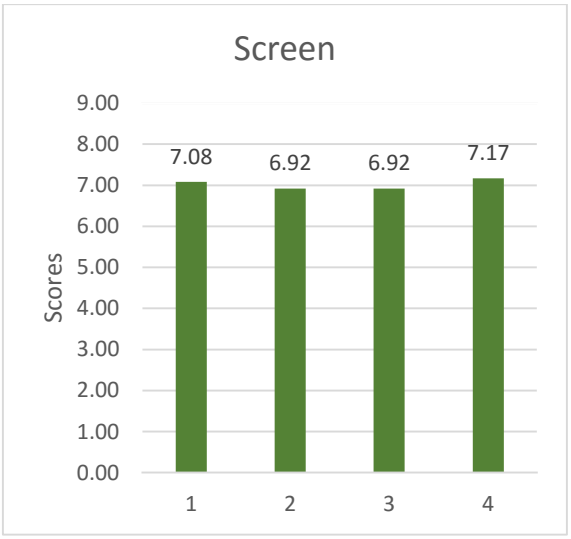


Key for X-Axis

1 poor-excellent
2 difficult-easy
3 frustrating-satisfying
4 dull-stimulating
5 inflexible-flexible

Figure 6.16
Graph of Group 1 results - Overall reaction to Kent LiveMap

The group 2 results for the screen are shown in Figure 6.17. The overall average score for this category was 7.02. The highest score in this category was the *'structure of screens'* rating where the participant's average score was 7.17. This indicates that the participants were highly satisfied with the structure of the screen. Both the *'highlighting simplified task'* rating and the *'organisation of information'* rating scored the lowest where the participant's average score was 6.92. However, this score is still well above the middle score of 4.5 and indicates a reasonable level of satisfaction for these interface factors.

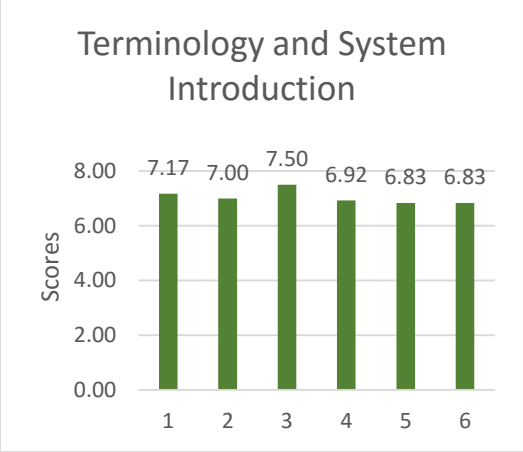


Key for X-Axis

1 Reading characters on the screen
2 Highlighting simplified task
3 Organisation of information
4 Structure of screens

Figure 6.17
Graph of Group 2 results - Screen

The group 3 results for terminology and system introduction are shown in Figure 6.18. The overall average score for this category was 7.04. The highest score in this category was the *'position of messages on screen'* rating where the participant's average score was 7.50. This indicates a high level of satisfaction for this interface factor. The lowest score in this category was for the *'Kent LiveMap informs about its progress'* rating and the *'error messages'* rating where the participant's average score was 6.83 in both cases. It is evident from this score that the participants experienced a reasonable level of user satisfaction in relation to these two interface factors.



Key for X-Axis

1 Use of terms throughout Kent LiveMap
2 Terminology related to task
3 Position of messages on screen
4 Prompts for input
5 Kent LiveMap informs about its progress
6 Error messages

Figure 6.18
Graph of Group 3 results - Terminology and system introduction

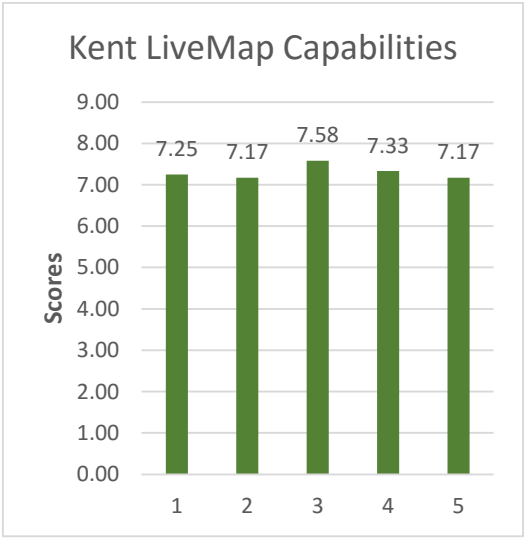
The group 4 results for learning are shown in Figure 6.19. The overall average score for this category was 7.63. The highest score in this category was the *'learning to operate Kent LiveMap'* rating where the participant's average score was 7.83. This indicates a high level of satisfaction in terms of learning how to use the application. The lowest score was the *'remembering names and use of commands'* rating where the participant's average score was 7.42. This score indicates a more than reasonable level of satisfaction for this interface factor despite it being the lowest score. This particular category scored the highest overall average for the five groups tested and demonstrates well above average levels of satisfaction for the six interface factors tested.

Key for X-Axis

1 Learning to operate Kent LiveMap
2 Remembering names and use of commands
3 Performing tasks is straightforward
4 Help messages on the screen (Legend)

Figure 6.19
Graph of Group 4 results - Learning

The group 5 results for Kent LiveMap capabilities are shown in Figure 6.20. The overall average score for this category was 7.30. The highest score in this category was the *'Kent LiveMap tends to be'* rating where the participant's average score was 7.58. The two lowest scores were in the *'Kent LiveMap reliability'* rating and the *'designed for all levels of users'* rating where the participant's average score was 7.17.



Key for X-Axis

1 Kent LiveMap speed
2 Kent LiveMap reliability
3 Kent LiveMap tends to be
4 Correcting your mistakes
5 Designed for all levels of users

Figure 6.20
Graph of Group 5 results - Kent LiveMap capabilities

In conclusion, four of the categories scored an overall average above 7.00 and one category scored an overall average below 7.00 namely, the group 1 category - Overall reaction to Kent LiveMap, which scored an overall average of 6.92. From these results it is clear that the Kent LiveMap application scored well across the majority of categories and reasonable to high levels of satisfaction were achieved. In particular the learning category demonstrated that the application was easy to use and helpful to the participants.

However, improvements can be made and the lowest scoring interface factors for each of the five categories can be used to address various issues with the application which can be worked upon for further development in the future.

6.7.4 Research Questions

The two principal research questions and their related parts were addressed from the findings. The feedback from participants and material from the literature review was also used to expand on the findings. The questions are discussed in detail below.

6.7.4.1 How can a map with dynamic real time data be generated through crowdsourcing?

With respect to this research question, a majority of the participants gave feedback about parking as the Kent LiveMap application only used information relating to parking on campus during the testing. The map application did however; generate real time data through crowdsourcing of information. People who are interested in obtaining the same kind of information need to co-operate and should be prepared to contribute information individually so that the output from the application is both reliable and useful to users.

If, as was the case with Kent LiveMap, information is demanded by a group of users who have a common goal, then that information can be shared via the social network plug-ins. In the case of Kent LiveMap, the pool of users is effectively a captive audience and it is in their best interests to share information by being responsible and contributing updates as frequently as they can. This crowd sourced information then

becomes valuable and benefits users, which in turn makes for an efficient and convenient application that will be in demand.

6.7.4.2 Can crowdsourcing of information offer reliable data?

User-generated information that was shared proved to be effective for the Kent LiveMap application as the users provided real time information relating to car parks, availability of parking spaces and permit parking. The crowdsourcing of information in the limited context of the Kent LiveMap prototype did produce reliable data. However, this is a highly controlled study with a small sample size. There are no guarantees that information required by users crowdsourced in this way would be reliable. For example, in the context of a similar application being used for a small town or city there are other significant issues. Factors such as user population, motivation to crowdsource and type of information demanded by the user can affect the accuracy and reliability of data.

6.7.4.3 Is crowdsourcing of information sufficient to develop a viable application?

For the Kent LiveMap prototype the findings show that crowdsourcing of information gathered from students and visitors could be used to develop a viable application. The parameters used in the study ensured that relevant and reliable information was available for users. However, in other contexts, this crowdsourcing of information would have to be modified or added to. Information obtained on a larger scale usually has to be moderated, filtered and authenticated before going live. It may be that information provided to users is sourced from a third-party to ensure the accuracy and reliability of the data. This may also have financial implications, as third-party provision of information would involve licences and fees.

6.7.4.4 How can LiveMap enhance users' experience on campus?

With respect to this research question the findings obtained from the testing of the application showed that Kent LiveMap saves time, is convenient, informative and makes it easy to find parking. Saving time and convenience are two significant benefits to the user. Participants agreed that Kent LiveMap is both informative and helpful making it easy to find car parks on campus especially since the university has

different types of parking permits. The convenience factor, saving time and ease of use of the application clearly demonstrates that Kent LiveMap enhances users' experience on campus.

6.7.4.5 What different types of information can Kent LiveMap deliver?

With respect to the use of Kent LiveMap for parking information most participants were interested to know the number of available parking spaces and the various locations where they can park on campus. Other participants wanted to know about traffic information. Besides the parking information requested, participants also mentioned that they would like to see other kinds of information in the application such as room availability on campus or in the surrounding area, areas of traffic congestion, locations such as the essentials shops on campus, events around campus, sales around campus as well as information on available computer spaces in the library.

With regard to the kind of information the participants would be willing to share, participants were happy to share any parking information as Kent LiveMap only provides car park information. Participants would also be willing to share other relevant types of information as outlined above, subject to such information being made available in the Kent LiveMap application.

6.7.5 Likeability of Kent LiveMap

Participants stated that they liked Kent LiveMap because of its simplicity and because of the ease of learning how to use the application. The information provided was informative allowing users to access available car parks and users could easily share information.

6.7.6 Suggestions for Improvement

Since the Kent LiveMap application works by providing parking locations, the participants suggested other similar aspects, which could improve the application. The main suggestion by participants was providing bus locations and bus times so that students can find the nearest bus stop when needed.

One participant suggested adding locations to find food stalls in the university. Besides that, room and computer availability in the library were also suggested. An interesting idea suggested by one of the participants was to use the application to find their tutor or seminar leader, the reason being that this would save students time by checking whether tutors were in the office or not.
In terms of the application interface, one participant who was colour-blind was confused with the colours used on the permit markers. This problem could be addressed to provide a solution for colour-blind users. A participant suggested that the application shouldn't be limited to twitter as not everyone uses it.

6.7.7 Smart Poster

In terms of the design of the smart poster, there were mixed reviews about it. Some participants said that it was attractive and clear. Other participants commented that it needed to have more information, for example what is NFC? Not all students and users are aware of NFC technology and information should be provided to explain the technology or how to use it. Since the current version of the Kent LiveMap application was only used for locating car parks, the participants suggested including a car symbol in the smart poster.

6.8 Discussion

The Kent LiveMap study significantly improved on the first study. There were improvements in the way information was obtained and in the kind of information obtained for this study. A system usability scale and a user interface satisfaction instrument were used as the basis for developing the questionnaires. The interview method was adopted and found to be very useful in obtaining opinions, suggestions and answers to selected questions as it allowed for discussion during the interview session.

1. **Methodology:** The methodology used in this study was improved. The instructor gave more tasks to the participants. Besides answering carefully designed questionnaires, the participants were also interviewed. The activities and voices of the participants were recorded so that the researcher could

replay participant's activities and answers at a later date and have a complete and accurate record of the testing.

2. **Questionnaires:** Three sets of questions were administered as part of this study. The first questionnaire was a system usability scale instrument, the second was a user interface satisfaction instrument and the third questionnaire consisted of a set of open-ended questions. The open-ended questions used in the study provided a diverse range of answers by the participants, which offered very useful feedback.

3. **Environment:** The location used for meeting and briefing was in the participant's home. The location is flexible because the Kent LiveMap application can be accessed anywhere, as long there is an Internet connection. Another reason for using the participant's home was for the recording purposes.

4. **Equipment:** A webcam and a smartphone were loaned from the department to run this study. The webcam was used to capture the participant's actions. The instructor's laptop was used to store and record the interview process.

5. **Number of Participants:** The number of participants in this study was deemed to be adequate. However, when working with averages for the system usability scale and user interface satisfaction instruments, it is advisable to increase the sample size of participants.

6. **Permission:** The participants were asked to sign a consent form for the results of testing to be used in the study. Permission and consent is necessary as participant's voices and hand motions were recorded during the interview.

6.9 Conclusions

This study explored the use of the Kent LiveMap application using a smartphone. A web map application was developed for Kent LiveMap with NFC tags and QR codes being used to transfer relevant website links. The study employed a more rigorous methodology than previously and produced a meaningful set of results, which can be used as a basis for further development.

The study proved that the web map application could generate real time data through crowdsourcing. One of the issues of crowdsourcing information is to guarantee that users will share relevant information in a sincere and responsible manner for their own benefit and that of other users. In terms of the Kent LiveMap application participants in the study were willing to share information, because it was useful to them and was the same type of information demanded by other users.

In terms of enhancing users' experience participants agreed that the Kent LiveMap application makes users' life easier in terms of saving time and personal convenience. Kent LiveMap was designed and developed to crowdsource information so that users could conveniently locate car parks on campus in the University of Kent. The application can be expanded to supply bus information and traffic information. Other possibilities include providing information relevant to students, lecturers and visitors to the university such as the location of important events and facilities on campus.

CHAPTER 7
Future Development

7.1 Introduction

The prototype development was successfully implemented for the *Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah* and *Kent LiveMap* mobile applications. However, improvements can be made, particularly with respect to design and the type of information used by the two applications. Based on the studies, relevant and constructive feedback given by the participants provides a good source of possible amendments to the existing prototypes as well as additional ideas for further development.

7.2 Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah application

Photographs - The current content of the Kronologi SHHB mobile guide provides a limited number of photographic images for each of the decades covered. Additional watermarked photographic images can be included, subject to approval and permission to use such material, to make the guide more comprehensive, informative and interesting.

Audio - Audio was not included in the current prototype mobile guide. Audio related to His Majesty, for example a Titah (Royal Address) from His Majesty would serve as a useful addition to the mobile guide. Other audio excerpts sourced from interviews of well-known personalities and experts in this particular chronology would add to the level of interest. Providing a sound track is another option to enhance users' experience of the mobile guide.

Video - Video is another feature, which can be added to the mobile guide. National events that involve His Majesty such as the annual National Day celebrations, His Majesty's Birthday celebrations or a specific Titah can be included in the mobile guide in video format (Figure 7.1). Videos can either be downloaded from the web or embedded from a video website provider such as YouTube.

Figure 7.1
Screenshot of a Titah given by His Majesty taken from YouTube

Suggested links - The existing information provided in the mobile guide could have links provided which relate to other relevant webpages and sites. By having a suggested links feature the user can access and obtain more information and improve their knowledge accordingly. For example an image of a National Day celebration in 1990, could suggest a link to a previous National Day celebration or links to other appropriate and relevant celebrations.

Language Options - The current language used in the mobile guide is Malay as the research participants are all Malay speakers. The Malay people comprise 67% of the population in Brunei Darussalam. There is a smaller Chinese population with English being widely used as a business language. Malay, Mandarin and English language options would increase the versatility of the mobile guide and additional languages can be added depending on the demand from the tourist sector.

7.3 Kent LiveMap application

Information - The current information provided in the Kent LiveMap application relates to parking only. The application is designed to give information about car parks available on campus; location of parking facilities and the various parking permits operating on campus. Other relevant and useful information can be crowdsourced in a similar manner to enhance users' experience. This can be built in to the application to make it a practical and useful real time provider of relevant information on campus. Examples of the types of information demanded by students, lecturers and visitors to the University of Kent are outlined as follows:

1. Transport information: Bus stop locations and bus schedules in and around the campus. Bus times vary during the weekends and on public holidays.

2. Amenities information: Opening and closing times for cafes, shops and food stalls on campus. Locations of these amenities can be easily accessed using LiveMap and other useful information can be provided such as menus, promotions and special offers. Feedback can be given using social networks to inform of any congestion at these locations.

3. Other information: Automatic Teller Machine (ATM) locations on campus and breakdown or non-availability, Library occupation information, Lost and Found information. A social network service on the LiveMap application would allow users to report whether items have been lost or found.

Social Networks - The social network used by the Kent LiveMap prototype is Twitter. Other social network platforms can be added as not everyone has a twitter account. A Facebook share button can be included to allow the user to share information. The Instagram social network can also be added. Instagram has the advantage of being able to filter images if captioned with a specific hash tag for example '#Kentgrads'. Instagram will only show photos with this hash tag allowing users convenient access to relevant topics.

Interface for Colour Blind users - One participant in the research study was unable to distinguish between the pink, yellow and blue markers assigned to the various parking permits issued on campus. The participant suggested adding text to the marker so that he would know which parking permit he was looking for. Other solutions can be developed to provide a useable interface for people who are colour blind

Smart Poster - The smart poster can be improved by adding a short description about Kent LiveMap and what it does. Brief instructions on how to use the NFC and QR code technologies would also add to the clarity of the smart poster.

7.4 Conclusions

In conclusion, it is clear that the two prototype mobile guides can be significantly improved upon in terms of functionality and usefulness to the user. Participants suggested ideas for improvement during research testing. Improvements that enhance users' experience and overall functionality of the two mobile guide applications are discussed in 7.2 and 7.3 above.

In summary the Kronologi SHHB application can be further developed by increasing the amount of relevant content, adding audio, adding video and adding relevant suggested links. The Kent LiveMap application can be further developed by widening the scope of useful information available to users. Real time information updated through crowdsourcing of the relevant information by users could make this a 'must have' app on the University of Kent campus. Parking, transport, amenities and other information as outlined previously will significantly enhance users'

experience of the application. Including more social networks will increase the ability to share information as well as getting real time updates.

The researcher is optimistic about the possible options for further development. Despite the limitations of the two prototypes it can be concluded that both of these applications have their relative merits. The Kent LiveMap application has significant potential if the challenges of crowdsourcing real time information are overcome.

CHAPTER 8

Summary of conclusions and discussion

This research programme investigated mobile guide technologies using smartphones and whether or not the specific applications developed enhance users' experience. The use of mobile guides was explored in a museum environment and in a university environment. The development of four applications was undertaken involving the use of mobile technology. NFC tags and QR codes were the preferred technologies used. Two of the applications did not proceed to the testing stage of development, namely an audio tour guide for use by the visually impaired in the University of Kent (Chapter 3) and a scavenger hunt application for use by students, also in the University of Kent (Chapter 4). The two applications that proceeded to the testing stage were the Kronologi SHHB mobile guide for use by visitors to the Brunei Museum in Brunei Darussalam (Chapter 5) and the Kent LiveMap application for use by students, lecturers and visitors to the University of Kent in England (Chapter 6).

The Kronologi SHHB application developed by the researcher was a museum mobile guide, which used His Majesty Paduka Seri Baginda Sultan Haji Hassanal Bolkiah of Brunei Darussalam as a subject. A chronology of His Majesty over four-decades was the basis of the content for this application which was developed for use in museum environments. The testing stage of development was carried out in Bandar Seri Begawan, the capital of Brunei Darussalam. A presentation was given at the National Archives building in Brunei to familiarise participants with the technologies used and the operation of the application during testing. The majority of the participants were officers of the National Archives; mainly curators and were interested to implement a mobile guide of this nature in the Brunei Museum.

Unanimously, the participants agreed that the Kronologi SHHB application was a viable mobile guide that could enhance users' experience in the Brunei Museum. Participants gave suggestions as to other features that could be included in the mobile guide and the researcher selected appropriate additions, which could improve the functionality and usefulness of the application. However, endorsement by participants does not provide an adequate measure of the efficiency, functionality or usefulness of the application. Measuring these factors in a scientific and valid way is crucial to being able to evaluate the application for its relative merits.

It was apparent from the results and subsequent analysis that mistakes were made during the testing of the application. The methodology chosen by the researcher was not rigorous. The sample size for testing was too small; interrogation techniques chosen were limited in scope and protocol oversights were made. In conclusion, the research results were heavily qualitative in nature and it was difficult to draw statistically significant and valid conclusions from the data collected. The outcome, though disappointing, provided valuable lessons for the researcher on how to conduct testing in the future, which was put to good use later in the development of the Kent LiveMap application.

The Kent LiveMap application developed by the researcher was a mobile map application, which utilises crowdsourcing of information from its users to provide real time information about available car parks, location of car parks and types of

permit parking on campus at the University of Kent. The testing stage of development was carried out in participant's homes, all of who were students of the university. The availability and ownership of smartphones meant that all participants could readily access the Kent LiveMap mobile guide. The ease of use of such mobile guides developed specifically to be run on a standard smartphone indicates that fully developed applications of this nature could provide a viable economic alternative for clients wishing to implement these technologies in various environments such as the museum and university environments selected for this research study.

The methodology used in testing the Kent LiveMap application represented a significant improvement on the earlier development of the Kronologi SHHB application. Participants were familiar with QR codes but not with the use of NFC tags. Comprehensive instructions were given to familiarise all participants with both technologies and with the tasks required for the testing of the application. All participants were interviewed and questionnaires took the form of a usability index, a user interface satisfaction index and open-ended questions to elicit feedback from the participants including ways of improving the Kent LiveMap application. All interviews were recorded, written consent obtained and protocols followed. The interviews and various instruments making up the questionnaires provided a significant amount of data, which could be analysed, and sensible conclusions drawn.

The findings show that Kent LiveMap in its current prototype form is easy to learn and could provide useful parking information to meet the needs of the user. The overall average for the usability index and the interface user satisfaction index supports and indicates a high level of user satisfaction across the various interface factors assessed as well as confirming that the application is both easy to understand and easy to use. In conclusion, this would support the hypothesis that use of the Kent LiveMap application can enhance users' experience.

The feedback from the participants was particularly useful as it provided the key idea of using the application to provide other information that could benefit students and others on campus. Transport, amenities and other information could be supplied on

demand. Co-operative crowdsourcing of information in real time would ensure the importance and usefulness of this map application.
The researcher faced many challenges during the course of this research study. Some challenges were met with success and others were not. The failure to develop the mobile audio guide and the scavenger hunt application further was very disappointing and provided a steep learning curve for the researcher. Despite these setbacks the positive feedback from the development of the Kronologi SHHB mobile guide and the Kent LiveMap application indicate that these could be successfully developed further into full-blown applications, which can enhance users' experience.

With respect to the research questions put forward by the researcher in Chapter 1 based on the study of the Kent LiveMap application, two important factors to consider when generating a map with dynamic real time data through crowdsourcing are the sharing of user-generated information and the type of information demanded by users. A more significant issue is how to motivate users to crowdsource relevant information so that the application will be viable and can function efficiently in real time with up to the minute information regarding parking and other information demanded by the user

8.1 Future Work

Future work developing mobile guides can be explored. The researcher intends to look at various aspects of running mobile guides on smartphones. One of these aspects is mobile guide crowdsourcing. This is of particular interest to the researcher as evidenced by the development of the Kent LiveMap application. Users can crowdsource anywhere and it is this versatility, which can be exploited to provide the kind of information demanded by the user. Crowdsourcing information in this way is economic, co-operative and efficient. However, many challenges have to be faced and overcome in order to implement seamless real time data managed in this way.

Another interest and challenge is to develop the play and fun aspect of mobile guides. The scavenger hunt application will be the basis for this work. The immediate challenge will be to find ways of making the scavenger hunt more

interactive for individual users or teams. The competitive aspect of the scavenger hunt can be enhanced with various games and simulations.

One of the initial motivations during the early stages of this research study was the interest shown by officers and personnel from the museums department in Brunei Darussalam to implement a mobile guide in the Brunei Museum. The researcher intends to pursue this project and is fully aware of the limitations exhibited by the prototype for the Kronologi SHHB mobile guide. The experience gained from undertaking this, and the other development projects as part of this research study, is invaluable in being able to provide a suitable solution for the Brunei Museum.

Finally, the researcher intends to participate in one of the national information and communications technology (ICT) competitions in Brunei Darussalam. The Brunei ICT Awards (BICTA) is an annual platform for young developers to showcase and develop an original idea to pilot stage and beyond. The organisation offers financial support for winners in the various categories. BICTA is government funded and aspires to develop original ideas into working prototypes, which can be used as start-up business ideas for young entrepreneurs. The aim is to develop a business model for award winners both for the local and regional market. The researcher intends to use the idea that led to the Kent LiveMap application to enter BICTA.

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Appendices

Appendix 1 - Questionnaire for Kronologi SHHB

FEEDBACK / QUESTIONNAIRE

Name _____

Age _____

1. The *Kronologi KDYMM Paduka Seri Baginda Sultan Haji Hassanal Bolkiah* is easy to use? (if no state the reason(s)) **YES** **NO**

_____

_____

2. If you want to improve the user interface what would you suggests?

_____

_____

3. Which one is easier? Using NFC or QR code?

_____

_____

4. Do you think the usage of smart phones will enhance the visitor's experiences in the museum? Give reason(s).

_____

_____

5. Suggestion(s) to make the application more interesting.

_____

_____

Appendix 2.1 - Participant's feedback for Kronologi SHHB

Feedback / Questionnaire

Name: Natty

Age: 20

1. The "Kronologi KDYMM Sultan Haji Hassanal Bolkiah" user interface is easy to use? (if no state the reason(s)) YES NO

Yes

2. If you want to improve the user interface what would you suggest(s)?

3. Which one is easier? Using NFC or QR code?

QR code

4. Do you think usage of smart phone will enhance the visitor's experiences in the museum? Give reason(s).

Yes,
able to share visitors experience → advantage
disadvantage → sometimes difficult to control

5. Suggestion(s) to make the application more interesting.

need monitoring
not all info to be included, choose certain info ...
info on display should not be exactly the same with application info

Feedback / Questionnaire

Name: Hj Kolam Hj Gapor

Age: 56.

1. The "Kronologi KDYMM Sultan Haji Hassanal Bolkiah" user interface is easy to use? (if no state the reason(s)) YES ✓ NO

2. If you want to improve the user interface what would you suggest(s)?

way of making loading info faster.

3. Which one is easier? Using NFC or QR code?

Both are easy.

4. Do you think usage of smart phone will enhance the visitor's experiences in the museum? Give reason(s).

Yes, a different approach to getting info from exhibit, interesting/exciting to young visitors, can get info and leave and take home. can get feedback and contribution from visitors.

5. Suggestion(s) to make the application more interesting.

Suggested future improvements are good/will improve/make the apps more interesting. Looking forward to get & see the prototype.

Appendix 2.2 - Participant's feedback for Kronologi SHHB

Feedback / Questionnaire

Name FAUZIAH HABIB

Age 46

1. The "Kronologi KDYMM Sultan Haji Hassanal Bolkiah" user interface is easy to use? (if no state the reason(s)) (YES) NO

2. If you want to improve the user interface what would you suggest(s)?

3. Which one is easier? Using NFC or QR code?
NFC.

4. Do you think usage of smart phone will enhance the visitor's experiences in the museum? Give reason(s).
YES. BEST FOR VISITORS THOSE WHO DON'T HAVE TIME TO BROWSE. AND WANT THE INFORMATION FOR FURTHER READING.

5. Suggestion(s) to make the application more interesting.

Feedback / Questionnaire

Name Nurasikah Ayuni

Age 27

1. The "Kronologi KDYMM Sultan Haji Hassanal Bolkiah" user interface is easy to use? (if no state the reason(s)) (YES) NO

2. If you want to improve the user interface what would you suggest(s)?

3. Which one is easier? Using NFC or QR code?
NFC

4. Do you think usage of smart phone will enhance the visitor's experiences in the museum? Give reason(s).
Yes. Convenience & ~~additi~~ can get additional information

5. Suggestion(s) to make the application more interesting.
include audio & video

Appendix 2.3 - Participant's feedback for Kronologi SHHB

Feedback / Questionnaire

Name [redacted]

Age 50 yrs old.

1. The "Kronologi KDYMM Sultan Haji Hassanal Bolkiah" user interface is easy to use? (if no state the reason(s)) **(YES)** NO

2. If you want to improve the user interface what would you suggest(s)?

3. Which one is easier? Using NFC or QR code?

Both – depend on capability of type of mobile phone used.

4. Do you think usage of smart phone will enhance the visitor's experiences in the museum? Give reason(s).

i) Review and compare information provided in different galleries.

2) Enable visitors to give feedback

5. Suggestion(s) to make the application more interesting.

Create hyper-link to other relevant web-sites, published references, international & local experts / institutions, current-related activities.

Appendix 3.1 - Questionnaire for Kent LiveMap

Demographic

1) Age = 18-20 | 21-25 | 26-30 | 31-35 | Other:____
2) Gender = Male | Female
3) Do you own a smartphone? = Yes | No
4) Which phone do you use? = Samsung | iPhone | Nokia | Other: _____
5) Have you used QR Code or NFC? = Both | QR Code only | NFC only | No

System Usability Scale

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I would like to use Kent LiveMap frequently.					
2. I found Kent LiveMap unnecessarily complex.					
3. I thought Kent LiveMap was easy to use.					
4. I would need the support of a technical person to be able to use Kent LiveMap.					
5. I found the various functions in Kent LiveMap were well integrated.					
6. There was too much inconsistency in Kent LiveMap.					
7. Most people would learn to use Kent LiveMap very quickly.					
8. I found the Kent LiveMap very difficult to use.					
9. I felt very confident using the Kent LiveMap.					
10. I needed to learn a lot of things before I could get going with Kent LiveMap.					

Appendix 3.2 - Questionnaire for Kent LiveMap

Questionnaire for User Interface Satisfaction

Please indicate the scale of:

GROUP 1

OVERALL REACTION TO KENT LIVEMAP		0	1	2	3	4	5	6	7	8	9	
1.	poor											excellent
2.	difficult											easy
3.	frustrating											satisfying
4.	dull											stimulating
5.	inflexible											flexible

GROUP 2

SCREEN		0	1	2	3	4	5	6	7	8	9	
5. Reading characters on the screen	hard											easy
6. Highlighting simplified task	not at all											very much
7. Organisation of information	confusing											very much
8. Structure of screens	confusing											very clear

GROUP 3

TERMINOLOGY AND SYSTEM INFORMATION		0	1	2	3	4	5	6	7	8	9	
7. Use of terms throughout Kent LiveMap	inconsistent											consistent
8. Terminology related to task	never											always
9. Position of messages on screen	inconsistent											consistent
10. Prompts for input	confusing											clear
11. Kent LiveMap informs about its progress	never											always
12. Error messages	unhelpful											helpful

Appendix 3.3 - Questionnaire for Kent LiveMap

GROUP 4

LEARNING		0	1	2	3	4	5	6	7	8	9	
5. Learning to operate Kent LiveMap	difficult											easy
6. Remembering names and use of commands	difficult											easy
7. Performing tasks is straightforward	never											always
8. Help messages on the screen (Legend)	unhelpful											helpful

GROUP 5

KENT LIVEMAP CAPABILITIES		0	1	2	3	4	5	6	7	8	9	
6. Kent LiveMap speed	too slow											fast enough
7. Kent LiveMap reliability	unreliable											reliable
8. Kent LiveMap tend to be	noisy											quiet
9. Correcting your mistakes	difficult											easy
10. Designed for all levels of users	never											always

Appendix 3.4 - Questionnaire for Kent LiveMap

1) How can we generate a map with dynamic real time data through crowdsourcing?

- What kind of information would you look up?
- What kind of information would you share?

2) How can LiveMap enhance users' experience on campus?

- If LiveMap is online:
    - Why would you use it?
    - Why would you recommend it?

- Tell me about your experience using Kent LiveMap?
- When will you use LiveMap?
- What do you think about the design of Kent LiveMap?
- What do you like about Kent LiveMap?
- How can LiveMap be improved?

Appendix 4 - Consent form for Kent LiveMap interview

UNIVERSITY OF KENT
CONSENT FORM

I,……, give the University of Kent (hereinafter referred to as "the University") permission to record my image and/or voice and grant the University all rights to use these sound, still, or moving images in any medium for educational, promotional, advertising, or other purposes that support the mission of the University. I agree that all rights to the sound, still, or moving images belong to the University.

Signature ……..... Date ……..…….....

Appendix 5.1 - Compilation answers for Kent LiveMap interview

What kind of information would you look up?	
Participant 1	Parking spaces, room availability (for studying), congestion in certain spaces (e.g. essentials). *"Because it is campus map, I would want information of which places are congested for instance essentials, the queues, if it is appropriate to go the at certain time. Long queue or not. Other than that rooms are occupied on campus and available for studying. I think it would be nice to have bus information as well because they do have in London on timetables and how long the bus takes to certain bus stop."*
Participant 2	Bus time, study room availability. *"I can't think of anything right now."*
Participant 3	The time of bus at each bus stop and the availability of computers that can be use anywhere in the university.
Participant 4	Information regarding other areas around campus. E.g. events around campus, information on library available computer spaces, café events, and sales around the campus. *"No of parking, no of available spaces, route if the area of congested or not."*
Participant 5	Looking up available parking on campus, What kind of parking spaces is permitted? *"Well, amount of parking space available on campus, where visitors are permitted to park which part of university because not every parking university you can park, and like you can also look the map and get to other places. "*
Participant 6	Kent Parking Map. *"Kent Parking, I guess the map."*
Participant 7	Nearest bus stop, Parking availability and location. *"The parking spaces, where parking spaces are available, different types of parking spaces available and the availability of the parking spaces".*
Participant 8	Parking Spaces, Additionally, bus availability (e.g. when it moves from one stop to another) *"If I got a car then I wanna see where I know where I can't park and where I can park, so it will make it easy and save lots of time "*
Participant 9	Parking. *"From what I can see it's just a parking."*
Participant 10	Parking space availability, Nearby parking spaces. *"Well, basically the availability number of parking and when it was last updated. That's what I need to know"*
Participant 11	Indicator of food on campus. *"Available parking spaces."*
Participant12	Availability of parking, location, traffic info. *"Location, traffic depends If I have a car, traffic, parking area."*

Appendix 5.2 - Compilation answers for Kent LiveMap interview

What kind of information would you share?	
Participant 1	(Same as above) *"Same answer like room available"*
Participant 2	The place, how busy the street is. *"Class, Not sure"*
Participant 3	The exact of location of places maybe lecturers or seminar rooms.
Participant 4	Events that's occurring around campus, computer spaces around campus. *"Same, like congestion."*
Participant 5	The amount of parking spaces available on campus. *"In regards to this application, share if there's empty spaces, if there's spaces available you can tweet it so the people can aware with the empty spaces and as well which parking spaces are permitted for people "*
Participant 6	Parking Slots. *"Parking information"*
Participant 7	Parking information location, Current user location. *"I would share basically the availability"*
Participant 8	Usually, personally, I won't but if I have to, I'll tweet about my frustration of not getting a park and directing people to area where there is park. *"Personally I don't think I would coz I don't have the time to do so but if I want to do it, I would be like oh k, this place is full don't go there but there's a plenty of parks here if you're running late or you going to this area there will be park"*
Participant 9	Interesting stuff going on. *"If it's full of course, and if I know something crazy happening about might as well just tweet it, like if there's couple fighting."*
Participant 10	The availability of parking space esp. if it's full of or almost full. *"Would share normally if there's little space available or if it's full. So I would know how people would feel if come there and everything is full."*
Participant 11	What food is available that day? *"The parking spaces are full or not."*
Participant 12	Availability of parking area, traffic information. *"Traffic as well."*

Appendix 5.3 - Compilation answers for Kent LiveMap interview

If LiveMap is online: Why would you use it?	
Participant 1	To find parking spaces on campus for easy access. *"Yes, because it's just easier to get around campus and no more wasting journey."*
Participant 2	It is easy to use and simple enough to understand. *"Yes, It provide information you need"*
Participant 3	If the LiveMap have information regarding the bus times and when there is peak time in any places such as library, computers rooms and dining places.
Participant 4	User interface is quite simple, it loads up pretty quick it does not lag at all, if I were to post up an update with the system it would only take 4-5 mins so for now as it is, its quick enough. It's simple enough as the fact that it uses the NFC or scan system; hence there is the ease of access to the site. *"Basically the idea is to know where the parking spaces are and where is available its good it's fast and easy to load"*
Participant 5	To look for parking space. *"To find parking"*
Participant 6	To save time. *"To save time before going, if I have a car"*
Participant 7	Find parking spaces. *"It would be easy to find out where the parking available without wasting time, more efficient"*
Participant 8	Convenient and informative – Helpful! *"It's convenient and you don't actually have to waste time you know where exactly where to go and you can just check like in the library which places are available, something like that"*
Participant 9	To find parking. *"If I'm driving in the UK of course I'm going to use it, It's going to save up more time especially early lecture "*
Participant 10	Yes, when I have the data. *"Recently my dad rented a car so we always go to this trouble looking for parking spaces so it would be very helpful especially when you know when there is another parking nearby and to know which one could we access or which one we shouldn't so which permit. Normally visitors they don't have a permit sometime we accidentally park in a place where you need that permit so We won't involve our self-such a trouble or complication so I think this application would help people very much."*
Participant 11	If I'm a driver, it would be known access to parking. *"For convenient purposes so that you won't go to other parking area when you know it is already full."*
Participant 12	Kent Student. *"For instance if I have a car so it is easier for me to park my car straight away."*

Appendix 5.4 - Compilation answers for Kent LiveMap interview

If LiveMap is online: Why would you recommend it?	
Participant 1	Easy access around campus. *"Yes, because it's just easier to get around campus and no more wasting journey."*
Participant 2	It's useful and very convenient. *"Yes! I would, same reason to provide information and it provides parking spaces."*
Participant 3	Some people have complains how there are no parking available which make them late to come into lectures on time therefore it is better for people to use the information in LiveMap to save s more of their time.
Participant 4	First of all it's a system developed for the ease of the students as well as the teaching staffs and the communities based within the university. There is as well potential for the system/LiveMap to grow forward or to evolve from simply a system for the organisation of parking lots it can do more than that, therefore I would like to see the future iteration of the system. *"Because it is fast and pretty easy and you can share it there are share button to use in twitter and everybody can know the situation within the University of Kent"*
Participant 5	Easier to look for parking. *"Because it is easy and simple and not complicated without you even instructing me I could even actually use it without the instruction"*
Participant 6	Quick & Easy. *"Because it saves time and energy, I would recommend it as it makes life easier."*
Participant 7	Efficient, less time wasted. *"More efficient for people, don't waste time going to other parking spaces when the information is already available to you"*
Participant 8	Same reason as above. *"Mainly because it's convenient, saves you a lot of time."*
Participant 9	Easy to use. *"It's convenient"*
Participant 10	Because it would save people time looking at the wrong parking slots. *"I would because like I mention before this especially when people who come approach me to ask me if I know where to rent a car and automatically tell them you should have this application as well, it would be useful for them."*
Participant 11	It's convenient. *"Because it is informative and it's convenient for drivers."*
Participant 12	Cause it be useful if I have a car. *"Easy for people who has a car; instead like the check parking space on their own they can just check from their phone."*

Appendix 5.5 - Compilation answers for Kent LiveMap interview

Tell me about your experience using Kent LiveMap?	
Participant 1	Easy use, no difficulty finding information. *"I think the app is easy to understand, easy to navigate around and very simple."*
Participant 2	Easy access and understandable. *"It is very useful, you don't have to waste your time for parking spaces, especially when you're in hurry to go to lectures, seminar and it easy app, simple and straight away."*
Participant 3	It is stimulating, to retrieve information needed is quite fast, to inform others through twitter or other social network is helpful for others.
Participant 4	Smart, Clean, Organised enough for users to explore & find out.
Participant 5	It was good, simple and straight to the point. *"It was good, it simple, it is not complicated to be use, you can navigate it and it is not that difficult."*
Participant 6	Easy, Interactive. *"It's easy, and very interactive and you can share it"*
Participant 7	Easy to use. *"Very easy, everything is there, the keys maybe it take a few minutes just to figure out what each button does, but everything is fine its look good as well."*
Participant 8	It was fun, something different and stimulating. *"It was really interesting, I got a little bit confuse at first because I'm not used to this phone, not the map but the phone, so I think if it actually downloaded on your individual phone where you can familiar with the graphic and setting I think it will be easy but I think it is very useful"*
Participant 9	Smooth. *"Probably during first time it can be a bit confusing and because there's not much instruction which you just scan QR code and tap the NFC and then your own your own but I think most of the sign if the people had use something like Google Maps it's should be self-explanatory other than P parking other than that should be fine I guess."*
Participant 10	It's very useful and easy to use. *"It quite straight forward, well like I said I am not really a twitter user, it would be nice different ways of giving information because if you were to have this application you would need a twitter as well."*
Participant 11	Confusing at first but easy to figure out. *"It pretty good idea but a little confusing at first, you need to get use to navigating through the website actually to get an idea how to use it. Once you know it's a good idea."*
Participant 12	It was easy, but have difficulty with some colours s I'm colour-blind. *"Easy, maybe I need like to get used to it first but it quite simple and I barely touch technology it quite easy."*

Appendix 5.6 - Compilation answers for Kent LiveMap interview

When will you use LiveMap?	
Participant 1	When I need to look for parking. *"For this case when I need parking."*
Participant 2	Everyday *"Like going to Uni"*
Participant 3	When I need certain information regarding the availability of spaces in the library.
Participant 4	When in need of parking spaces / sale around campus. *"It's easy and it's pretty simple to explore and it's not that hard"*
Participant 5	When to look for a parking space. *"If someone need parking space, I don't drive but if someone ask where can I look for parking space available, I can recommend this app because it is easy for them and they can't get lost because they can map them"*
Participant 6	Before heading to Uni / using parking space. *"Before going to class"*
Participant 7	When I need to find parking. *"Anytime actually, when I actually have a car and drive to Uni and find spaces."*
Participant 8	When I need to, save time and effort, good for planning of journey. *"When I need to use it to find a park."*
Participant 9	If I ever need a parking. *"If I'm late for class, on your way to Uni probably you gonna look for parking and go straight there rather than circling the Uni around and find a parking "*
Participant 10	In the car when I'm about to leave. *"If I have data in my phone and where I don't have to go through using the map application in my phone and straight away using this."*
Participant 11	When it has food indicators. *"If I have a car."*
Participant 12	When I have a car, when I'm searching for building. *"When I have a car."*

Appendix 5.7 - Compilation answers for Kent LiveMap interview

What do you think about the design of Kent LiveMap?	
Participant 1	Simple, neat. *"I said it before it's very simple the colour are not too striking they're just pastel colour which is nice and easy to navigate and understand information."*
Participant 2	Its usable *"It's ok, easy to use, clear"*
Participant 3	It can be improved through the fonts and enlarge the Kent LiveMap word because the design did not attract me enough to use the application.
Participant 4	Simple *"It's Pretty nice thing to have if you one of student who use cars in the University because you know I bet if I would drive within the University of Kent and I have to look around campus to get parking spot, so now basically I need to go online and could check it up, because nowadays we have 3g network it not gonna take a while to load."*
Participant 5	It is a simple layout and easy to understand. *"It's good, it simple and there's you can go for transport which an easy path for like people using car and there's pathway for people walking or cycling and it's not complicated."*
Participant 6	Interactive, easy. *"It is interactive and it's easy to use"*
Participant 7	Looks good, everything is well integrated. *"Looks good, the icons are easily distinct and you know which button are which they all got colour and they're clearly clear, everything is clear"*
Participant 8	Like the colours. *"It's nice it's really informative but then the only thing that if I am still not familiar with the legend whether its full, empty I have to go back so I have to enlarge and minimised I think that's the one slight made a little more difficult so you have to like a cross reference instead just like look straight to the map."*
Participant 9	Simplistic & modest. *"it simplistic, I think that's about it"*
Participant 10	It's simple, colourful and straightforward. *"It was good I like it, colourful and it is easy to understand. Straight forward."*
Participant 11	Too small for scale. *"I think it's good, if it involve other thing like food stalls available in campus, but the idea behind it is really good so you just need to expand on it."*
Participant 12	It's very modern, simple and interactive. *"It's really minimalist."*

Appendix 5.8 - Compilation answers for Kent LiveMap interview

What do you like about Kent LiveMap?	
Participant 1	The simplicity of it, use of light pastel colours – not overwhelming. *"The simplicity of it how everyone can easily understand it."*
Participant 2	It tells you the latest information *"It provides information"*
Participant 3	It is very easy to understand, very informative, very straightforward.
Participant 4	It is easy to explore & learn. *"It simple, it's easy and it is interactively simple."*
Participant 5	The simple layout, easy accessible. *"It's simple, it's not hard and you can find parking which you need in Brunei, It might good app for Brunei "*
Participant 6	Easy to share information. *"Easy to understand, it's like most map app the benefits it you can share it"*
Participant 7	Informative, less time wasted finding parking as information can be found on phone. *"It is easy to use, it provide information what you need, its works it helps the user to find parking."*
Participant 8	Its use is good. *"It is very up to date and every time you find something out it's just going to be there. You can find from your phone where around in campus, you can find park whether its full do you need to waste time and energy and effort to get to the place or should you just find different route"*
Participant 9	Simple. *"It works basically, probably. Ok the first thing is it works. The second thing is I like it simple so it is convenient to use it that way and probably it much easier to load rather than fancy background, fancy design and everything else."*
Participant 10	" *"Basically easy, easy to follow, useful information that's what normally need when you had a car, you rent a car here, especially when you not familiar with the areas it makes you feel more knowledgeable about other place. Basically, it's helpful and information what this is."*
Participant 11	It's a smart idea. *"I like it because it has access to twitter, I think it is very smart."*
Participant 12	It's very modern, especially for this century of this generation. *"Looks sophisticated, modern, not too complicated with colours, simple."*

Appendix 5.9 - Compilation answers for Kent LiveMap interview

How can LiveMap be improved?	
Participant 1	A side from the extra info above, no others. *"Other than information I suggested earlier, maybe provide more information other than parking, beyond parking but this is ok"*
Participant 2	Adding more live information about other thing. *"Bus information "*
Participant 3	It can be improved by informing whether there are other places available for lunch, the availability of computer rooms that can be used and whether there are peak times on when the computers are all used by the students.
Participant 4	Include area information, include If the area is congested or not. *"I've said that in first question, number of route congested or not, number of parking available "*
Participant 5	Adding bicycle parking, banks location – available notes, location – mapping where you are and get from one location to another. *"There's people who ride bike here and they might wanna know where they can park their bicycle"*
Participant 6	Bus times, traffic. *"Traffic, bus time, where the bus is."*
Participant 7	GPS, location tracking, provide traffic information and bus stop location. *"Bus terminals, bus stop, nearest bus stop near you, basically the traffic maybe, like the traffic lights where congested or not then does the site has GPS like tracking? Maybe it can follow where you are and if you wanna go the nearest parking it find the nearest route. "*
Participant 8	Status update should be shortened (delay in time); The legend should be on the enlarged map to prevent having to exit full screen and needing to cross-reference. *"I don't particularly have any idea how we can improve it, I think it's good already. Being somebody who uses a bus maybe something like, have certain bus have left certain bus area will it come where I kinda know where to go considering I don't use car here."*
Participant 9	Try to use for library as well or other thing as well. *"I think it shouldn't be limited to twitter, because not everyone use twitter probably it only gonna be for Kent students mostly I think it should be better if you use something using their account like Microsoft account, their live account rather than tweet because not everyone have twitter. The one thing that comes to my mind is the seating in the library; I think that should be good. If the computer room is full or the social area is full then someone outside the library can just look oh just go to floor 4 or floor 2 it much easier that way and it won't annoy other student that studying. Probably if it can be used for the Kent Library, the book library as well I think that would be more convenient rather than you have to take out your tablet or you have to take out your and go to library.kent.ac.uk you just look at the library book or sometime you have to go to the library itself and just to search the book. I think it just more convenient if you have app for that so you can access the whole resources in the library."*
Participant 10	More info about nearby parking spots near a targeted destination. *"Bus routes probably, Bus time, Bus stops."*

Participant 11	Give food indications. *"Things like what everyone look for, like food. So maybe like other than P they have like S so indicate which area they have food the choices and stuff. Like new stall in KBS for example, no one would actually know. Maybe indicates where you can find our tutors are. Maybe for example because we have office house every week to meet our seminar leader maybe if they were on campus and they have to log in and check in or check out so we would know if they're currently in on during office hour or not so that way people don't have to come and see if there're in or not."*
Participant 12	Use more pictures of icons, use easier colours for the legends. *"Maybe for the icon thing the colour, maybe make it more distinct, because it was red and brown, er.. green.. Maybe red, blue and yellow. Can't see specific colour because colour blind. Maybe I prefer picture or text. And add more traffic info."*

Appendix 5.10 - Compilation answers for Kent LiveMap interview

Poster	
Participant 1	*"I think it attractive because it use contrasting colours, I would recommend there tend to be empty spaces and looking at it first-hand personally I wouldn't know it Kent LiveMap I think it should provide information about Kent LiveMap, a few text, overall it's good."*
Participant 2	*"I think I would be curious because I don't know what it is."*
Participant 3	-
Participant 4	*"Yea, why not, since it is easy and take out your phone and tap your phone and directly. I'd say the wording, no more wasted journey join Kent LiveMap it needs to be bigger. If I were to see this on the post I might miss it because you know university student are in a hurry."*
Participant 5	*"You should add like car symbol, the transportation, text fine cos its big "*
Participant 6	-
Participant 7	*"The poster it's clear, We know what is provided and it is easy to use basically. Maybe bigger text and people may not know what NFC is maybe can explain what NFC is"*
Participant 8	-
Participant 9	*"The design, I won't say it bad I won't say it good either because it's just for me it's just bland, it doesn't pop-up because there's some other adverts in the Uni when you just pass oh you just gonna look at that because there's something about it. Not this one. "*
Participant 10	*"I would naturally assume that's not a website because I don't see the .com, so naturally I would assume it's like maybe a society or an event so I would suggest if you put .com at the end but overall the whole thing is perfect even the colour."*
Participant 11	*"It's too limited in information. If I saw a brochure of you know this one pass to me I would toss it because I don't know it relevant to me. Even though if people who drive they won't know that P stand for. Maybe there's indication like drivers, join Kent LiveMap today. So they know about parking. So they will care more. Literally there's no appeal for student who don't have car right now."*
Participant 12	*"I think people are more attracted simpler adverts like stick out."*

Appendix 6 - System Usability Scale scores

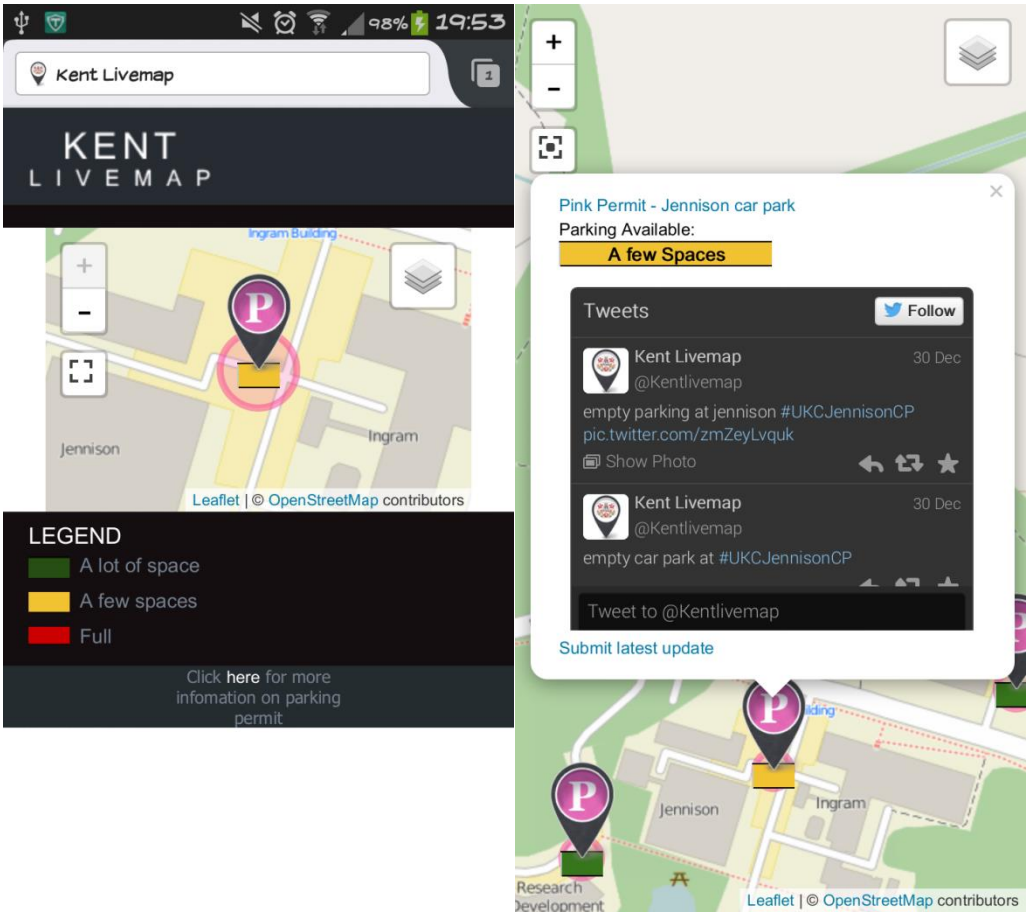
	1	2	3	4	5	6	7	8	9	10	11	12
1. I would like to use Kent Livemap frequently.	3	3	3	3	2	4	3	3	2	3	0	3
2. I found Kent Livemap unnecessarily complex.	4	3	4	3	4	3	4	3	3	3	2	3
3. I thought Kent Livemap was easy to use.	4	4	4	3	4	4	4	3	3	3	2	3
4. I would need the support of a technical person to be able to use Kent Livemap.	3	4	4	2	3	4	4	4	3	3	4	1
5. I found the various functions in Kent Livemap were well integrated.	4	3	2	2	3	4	4	3	3	3	3	3
6. There was too much inconsistency in Kent Livemap.	4	3	3	3	3	3	4	4	3	3	3	3
7. Most people would learn to use Kent Livemap very quickly.	4	4	3	3	3	4	4	4	2	3	2	3
8. I found the Kent Livemap very difficult to use.	4	4	4	3	4	3	4	4	4	3	3	4
9. I felt very confident using the Kent Livemap.	3	4	3	3	4	3	4	4	4	3	2	2
10. I needed to learn a lot of things before I could get going with Kent Livemap.	3	3	4	3	4	4	4	4	3	3	4	0
Total Score	*36*	*35*	*34*	*28*	*34*	*36*	*39*	*36*	*30*	*30*	*25*	*25*
SUS Score	**90**	**87.5**	**85**	**70**	**85**	**90**	**97.5**	**90**	**75**	**75**	**62.5**	**62.5**
											Average	***SD***
											80.83	**11.55**

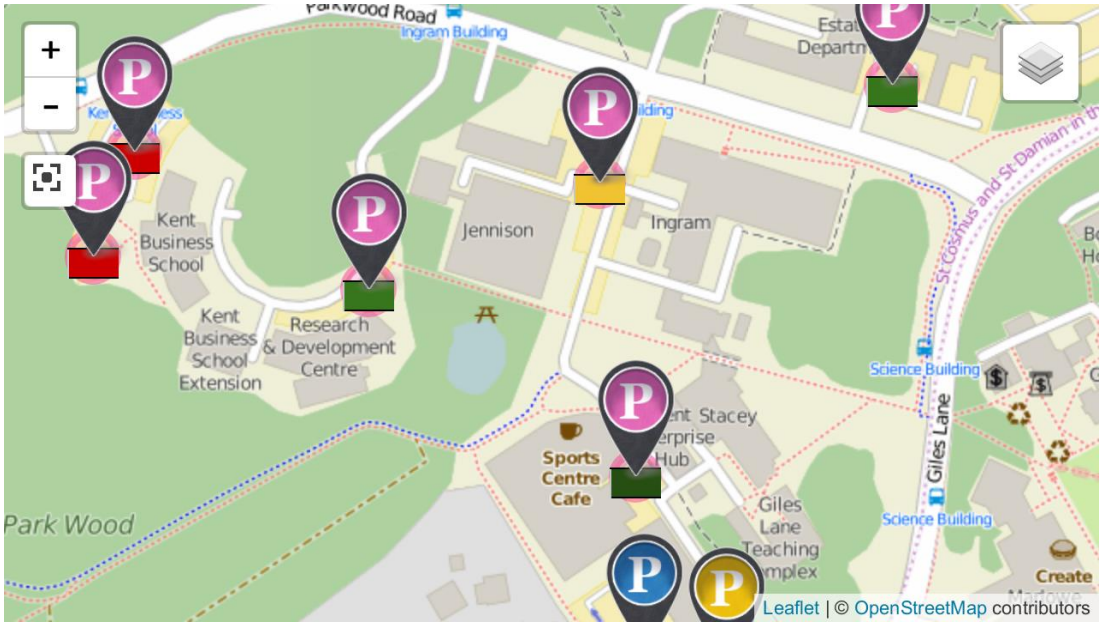
Appendix 7 - Questionnaire for User Interface Satisfaction scores

OVERALL REACTION TO KENT LIVEMAP	Mean	SD
1	7.00	1.28
2	7.67	1.07
3	7.33	1.56
4	6.17	1.95
5	6.42	1.73
SCREEN	Mean	SD
1. Reading characters on the screen	7.08	1.83
2. Highlighting simplified task	6.92	1.31
3. Organisation of information	6.92	1.62
4. Structure of screens	7.17	1.59
TERMINOLOGY AND SYSTEM INFORMATION	Mean	SD
1. Use of terms throughout Kent Livemap	7.17	1.27
2. Terminology related to task	7.00	1.28
3. Position of messages on screen	7.50	1.00
4. Prompts for input	6.92	1.44
5. Kent Livemap informs about its progress	6.83	1.34
6. Error messages	6.83	1.70
LEARNING	Mean	SD
1. Learning to operate Kent Livemap	7.83	1.34
2. Remembering names and use of commands	7.42	1.93
3. Performing tasks is straightforward	7.67	1.61
4. Help messages on the screen (Legend)	7.83	1.27
KENT LIVEMAP CAPABILITIES	Mean	SD
1. Kent Livemap speed	7.25	1.22
2. Kent Livemap reliability	7.17	1.27
3. Kent Livemap tend to be	7.58	1.56
4. Correcting your mistakes	7.33	1.92
5. Designed for all levels of users	7.17	1.34

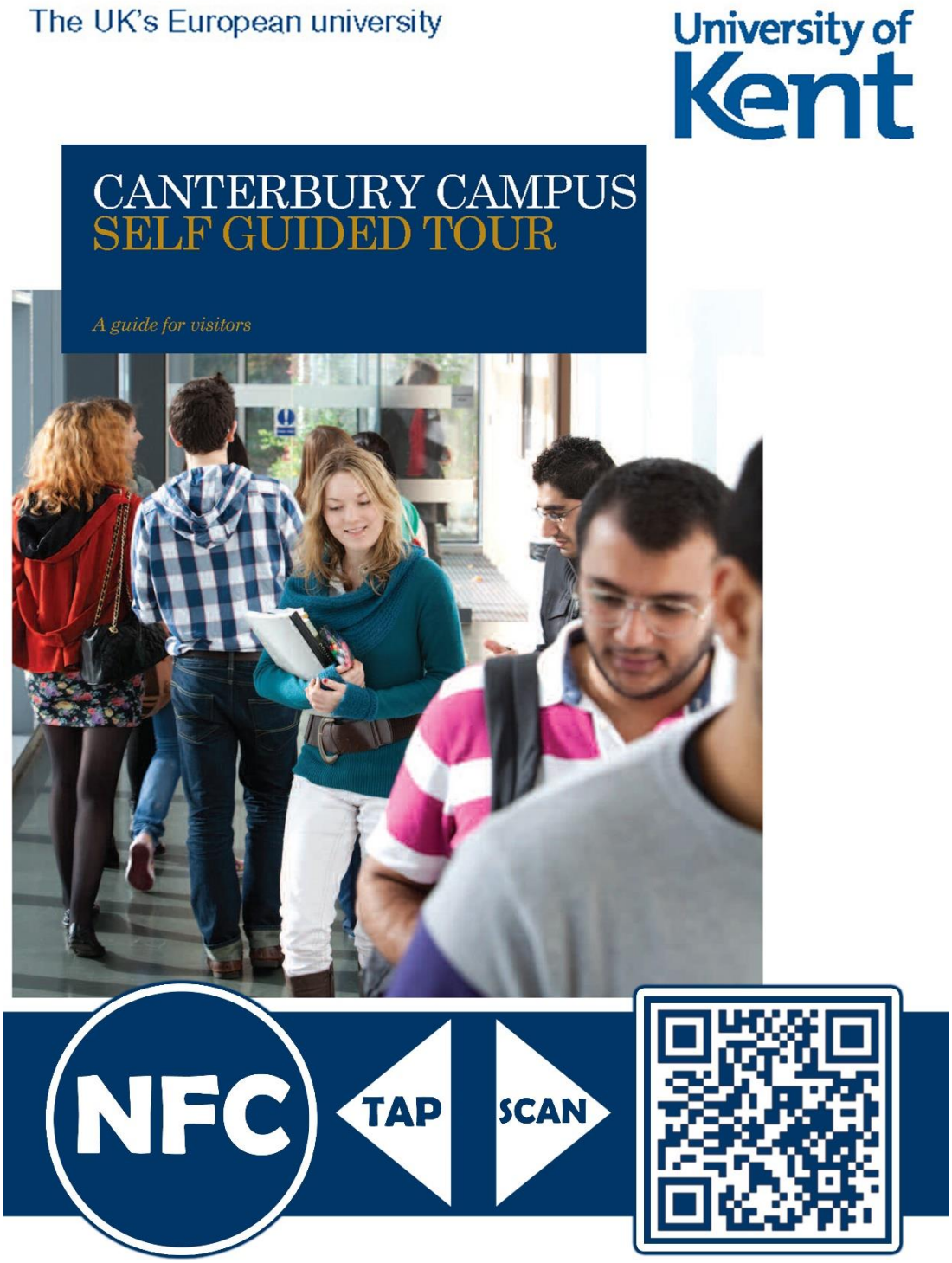
Appendix 8 - Kent LiveMap Smart Poster

Appendix 9 - Kent LiveMap User Interface





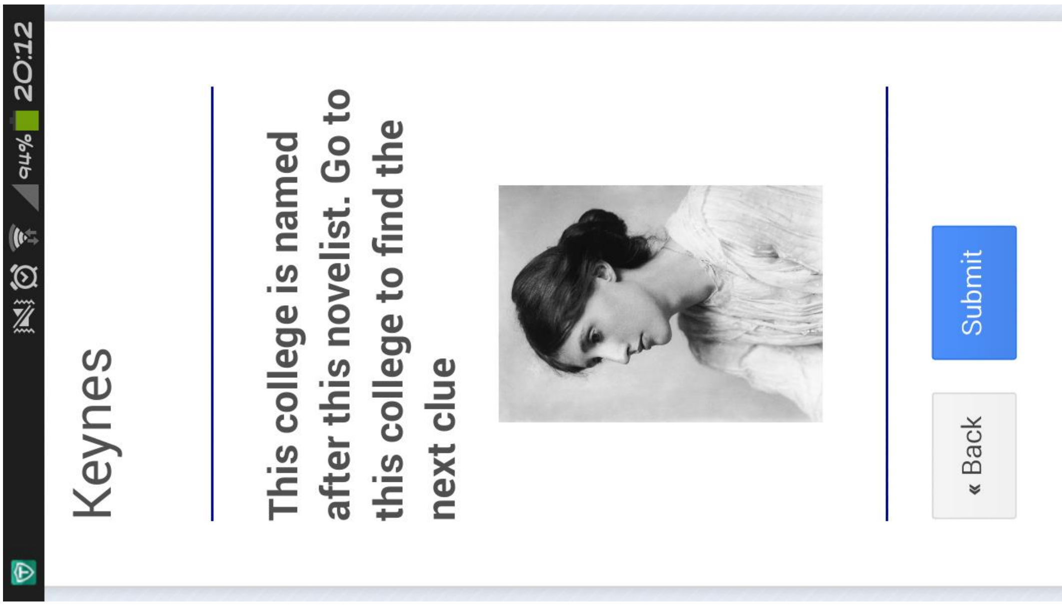
Appendix 10 - Mobile Audio Guide Smart Poster



Appendix 11.1 - Scavenger Hunt Smart Poster

Appendix 11.2 - Scavenger Hunt Smart Poster

Appendix 12.1 - Scavenger Hunt User Interface



Appendix 12.2 - Scavenger Hunt User Interface