

Investigating Mobile Technology for Experiential Outdoor Heritage Practices

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Abstract

This thesis investigates the potential of innovative mobile guides to enhance heritage experiences during walks in historic urban precincts. Focusing on the effects of smartphone-based and mobile projector-based guides, the research explores how different display modalities influence visitors' embodied and social engagement, behavior, and meaning-making processes in complex, multi-sensory heritage environments. Through a series of empirical studies conducted in Canterbury's historic high street, involving 66 participants, the research employs a multi-method approach including surveys, interviews, observations, and participant-generated materials. The findings reveal that while smartphone guides often create a 'bubble' effect, isolating users from their surroundings, mobile projector guides foster more exploratory, playful, and socially engaged interactions with the heritage site. The thesis proposes a novel approach to designing mobile guides through the lens of 'playful walking', emphasizing the importance of supporting not only cognitive engagement but also multi-sensory, embodied, and social interactions. This approach is synthesized into actionable design considerations and four innovative design directions, illustrated with conceptual examples. Key contributions include technology design, empirical observations on the affordances of different mobile guide types, and a set of design principles for creating devices that support embodied heritage interpretation practices. The research highlights the potential of mobile projector guides to transform static heritage sites into dynamic spaces for interaction, fostering deeper connections between visitors and their surroundings. While primarily focused on historic urban precincts, the findings offer broader implications for designing mobile guides that enhance heritage experiences in contexts such as archaeological sites, living history museum, etc.

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Mitigation Statement

Dear Examiner,

In December 2019, a COVID-19 pandemic outbreak was triggered in Wuhan, China. In March 2020 (the beginning of year 3 of this PhD), the UK government and NHS had to implement a lockdown and work-from-home to contain the viral spread. Over the next two years, access to workplaces, educational institutions, and meeting people from other households was restricted. The restrictions were gradually withdrawn in July 2021, and life in the UK has returned to normal due to a rise in vaccinations and a decline in the virus' spread.

The 2020–2021 lockdown affected the third and half-fourth years of the PhD. Working from home during the 18-month COVID-19 lockdown had a detrimental impact on the researcher's work, and familial, physical, and mental wellbeing. The process of analysing the data and documenting the results slowed down considerably. In years 3 and 4, the lockdown prevented the in-person field study on Canterbury High Street for new data collection. These factors severely hindered the overall research plans and, specifically, Study 3's data collection could not be completed with the desirable sample size. The March 2022 cyberattack shut down all School of Engineering IT systems, further delaying the work. Due to ethical and security considerations, all of the data from the three studies was kept on the school's servers. However, due to the cyberattack, researchers' access to the department building, work computers, and all the data was suspended for over two months. This effectively halted the analysis of Study 3 data and the writing-up of the results from previous studies.

Thus, COVID-19 and the cyberattack hampered the research and significantly slowed the progress of this PhD. Nevertheless, the researcher ensured that these incidents did not affect the quality of the work and hopes that the thesis meets your high standards.

Mayank Loonker, October 2022

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Chapter 1

Introduction

Every year, millions of people visit heritage sites worldwide as tourists. At these sites, visitors engage in various activities and use various aids for heritage interpretation (learn about and appreciate the heritage) and connect with the past. One such popular activity for heritage interpretation at outdoor heritage sites, such as natural heritage sites or historic urban precincts, is heritage walks or trails. During these on-foot explorations, visitors often use digital interactive mobile guides to support their heritage interpretation and navigation at the site.

The characteristics of such mobile guides, i.e. their form, the display type they support, mode of interactions, etc. can significantly influence how visitors explore and experience sites and their heritage. This research primarily aims to investigate the effects of different characteristics of mobile guides on visitors' interpretation process, engagement with the site and the resultant heritage experience during heritage walks in historic urban precincts. By examining the different characteristics of mobile guides during heritage walks in historic urban precincts, the study seeks to address the growing need for innovative solutions that can lead to embodied and social heritage interpretation [72] and enhance visitors' heritage experiences.

The purpose of this chapter is to provide an overview of the context in which this research is situated, outline the main objectives and goals of the study, and discuss its importance and potential impact. By establishing a clear foundation,

this chapter sets the stage for a detailed exploration of the role of mobile technology in enhancing heritage experiences during heritage walks in historic urban precincts.

1.1 Heritage site

Heritage encompasses the cultural, historical, and natural assets inherited from previous generations, that form a crucial link between past and present and help in shaping the future [128, 220, 224]. The significance of heritage lies in its symbolic value and educational value, its role in shaping collective and individual identities [145], and its contribution to cultural continuity and diversity [55] and tourism [219].

For management purposes, heritage has been broadly categorised as cultural or Natural. Cultural heritage can be tangible like monuments, buildings, objects and art or intangible like traditions, languages, and knowledge [89, 227, 228].

Heritage sites are tangible cultural heritage that typically consists of landmarks or landscapes of exceptional cultural, historical, and natural value to a local community, a country or the whole of humanity. These sites are protected and preserved for future generations. Many of these heritage sites are open for public visitation, serving as essential resources for understanding and appreciating heritage and tourism [219].

Below is a non-exhaustive list of categories that illustrate the diversity of sites that might be considered heritage sites [89]:

1. Cultural Heritage Sites: archaeological sites, ruins, historic buildings, etc.
2. Historic urban precincts: urban landscapes, their old or cultural parts as well as ruined cities
3. Cultural landscapes: parks, gardens and other man-made landscapes
4. Sacred or religious sites

5. Tragic or Dark sites: Battlefields, concentration camps, etc.
6. Industrial heritage sites: factories, mining sites, etc.
7. Living heritage sites: Locations where traditional skills and practices continue to be preserved and transmitted across generations.
8. Natural Heritage Sites: natural landscapes and landforms, oceans and water bodies

1.1.1 Historic urban precincts

While there are various kinds of heritage sites, this research is centred on **historic urban precincts**, which are also known in the literature as 'historic precincts', 'heritage precincts', or 'tourist precincts'[84]. Historic urban precincts are typically well-maintained historic districts within larger modern cities, where numerous buildings and customs of heritage value are located in close proximity[14]. These precincts are primarily recognized as heritage sites due to their physical characteristics (built heritage), which reflect specific histories, cultures, or activities, serving as major attractions for visitors and contributing to their distinctive identity [84].

It's crucial to understand that historic urban precincts are more than just a collection of aesthetically pleasing buildings showcased as points of interest (POI) to visitors. The cultural and historical narratives are interwoven throughout the entire site. These precincts are rich in multi-sensory information, encompassing sounds, smells, visuals, and social activities [14, 44, 104, 146, 163]. Given their complexity, dynamism, lived-in and immersive nature as cultural and informational ecologies, focusing solely on experiencing curated POIs (aesthetic, cultural or historical aspects) can be restrictive. The ability to soak the atmosphere and observe the little things that make up its character is important [96]. Thus, visitors' heritage experiences in such spaces are influenced by a variety of factors.

Exploring these sites amidst the bustling streets [14] can be challenging for visitors, however, heritage walks have become a popular method for exploring such

areas. These walks enable visitors to engage with the physical, sensory, and social aspects (including interactions with locals) of not just the POIs but the whole site, fostering a connection with the place and providing a rich, enjoyable, and memorable experience [14, 104, 146].

1.2 Heritage experience

While visitor motivations can vary significantly, research has suggested that tourists' primary motivations for visiting heritage sites such as historic urban precincts are social-psychological factors such as **escape** from a perceived mundane environment; relaxation; and improved familial bonding; followed by Cultural motivations such as **education** and novelty [1, 28, 49, 164]. To meet tourist expectations during their visits to heritage sites, enhance their relationships with sites, and improve their performance, cultural and heritage organisations have been paying more attention to the experience perspective in recent years [28].

There is no single definition of heritage experiences as visitors' backgrounds and the nature of the site can lead to multiple responses to a heritage site. However, as shown in Fig 1.1, in the context of outdoor cultural heritage sites such as historic urban precincts, researchers suggest that **heritage experiences** are the **meaningful personal connection that visitors forge with the site and its past** [15, 218] in the lived moment (*Erlebnis*) and through subjective reflection and meaning-making (*Erfahrung*) [94, 123] by evaluating the **rich, active, and multifaceted engagements with the site** [11, 42, 102, 120, 123, 178, 183].

Research at cultural heritage sites such as historic urban precincts of which the built architecture and place are key components, has helped identify various aspects of a heritage site that visitors can interact with and which play a critical role in shaping visitors' heritage experiences. As shown in Fig 1.1, these aspects are related to the site's (a) Originality and uniqueness of place and activity [188, 235]; (b) Aesthetic of the built environment (beauty and state) [40, 206]; (c) Pleasure

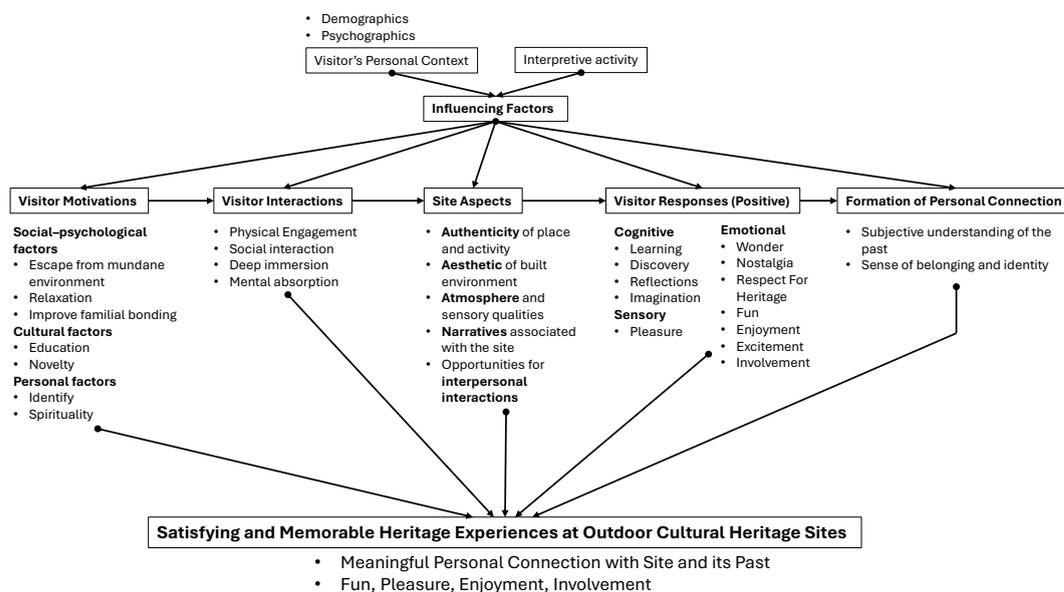


FIGURE 1.1: As shown in the model, visitor motivations, visitor multifaceted interactions with the different aspects of heritage sites and visitor responses lead to personal Connections between visitors and the site. All these factors collectively help create satisfying and memorable heritage experiences for visitors at outdoor cultural heritage sites. However, visitors' backgrounds and the design of the interpretation activity significantly influence the shaping of the heritage experience.

arising from atmosphere and sensor qualities [44, 154, 206]; (d) Learning emerging from the narratives associated with it [41]; e) Interpersonal interactions with companions that occur there [28, 68, 120, 170, 177]. Thus, heritage sites and their experiences are multifaceted.

Visitors' active physical and social interaction with these aspects, deep immersion and mental absorption in the outdoor space of the site trigger their cognitive (reflections and imagination), sensory and emotional responses like wonder, nostalgia, pleasure and respect for heritage in visitors (refer Fig 1.1) [123, 124, 131, 183]. Through these reflections; social interactions; and sensory and emotional connections, visitors form their subjective understanding of the past; and personal connection with the site [11, 38, 88], which foster a sense of belonging and identity [218] and creates satisfying and memorable heritage experiences [28] (refer Fig 1.1). Thus, to create satisfying and memorable heritage experiences, it is crucial to support visitors' interaction, immersion and absorption of various aspects

of the outdoor heritage sites. Such engagements should consist of a combination of cognitive, physical, social, and emotional interactions with the various aspects of the site [44, 176, 178, 183].

In addition to the experience at the heritage site, overall tourist experiences of visiting a heritage destination are also influenced by tour management and planning, site accessibility, quality of accommodation, the host's attitude and hospitality, and the quality of infrastructure and hygiene. However, the focus of this study is primarily concerned with the visitor's heritage experience at the site.

As pointed out in Fig 1.1, visitors' personal context - their demographic and psychographic profiles of visitors such as their age, race, gender, cultural context, social context, educational background, political views and religious beliefs also influence visitor's motivation to visit a heritage site, their perception of the site, the value that they attribute to the site, their interaction with it and their overall experiences at the site [68, 101, 125, 186]. Visitors' interests and motivation can range from being learning-focused to entertainment-focused. To address this, researchers have suggested implementing more variety of programs that visitors choose from to suit their needs [179].

The design of interpretation activity with heritage sites also significantly affects the visitors' heritage experience (refer Fig 1.1). For example, exploring a site independently allows for personal discovery and reflection, while a guided tour can provide a deeper learning experience. Mobile digital interpretations supported by mobile guides, such as digital storytelling or location-based treasure hunt games can also offer emotionally engaging and playful ways to connect with the site. However, this research does not intend to focus on the design of interpretive activity.

The core focus of this research is to explore ways to design mobile devices (medium of interpretation) that can support support visitors' embodied heritage interpretation practices [72] which involve rich and multifaceted/multimodal engagement with the physical, cultural and social aspects of the site and enhance the heritage experience in historic urban precincts. Thus, this research focuses on evaluating visitors' bodily engagement and emergent experience at the heritage site while using

mobile guides - the interplay that unfolds between the heritage site, the visitors, their companions, and the device (mobile guides). Understanding this interplay is crucial for drawing out insights that can inform the design of mobile guide devices that support visitor's embodied interpretation, improve immersion and interaction at heritage sites, and enhance their overall heritage experience [76].

1.3 Heritage visits, interpretation and walks

Visitors typically visit heritage sites as tourists, engaging in what is known as heritage tourism — the act of travelling with the motivation to experience cultural, historical, or natural places, artefacts, and activities that reflect the stories and people of the past [54, 113, 204]. While visiting heritage sites, tourists are motivated by diverse reasons, including recreation, relaxation, education, personal and spiritual enrichment, family bonding and more. Regardless of their specific objectives, visitors participate in various activities to enhance their experience at the heritage site. These activities may include:

- Exploring the site independently or with companions
- Taking photographs of interesting elements or with companions at the site
- Walking on predefined trails using maps and signs
- Taking audio-guided or professionally guided walks through the site
- Engaging in site-specific activities, such as praying at religious sites (if permitted)
- Participating in treasure hunts or other hands-on activities.
- Attending talks, exhibitions, or interpretation centres at the site

Through self-initiated activities, visitors explore the site, gather information about its history and significance using sources such as signs, brochures, interactive displays, and digital guides, and engage in discussions to appreciate it further and create lasting memories.

Others may participate in organised interpretation activities like visiting on-site exhibitions, guided walks, hands-on activities, and treasure hunts. These activities engage visitors with the site, provide information related to on-site resources in a manner that resonates with visitors and direct their attention to significant elements, enhancing their understanding and enjoyment of the site. These information materials and activities like guided tours at heritage sites are designed and facilitated by heritage professionals for heritage interpretation [216] with the aim of:

- Enhancing visitors' understanding of the site's history and significance
- Offering new perspectives on the site
- Developing sensitivity and appreciation for the site
- Encouraging positive attitudes and behaviours toward the site
- Fostering meaningful personal connections with the heritage

More recently, motivated by phenomenological perspective to knowledge creation as led to researchers to discuss embodied heritage interpretation practices which involve using the human body and sensory experiences as tools for understanding and interpreting cultural heritage sites and artifacts [44, 72, 179]. This approach recognises and emphasizes that cultural knowledge emerges from movement and bodily engagement with heritage spaces, rather than just visual observation or textual reading. It uses techniques like walking through landscapes and physically exploring monuments to gain embodied knowledge of past cultures viewing landscape and architectural spaces as places for active bodily exploration rather than just passive viewing. This approach aims to create more immersive, multisensory, and experiential ways of interpreting cultural heritage.

1.3.1 Heritage walks

In this research we focus on Heritage walks, one such heritage interpretation activity that is attractive to visitors and provides rich, multifaceted embodied engagement, ensuring visitors have a meaningful and engaging experience [47].

Heritage walks or trails involve on-foot exploration of a heritage site along specified historically evolved paths or newly purposefully created routes which allow viewing of key heritage elements, such as natural features or built structures of the site as bundle [210, 215]. Walking along these routes is not only recreational but also allows visitors to explore, discover, and appreciate significant heritage elements or scenic vistas of an area in a structured manner [215, 221].

These walks or trails can be guided by professionals who offer detailed information or independently done using maps and signs. Heritage walks [215]. They can be in various forms, including brief city-centre walks and extended hikes, each differing in length, location, and purpose [32]. They can be designed to cater to diverse visitor preferences and abilities through flexible duration and route options, ensuring that a broad audience with varying interests and mobility levels can fully enjoy the experience.

Heritage walks are a particularly well-suited mode of engagement and interpretation for heritage sites which have a high concentration of points of interest spread in an area that collectively tell the story of the area's past. Thus, heritage walks have become a popular interpretation activity for exploring historic urban precincts [215].

When visitors walk through the streets of historic urban precincts to explore the site, the site metaphorically transforms into an 'open-air museum' [193]. While walking, visitors get the opportunity to explore thoroughly, observe features up close, and appreciate intricate details, gaining a deeper understanding of the historical and cultural context [14]. The physical act of walking allows visitors to have a sensory first experience of the sites [104]. While walking they can touch the walls, feel the ground, and absorb the sights, sounds and smells of the site which can

evoke feelings, enhance the heritage experience and also improve retention of the events [14, 104, 146]. Visitors also have the opportunity for social interaction with the local community during heritage walks, adding a valuable social dimension to the experience [14]. Additionally, while walking the site's resources to be used for fun and adventure with companions, making the experience more enjoyable. Thus, heritage walks promote cognitive, social, emotional and multi-sensory engagement with the site and allow visitors to create personal interpretations, and intimate connections with the place [221] and its past, providing memorable and meaningful heritage experiences [163].

Through heritage walks, curators aim to highlight various aspects of a site, such as its natural resources, historical events, cultural practices, notable figures, and architectural styles [215]. To connect different sites and stories within the area, heritage walks are often curated around a theme that follows a narrative thread [215]. Earlier heritage walks were only focused on history and built heritage, but newer walks have also explored new themes including literary trails, culinary routes, craft paths, festive walks, night walks and more [26, 195, 221]. Many cities worldwide offer thematic heritage walks. For instance, In the UK, London features walks like the Beatles tour and the Harry Potter walk, while Canterbury offers history-focused and ghost walks. In India, cities such as Delhi, Mumbai, Ahmedabad, and Bangalore provide historic and architectural heritage walks. Food or festival-focused walks, like the Street Food Walk in Mumbai or the *Pandal* Walk in Kolkata during *Durga* Puja, are also offered.

Beyond visitors, heritage walks also offer several advantages to other stakeholders. Through these walks, Both visitors and locals appreciate and value these sites fostering a sense of pride among residents and encouraging them to engage in preservation and conservation efforts [215]. They act as marketable tourism products benefitting the urban authorities and local communities [195]. By attracting new visitors, heritage walks create business opportunities for local traders and artisans and generate employment for residents [195, 215].

Overall, Heritage Walk is a versatile and effective heritage interpretation activity. They offer visitors a multisensory and meaningful way to explore and engage with the heritage of a place while providing a balance between learning and enjoyment, making heritage accessible to a diverse audience.

Since the majority of visitors have no background knowledge of the sites and are likely to spend only a limited time at the site, it is difficult for them to interpret the site and its cultural significance without a guide. However, participating in guided heritage walks poses some challenges. Visitors are often compelled to follow the pace of the tour guide, which restricts their ability to explore at their own pace. Additionally, hearing the narration provided by the tour guide can be difficult to hear in noisy environments.

Traditionally visitors have relied on professional guides but more and more people have started to explore the use of mobile guides as they offer more flexibility. These mobile guides facilitate navigation, provide on-site information, and allow visitors the flexibility to explore at their own pace. Thus, to enhance the interpretation and engagement during heritage walks researchers have been exploring ways to integrate appropriate digital technologies, such as interactive mobile guides that support features like digital storytelling and augmented reality.

1.4 Mobile technology for heritage experience

Handheld location-aware mobile guides (hereafter called **mobile guides**) are popularly used by visitors to enhance their experience during walking-based explorations of outdoor cultural heritage sites [81, 222]. These mobile guides are handheld devices that utilize the internet, interactive content, digital displays, and GPS technology to assist visitors in navigating the site and provide them with location-specific information, enhancing their overall experience.

The design and implementation of mobile guides have been of interest to the research community since the early 2000s [39, 231]. However, smartphones have

become the preferred device for implementing mobile guides since their launch. This is due to several reasons, including a) ease of use on the go; b) support of multimedia, location-aware media and screen-based augmented reality (AR) content; c) wide availability of tools that support easy development of new software; and d) easy and low-cost deployment for cultural organisations, since users can ‘bring their own device.’

Since smartphones act as a comprehensive platform (with a variety of sensors including GPS, touch screen display, and operating system), the majority of design and research efforts in the field of mobile guides for cultural heritage have focused on leveraging the technical features of smartphones to implement location-aware and AR applications [22, 61, 78, 209]. The primary objective has been the development of applications that support navigation and convey the historical and cultural significance of the site to the user through location-aware information. To enhance cognitive and emotional engagement researchers have used several approaches such as storytelling, pervasive gaming or personalisation of information [12, 63, 143, 166]. However, the design approach of these mobile-guide applications has been largely focused on supporting only cognitive and emotional dimensions of engagement, which emphasises delivering relevant information about the site in interesting formats to shape peoples’ heritage experiences. Design for supporting the physical, sensory and social forms of engagement has been largely overlooked.

1.5 Motivation and purpose of the study

Although providing information about a site’s history and notable features is essential for helping visitors identify important aspects and comprehend the site’s significance, numerous scholars argue that this alone is insufficient for visitors to have a fulfilling heritage experience [44, 154, 178]. Moreover, they have suggested that visitors actively generate their own interpretations of heritage at sites and

museums. Researchers at the intersection of museums, heritage and technology advocate encouraging and facilitating their multifaceted engagement during heritage interpretation activities to empower visitors to develop these personal interpretations, meanings and connections [44, 59, 178]. Thus, researchers argue that for rich heritage experiences, designers of heritage experience should not overemphasise the focus on education [179], but also explore ways to support embodied and social engagement, i.e. bodily and sensory interaction with surroundings and interaction with people as they can stimulate different kinds of cognitive and emotions responses.

This has motivated several researchers in the field of human-computer interaction (HCI) focused on designing interactive technology to enhance heritage experiences to explore diverse approaches in developing systems that facilitate different types of engagement at the site, such as supporting: a) interaction with material and physical aspects of heritage [178]; b) embodied engagement and place experience [44]; c) multisensory and aesthetic experience [19, 154]; d) active participation, and social interaction [123]; and e) playfulness [110, 194]. It is important to note that their focus has moved beyond the design of applications that deliver site-specific information in an interesting format. They have explored ways to design new interactions with newer aspects of the site. Nevertheless, the outcomes of such explorations have mainly been in the form of static interactive installations or location-specific tangible interactions [44, 154] limiting their impact on the visitors' engagement across the whole spread of the site. However, in the case of historic urban precincts, it might be valuable to have mobile guides or devices which could support new forms of interactions and multifaceted engagements across the site. It would allow visitors to leverage the opportunities for such engagements and interactions throughout and anywhere in the historic urban precincts. Nonetheless, there is limited research undertaken to explore the design of mobile devices or guides, that could support such multifaceted engagement during heritage interpretation activities, especially heritage walks in historic urban precincts.

Therefore research and exploration are required for the design and development of mobile guides aimed at supporting visitors' embodied, sensory and social engagement during heritage walks in outdoor cultural heritage sites, particularly in historic urban precincts. By doing so, we can enhance visitors' cognitive and emotional responses to the site, foster a sense of personal connection with our shared heritage and help create a more memorable heritage experience.

The second motivation for this study is concerned with the hindrance that smartphones tend to create in the context of heritage walks and in supporting diverse types of engagements at heritage sites. As discussed in the previous section, smartphones can provide interesting opportunities for interaction and participation during cultural heritage walks [100, 175]. However, their form factor and way of being used predominantly leads to a heads-down interaction, which limits the users' attention and engagement with their physical surroundings. By drawing the visitors' attention away from the physical space onto a framed window (screen of the device), smartphones lower spatial awareness and increase social isolation [112, 172] which can adversely affect the richness and diversity of types of engagements that visitors can have at the heritage site and ultimately their heritage experience. To eliminate the distraction caused by the use of smartphones during outdoor heritage tours, prior works have explored several approaches such as revealing content directly in the physical space of the heritage sites through different types of digital augmentation and/or by employing interaction techniques which do not require heads-down interaction [23, 96, 99, 119, 211]. However, these methods of information display and interactions lack the ability to support visitors' multi-sensory, bodily and social engagement with the site and the people around them.

To fully leverage visitors' physical presence at heritage sites and facilitate the emergence of subjective heritage experience experiences, it is essential to support not only distraction-free exploration but also to encourage and cultivate rich and diverse types of engagement. Thus, a broader approach to the design of mobile guides for on-foot exploration of historic urban precincts is required that goes beyond problem-solving (eliminating distraction) and explores ways to encourage and support new behaviours (situated engagement).

1.6 Aims and scope of research

Heritage walks are ideal for exploring and interpreting historic urban precincts as they facilitate diverse ways (cognitive, social, embodied and sensorial) of engaging with the immersive, multi-sensory and lived-in heritage sites. Such diverse ways of engagement with heritage sites lead to subjective interpretations of cultural past and fulfilling and memorable heritage experiences. When thoughtfully designed, mobile guides have the potential to enhance visitors' heritage experience by providing new avenues for engagement with the site, fundamentally altering the nature of visitors' engagement with heritage sites while walking.

Therefore, the primary aim of this study is to inform the design and development of innovative mobile guides that can enable embodied interpretation practices and enhance heritage experiences in outdoor cultural heritage sites during heritage walks. Thus, this research focuses on investigating the effects of mobile devices with different characteristics on visitor engagement during a heritage walk in historic urban precincts.

Handheld mobile technology, when used during walking, can become an extension of the body, similar to how a blind person's stick extends their tactile sensation, influencing their perception and interaction with the environment [64]. This embodied relationship between technology and the user shapes actions and cognition, including social practices [108, 112]. Based on these observations, this research hypothesises that mobile technology with different characteristics can have varying impacts on how people dwell and interact with their surroundings and, thus their heritage experience. Thus, by examining mobile devices with different characteristics, this study aims to uncover how different devices shape the relationship between people, technology, and surroundings during heritage walks in historic urban precincts.

The first mobile device that this research aims to study is smartphones. While researchers have studied the impact of smartphones on user's spatial awareness,

attention to the screen, and social outlook while walking these studies were conducted in the context of navigational walks [105, 141, 162]. The intentions of the person differ during a navigational walk and heritage walk. During navigation, a walker aims to efficiently reach the end destination, whereas, in a heritage walk, the intention of the walker is to observe, explore, engage and appreciate a place [14]. During a heritage walk in an outdoor heritage site, the walker seeks awareness, engagement, attunement, pleasure, discovery etc. [64, 242]. As heritage walking is different from navigational walking, it is important to conduct a separate study to understand the impact of a smartphone on users' way of being and walking during a heritage walk. Although some studies have examined the impact of mobile devices on visitors' behaviour and engagement in a museum [133, 134] such a study has not been conducted during a heritage walk in an outdoor heritage site such as a historic urban precinct. Thus, this study examines the effects of using a smartphone-based mobile guide during a heritage walk.

In addition to studying the effects of popularly used smartphones, this research seeks to study the effects of mobile devices with a display modality that offers contrasting characteristics to smartphones' small and private screens. This includes technology that enables shared viewing of content, as well as blending of digital content with the physical environment.

Presently, various devices offer display modalities with characteristics distinct from the small and private screens of smartphones. Wearable devices such as augmented reality (AR) glasses or smart glasses enable users to view the information as an overlay on the physical surroundings while walking. However, these devices do not support shared viewing of information, which limits their capacity to support social engagement with companions. Public display screens allow both in-situ and shared views of information. However, installing them in outdoor heritage sites such as historic urban precincts can be challenging due to the laws for the protection and conservation of heritage sites and concerns about vandalism and weather conditions.

Alternatively, mobile projectors, such as handheld Pico projectors, offer a portable, large, shareable, and blended display. They can enhance shared social encounters [20, 134], enable situated learning [196], and support affective experiences [123] while mitigating the distraction of users from their surroundings. Despite these advantages, there has been limited research on how mobile projector-based guides affect user behaviour and experiences during heritage walks in historic urban precincts. Although mobile projectors have limitations, such as daytime use, they present contrasting characteristics to smartphone screens. Therefore, this study investigates the use of a mobile projector-based guide as an alternative mobile device.

1.7 Research Questions

In this research, we investigate and compare the potential of mobile projector-based guides and smartphone-based guides in enhancing engagement and meaning-making during heritage walks in historic urban precincts. The primary aim is to provide an understanding of how mobile guides influence heritage experiences of historic urban precincts, thereby informing theoretical and design research. Specifically, this study addresses the following questions:

1. How do users engage with the physical environment using their mobile guides in historic urban precincts during heritage walks?
2. What kind of inter-relationships emerge between user, mobile guide and heritage site during an heritage walk in outdoor cultural heritage site?
3. How do the use of mobile guides in historic urban precincts during heritage walks effect the social experience of the users?
4. What feelings, attitudes and concerns do mobile devices with different display modalities evoke during heritage walks in historic urban precincts?

5. How can we design mobile guides that motivate and support embodied interpretation heritage practices in outdoor cultural heritage sites during heritage walks?

1.8 Research approach and methods

As discussed in the previous section historic urban precincts are a unique type of cultural heritage site that are not merely static monuments but dynamic lived-in spaces that are filled with multi-sensory information and the hustle-bustle of daily life. The multifaceted nature of these precincts can profoundly shape visitors' attitudes, behaviours, and interactions with the site.

Heritage walks are situated and social activities. Thus, to effectively investigate and comprehend users' utilisation of smartphone-based or mobile projector-based guides during heritage walks in these precincts, it was imperative to situate the study within an appropriate field setting. This approach ensures that the research is conducted within a relevant context, allowing for more accurate and nuanced observations.

Moreover, the intention and sense of purpose of visitors play a crucial role in influencing their behaviour. Recognizing this, the study was designed and executed as a heritage walk within a historic urban precinct - the historic high street of Canterbury, a medieval city in the UK. This methodology allows for a more authentic examination of user interactions with digital guides in situ, capturing the complexities of the visitor experience in these unique environments.

To address the research questions, three studies were conducted, involving a total of 66 participants. The initial two studies focused on examining the impact of smartphone-based guides and mobile projector-based guides, respectively, on individual behaviour, attitudes, and cognitive processes. The third study investigated the influence of both devices on group dynamics and social interactions during visits.

These studies aimed to observe and analyse how users explored and engaged with their environment, utilised the devices, interacted with companions or passersby, as well as their thoughts and emotions. To collect comprehensive data on these diverse aspects, a multi-method approach was employed. This included surveys, in-depth interviews, observations, and participant-generated drawings and experience maps. The utilization of multiple data collection methods facilitated the capture of rich, multifaceted information and enabled triangulation of observations, thereby enhancing the reliability of the findings.

1.9 Contribution and significance of Work

The specific aim of this study is to inform the design and development of novel mobile devices that enable visitors to engage in diverse ways during heritage walks in complex, multi-sensory, lived-in, and dynamic cultural heritage sites. The research investigates the effects of two types of mobile devices with distinct display modalities on visitors' engagement in a historic urban precinct. Key contributions of this research include:

1. A comprehensive literature review synthesising research on heritage, heritage tourism, heritage interpretation, and technology design for heritage experiences. This review emphasises the importance of designing technologies that support not only cognitive engagement but also multi-sensory, embodied, and social interactions with heritage sites. These multifaceted engagements are shown to trigger reflections and emotions that potentially lead to deeper, more personal connections with heritage.
2. A proposed approach to facilitate rich interactions in large outdoor heritage sites, specifically historic urban precincts. This approach suggests designing mobile devices and interactions to support heritage interpretation and exploration through the lens of **playful walking**.

3. Empirical observations on the specific affordances of smartphone and mobile projector-based location-aware guides during a heritage walk in the High Street of Canterbury, UK. These observations provide insights into how different display modalities may influence users' behaviour, meaning-making processes, and overall experiences during heritage walks in historic urban precincts.
4. Actionable design considerations for mobile devices used in heritage walks, derived from a synthesis of literature and empirical findings. These considerations focus on engaging users' creativity and imagination and supporting interactions that are open-ended, voluntary, embodied, social and playful.
5. Four design directions, accompanied by example designs, to illustrate the practical application of the proposed design considerations for mobile devices supporting playful heritage walks.

This study shows that mobile projector-based guides can benefit visitors exploring cultural heritage sites on foot as they could lead to richer and multifaceted heritage experiences. Implementing such novel mobile devices could provide heritage professionals with new ways to support unique experiences and potentially attract visitors seeking unique ways of experiencing urban heritage precincts, especially after sunset.

This proposed design approach, and considerations open possibilities for exploring new designs of mobile devices and interactions that could facilitate diverse ways of engaging with outdoor cultural heritage sites during walks.

As these studies and findings are primarily situated in the context of historic urban precincts, the proposed design approach for mobile devices may apply to other historic urban precincts. However as each historic urban precinct is unique, further research would be necessary to confirm the efficacy of the proposed design approaches in these new contexts.

The findings and reflections based on this research were published in:

Peer-reviewed conferences: Mayank Loonker, Sophia Ppali, Rocio von Jungefeld, Christos Efstratiou, and Alexandra Covaci. 2022. “I was Holding a Magic Box”: Investigating the Effects of Private and Projected Displays in Outdoor Heritage Walks. In ACM SIGCHI Conference on Designing Interactive Systems, pp. 1565-1580. doi: 10.1145/3532106.3533468. (DIS '22). Association for Computing Machinery, New York, NY, USA.

Publication is under review: Mayank Loonker, Sophia Ppali, Rocio von Jungefeld, and Christos Efstratiou. 2023. Let’s go for *playful walking*: An integrated approach for designing mobile technologies for experiential outdoor heritage visits. In ACM CHI Conference on Human Factors in Computing Systems (CHI’ 23).

Editorial-reviewed workshop paper: Mayank Loonker, Rocio von Jungefeld, and Christos Efstratiou. 2022. Exploring the Potential of Mobile Projectors as a Body-Instrument for Performance. In. Performances’22 : A Workshop on Designing the Performances of the Future at IMX 2022. ACM International Conference on Interactive Media Experiences (IMX 2022), pp. 171-177. doi: 10.6084/m9.figshare.20069519.v1.

1.10 Structure of the Thesis

The thesis is structured into eight chapters, progressing from theoretical foundations through empirical studies to design implications and conclusions. The first two chapters establish the context and methodology, followed by three chapters presenting empirical studies. The penultimate chapter synthesizes findings into design principles, while the final chapter discusses broader implications and future directions. This structure allows for a comprehensive exploration of the research questions, moving from theory to practice and back to theory in a reflective cycle.

The chapters are organized as follows:

Chapter 2 provides a comprehensive literature review, examining the intersection of heritage interpretation, embodied cognition, and mobile technologies. It establishes the theoretical foundation for the subsequent empirical studies. The chapter explores key concepts in heritage interpretation and more recent experiential approaches. It delves into theories of embodied cognition and their application to heritage contexts, discussing how physical engagement shapes understanding and experience. The review also critically examines the evolution of mobile guide technologies in cultural heritage settings, identifying gaps in current research and practice that this thesis aims to address.

Chapter 3 outlines the research methodology, detailing the multi-methods approach employed across three empirical studies and a speculative design phase. It justifies the selection of participant observation, semi-structured interviews, and creative methods such as participant drawings. The chapter discusses the rationale behind combining qualitative methods to provide a holistic understanding of user experiences. It also addresses methodological limitations, such as the specificity of conducting the study within a single urban heritage precinct, and describes strategies employed to mitigate these limitations, ensuring the robustness and credibility of the findings.

Chapter 4 presents the first empirical study, focusing on how smartphone mobile guides influence users' embodied and spatial engagement during heritage walks. The findings reveal challenges in maintaining meaningful connections with the physical environment when using screen-based guides. This chapter explores how smartphones often create a 'bubble' effect, isolating users from their surroundings and hindering the sensory and spatial connections that are crucial for embodied heritage interpretation. It discusses the implications of these findings for the design of future mobile guides, suggesting ways to balance digital content delivery with physical site engagement.

Chapter 5 explores the potential of mobile projector guides to enhance embodied heritage interpretation. This study demonstrates how projection-based interfaces can foster more exploratory and playful engagement with heritage sites. The

chapter examines how the outward-facing nature of projections encourages users to adopt slower, more deliberate walking patterns and engage in exploratory walking. It discusses how projector guides support embodied meaning-making by allowing users to directly overlay historical images onto current structures, transforming static heritage sites into dynamic spaces for interaction.

Chapter 6 investigates the social dimensions of heritage experiences, comparing how smartphone and projector guides affect group dynamics and collective meaning-making during heritage walks. This chapter reveals significant differences in how these technologies shape group cohesion, collaborative exploration, and shared interpretation practices. It examines how projector guides foster group cohesion by creating a collective visual reference, while smartphone guides often lead to reduced environmental awareness and social interaction. The chapter also explores the potential of mobile guides to facilitate incidental sharing with bystanders, contributing to the discovery of polyvocal and personally meaningful narratives.

Chapter 7 synthesizes the empirical findings into a set of design principles and considerations for future mobile guides. It introduces the concept of 'playful walking' as an approach to designing for embodied heritage experiences and presents speculative design concepts that exemplify these principles. The chapter proposes novel design considerations such as 'extending the reach of the visitor' and 'bringing surroundings into play'. It offers four innovative design directions, each illustrated with a conceptual design idea: Touchy connectors, Curious explorers, Wonder eyes, and Creators of chance encounters. These concepts demonstrate how the proposed design approach can be translated into tangible technological solutions that enhance embodied and social engagement with heritage sites.

Chapter 8 concludes the thesis by discussing the broader implications of the research for the fields of HCI and heritage studies, acknowledging limitations and suggesting directions for future research. It reflects on the potential of mobile projector guides to foster more exploratory, playful, and socially engaged heritage walks, while also recognizing that technology alone cannot guarantee an enriched

heritage experience. The chapter emphasizes the need for careful design that balances information delivery with experiential engagement. It also discusses the limitations of the study, such as its focus on a single urban location, and suggests avenues for future research to explore these concepts in diverse settings and with varied user groups.

Chapter 2

Key facets, practices and mobile technologies for experiential outdoor heritage interpretation

As discussed in the previous chapter, memorable heritage experience emerges from the multifaceted engagement of visitors with the site. The literature in heritage studies, museum studies, and related HCI work has explored a variety of facets for designing and analysing heritage interpretation practices, technology, and experiences. To provide conceptual and contextual ground for the work in this thesis, this chapter identifies and discusses key facets and practices that have informed the design and analysis of experiential heritage interpretation and interactive technology in the cultural heritage sector: embodied, social interactions, space-place, aesthetics, performance, walking, and play. These conceptual facets have been identified through a literature review across heritage studies, museum studies, tourism and HCI. This discussion on these key facets of experiential heritage interpretation practices is accompanied by a review of previous work that traces the evolution of the design and evaluation of mobile guides.

Overall, this chapter highlights the need to research and design mobile guides that support experiential heritage interpretation practices. These discussions help

identify the types of interactions considered desirable for supporting rich interpretations and heritage experiences. Common aspects identified through the analysis of different concepts would be crucial when designing or analysing encounters between visitors, mobile guides, and outdoor cultural heritage sites mobile guide-aided heritage interpretation practices - encounters between visitors, mobile guides, and outdoor cultural heritage sites, such as historic urban precincts.

This chapter aims to address the following objectives:

1. Investigate the importance of experiential heritage interpretation practices and explore facets that inform the design of experiential interpretation practices at outdoor cultural heritage sites.
2. Trace the design strategies objective for designing mobile guide-based interpretation at outdoor cultural heritage sites.

2.1 Heritage interpretation: From learning to experiential practice

Historically, and often still today, interpretation activities for outdoor cultural heritage sites primarily focus on educating the public by delivering *authorized heritage discourses* to increase awareness, knowledge, appreciation, and understanding of their history and culture. Researchers have found evidence to support that visitors seek learning when visiting heritage destinations and learning new knowledge leads to visitor satisfaction [67]. Under this approach, communication and activities are typically designed such that visitors are required to see specific objects or aspects of a site and mentally juxtapose them with the institutionally authored information [163, 206]. Under this education-oriented interpretative approach, the emphasis of designing interpretation activities is on curation, crafting information, guiding visitors' gaze at sites or artefacts, and presenting information that enables visitors to learn new things.

Over a period of time researchers found evidence suggesting that in addition to learning something new, people have various motivations and seek a variety of things from their visit to outdoor historic sites [29, 66, 219] such as :

- To enhance one's own life (personally and culturally)
- To escape from routine
- To see something unique and authentic
- To form a connection with past
- To have fun, recreation, and enjoyment
- To relax
- To spend time with friends and family
- To satisfy personal curiosity

Visitors' interest during their visit to an outdoor historic site can range from being passionate and active to casual and laid-back. Their visits are motivated by a desire to fulfil their own goals by leveraging one or more aspects of the heritage site, including its aesthetic, historical, cultural, or social aspects [66]. The learning-driven and one-size-fits-all approach fails to address visitors' varied interest levels, expectations and needs during a heritage visit. In learning-focused heritage interpretation activities, visitors are typically seen as having a single goal — learning. They are viewed as passive observers, with heritage sites or artefacts treated as objects to be viewed from a distance. This approach overlooks visitors' emotional engagement and multisensory involvement, as well as their ability to create personal, subjective meanings from tangible cultural heritage [160, 206].

On the other hand, the unique aspect of outdoor heritage sites like historic urban precincts or living museums is that they are naturally embedded with opportunities for visitors to engage in historic, cultural, social, and sensory explorations and discoveries [44, 163]. They can offer rich multi-sensory experiences arising from

hearing, seeing, smelling, and touching the material and social setting, enabling visitors to experience the atmosphere of the whole “sensory space” [44, 163]. These types of experiences are difficult to replicate within museum settings, where historical artefacts are removed from their original context and placed in organised, sterile, artificial environments to be seen but not touched. However, in learning-focused heritage interpretation activities, the emphasis is on the symbolic function and visual qualities of the heritage [88]. The creators of mobile guides who are influenced by this approach to heritage interpretations often fail to leverage the meaning-making potential of historic sites’ physical, material, and sensory qualities [206].

Realising that meaning-making in outdoor cultural heritage sites is an interactive process that engages visitors emotionally, socially and sensorily with the site [76, 160], recent work in tourism, museum and heritage studies has argued for an experience-oriented approach [44, 59, 178]. McIntosh [156] recommends that when designing visitor experiences for heritage sites, the focus should be on the experiential and interactive aspects rather than on factual learning. Staiff [206] suggests that in an age where information about heritage sites is readily available, the focus should shift towards the individual’s experience of *being there* in the moment, their sensorial or aesthetic experiences, and their affective response towards the heritage. Smith [205] contends that heritage only comes into being when the visitor experiences it. The following section focuses on the discussion of key facets that have informed the implementation of experiential heritage practices.

2.1.1 Embodied experience

The concept of embodied experience, which emerged within phenomenology, proposes that situated bodily action (e.g movement in space, gestures) and sensory perception (e.g seeing, hearing, touching, tasting, smelling) in the physical or social world are the fundamental basis for knowing, understanding, meaning-making and forming memory [157, 238].

Research acknowledges that embodied encounters with tangible heritage can shape individuals' *affective* and *cognitive* (thoughts and reflections) responses [131]. Actions such as touching the environment through the feet contribute to haptic and sensorial awareness of the site, and the emergence of lived experiences. Such actions can also evoke feelings of connection with the surroundings - a strong sense of *being there* [44, 59, 241].

Heritage interpretation practices that acknowledge the value of embodied experience, view the visitor's body as a dynamic entity — as a medium to perceive, sense and understand the heritage site. Bodily presence and actions in the outdoor historic site play a critical role in enabling visitors to make rich personal interpretations, develop an appreciation and assign subjective value or meaning to heritage, forming lasting memories [59, 163, 237]. Visitors' movement plays a crucial role by enabling them to see the site from different perspectives, enabling them to understand the relationship between various elements in their surroundings, giving a new dimension to the heritage experience [206]. While such engagements do not serve the goal of conveying historical facts, they enrich the experience with emotions and sensations, leading to long-term benefits in the form of enjoyment, reflection, and imagination [156]. Furthermore, according to Falk et al. [68], visitors enjoy looking, touching, smelling and listening more than reading information. Therefore, **supporting bodily and sensory engagement is essential for embodied experiences of heritage** [178].

From the perspective of this study, it is important to note that the material, physical, social and atmospheric aspects of the historic urban precincts provide the perfect opportunity to facilitate embodied experience as they can engage the body in action and multiple senses [44]

2.1.2 Social experience

Most people tend to visit heritage sites with friends and family or with tourist groups. Visitors perceive such visits as leisure activities and the historic sites as

places for social experiences [65, 202]. Such social experiences during heritage visits emerge from interpersonal interactions, togetherness and cohesiveness of the group [56].

Good social interaction has been found to enhance group and individual heritage experiences [67, 91, 137]. Group interaction can stimulate *affective and cognitive responses* such as nostalgia, wonder and appreciation, increasing visitors' involvement and understanding of the heritage sites [177]. It can also support visitors in sustaining attention by allowing for short intermittent breaks to talk amongst themselves and reflect before getting back to exploring the site. Additionally, observing the behaviour and what other visitors around them find interesting about the site helps individual visitors identify and determine their own ways of engaging with the site [136].

Social interaction among companions during the visit can improve family bonding and help community building [177] further adding to a positive experience. Social interactions with passersby (locals, other tourists, etc.) also play a significant factor in enhancing the overall experience of heritage tours [36]. Interactions with locals and group members can help visitors discover poly-vocal and personally relevant associations and narratives (pluralistic views of heritage) instead of institutionally *authored heritage discourses* [197, 198]. Such interactions can enable the discovery of the *spirit of place* [106].

Use of tangible heritage resources as *social objects*, (e.g. architectural elements or objects placed on site) have been found to trigger and support verbal and embodied communication as well as shared use among group members or strangers [203]. This, in turn, can play a vital role in sharing, reflecting and collective meaning-making [16, 136].

2.1.3 Space - Place experience

The term **space** has been used to refer to the objective, continuous, and concrete fabric of reality that contains the arrangement of physical and material structures

and objects [42, 138]. On the other hand, **place** has been used to refer to the meaningful subjective entity that emerges when space is layered with personal, social and cultural meaning through an individual's actions and adaptation [42, 138]. As individuals convert space into a place by using, adapting or appropriating a specific physical location, the place becomes bound to and intertwined with that location. This process of place-making allows users to appreciate and develop an attachment to their surroundings. Consequently, supporting space - place experiences in the context of outdoor heritage sites can enrich visitors' heritage experiences [44].

The space - place experience is based on five dimensions: 1) geometrical and geographical dimensions of space - physical features and arrangement of the space; 2) sensorial dimension - sensorial qualities of space; 3) social dimension - social opportunities offered by the place; 4) cultural dimension - cultural conventions of the place; and 5) personal dimension - individual thoughts, feelings and emotions evoked by the place [42, 52, 138, 223].

Researchers suggest that at outdoor cultural heritage sites, cultural and historical narratives are intertwined not only with the specific POIs, but with the whole material and social setting, and atmosphere of the space [163]. The physical remains of the past provide clues that trigger imagination and act as a window to how life used to be. They offer visitors continuous multi-sensory space where they can walk with all their senses simultaneously immersed [44, 163]. Moreover, outdoor cultural heritage sites such as historic urban precincts are lived-in social spaces, where the presence of other visitors or locals adds to the atmosphere. Watching people and interacting with them at heritage sites, enhances the visit (See section 2.1.2) and contributes to the space - place experience [52, 223]. In addition, they can evoke feelings or reflections about the place [131, 223] and a sense of connection [44], act as 'cultural symbols' with which individual or collective memories are associated, and elicit a plethora of emotions among visitors [10]. The built heritage or its ruins at a historic site have the potential to evoke curiosity, invite exploration, and offer opportunities for making personal discoveries; all of which can trigger visitor's imagination, lead to direct and lived experiences of the sites [24, 31, 53, 157, 223], and in turn, convert space into places. Tuan [223]

also characterises attachment to place as a function of time, i.e., a person would become more attached to a place the more time they spend there.

When designing heritage interpretation activities informed by the concept of space - place, past work suggests **seeing heritage sites not only as static physical locations meant to be passively viewed from afar but as settings for physical exploration, multisensory experiences, social interaction and self-expression** [9, 163].

Therefore, researchers suggest that to facilitate space - place experiences, the relationship between the site and visitor must be strengthened through embodied engagement (see section 2.1.1) and social interaction (see section 2.1.2) [44, 138, 163].

2.1.4 Aesthetic experiences

Another important experiential aspect at heritage sites is aesthetics [229]. As a branch of philosophy, aesthetics has been concerned with determining what makes something appreciable. In the context of heritage, aesthetic experience is the emergence of memory, imagination, thoughts, emotions (e.g. awe, joy, pleasure), and the feeling of *being there*, which emerge from connecting with the cultural heritage site through multi-sensory perception (e.g. visual, auditory, tactile), and physical encounters or corporeal interactions with the site [149, 163].

It is also worth noting that there is a strong resonance between the aspects that shape aesthetic experience and space - place experience such as: geometrical and geographical dimensions of space, sensorial dimensions, social dimension, and personal dimension (see Section 2.1.3). Kirillova and Wassler [126] identify three aspects that can enhance the attractiveness and shape the aesthetic experience at a heritage site.

- Physical features and visual aspects of the built environment or landscape as one of the aspects [126].

- Sensory qualities (smell, sound, taste, textures) and atmosphere (the weather) of the site [126]. Such multisensory perceptions of the environment can trigger cognitive and affective processes [189, 207] and lead to subjective and authentic aesthetic experiences.
- Visitors' awareness of the presence or absence of people, the diversity of the population, and interaction with locals.

Aesthetic experiences arising from these different facets of heritage sites can improve visitors' valuation of the heritage, increase their involvement with it, and create a lasting impression [19]. Supporting aesthetic experiences can be beneficial as it can help fulfill visitors' goals of witnessing something unique and precious, experiencing pleasure and enjoyment or escaping from routine (see Section 2.1).

Among all senses, the sense of motion (kinaesthesia and proprioception) plays a central role in aesthetic experience as it leads to the coupling of action and perception [207]. Therefore, physical movement-based heritage practices such as walking and gesturing could play an important role in generating this type of experience in outdoor locations since they provide an opportunity to enhance visitors' awareness and facilitate situated and multi-sensory heritage encounters with the site. Thus, to facilitate an aesthetic experience of outdoor heritage sites, researchers suggest supporting corporeal encounters (see Section 2.1.1) and social interaction (see Section 2.1.2) [126] at the site.

The following three sections will explore various practices identified by researchers to support experiential heritage interpretation.

2.1.5 Performative practices

The concept of performative practices as applied within museums and heritage is based on the phenomenological understanding of the body and world, informed by the concept of embodiment (discussed in Section 2.1.1) and Goffman's dramaturgical approach to sociology [82]. In the context of interpretative practices

at outdoor cultural heritage sites, performative practices comprise visitors' situated bodily actions that reflect their emotions, connect their imagination with the heritage site, and pave the way for generating meaningful experiences [11, 88].

During research in a museum and historic site, Bagnall [11] found that visitors' corporeal (or performed) encounters with heritage sites frequently took primacy over cognitive engagement. The emotional responses stimulated by the physicality of encounters with the heritage site led to authentic experiences, as people felt they were getting a good idea of the past. The same author also found that such performative readings of heritage sites lead to personal negotiation of the information presented at the site. Haldrup et al. [88] contend that heritage and its subjective meanings are always in the process of being created through the dynamic interplay between visitors' sensing and doing bodies, the socio-material aspect of site and visitors' creative appropriation of the site. Therefore, **the goal of heritage interpretation activities should be to tune in with visitors and open their minds to new experiences**, enabling them to register certain moods and 'feel' things by engaging with the objects, space, and the atmosphere of the place [88].

Performative practices are embodied, social and affective. Experiencing heritage is an active process in which visitors connect past and present through their performative practices which may be subtle or undetectable. Consequently, to encourage and support the performative interpretation of heritage, designers and scholars should discard the notion of heritage interpretation as education and visitors as passive agents [11].

Performative readings of heritage are based on an individual's personal history [88]. Therefore researchers highlight the importance of bringing personal memories into play to fuel visitors' imagination and emotions which can lead to performative actions [11]. Additionally, performative practices typically emerge during social interactions [88].

2.1.6 Walking practices

Walking is often perceived as mundane, biomechanical and repetitive body movement undertaken to traverse space and reach a target destination. However, walking can also lead to embodied experiences as it enables people to explore their surroundings by physically moving in the space and interacting with it - touching the ground with their feet, seeing the details, hearing the sounds, smelling the scents and feeling the atmosphere [48, 109]. Moreover, it can generate social experiences as visitors get the opportunity to notice, participate, and respond to each other's actions, coordinating their movements in the space [64]. It can also trigger feelings, thoughts, imagination, free flow of ideas, and creativity [64, 171], as well as facilitate sensory and affective immersion in the environment that leads to feelings of *being there* [64, 182]. Due to its ability to support embodied (see Section 2.1.1), social (see Section 2.1.2) and affective experiences, walking can play a significant role in shaping place-based and aesthetic experiences at outdoor cultural heritage sites. Therefore, Walking has emerged as a very important experiential heritage practice at outdoor cultural historic sites such as historic urban precincts in the form of heritage walks or tours.

When visitors walk through a heritage site, they get the opportunity to: 1) view the site from different vantage points, observe its physical features, and make their own discoveries by moving closer or further; 2) understand the relationship between different elements and the surroundings by juxtaposing the activities of locals and visitors, old and new buildings or POIs; 3) form new imaginative connections with the site, creatively appropriating the site and weaving stories of the past and present, and forming new long-lasting memories [64, 158]; and 4) engage in performative practices - enact their agency, and express themselves through gestures, positions, and orientation [190, 206]. Hence, heritage walks enable visitors to form a more textured and complex interpretation of the site that reading textual information alone may not fully support [59, 64, 69, 75].

2.1.6.1 Experiential walking rhythm

It is important to understand that specific rhythms and pace of walking can play an important role in shaping how visitors dwell in, engage and experience heritage site [64, 242]. Slowing down the pace can enhance walks' potential to support social, sensorial and spatial awareness; trigger emotions, reflection, and imagination; and evoke performative practice [69, 163, 242]. slow-paced walk, or one marked by intentional pauses may allow people to observe and become more aware of their surroundings through a well-balanced combination of all their senses (instead of the dominant use of visual perception). Awareness and immersion gained from such slow and punctuated rhythms of walking fosters attunement and engagement with the surrounding environment. Such rhythms of walking can enable visitors to familiarise themselves with the place and participate in its social activities by spending more time in it which in turn may lead to a deeper appreciation of and attachment to the site [69, 223, 242]. Such walking practices may resonate well with visitors' who seek fun, recreation or satisfy personal curiosity (see Section 2.1). Thus, slow and environmentally-attuned forms of walking during the exploration of heritage sites such as historic urban precincts can lead to satisfying and memorable heritage experiences.

To encourage people to consciously engage in slow-paced and environmentally-attuned walking, visitors should be prompted to walk for pleasure and discovery instead of walking to reach a target destination. This might be encouraged by shifting visitors' attention from looking straight ahead into the distance to looking sideways at details that are closer to them which may reveal surprising connections [174]. More importantly, visitors should feel they have the agency and the opportunity to enact that agency [163, 190]. To achieve this, it seems paramount to spark visitors' curiosity and inspire them to pause, pick up things and take routes of their own choice instead of following prescribed ones.

2.1.7 Play and Playfulness

Play is an open-ended, voluntary, and unpredictable activity in which people engage for enjoyment or recreation rather than for profound or practical purposes [50]. It emerges as a situated cultural experience between an individual's actions and thoughts, and their environment [168]. Being in a playful state induces physical spontaneity, joy, a sense of humour, social spontaneity and cognitive spontaneity [140]. Play motivates people to engage their creativity and imagination, providing them with agency, and preparing them to respond to the unexpected [3, 50, 92, 200]. In doing so, play generates awareness, attunement and engagement with the surrounding environment [50, 232].

Play is mindfully attending and physically interacting with the social and material setting. Space or objects in space play a significant role in enabling play and affecting its rhythm and pleasure [234]. Play establishes an intimate and active (participatory) connection between an individual and their surrounding world by increasing the intensity of the experience. It also facilitates meaningful social relationships and evokes positive emotions such as pleasure or excitement [194, 200]. Thus, play can lead to embodied, social, spatial and aesthetic experiences.

Play-based encounters enable people to form meaningful social and material connections, feel intimacy or empathy, and be aware of their body movements in the space [2, 168, 194]. Nevertheless, if play is not appropriately contextualised into the culture of the place, it could contest visitors' cultural understanding of the location or it could make them uncomfortable to engage in play activities [194].

Even though existing work acknowledges a ludic turn within heritage practices, in museums and outdoor cultural heritage sites, researchers often focus on implementing structured, guided reward-based, role-playing, treasure-hunting games instead of play [123, 194]. These games are administered as pre-defined task-oriented activities to fulfil the learning objectives outlined by the cultural organisation. Instead of gamified task-oriented activities, Bertan et al. [3] argue for exploring

situated and emergent play. They suggest that this type of play should be: a) rooted in ongoing activity and context, b) flexible, open, and player-motivated, and c) support social bonding, exploration, creativity and joyfulness. **To enable such play it is important to allow visitors to act in response to their environment in a plethora of ways.** It is important to note that such situated and emergent play is more in line with what visitors desire 2.1 of escapist experience, fun and recreation; and aligns well with the experiential heritage practices, which try to move away from a top-down, prescriptive educational approach and towards an approach driven by visitors' subjectivity and feelings (see section 2.1). Moreover, this type of play can take the shape of performative practices as well as environmentally attuned forms of being and walking as it is social and engages emotions, imagination and bodily actions. Nevertheless, exploring the design and implementation of interactive technology for situated and emergent play in a heritage context is still under-researched.

As discussed so far, at outdoor cultural heritage sites such as historic urban precincts that primarily consist of built heritage and streetscapes bustling with human activities, heritage interpretation needs to be multifaceted and layered consisting of embodied, social, affective, spatial, and aesthetic dimensions. The discussion of distinct yet interrelated concepts in this section reveals some factors that could lead to experiential heritage interpretation at historic urban precincts:

1. In addition to learning, cater to visitor motivations such as escape, personal connection with the site, fun, and relaxation
2. Support awareness of the multi-sensorial and atmospheric aspects of a space
3. Engage the sensor-motor potential of the body and support exploration of physical space
4. Encourage and support social encounters
5. Engage visitors' memories and prompt reflections
6. Enable visitors to perform their emotional responses

7. Trigger imagination and creativity-driven participation

Engaging in performative practices, slow and punctuated walking rhythm, and play at such sites can allow visitors to have such layered and multifaceted experiences ultimately leading to the formation of satisfying and memorable heritage experiences.

2.2 Heritage interpretation practices

The first part of the chapter focuses on identifying facets and practices that have been found crucial for supporting embodied, sensorial and social interpretation the formation of memorable heritage experiences at outdoor culture heritage sites.

In addition to learning about historical facts and narratives, Heritage interpretation practices such as slow and punctuated forms of walking, performative practices, and play are multi-dimensional (see Fig 2.1). They comprise different forms of engagement that shape the overall heritage experience at outdoor cultural heritage sites. These heritage interpretation practices encourage visitors to engage in multidimensional ways - corporeally, socially, and psychologically, setting the foundation for a deeper connection with the site. Corporeal engagement includes walking, pointing, and sensory encounters with the physical surroundings and atmosphere. Social engagement occurs through interactions with fellow visitors and residents. Psychological engagement involves emotional responses, reflection and imagination.

These engagements trigger multi-dimensional experiences - embodied, social, affective, and cognitive (see Fig 2.1). Embodied and sensorial experiences which arise from the corporeal interaction with the environment deepen immersion and emotional entanglement with the site and enable discovering personalised interpretations of the site. Social experiences trigger memories and enhance shared

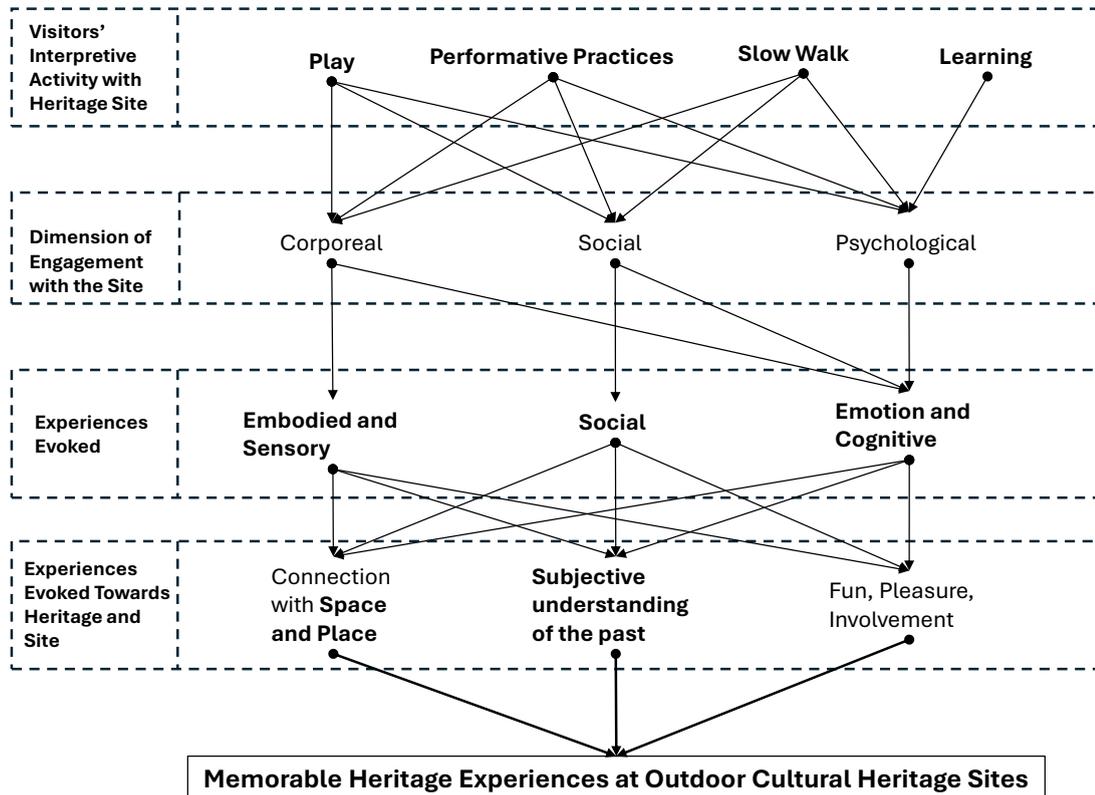


FIGURE 2.1: This model shows how heritage interpretation activities initiate a series of visitor multidimensional engagements that culminate in a meaningful and memorable interaction with the heritage site.

meaning-making. Affective experiences, like the feeling of awe or pleasure, improve visitors' engagement with the historic site. Finally, cognitive experiences stimulate the imagination, encouraging visitors to reflect and visualize the past.

These intertwined multidimensional experiences collectively shape three types of visitor experiences (see Fig 2.1). Aesthetic experiences are the emotional enjoyment or pleasure derived from being at the site that leads to the valuation of the site and its past. Space-place experiences emerge from a sense of attachment and appreciation for the site, leading to a meaningful connection with the place itself. The third aspect is the subjective understanding of heritage, where visitors form their own interpretation of the site's historical and cultural significance.

Ultimately, these personal experiences collaborate to create a memorable heritage experience. The interactions between the corporeal, social, emotional, and cognitive dimensions allow visitors to not only enjoy the site but also develop a deeper

appreciation and understanding of its heritage. This holistic and immersive engagement makes the heritage experience rich, satisfying and memorable.

The model suggests that people can make meaning of heritage through multiple forms of knowing, i.e., corporeal, sensory, emotional, cognitive and social. On the other hand, outdoor cultural heritage sites have the potential to support multiple forms of engagement - physical, social and psychological. Thus, interpretation activities at such sites need to leverage opportunities afforded by the site and people's capacity to experience and understand the past through multiple modes.

Further, people do not visit heritage sites with a single objective. They have a variety of motivations which may be related to having fun, relaxing, socialising or experiencing something new. These considerations about the site, people's capacity for meaning-making and their varied motivations have prompted scholars to consider experiential approaches to heritage interpretations in addition to education-focused approaches. Heritage practitioners and scholars have started exploring forms of walking, performative practices and play as means for heritage interpretation.

With this understanding of heritage experience and forms of heritage interpretation, the second part of this chapter reviews the state of art of mobile guides.

2.3 Mobile guides

This section traces the evolution of mobile guides. The discussion is organised based on the design intent and interpretive approach. While the focus of this review is to identify different approaches that researchers have used to design mobile guides for outdoor built heritage sites, at times the review also refers to work done within the context of museums.

2.3.1 Mobile guides to support context-aware and personalised learning and exploration in outdoor heritage sites

To facilitate visitors' on-foot exploration and engagement at the outdoor cultural heritage sites, heritage practitioners often design heritage walks or trails through the landscape which connecting multiple points of interest (POI) such as buildings, streetscapes, or natural features of the site [75]. Often, such walks are accompanied by a guide who helps visitors navigate the space, focus their attention on specific details and engage, educate and entertain them through captivating stories at various locations.

Several technological trends, including the internet, hypermedia, GPS-based location-aware technology, and mobile devices like PDAs, laid the foundation for the development of handheld mobile guides. These experimental and commercial guides were designed to help visitors navigate and learn about locations during heritage walks or explorations of historic urban precincts. Researchers became interested in developing and exploring these solutions because mobile devices, combined with location-based applications, offer unique advantages. They allow for layering outdoor heritage sites with interactive information without the need for physical alterations. This is particularly valuable in locations where new multimedia displays or installations are either prohibited by law or impractical due to the risk of weather damage or vandalism.

Early projects such *Cyberguide*, *GUIDE*, and *CRUMPET* focused on solving technical challenges which could enable them to provide flexibility in planning routes and location-aware [39, 144] personalised recommendations and information to support users' interest and learning during outdoor urban exploration [187]. Evaluation of *GUIDE* with experts and lay users in the field showed acceptance for using such guides, trust in the navigation provided by the device and overall enjoyment from using it [39]. However, they suggested the need to gain a better understanding of users' requirements for content and information.

After the introduction of smartphones, the use of location-aware applications for heritage exploration and interpretation advanced further. This was due to the devices' ubiquitous presence, ability to provide access to site-specific content on the go and to support user's learning [21, 78, 100, 175].

Systems like *COMPASS* and *mobiDENK* were designed to offer context-aware and personalised POIs recommendations and information. Additionally, to enhance users' awareness of their surroundings, they provided visual navigation support by displaying users' position, trail's path and other points of interest on the interactive map [129, 230]. User testing of *mobiDENK* in a large historic garden with multiple monuments revealed valuable insights. Participants appreciated that the guide included old photographs in addition to textual information, as this feature enabled them to compare the past with the present [129]. They also liked the display of their position on the map in relation to the monuments in the vicinity as it enabled them to view those monuments in their actual immediate surrounding. Users identified this feature as the biggest advantage of using the *mobiDENK* system as it allowed for the chance discovery and exploration of monuments whose significance they were not aware of. However, the technological limitations such as limited battery were observed as a hindrance to the user's desire to do longer heritage walks.

Vlahakis et al [231] developed *ARCHEOGUIDE* which is often considered the first system designed to offer augmented reality tours of archaeological sites (Olympia, Greece) in the form of 3D reconstruction of the ancient ruins and life. They implemented the mobile guide system in 3 configurations - a head-mounted display (HMD) system with a laptop and mouse; a pen-tablet and; a palmtop. When these guides were evaluated through a field trial, it was found that while people liked the realistic augmented reality experience afforded by the HMD, they preferred the palmtop-based guide as it was very compact and lightweight compared to the size and weight of the HMD setup.

Overall, the early phase of mobile guide development focused on overcoming technical challenges to enhance user experience through personalized, context-aware

information delivery. Thus, it is evident that they adopted the learning-based approach to heritage interpretation.

The evaluations were focused on users' acceptance, trust, experience of the user interface, information requirements and device preference. The findings of these studies highlight the importance of supporting flexibility in exploration; the ability to adapt to users' interests; providing sufficient information and; multimedia content such as old photographs. However, technological limitations such as battery life and device ergonomics were identified as areas needing improvement to better meet users' needs and preferences.

2.3.2 Mobile guides as location-based storytelling

While some researchers were focusing on addressing the technical aspects of mobile guides, others started to move beyond application features and usability-driven factors. They started exploring ways to enhance emotional and cognitive engagement. This led to the design and evaluation of location-based storytelling for design mobile guides.

To entertain and educate visitors about historically and culturally significant events, Dow et al. [58] designed an application for the *Historic Oakland Cemetery*, Atlanta. They utilised the physical environment and the grave sites as the base for delivering an audio-based dramatic experience in which the ghosts of the cemetery told visitors stories about their lives and times in addition to giving navigational clues to the audience. Two critical concerns that researchers explored while designing the mobile guides were balancing users' agency in linear narrative-based storytelling and ensuring distraction-free exploration while delivering the content. While researchers chose to work with a linear narrative, to address the concerns relating to users' agency, they offered users more options to select from several topics, interact with the content and ability indicate when they wanted to move to the next site. To ensure distraction-free exploration researchers decided to proceed with a guide which would only offer audio experiences. To study the influence of

the mobile app on user engagement, they conducted a user study in the cemetery and followed it with interviews. They tracked users' movement through the sight using GPS and recorded when they pressed different buttons on the app. While observing the users' behaviour during their individual walks, researchers found that users chose to walk away from the site while still listening to the content. In terms of content, while users found the content interesting, they often skipped many segments, indicating that people would have preferred shorter snippets.

To enhance the visitor experience and provide a comprehensive understanding of the 1746 battle events at the Culloden Battlefield site near Inverness, Scotland, Pfeifer et al. [181] implemented a location-aware mobile guidance system. Along with the PDAs, visitors received a single-earpiece audio device to allow for ambient sounds of the site to be heard. As visitors traversed the battlefield, the content was automatically triggered by their GPS location, offering a non-intrusive experience that allowed visitors to focus on the site rather than the device. During the user study, Pfeifer et al. [181] found that user-perceived accuracy was more important than technical GPS accuracy. They reported that many visitors preferred minimal interaction with the device and reading visual content on small screens proved challenging in outdoor conditions. Thus, the researchers suggested adapting content to technological constraints and the environment.

To engage the users and to help them connect the locations with stories and information researchers have explored provided the narration through the character. For example, in the *Westwood experience*, the 'mayor' of the city is the narrator who shares the history of the city while telling his own love story [240]. The app provides users with images of buildings or landmarks so that they can locate them. The stories are presented through a mobile device using augmented reality and videos. The researchers used both quantitative and qualitative methods to evaluate the mobile guide experience across outdoor and indoor environments for narration in mobile environments, social dynamics and Mixed Reality (MR) effects. Researchers found that integrating the historical information with the love story of the 'mayor' diluted the impact and engagement as people did not relate to the 'mayor's' character. As the narrative was broken into chunks to be delivered

at different locations, users did not experience the flow of the story. The user got distracted from the story while walking between two locations. Researchers also found that for a good experience, the information should be designed to ensure a strong connection with location. Concerning social dynamics, researchers found that the use of headphones leads to isolated experiences and users felt anxious due to awkwardness to stand and watch long videos (2 to 3 minutes) on the street. For MR, researchers reported that users found MR effects useful for connecting the real and fictional worlds. In another storytelling-based application, *Carletto the Spider*, a 3D anthropomorphic spider character was designed to guide the visitors through the historical site [143]. The application allowed users to watch 15 to 50-second-long animated videos. Researchers studied the application quantitatively and qualitatively to evaluate the effects of interactivity, mobility and the goal of information dissemination on Storytelling in the cultural heritage context. In contrast to the findings of *Westwood experience*, the findings revealed that participants liked the character describing it as a funny 'travel mate.' This may be explained by the fact that the character did not spend time telling its own story. Another finding from the study was that visitors expressed their dissatisfaction with the isolating nature of the mobile guide.

Some researchers explored innovative design approaches such as participatory design to create a mobile guide. For example, for an archaeological rock art site, rather than relying solely on expert perspectives, researchers involved the public in the design of the mobile guide app [8, 77]. Researchers wanted to engage with visitors' actual experiences and situate the design within their personal, technological, and natural contexts. To engage potential users and understand their experiences and needs, participatory and empathetic design methods were employed through a series of five co-experience workshops with 39 participants. These workshops included informal activities such as site visits, conversations, and storytelling, with data collected through notes, photos, videos, and participant-generated content. Thematic analysis of the materials revealed that locating and identifying rock art panels at the sites was a major challenge for participants [8, 77]. Based on the

experience of using a low-tech prototype mobile guide app which provided granular navigation assistance through maps, directions, and contextual images, and facilitated flexible, non-linear exploration to accommodate varied visitor styles, participants expressed a desire for the ability to speculate about meanings, supported by evidence-based information. The researchers highlighted the importance of considering the situated context of heritage experiences, and stressed the significance of connecting to the landscape through multiple senses, 'felt' experiences, and a sense of place. Digital interpretation, they suggested, should enhance, not detract from, the landscape experience [8, 77]. Taking a step further, the *VisAge* project, explored a community-authored augmented reality (AR) system to tell stories and cultural histories about urban environments [118]. However, a detailed evaluation of the system was not reported.

McGookin et al.[155] conducted a study to explore the design and evaluation of location-based cultural heritage applications that can be used tangentially by visitors when their primary motivations might not be centred around heritage exploration. To achieve this, McGookin et al.[155] developed and evaluated a cultural heritage application called "Explore" for the Finnish recreational island of Seurasaari. The "Explore" application was designed to support its use as a secondary activity during visits, providing notifications when visitors were near a location of interest, without disrupting their main activities. Visitors could choose to respond to or ignore these notifications. The study involved 26 groups of visitors (45 participants in total), comprising both locals and tourists. Participants were informed that they could interact with the app as much or as little as they wished during their visit. Data was collected through pre-visit questionnaires, logging device interactions, and post-visit interviews. The analysis included thematic coding of interview transcripts and triangulation with logged data to understand the app's integration into the visit. The results revealed different usage patterns between locals and tourists. Tourists, who often visited the island spontaneously, used the app to enhance their exploration, while locals, with more planned visits, used it to gain additional insights into familiar places. McGookin et al. [155] found that users preferred short bursts of interaction and that frequent notifications could be

distracting. They recommended designing for varying levels of engagement and avoiding highly immersive experiences. The study also highlighted the value of designing mobile guides as companions that allow users to explore the site in any order, suggesting a move away from narrative-based approaches that may require visitors to explore the site in a certain order. They argue that cultural heritage applications should respect the primary motivations of visitors and integrate seamlessly into their ongoing activities. However, it is important to note that not all visits are not tangential. In scenarios where visitors, whether local or tourist, engage in planned heritage activities such as heritage walks, a more evocative and immersive experience might be appropriate.

By studying design location-based storytelling and their potential to enhance emotional and cognitive engagement during outdoor cultural heritage walks these studies reveal several relevant design choices and useful insights. While *Historic Oakland Cemetery* was designed as a linear narrative other apps provided users the freedom to choose their own path to allow visitors greater agency and flexible exploration options [8, 77, 155].

Researchers explored different methods of content creation. While some apps relied on experts, others explored a participatory approach to include non-elite history [8, 77]. It was found that interpretive openness and a balance between fictional narratives and historical information is crucial for an engaging heritage experience [8, 58, 240]. Additionally, findings suggest that while exploring outdoor heritage sites such as urban precincts, users prefer shorter segments of information [58, 155, 240].

In a location-based media experience, content or media is only available at specific points. These studies underscore the importance of ensuring a strong connection between content and location, as well as ensuring distraction-free exploration [8, 58, 240]. Researchers of the *Westwood experience* observed difficulties in maintaining users' continuous engagement with the heritage experience while using location-based media in the urban precinct. They observed that during the intervals without media, while users walked between two POIs, users were often

distracted by activities and occurrences in their surroundings [240]. This implies that researchers did not consider the events and activities occurring in the urban space as integral to the visitors' heritage experience of the urban site.

Although various studies focused on audio-based content, the use of headphones was found to create isolated experiences [240]. Consequently, these studies highlight the importance of supporting social awareness during the exploration of outdoor cultural heritage sites [143].

2.3.3 Mobile guides as location-based games

Alternative some researchers explored designing and deploying location-based games or pervasive games to attract, involve, and engage users during exploration and learning in heritage sites or historic urban precincts,.

One of the earliest examples of implementation of an urban-scale pervasive mobile game was *REXplorer* [13]. It was designed to engage young tourist groups (aged 15-30 years) exploration of the UNESCO World Heritage site - the city of Regensburg, Germany. This paid game enabled groups of tourists to gather information and directions for walking through the city through encounters with the spirits of historical figures associated with significant buildings in the historic urban precinct. The core component of the gameplay was that users could awaken and communicate with a spirit at the specific heritage buildings by waving a device to *cast a spell*. The device which was introduced to users as a paranormal activity detector looked like a wand and comprised of a mobile phone and GPS. The app allowed players to choose their own path and pace. To enable visitors' unhindered attention towards the beautiful architecture of the city, designers primarily used audio content. However, to facilitate a social experience instead of headphones, a phone loudspeaker was used to play the audio. By evaluating the device and game through several play sessions at the site, researchers found that users were comfortable with performing gestures in public. On the other hand, while the strategy of using headphones helped support shared experience, some

users were uncomfortable as they felt that the audio playing on the loudspeaker was disturbing the passers-by. Users appreciated the freedom to choose a path and pace but felt a bit disappointed when they had to return to a location they had already been to. While most users found the game engaging and entertaining, the users interested in learning expressed that the information about the city was insufficient and too character-centric. Interestingly, it was found that the characters in the stories became a medium for visitors to remember and connect with the specific buildings. Overall the game was design was found to be quite successful in promoting users' playful exploration and learning in the city.

To provide users with a modified view of their surroundings, the researcher implemented a pervasive AR game *TimeWarp* in the city of Cologne, using a combination of the head-mounted display and PDA [93]. Findings from a questionnaire-based survey after the participants played the game in the urban precinct revealed various technical challenges related to the implementation of AR. At a broader level, researchers highlighted the difficulties in maintaining users' continuous sense of presence and engagement with the game as It was not feasible to augment the entire space - a challenge closely aligned with the concerns raised by the designers of the *Westwood experience* [240]. Reflecting on the game interactions, researchers suggested the need to simplify the interactions such that they are intuitive.

Mobile location-based games have been utilised by researchers to support outdoor learning in in local historic precincts. *Frequency 1550* was developed to help secondary students playfully learn the history of medieval Amsterdam. It was designed as a day-long team role-playing game where students were required to navigate through the city and search for the specific sites using a map on their device [103]. The teams were provided different assignments through the app which prompted them to observe and engage with different information sources. Similarly, *Oracle of Delphi* was designed as a mobile augmented reality (mobile AR) treasure-hunting game application to enhance and support educational groups' exploration and learning in open-air spaces of the Delphi archaeological site [63]. The game required users to follow a story, visit specific locations, observe the site and respond to the quiz in the app. Findings from both studies suggest that

groups of students showed that playing location-based games enhanced students' engagement and learning. A questionnaire-based survey of students' experience of playing *Oracle of Delphi* suggests that while playing the game at the site students were thoroughly entertained and immersed (read involved) in the game. It was observed that participants were enthusiastically involved and group spirit was well supported while playing the game. However, students also reported being more focused on the game than observing the monument. This is problematic in the context of open-air heritage site exploration and highlights the need to balance gameplay with encouraging attention to surroundings. The design of location-based games such as *Ghosts in the Garden* [185] and *Porto: Unlocking Porto* [167] was motivated by the desire to explore how mobile technologies can change the way visitors engage with, discover locations, and learn and interpret historic sites. *Porto: Unlocking Porto* was a single yet flexible story to engage the players with the key POIs of Porto, Portugal while they followed an augmented reality path and played small games [167]. As the focus of the designers was on telling a story in the city with a multimedia system, at the design stage they paid attention to the various aspects like story, art, sound and game design. Researchers found that the design of the game enabled visitors to explore independently as well as have opportunities for social interaction [167].

Ghosts in the Garden aimed to move beyond passive information consumption and traditional, authoritative forms of heritage interpretation, towards more active and participatory methods. To enhance the affective relationship between technology, place, and outdoor heritage, *Ghosts in the Garden* explored the potential of a non-didactic, games-based approach to build a historical understanding of Sydney Gardens in Bath. The prototype featured multiple narrative paths, allowing visitors to choose at key points, leading them through branching narratives as they explored the space. This approach enabled visitors to piece together information from different characters, impacting the narrative and promoting visitor agency. The content focused on lesser-known historical figures from the 1820s, presenting history from below rather than focusing on elite figures.

To prioritise immersion in the physical space, only audio, rather than visual reconstructions, was used to engage the imagination. To minimise the overt presence of technology, the design of the location-based experience utilised a custom *Time Radio* prop to conceal the smartphone and speaker. For heritage interpretation, visitors were given the *Time Radio* prop which allowed them to encounter encountered GPS-triggered audio of historical characters while walking through the gardens.

In audience evaluations, Poole [185] found that 73% agreed that the guide was educational, suggesting visitors absorbed historical context through interactive narratives. However, the findings highlighted the challenges of balancing affective interpretation and game elements with factual rigour, as affective interpretation, which prioritises emotion and personal response, can conflict with audiences who prefer factual accuracy. Poole [185] claimed that the project successfully demonstrates the potential of mobile locative technologies, the value of concealing technology, and game mechanics to create an educational, immersive, and engaging heritage experience.

These location-based games use role-playing and acting of choosing one's own path as an engagement mechanism. Collectively, these explorations demonstrate the significant potential of such game-based mobile guides for heritage interpretation as they have been found to support users' agency and enhance engagement, learning, exploration of the site and Social Interaction.

Like the studies in the previous section, these studies also emphasise the importance of supporting users' ability to observe and appreciate the physical surroundings; choose their own paths and pace; and balance game narrative with accurate historical facts. Additionally, the findings highlight the need to ensure simple, intuitive and non-intrusive interactions and concealment of technology.

2.3.4 Media type for mobile guides for outdoor cultural heritage sites

When designing mobile guides for outdoor cultural heritage explorations, designers can choose from various types of media. Only a few studies have specifically examined the effectiveness of different media types for mobile guides intended for use at outdoor cultural heritage sites, such as historic urban precincts.

To understand how people perceive, handle and interact with different multimedia on mobile systems in outdoor location-based contexts Candello [30] studied a mobile guide prototype that delivers cultural heritage information about sculptures in the city of Brighton, UK. 32 participants followed a short sculpture tour in an urban precinct using a touch-screen mobile phone to access the application. The study reported that most users prioritised reading text, followed by listening to audio and viewing pictures. The length and quantity of information accessed by users was influenced by their prior knowledge, language skills and availability of time. Participants used the pictures of the original subject to learn about the history and pictures of sculpture to locate them. The audio was useful when participants wanted to see the details of the sculpture while listening to the content. Findings indicate that viewing videos outdoors was found to be cumbersome.

As there is growing interest in utilising AR media to explore a historic site, Javornik et al. [116] investigated the suitability of different types of AR media types, when used during outdoor exploration of built heritage sites. They evaluated media types' influence on users' flow experience as well as other cognitive, affective and behavioural responses [116]. They ran a study with 85 participants. 3 groups used 3 apps that overlaid content in different configurations – an AR app with textual information, an AR app with both text and images and an audio guide app – while exploring the university campus. The findings suggested that a combination of images and text was more influential in retaining users' attention and engagement compared to the apps with only text or audio. They suggested the images in AR media can be used to magnify small or hidden details, represent historic elements and reveal interiors of buildings where participants cannot enter.

The findings from these studies build on earlier research. Consistent with the developers of *mobiDENK*, who found that participants valued the inclusion of old photographs alongside textual information [129], these results underscore the importance of combining text and images to enhance user engagement and improve the experience of exploring outdoor sites with mobile guides. Similarly, aligned with the conclusions of [58, 155, 240], these studies indicate that content length and type should be optimized for outdoor heritage exploration. Users preferred shorter, more concise media to avoid standing for long periods to read, listen, or watch. Furthermore, echoing concerns from *REXplorer* users about using audio on speakers during urban heritage walks [13], these studies suggest that users aim to minimize disturbances to passers-by while engaging with content in urban spaces.

2.3.5 Mobile augmented reality for outdoor cultural heritage

Alongside location awareness, the incorporation of display screens and cameras on smartphones has made them an ideal platform for augmented reality (AR) applications. The smartphone's screen and camera allow users to view digital information overlaid onto their physical surroundings. Consequently, several studies have investigated how mobile AR guides can enhance the exploration of outdoor cultural heritage sites.

In developing mobile AR guides, researchers have aimed to enable users to seamlessly access and view information or missing artefacts overlaid on the site. To achieve this, they have concentrated their efforts on implementing efficient and effective environment detection techniques [4, 209, 212]. These techniques allow the system to use features of the real environment as triggers for displaying related information or artefacts. In one study, participants rated their experience of using such a system positively for intuitiveness, ease of use and learning [209].

Mobile AR application *CityViewAR* was designed to provide information about buildings and historical sites that were affected or destroyed by earthquakes in the

city of Christchurch, New Zealand. The app provided AR content such as 2D map views, 3D models of buildings, panoramic photographs and more. Researchers studied the experience of using the app, on a public street in the city centre which had 21 points of interest (POI). 42 people with different tech-savviness, prior experience of using CityViewAR, and prior knowledge of the site participated in the study. Half the participants used the AR view while others used apps without AR. The researchers collected data on parameters such as the duration and distance of the walk and used a questionnaire to collect qualitative responses to open questions and quantitative responses on the Likert scale. They also recorded users' paths of exploration using GPS and observations. Researchers found that the group using AR explored the site more actively and rated their experience of using the app higher than the other group [135].

Langlotz et al. [132] developed *Urban Pointer*, an innovative and more accurate urban pointing interface for browsing location-based media outdoors. Similar to the approach of Strelak et al. [209], they combined computer vision-based methods with sensor data to achieve precise global localization and pose tracking, addressing the limitations of standalone device sensors like GPS and magnetic compasses. They also made physical modifications such as adding a 90° prism on the front-facing camera of the mobile phone to allow users to point at objects or places without "looking through" the phone. The researchers made this design choice believing that the pointing interface might be preferred by users given its improved ergonomics and social acceptance. From the perspective of this thesis, the point-to-browse gesture is the most interesting contribution of *Urban Pointer* [132], as it fundamentally alters the user relationship with the device. Instead of creating a digital divide, this innovative approach transforms the mobile phone into a bridge between users and their environment. By allowing users to point at locations of interest, the device becomes an extension of natural exploratory gestures, blurring the line between digital and physical realms. This seamless integration of technology with human behaviour offers a more intuitive and immersive way to engage with location-based information, potentially enhancing user experience and opening new avenues for environmental interaction. However, further research

is needed to fully understand how this interaction modality influences users' experiences when exploring locative media in urban settings.

While all the previous research focused on technical solutions for precise detection of locations, *KnossosAR* - a mobile AR guide for the UNESCO World Heritage archaeological site of Knossos, Crete, Greece was designed to explore UI design to communicate about the buildings that were not directly visible to users in the AR view. The study aimed to understand the usability issues and user preferences while using mobile AR guides. In a 30-minute field study with 16 users divided into three groups, Galatis et al. [78] studied and compared the user experience of using AR-based and map-based mobile guides in outdoor cultural heritage sites. During evaluation users rated KnossosAR highly for perceived usefulness, ease of use and enjoyment. However, researchers did not report the impact of mobile AR guides on the user experience of exploring heritage sites.

Duguleana et al. [60] developed *TowerAR*, a mobile AR application to explore a new interaction paradigm for mobile AR which could enable visitors to visualise the heritage site in different periods during their exploration of the outdoor site exploration. They designed an app that presented five epochs and related historical information for locations such as the Leaning Tower of Pisa, the Cathedral and the Baptistery, all key landmarks from Piazza dei Miracoli in Pisa. The findings from a user study with 15 users indicated that users enjoyed and felt excited while using the app. In another study, that evaluates the potential of AR content in a mobile guide to address different goals such as presenting missing architectural elements, adding a historic figure in action to a scene, and complete recreation of a scene, researchers highlighted the need to design dynamic and interactive content over static content and a good interface to improve engagement with the mobile AR guide [22, 61].

Chang et al. [37] moved their focus beyond usability and UI design and focused on studying the influence of mobile AR guides on experiential dimensions that are important for memorable heritage experiences at outdoor historic sites. They studied the mobile AR guide for the sense of place and learning achievement with

87 university students who were divided into 3 groups who used different aids during their exploration of the site - AR mobile guide, audio-guide, and without a guide. In addition to quantitative surveys to measure learning achievements and sense of place, researchers used Interviews to gain a deeper understanding of factors that contributed to the formation of a sense of place. The quantitative results indicated that visitors who used AR guidance showed significant learning and sense of place effects and demonstrated positive attitudes toward the use of the mobile AR guide. The analysis of interview data also showed that the group using the AR guide experienced a higher degree of enjoyment, Interest, knowledge acquired and learning motivation [37].

The review of these studies indicates that the primary motivation behind developing mobile AR guides has been to allow visitors to view reconstructions of destroyed historical sites or add missing elements from different historical periods to heritage sites. Much of the research has concentrated on addressing the technical challenges of accurately detecting and overlaying digital content on the physical environment in outdoor heritage contexts. However, some studies have also focused on enhancing the user experience of mobile AR applications and their impact on heritage engagement. Despite this, there remains a clear need for further exploration of how mobile AR guides affect visitors' heritage experiences at outdoor cultural heritage sites, such as urban heritage precincts.

2.3.6 Mobile guides for enhancing social interaction

Visitors often visit museums and heritage sites in groups, viewing these visits as opportunities to strengthen bonds with family or friends, interact with other visitors or locals, and engage in collective meaning-making [67]. This social aspect of heritage visits has motivated researchers to design mobile guides with features that support and enhance social interactions between visitors and their companions.

One such example *Sotto Voce*, was designed to increase visitors' awareness of the interests and activities of other group members during their visit to a museum.

Sotto Voce enabled users to have shared listening or independent listening of audio narratives about the exhibits. The main feature of the app was that it enabled visitors to share audio information about their activities on the mobile guide with their companions using audio eavesdropping. This feature was included to enable companions to perform periodic check-ins or follow the activities of each other [6, 85]. Researchers studied the users' experience of the app and the heritage experience of the historic house museum with 6 pairs through a field trial, observations and interviews. They found that eavesdropping audio enabled pairs to easily coordinate (disengage, re-engage, check-in or follow) with each other and enabled pairs to maintain a strong connection [6, 85]. The adoption and use of the *Sotto Voce* is influenced by the visitors' relationships with each other, the nature of their visit and museum visiting strategies, and the presence of other people [85]. They suggested that the use of *Sotto Voce* freed participants' minds from thinking of ways to coordinate which allowed participants to focus their attention on their surroundings leading to higher awareness and exploration of the exhibits. They also suggested that providing both individual control and shared experiences can enhance the overall visitor experience [85].

CoCicero used a game-based approach to motivate visitors who might be strangers to each other to collaborate, socialize and learn in a museum setting [57]. It was implemented using a combination of PDAs (for individual gameplay) and public displays (for public viewing of shared gameplay) where visitors could see the locations of other visitors and locations of tasks in the gallery space. The evaluation outcomes of various factors including the system's ability to motivate collaboration were largely positive [57]. However, users suggested that such an approach felt forceful at times and was more suitable for children.

To gain a deeper understanding of how role-playing and promoting social interaction affect users' heritage experience, Perry et al. [177] created a storytelling experience. They presented two fictional characters narrating two different perspectives on the various topics throughout the experience. At the start of the experience, visitors were also asked to take roles such as a hunter or an artist

and through the experience participants were explicitly prompted to communicate or/and collaborate at various pre-identified interaction points. To evaluate this approach, a study with 6 pairs was conducted at Çatalhöyük, a UNESCO World Heritage archaeological site. The data was collected in the form of audio recordings of groups' conversations; observational of pairs during each tour; and 30 to 60-minute audio-recorded interviews conducted following the tour. Participants reported that the design of the heritage interpretation activity encouraged them to work collectively to negotiate and develop their understanding of the past. It was found that such a social experience-based heritage interpretation approach led to self-reflection, personal transformation, imagining the past and developing a deeper connection with the site and the people who lived there.

2.3.6.1 Understanding social interaction within museums

To inform the design of mobile guides that support social experiences, researchers have tried to study and understand the group dynamics during a museum visit. Dim et al. [56] focused on exploring ways to understand the level of 'togetherness' among the group during a museum visit. By togetherness, they meant "*social activity which enables mutual sharing of thoughts, feelings, knowledge, wants and needs, among group members*". They identified 'social interaction' and 'proximity' (if the group members are standing together or apart) as two measures of togetherness. To measure social interactions, they tracked the length of voice conversations and to measure 'proximity' (a precondition for face-to-face social interaction and conversation) they classified the groups state into either joined or separated.

In another study, Rennick-Egglestone et al. [191] observed how 8 families of varying sizes interacted and used a tablet with a bespoke app. The study was conducted in the open-air and indoor galleries of the science education centre in Toulouse, France. They especially focused on how family members collectively managed the tablet as a visiting resource. Based on the observations and interviews they formed different models of usage which highlighted the different roles individuals assume in a group like leader, facilitator and autonomous and how that affects the group's

engagement with the app. They recommended that in addition to being mindful of site conditions while designing the app and content, designers should also consider ways to support different roles that individuals assume in a group while exploring such sites, especially facilitators. They also recommended designing applications to accommodate users' repeated engagement and disengagement with the app which is in contradiction to concerns of continuous engagement raised by researchers of *Westwood experience* [240].

Researchers suggest that while designing mobile guides for group experiences, it is important to consider a certain amount of flexibility as it suits the shifting nature of individual visitors' attention and varying paces of individual visitors in the group [177, 191]. Researchers observed that groups often do not act as a single unit throughout their museum explorations. Different group members like parents, children and older individuals go through museums at their own pace, each with their expectations and goals [177, 191]. Thus, it is important to not force group interactions [177].

2.3.6.2 Non-smartphone based mobile guides for enhancing social interaction

While researchers have tried innovative interactions, games and storytelling approaches to design mobile guides for promoting social interaction within the groups during the visit, these solutions have been presented using mobile phones which are inherently designed for personal use. Some researchers have been concerned about the usage of mobile phones as guides within museums and heritage sites. They argue that these devices can diminish face-to-face interactions among co-located visitors as engaging with information on a mobile screen tends to captivate visitors' attention, thereby isolating them into individual bubbles or *cocoon* [115, 225]. This has motivated researchers to explore alternative devices that provide single shared displays such as mobile projectors to support co-located shared activities.

Wakkary et al. [233] designed Kurio, an interactive museum guide aimed at improving social interaction and learning for families visiting museums. In addition

to strategic uses of games to motivate learning and structure the visits, *Kurio* employs two more strategies: 1) ‘Embodied interaction’ to support social engagement and playful interaction with exhibits; and 2) A ‘hybrid system’ combining tangible and graphical interfaces via PDAs and tabletop displays. The system incorporates a set of tangible devices, including a pointer, reader, and listener, for interacting with exhibits. Similar to the approach adopted by [57], the PDA facilitates coordination between family members and tracks progress, while a tabletop display shows the overall game state and provides additional information. The game narrative casts family members in the role of time travellers who must complete missions and challenges them to gather historical information and repair their time map. To evaluate *Kurio*, a 45-minute trial was conducted with 25 participants (8 families with children) in a local history museum. Data was collected through pre- and post-session questionnaires, interviews, observations, and follow-up self-administered interviews conducted 2-4 weeks after the initial session. Participants found *Kurio* engaging, fun, and beneficial for learning. The system facilitated the involvement of all family members, encouraged mutual assistance, and supported constructivist learning, active participation, and multi-sensory experiences. Wakkary et al. [233] concluded that by promoting collaborative actions and reflections among family members *Kurio* enhanced togetherness. The embodied nature of the tangible user interfaces (TUIs) allowed for a seamless interplay between social and physical contexts, easing the integration of technology into the museum environment. Most importantly, the combination of embodied interaction and game-based learning created opportunities for personal exploration and discovery, shifting the focus from mere information retrieval to active, engaging learning experiences. The overall design of *Kurio* demonstrates the potential for TUI and Games to foster meaningful family experiences and learning in museum settings.

Though the motivation behind the design of *Kurio* was to support social interaction, it is evident that it also enabled performative and playful practices by allowing users to express their agency and leverage the potential of the physical setting.

Similar to Wakkary et al.[233], Betsworth et al.[20] aimed to support heritage site visitors to engage in performative (i.e., social) practices, collaboration, and place-based experiences. They explored the use of mobile projectors as they allowed information to be projected onto the real world. The researchers proposed that projecting information into the environment, instead of viewing it on the small mobile phone screen, reduces the challenges of sharing the display and minimizes the disconnect between individuals and their surroundings caused by the visible presence of the device. From an exploratory study of the system with 58 participants at the National Botanic Garden, Wales, UK, researchers suggested that mobile projectors have the potential to enrich shared group experiences and interactions with bystanders. In the post-trial survey, both mobile projector and mobile phone-based systems were rated equally in terms of enjoyment, leading researchers to suggest that both modes should be explored in future implementations.

Lanir et al. [134] conducted a study with three devices – iPod, tablet and mobile projector across two controlled studies in a museum setting to examine the potential of different mobile display technologies for supporting shared experience. During the trials, researchers observed roles taken by group members, proximity, frequency of interactions, gestures etc. to understand the influence of mobile devices on group dynamics during mobile guide-aided exploration of the museum. To understand users' experience of using the devices data was collected through post-trial surveys. Users expressed that iPods gave a personal experience and were easy to hold and carry. Tablets were found to be interesting to use but not convenient to hold and carry around. They were found to be less suitable for a group as it was hard for everyone to see the display and forced people to be together. As expected, projectors were found to be suitable for groups. Users appreciated the flexibility to project near objects of interest as it improved the experience of interpreting and changing the size of the display. However, a significant challenge for participants was to find a suitable surface to project on and the inability to use projection while moving through the space. Overall the researchers concluded that the projector and tablet contributed to group cohesiveness. However, a surprising finding was that most participants wanted their own device as individual

control over the device and independence during exploration was important for them. This finding supports previous recommendations to account for the varying pace and intentions of different group members during museum exploration, suggesting that group interactions should not be forced [177, 191].

The review of research on mobile guide design for social interactions in museums shows that substantial work has been done in this area. Researchers emphasize the importance of supporting "togetherness" and accommodating different roles within groups to foster meaningful social interactions. Successful designs, such as *Sotto Voce*, illustrate the value of interactive patterns that naturally promote social interaction without forcing it. While designing mobile guides to enhance social interaction it is crucial to ensure individuals can disengage and re-engage with the group members as needed and maintain the freedom to follow their interests while coordinating and connecting with the group.

Researchers also acknowledge that the use of smartphone-based guides can isolate visitors. This has led to the exploration of alternative technologies such as tangibles and shared displays, like mobile projectors, which have proven effective. However, there is a significant gap in research evaluating mobile guides designed to support group social experiences during heritage walks in outdoor cultural heritage sites, such as historic urban precincts. These sites are distinct because they are lived-in environments, offering opportunities for visitors to interact with companions, residents, and other visitors, thus enriching their social experience.

Future research should focus on designing and evaluating mobile guide systems specifically designed for group use in outdoor heritage sites. This research should explore how these guides can facilitate meaningful interactions both among group members and between groups and the broader social context of the site. Such studies would provide valuable insights into the dynamics of social experiences in lived-in heritage spaces and inform the development of more effective and engaging mobile guides for these environments.

2.3.7 Mobile guides for supporting sensory and corporeal encounter

The examples discussed so far in this review highlight efforts to foster learning, emotional engagement and social interaction through mobile guides apps and devices that adopt storytelling and games-based approaches. However, as discussed in earlier sections, heritage experiences are multifaceted. Galani and Kidd [76] suggest that mobile digital heritage experiences function as transmedia narratives, where physical outdoor spaces and app content combine to intrigue and enable visitors to make sense of the heritage. The corporeal and sensory engagement with the physical setting of heritage sites influences visitors' cognitive and emotional responses 2.1.1. People create personal narratives of experience using both the physical space and digital content in an imaginative, multi-modal (multi-sensory) and multi-directional manner. Thus, the final experiences are formed between the physical space, mobile device, and participants' process of transmedial sense-making, which includes emotional, social, and cognitive domains [76]. This realisation has led researchers to develop mobile apps or devices that encourage performative and playful (open-ended and situated) exploration in heritage sites and museums. In the following section, we review such works.

To transform museums into coherent spaces for play and discovery, Wakkary et al. [232] sought to employ playful 2.1.7 and aesthetic 2.1.4 interaction. They aimed to design a prototype that supports playful interactions, promotes tactile engagement and discovery, responds to different learning styles, and serves as a virtual extension of the museum exhibition space. They developed an adaptive museum guide using a tangible user interface (TUI) for its playfulness and simplicity. They combined it with spatial audio displays to support imagination, exploration and discovery in a museum setting. The cube-shaped prototype - *ec(h)o*, comprised of four main components: position tracking, vision sensing, an audio engine, and a reasoning engine. These components collaborated to track visitors' movements and interactions within the exhibition space. Designed to provide diverse forms of

interaction, the prototype allows visitors to hold, manipulate, and interact extensively with physical objects. The prototype comprised of over 600 audio clips that provided information about the exhibits, encouraging exploration and interaction within the museum space. To evaluate this play-based design, the experiment focused on observing visitors' interactions with the prototype in a real museum setting. This setup allowed the researchers to analyse the degree and variety of play afforded by the prototype. Based on their findings, Wakkary et al. [232] suggest creating an adaptive museum guide that balances playfulness with functionality and learning. They found that not all users were open to the notion of play and acknowledged the difficulty of creating universally accepted approaches to museum interactions. They recommend balancing play with the exhibits vs. play with the device to prevent distraction from the main purpose of the visit. The researchers concluded that the design approach of a tangible user interface proved effective, as compared to the graphical user interface of handheld devices which could be distracting. Based on observations of participants' usage of audio files, they suggested balancing ambiguity with rich information to stimulate new imaginations and personal interpretations. This research highlights the potential of playful and aesthetic interactions to enhance museum experiences but also underscores the challenges of balancing play with traditional interpretive goals.

To encourage and support visitors' multifaceted engagement with 9 out of 25 sculptures and encourage group interaction in an outdoor sculpture garden at a historic country house, Fosh et al. [73] developed an innovative app. Central to the app's design was the structured local experience at each sculpture, divided into five distinct stages: approach, engage, experience, disengage, and reflect. This structure was inspired by heritage interpretation principles that emphasise deep personal engagement. During the 'engage' phase, the app provided unique textual and audio instructions, developed in collaboration with a performance artist, which encouraged visitors to stand or move in specific ways, adopt unusual viewpoints, or touch the sculptures. For the 'experience' phase, researchers collaborated with a sound designer to select music that aligned with each sculpture's

theme, enhancing the overall experience. During the 'reflect' phase, official interpretations of the sculptures were provided only after visitors had the chance to form their own interpretations, encouraged by their physical actions and the accompanying music. To balance individual contemplation with rich social interaction, the designers included opportunities for users to oscillate between moments of personal engagement and group discussion. The act of putting on headphones during the 'engage' phase served to isolate users temporarily, promoting deeper personal reflection. To evaluate the app's effectiveness, Fosh et al. [73] conducted a study with 29 participants, mostly in pairs. Researchers video-recorded visitors' interactions during their tour of the sculpture garden and conducted follow-up interviews. The findings revealed a largely positive response to the app's design. Participants followed instructions related to observing details, moving around, and touching the sculptures. However, they were reluctant to follow instructions about performing theatrical actions. The personal interpretations facilitated by the system were highly appreciated by participants, highlighting the app's success in stimulating imagination through unusual viewpoints, tactile interactions, and music. Participants appreciated receiving the official interpretations, particularly because they were provided after they had formed their own interpretations. It is noteworthy that not all participants agreed with the music selection or the official interpretations, highlighting the tension and differences between personal and official interpretations. This aligns with the previous findings suggesting that performative practices 2.1.5 can lead to acceptance or rejection of officially offered interpretation [11]. By encouraging visitors to engage in performative practices such as exploring unique perspectives, physically interacting with sculptures, and experiencing sculptures supported by thematic music, the app played a crucial role in stimulating interpretation and reflection. The study emphasises the importance of multi-sensory and physical engagement in enriching visitors' interpretive experiences in heritage settings.

To explore the design of mobile guides that integrate with outdoor cultural heritage sites to enhance visitor experiences Petrelli et al. [179] created novel prototypes involving a co-design process with designers, technologists and museum curators.

Five principles guided the design: 1) simplicity of interaction; 2) ensuring technology does not compete with the site for users' attention; 3) supporting social experiences; 4) offering choices; and 5) engaging visitors in physical activities. Subsequently, prototypes were tested in real-world settings that combine technology, interaction and the tangible historical setting. The evaluation focused on prototypes' influence on visitors' immersion, engagement and emotional connection to the heritage site. This process led to the iterative development of two prototypes: an interactive book with a bookmark to select the preferred theme, and an interactive belt with a set of cards, each representing a theme. These prototypes were designed to conceal technology and support tangible and embodied interactions, providing an immersive experience. The content was crafted to be evocative and open to interpretation rather than didactic. Notably, the design avoided screen displays in favour of audio-only delivery to maintain focus on the site, aiming for seamless integration of technology into the heritage experience. In practice, visitors walked around the site carrying the book or wearing the belt. Audio stories automatically played when approaching points of interest, and visitors could select different story themes using book pages or belt cards. The shared audio display supported group experiences, by encouraging discussion of content. A naturalistic and qualitative approach was employed to test the prototypes with 9 participants in groups in the field at the remains of the trenches and a fortified camp from World War I in the Italian Alps. Participants were invited to bring a companion, encouraging familiarity and natural interactions. Using the device (either the book or the belt) and a map of the place, participants were invited to make their visit in an order of their preference and without the limitation of time, allowing them to choose their own routes and pace. Each group had one prototype, and researchers observed how they appropriated and shared the device, examining distinct behaviours induced by the two different forms of prototypes. Researchers followed participants at a distance, recording video to analyse interactions with the device, among participants, and with the surroundings. They collected observational notes and interaction logs. Data was also collected through Post-tour interviews. Key learnings from the study reveal that familiar forms like

books which tourists often use reduced the novelty of the experience. While belt users engaged in more physical exploration of the site book users listened to more themes. Sound in place created shared and emotive experiences. The combination of crafted content and embodied interaction produces powerful effects and having choices for themes improved visitor engagement in interpretation. The research underscores the importance of co-designing interaction and content. Petrelli et al [179] concluded that effective heritage technology should offer multiple experiences, and engage them on physical, cognitive, and emotional levels. The researchers suggest rethinking technology design processes for heritage such as exploring multiple prototype forms to understand interaction effects, and simultaneously designing content and interaction for integrated experiences. The study also noted the challenge of designing technology that complements rather than competes with heritage.

In another study, researchers explored the integration of play and performative practices to craft mobile digital encounters that foster visitors' exploration and connection with art, the museum environment, and their companions. The motivation behind taking this approach was to create emotionally rich museum experiences. To achieve this, Ryding et al. [194] designed and developed a mobile application called *Never Let Me Go*, for use in any museum or gallery. This two-player system is intended for pairs of visitors, operating through roles of 'Avatar' and 'Controller,' with the option to swap roles every 10 minutes. The Controller can send commands or prompts to the Avatar via pre-recorded voice messages. These prompts fall into various categories, including basic action commands, body instructions, personal questions, imaginative prompts, and more. However, it is important to note that the app did not provide any official interpretation. The application was tested through a 40-minute field trial at the National Gallery of Denmark, involving 20 participants (10 pairs), followed by interviews. Observations and photos were also taken during the sessions. The results suggest that the use of the app intensified affective encounters by creating intimacy among pairs, enabling new emergent forms of connection between players and the art, and encouraging

players to engage in different body movements and explore space. The intense emotional response was also a result of new imaginations and relationship with art, and pushing the social boundaries of museum space through playful encounters. Based on these findings, Ryding et al.[194] suggested that, instead of designing for specific and defined relationships between people and people, people and art, or people and space—designers should focus on creating ‘emergent’ relationships that arise through persons creatively. They discussed the role of ‘ambiguity’ in design, as it can lead to ‘emergence’ by triggering a playful mindset, encouraging curiosity and exploration[79, 80]. The researchers also highlighted the significance of designing to support ‘intimacy’ in relationships, as it intensifies emotions. This research underscores the potential of using playful digital technologies to create more emotionally engaging and relationally rich museum experiences. This study presents a significant shift in heritage interpretation, emphasizing the emergent relationships and emotional engagement over the traditional practice of delivering official interpretations. This approach driven by notions of play challenges conventional practices and opens new avenues for designing heritage experiences that prioritize emotional richness and relational depth.

This review of these studies highlights the significance of designing mobile applications and novel devices that lead to physically, socially, and emotionally engaging experiences. A design approach based on tangibles, and the notion of play and performative practices can foster personal interpretation and emotional connections by increasing closeness between people and heritage elements, within group members and visitors and space. However, while introducing technology in this context, researchers have been concerned about balancing visitors’ attention and engagement between technology and heritage assets.

Across these studies, audio prompts or narratives were effective in encouraging performative and playful practices for intimate, sensory, and physical interactions; triggering reflection and imagination with displayed objects; and discussion among visitors. Nevertheless, only audio-based approaches are not always suitable. As discussed in previous studies, visual archival content can enhance the heritage

interpretation. Furthermore, hearing audio prompts in urban settings can be difficult due to environmental noise and concerns of disturbing passers-by. Thus, there is a need to explore methods that support the presentation of visual content while supporting playful and performative engagement.

Furthermore, implementing performative and playful practices through prompts presents challenges. Visitors often show reluctance to engage in such practices by following instructions. Therefore, prompts may not seamlessly translate to historic urban precincts, where social boundaries and rules may be perceived even more rigidly based on the users' backgrounds. In such settings, participants may be more hesitant to engage in theatrical performative actions. Alternatively, tangibles or artefact-based approaches may be a more subtle way of encouraging performative behaviours. However, exploring such novel approaches and designs that support experiential heritage practices in the context of historic urban sites has been largely overlooked.

Moreover, not everyone may be receptive to playful and performative heritage exploration. Visitors may find a lack of balance between play and learning distracting during the core activity of heritage interpretation. Future designs should consider user diversity and the need for coherent and balanced informative experiences when integrating such approaches.

The detailed analysis of localized interactions with specific exhibits, alongside concepts of designing for emergence, ambiguity, and intimacy, seems beneficial for crafting affective encounters in outdoor heritage sites. However, in historic urban precincts, factors such as noise, concurrent social activities, and the nature of heritage assets can distract visitors from heritage encounters. Further, historical narratives at such sites are embedded throughout the site, not just at points of interest (POIs). Therefore, new design strategies need to be explored to support emergent, ambiguous, and intimate encounters throughout the more complex, dynamic, and lived-in heritage sites such as urban heritage precincts.

2.3.8 Interactions for distraction-free mobile guides

As outlined in the previous section [2.3.6.2](#), many mobile guide designs have been driven by the need to address the loss of awareness caused by using screen-based smartphone displays while exploring museums. While the earlier discussion centred on mobile guide designs that tried to reduce device-induced distraction to enhance social interaction, this section examines studies and mobile guide designs specifically created to reduce distractions during the exploration of outdoor cultural heritage spaces, such as urban precincts.

The use of smartphone-based mobile guides requires users to pay attention to the screen of the device to read content or see navigational cues. Thus, their use while exploring points of interest (POIs) in cities can detract users from engaging with their surroundings. However, as discussed earlier, for satisfying heritage experiences, visitors must be aware, attuned and engaged (corporeally and emotionally) with their surroundings.

Using smartphones on the go can lead to divided attention, cognitive distraction, reduced situational-spatial awareness, increased inattention blindness, and risky behaviour amongst pedestrians [[105](#), [141](#), [161](#), [162](#)]. These problems are largely attributed to the "head-down" interactions with small display screens [[192](#)]. In addition to concerns about safety, these issues can compromise experiential quality while exploring historic urban precincts. Researchers have argued that such limitations make smartphone-based systems unsuitable for exploration in urban settings, as they interfere with visitors' ability to pay attention to and engage with their surroundings, and make their own discoveries of the place. This section discusses studies that attempt to address the challenge of balancing visitors' attention between mobile devices and their surroundings.

Though Sweep-Shake system [[192](#)] was not designed and studied for heritage context, it is discussed in this review as its interactions and features matched with a mobile guide designed for exploration of urban spaces, i.e. navigation in urban space and interaction with geo-located information. The system was developed to

investigate the potential of haptic feedback as an alternative to screen-based displays for exploratory navigation in physical environments. This approach aimed to reduce distractions, which are common when using screen displays to see navigational cues while walking. The system allowed users to explore/navigate their environment by pointing or sweeping the device across space to detect geo-tagged information. It offered a variety of vibrotactile effects as haptic feedback to indicate the presence and quantity of information at a location. It also allowed users to zoom in on specific areas to filter and select different types of data, such as text, images, videos, and audio content, using directional motions with the device. To evaluate the effectiveness of vibrotactile feedback for target discovery and filtering a comparative field trial was conducted with the Sweep-Shake and conventional map interface. The results demonstrated that haptic feedback was perceived as intuitive and effective enabling navigation without the constant need to look at a screen. However, it was found to be inefficient as compared to the visual system. Some participants likened the experience of using the *Sweep-Shake* system to a game of discovering locations and content. Researchers concluded that haptic feedback is a viable alternative to visual systems, enabling users to engage with both physical and digital worlds in a more immersive ‘heads-up’ manner. Additionally, users showed a preference for static text and images over audiovisual content, indicating a reluctance to engage with media that requires sustained attention while on the move.

Hornecker et al. [96] explored how mobile guides can enhance serendipitous exploration and discovery in urban settings. They developed a mobile application called *City Explorer* to support a mode of sightseeing characterized by wandering, wondering, and discovering a city like an intuitive and curious explorer. The application employed a proximity model and provided tactile alerts or audio alarms that intensified as users approached a point of interest and changed rhythm as they moved away. The main intention behind using a haptic-feedback system was to help users stay attentive to their surroundings and allow for the use of the system even while it was in the user’s pocket. The user feedback from a preliminary study of the system indicated that the proximity model needed further refinement.

Additionally, audio notifications were often inaudible in urban environments and were found to be distracting, suggesting that they could be eliminated.

To address the limitations of traditional visual guides and create an inclusive, accessible mobile guide for diverse users—such as the visually impaired and elderly, who may have difficulty with visual displays and touch screens—Szymczak et al. [211] developed a prototype called the *Lund Time Machine*. This prototype used tactile feedback to guide users by indicating direction and distance along the trail, while also delivering historical and cultural information through audio content. To enhance ease of use, the prototype also incorporated limited gesture controls. For example, users could shake the device to navigate through different options. Szymczak et al. [211] used Activity Theory to frame the device and inform the design and evaluation of the tourist guide application. Under this frame, the mobile guide was perceived not only as a tool for navigation and listening to audio but also as an interactive medium that enhanced users' engagement with the surroundings. The prototype evaluation was conducted with the elderly, visually impaired and children in the city centre of Lund city and at an archaeological excavation site in Uppåkra. Data collected through questionnaires, observations and audio-recorded conversations during the walks suggested that the vibration interaction and audio narrations were well-received, usable and satisfactory for most participants. Importantly, Participants were able to maintain focus on their surroundings, demonstrating that the guide enhanced rather than distracted from the experience.

To enhance the experience of discovering points of interest (POIs) in urban environments Ankolekar et al. [5] studied the potential of auditory cues, specifically musicons and auditory icons in comparison to traditional visual cues in terms of effectiveness, engagement, and emotional impact on users. The design approach involved creating distinct auditory icons (sound of object or activity) that represent different POIs and musicons (snippets of popular music) that evoke the POI's atmosphere. The rationale behind this approach was to explore the potential of musicons to provide a more engaging and pleasurable experience and

different types of auditory information to influence user experience. The prototype developed for this study included auditory icons, musicons, visual cues and mixed-modality cues delivered via a smartphone application. A comparative study with 15 participants revealed that auditory icons and musicons were error-prone and led to slower POI identification speeds compared to visual cues but were associated with higher engagement, fun and pleasure. Ankolekar et al. [5] suggest that musicons could be effectively integrated into location-based services to complement visual cues and enhance user experience. However, listening to audio cues in urban locations might be distracting and challenging [96].

To explore non-visual interaction techniques and implement a location-aware, wearable audio-tactile system that does not need users' visual attention Jylha et al. [119], designed a sensor-equipped tactile glove. The system provided audio-tactile cues about nearby POIs and guided users towards them using audio-tactile feedback. By pointing towards the POI user received a spoken description, with an option for a longer description. Like the design proposed by Hornecker et al. [96], this design also aimed to enhance the user experience by allowing free exploration and serendipitous discovery of POIs without pre-defined itineraries or direct mobile device interaction. The comparative study involved the use of the proposed glove prototype and a mobile guide app by 6 participants each to explore 13 POIs and two additional training POIs within a 0.12 km² area in a mid-sized city's tourist area. Data was collected to measure user efficiency, experience, and response times. Results indicated that the non-visual interface performed comparably to its visual counterpart in terms of efficiency. Although glove users' response times were slightly longer, the difference was not statistically significant. Both conditions yielded positive user experiences, with glove users demonstrating increased focus on their environment compared to baseline users. The study demonstrated the feasibility and potential of non-visual interaction techniques to enhance user engagement with their environment during urban exploration. The study also showed that users appreciate the autonomy provided by audio-tactile cues for exploring POIs. However, the small sample size limits the generalizability of the findings.

Hsieh et al. [99] explored the integration of visual augmented reality (VAR) and audio-haptic augmented reality (HAR) interfaces to enhance urban exploration. Their goal was to develop a system that allows users to focus on their surroundings rather than devices, by allowing them to switch between interfaces based on situational needs. Using an iterative design approach, the researchers created a prototype combining VAR and HAR interfaces. The VAR interface overlaid digital content onto a camera preview using on-device sensors, while the HAR interface employed a spatial sensing haptic glove for tactile feedback and gesture-based interactions and a headset for audio descriptions and icons. The study involved 36 participants exploring a historic city area, with 18 using the prototype and 18 using Google Maps as a control group. Participants completed tasks in three nearby squares, including locating and retrieving information about POIs. Data collected through questionnaires, video recordings, and interviews showed that participants frequently switched between interfaces based on situational demands. The VAR interface was preferred for quick, accurate information, while the HAR interface was favoured for overview and immersive exploration. The ability to switch between interfaces allows users to adapt to changing needs, enhancing their overall experience. Both systems equally supported pleasantness and presence. The research demonstrates the effectiveness of integrating VAR and HAR interfaces in urban exploration systems and emphasises the importance of designing flexible, multimodal systems that cater to diverse user preferences and contexts.

The primary aim of the aforementioned studies was to enhance user engagement with the physical environment during urban exploration. This was achieved by promoting more "heads-up" experiences through reduced dependence on visual interfaces. Additionally, some studies focused on supporting users' serendipitous discovery of points of interest (POIs) in urban settings. To accomplish these goals, researchers investigated alternative interaction methods for mobile guides using gesture, haptic feedback and audio cues.

The findings suggest that users generally appreciate the ability to focus on their surroundings rather than screens. Haptic and audio feedback emerged as effective alternatives to visual interfaces for navigation as well as content delivery.

Moreover, the combination of visual, and audio interfaces was useful as it allowed users to adapt to various contexts further enhancing the experience of heritage interpretation.

The may limitation of these designs is that they all rely on audio content barring one system [99] and utilise headsets for content delivery which have been found to socially isolate users [150]. Additionally, listening to audio notifications and narratives is challenging in noisy urban environments. Previous research has also shown that users find a combination of short text and images most engaging while exploring heritage sites [30, 116]. Thus an alternative approach that addresses visual distraction yet provides visual content needs to be explored.

2.3.9 Alternative Technologies for mobile guides

In addition to smartphones, newer portable devices such as smart glasses and mobile projectors are being considered by researchers to implement mobile guides. The primary reason for considering them is their ability to present information directly into the user's visual field and enable a seamless augmented reality experience. This section focuses on reviewing the findings related to these two devices in particular to evaluate their suitability for supporting social, playful and performative practices based on heritage interpretation.

2.3.9.1 Smart Glasses

Smart glasses allow users to view digital content directly superimposed and blended with the physical environment, which can be particularly advantageous in museum and heritage contexts as such non-intrusive presentation of information can facilitate a more immersive experience. Further, smart glasses can support the learning-based interpretation approach effectively. By presenting contextual and interactive information without pulling the user's attention away from their surroundings smart glasses reduce cognitive load and enable users to focus more

effectively. This enhances information retention and improves learning outcomes during city tours [130].

Motivated by the need to offer a distraction-free and more immersive experience, researchers have investigated the potential of smart glasses in supporting mobile interpretation within museum and heritage settings. The study of Litvak et al. [142] is most relevant to this thesis as they explored the use of smart glasses in an outdoor cultural heritage site. They selected EverySight Raptor cycling smart glasses for their lightweight, small form factor, and outdoor design qualities such as a tinted visor. Their app aimed to facilitate navigation between POIs using AR navigation aids and enhance visitor understanding and appreciation of cultural heritage sites through audio and video presentations. The study, conducted at the "Millennia Road" in the Hecht Museum in Haifa, Israel, involved 10 participants aged 18 to 65+. Data collection included direct observation and questionnaires focusing on user experience and satisfaction. Litvak et al. [142] found that smart glasses and smartphone-based guides were equally engaging in terms of media consumption, with no significant differences in audio and video usage. The participants using smart glasses were found to spend more time at POIs, possibly due to the users needing longer time to interact via touchpad on the arms of glasses. Despite usability challenges, researchers perceived smart glasses as promising technology for future cultural heritage site visits.

Despite the promising aspects of smart glasses, their use to support heritage experiences in outdoor cultural heritage sites presents several challenges. The small display size limits the amount of textual content users can read, and daylight can diminish the enjoyment of viewing videos [142, 151]. Furthermore, the private nature of the display makes smart glasses less effective for supporting collocated social experiences. Some users may also find the interaction techniques associated with smart glasses socially unacceptable, deterring them from using these devices in public settings [98, 127].

Given the current limitations of smart glasses concerning their usage for the exploration of outdoor cultural heritage spaces and the requirements for creating

memorable heritage experiences, they appear to be an ineffective solution. Currently, smart glasses are not well-suited for designing mobile guides that support social, playful, or performative heritage interpretation. To foster these interactions, smart glasses would need to rely on prompt-based strategies, which have inherent limitations [73, 194].

2.3.9.2 Handheld Pico Projectors

Handheld projectors are another technology that enables the mobile and pervasive augmentation of the physical surroundings with digital information through projected display without the need for onsite installations [239]. Being handheld, these devices afford the possibility for embodied interaction with augmented reality [147]. Moreover, projected displays are inherently public, providing a shared view of content for multiple people. Betsworth et al.[20] describe handheld projectors as "performative technology," suggesting that the way users operate these devices becomes a performance for others to observe. Their capability to engage users physically with their surroundings and support social interaction makes handheld projectors a suitable mobile device for use as mobile guides. Their use can enhance the experience of heritage walks and deliver rich, meaningful heritage experiences.

The efficacy of handheld projectors to support social experiences within the group and with bystanders during heritage interpretation activity [20, 134] has already been discussed in the previous section. With a similar intent, i.e., to enhance the tour experience while maintaining group cohesion, Hakkila et al. [87] explored using a combination of Pico projectors and fiducial markers to display augmented reality (AR) content during guided tours. In their study, a Pico projector was used by the tour guide to dynamically project fiducial markers near heritage buildings. Tour participants used an AR viewer application on Android devices to view the relevant augmented multimedia content. This prototype was tested with 27 participants across six tour groups on a university campus tour, comparing four information delivery methods: traditional paper posters, projected posters,

printed paper fiducial markers, and projected fiducial markers. Although the paper marker solution was most preferred (41% of participants), the novel projected and marker-based technique was considered more fun and interesting than traditional posters. While the paper poster ranked highest for ease of use, the projected marker solution created the strongest link between the guide and the audience. Despite challenges with lighting conditions and image stability, the projected marker technique showed the potential to enhance tour experiences. However, this study focused on using handheld projectors for projecting fiducial markers by tour guides rather than their use as mobile guides to be used by visitors.

To complement guided visits at the Refugi 307, a bomb shelter from the Spanish Civil War Schaper et al. [196] used co-design methods to create a digital heritage experience using handheld projectors. The study involved 40 children from a local primary school who participated in a guided visit to the shelter followed by a workshop. The final interactive digital content was designed such that it requires students to engage in embodied exploration while projecting it onto the physical environment and reflection. The data was collected during the trial of the prototype in the bomb shelter through observations of children's behaviour, video interviews, and children's drawings using low-tech prototypes as well as semi-structured interviews with teachers and guides. It was found that the use of handheld projectors to project content on the walls of the shelter engaged children's imagination and allowed them to empathise with the historical context. Overall it enhanced their connection and understanding of the events of the Spanish Civil War. This study demonstrated the potential of handheld projected media to facilitate meaningful relationships between the learning experience and the cultural heritage site, though the study was limited to children in an indoor setting.

Kidd [124] implemented and studied "With New Eyes I See" (WNEIS), which allowed users to project archival materials and other media onto historic public buildings and the natural environment of a park in Cardiff, UK. Participants were given a map and a mocked-up old military torch containing a projector, speaker, and smartphone that interfaced with RFID installations at various locations corresponding to the narrative. Data collected through post-walk focus

group discussions suggested that WNEIS supported a multimodal form of exploration, allowing participants to touch, listen, and feel, making the experience fun and engaging. Participants felt more involved and attached to the content. The ambiguity brought in by the presence of certain unplanned elements in the physical space was used by the participants to enhance their interpretive experience. Furthermore, WNEIS altered the relationship between the participants and the physical space as occasionally participants felt they were in a different time. Most importantly WEINS allowed for the creation of embodied and tangible digital heritage encounters with loose fragments in outdoor environments and transformed the nature of heritage interpretation and experience.

These studies collectively indicate that handheld projectors have the potential to introduce performative forms of exploration, significantly enhancing user engagement and interpretation of the heritage sites through embodied and social interactions. Handheld projectors' capability to support dynamic projections of digital content onto physical surroundings can be used to present information in a contextually relevant manner, engage users' imaginations and enhance the interpretive experience. Projects like WNEIS demonstrate that handheld projectors can support multimodal exploration of heritage sites, allowing users to touch, listen, and interact with the environment in diverse ways. This multimodal engagement can make the heritage experience richer, more immersive, and more memorable.

However, handheld projectors can be affected by lighting conditions and image stability issues. Bright environments or uneven surfaces can diminish the visibility and clarity of the projected content, impacting the overall effectiveness of the technology.

Overall, there is a limited exploration of handheld projectors in heritage walks across different heritage settings. More research is required to gain a reliable understanding of the efficacy and influence of handheld projectors on user engagement and experience during heritage walks, particularly in outdoor heritage settings such as historic urban precincts.

2.4 Conclusion

The conclusion of this chapter synthesises key insights regarding the use of mobile guides for experiential outdoor heritage interpretation, while highlighting a significant gap in the literature. While numerous studies have explored mobile technologies for heritage sites, most research has focused on solving technical challenges, such as navigation and location-awareness, and enhancing learning through digital augmentation. However, there remains a limited understanding of how these technologies can support more holistic, multisensory, and social heritage experiences that go beyond mere information delivery. This gap is particularly evident in the context of outdoor heritage sites, such as historic urban precincts, which offer unique opportunities for embodied, social, and spatial interactions that are often underexplored by existing mobile guide solutions. One of the most pressing issues identified in this chapter is the predominance of learning-centric approaches to heritage interpretation. While early mobile guide systems such as *GUIDE* and *Cyberguide* focused on context-aware, personalised learning, they often overlooked the diverse motivations visitors bring to heritage sites, including emotional engagement, relaxation, and social bonding. Moreover, much of the evaluation of these systems has centred around usability and information delivery, neglecting the rich multisensory and affective dimensions of heritage experiences. Visitors engage with heritage sites not just to learn, but to feel a connection to the past, enjoy the atmosphere, and create personal memories through bodily movement and social interaction. Another gap is the limited exploration of how mobile guides can support embodied experiences—those that arise from sensory and physical interactions with the site. While some research has addressed these needs, such as the designs proposed by Fosh et al. [73] and Wakkary et al. [232] that enhanced users' sensory awareness and actively engage visitors' bodies in the experience. Outdoor heritage sites, with their open spaces and lived environments, offer prime opportunities for embodied encounters, yet many mobile guides are still designed with a museum-centric approach that encourages passive observation rather than active,

physical exploration. The literature also lacks sufficient focus on how mobile technologies can enhance social interactions during heritage visits. Studies like *Sotto Voce*, which enabled shared audio experiences in museums, offer valuable insights into how technology can foster togetherness and collective meaning-making. However, there is a notable dearth of research on how these social affordances could be translated to outdoor environments, where interactions with not only companions but also locals and other tourists can significantly enrich the experience. Given that most visitors come to heritage sites with family or friends, it is crucial that mobile guides facilitate not just individual learning, but shared experiences that foster social cohesion and community-building. Furthermore, the research on playful and performative practices remains limited. While some systems, such as *REXplorer*, have experimented with gamified experiences to encourage playful exploration of historic sites, these are exceptions rather than the norm. Play and performative actions, such as walking tours that involve storytelling or re-enactment, have the potential to transform how visitors engage with heritage sites. Yet, mobile guides have been slow to adopt these experiential, non-didactic approaches, often defaulting to task-oriented designs that prioritize structured learning objectives over open-ended discovery and creativity. The review also reveals a significant gap in research on aesthetic and place-making experiences. While some studies have explored the aesthetic potential of mobile guides, particularly through augmented reality (AR) systems that visually reconstruct historic sites, there is a lack of attention to how these guides can foster a deeper sense of place. Heritage sites are not just collections of artefacts; they are lived environments that evoke memories, emotions, and personal connections. As discussed in this chapter, place-making involves more than simply viewing historical facts—it requires an appreciation of the site’s material, sensory, and social dimensions, all of which are underrepresented in current mobile guide designs. In conclusion, while the literature on mobile guides for heritage interpretation has made significant strides in addressing technical and informational challenges, it has yet to fully embrace the potential of these technologies to support rich embodied and sensorial interpretation and immersive experiences. Future research should focus on developing mobile guides

that not only educate but also engage visitors in embodied, social, and affective experiences. This shift towards experiential interpretation could enhance the emotional and sensory richness of heritage visits, particularly in outdoor settings like historic urban precincts, where the physical, social, and atmospheric qualities of the site are integral to the visitor experience. To fill this gap, future work must investigate how mobile technologies can be designed to support multisensory engagement, foster social interactions, and encourage playful and performative practices that contribute to a more holistic and memorable heritage experience.

Chapter 3

Going for a walk: Process, Methods, and Ethics

3.1 Introduction

This chapter describes the research design in relation to research objectives and the studies carried out during the PhD. Subsequent sections present the details of the methods used (i.e., participant observations, semi-structured interviews, etc), the process of data collection and analysis procedures. The chapter concludes by addressing steps undertaken to ensure the work is ethical and reliable.

3.2 Research goals

As discussed in the previous chapter, multifaceted experiences such as the embodied, social, space – place and aesthetic experiences and multidimensional practices such as walking, performative practices and play contribute to personally meaningful, memorable, and rich heritage experiences.

When visitors use mobile guides during heritage walks, these mobile devices get integrated into their performative and walking practices at the site and influence

their heritage interpretation [76, 160, 179]. These mobile devices influence users' awareness, embodied engagement with the space, social interaction and emotional response during such visits and ultimately affect their heritage experience.

Previous research has primarily concentrated on the design of app features and content to shape visitors' interactions with heritage sites. However, there is limited understanding of how different mobile devices used for mobile guides during heritage walks specifically impact visitors' physical and social engagement, as well as their emotional and cognitive responses.

Given these observations, this thesis aims to develop a deeper understanding of the influence of different mobile devices on visitors' engagement so that this understanding can be used to inform the design of new mobile devices/artefacts which can be used as mobile guides or 'technological companions' during on-foot heritage exploration. The key research questions were:

1. How do users adapt, make use of or incorporate mobile devices with different affordances/characteristics in their heritage interpretation practices during outdoor cultural heritage walks?
2. How do mobile devices with different affordances/characteristics shape visitors' heritage interpretation practices during outdoor cultural heritage walks?
3. How can we design mobile artefacts that motivate multidimensional engagement and intertwine with users' experiential practices during heritage walks at outdoor cultural heritage sites?

To address the first two research questions, empirical studies were carefully planned and conducted. In contrast, the third research question necessitated a generative approach. The following section discusses these in further detail.

3.3 Research approach and process

The first two research questions of this study mandated understanding how users make use of their varied affordances and how these different characteristics influence their encounters and heritage experiences during a heritage walk in an outdoor cultural heritage setting. The review of technological devices used as mobile guides for cultural heritage exploration and interpretation in Chapter 2 indicated that mobile projectors-based guides can offer contrasting characteristics and influence users' behaviour in different ways compared to a smartphone-based guide. Smartphones have become common everyday technology devices which provide a private view of content whereas mobile projectors which are still perceived as novel naturally afford shared display of information. Secondly, the projected display of a mobile projector is physically blended and seen as part of the physical environment. This is in sharp contrast to the distraction and digital divide from the surroundings experienced by users while using smartphone screens. Thus, it was decided to include these two devices in the study.

Thus to address the first two research questions, 3 empirical studies were planned and conducted (see Table 3.1).

- Study 1: Heritage walks with smartphone
- Study 2: Heritage walks with a mobile projector
- Study 3: Group heritage walks with mobile technologies

As shown in Table 3.1, **Study 1** and **Study 2** aimed to understand the individuals' use and influence of smartphone and handheld Pico projectors (referred to as mobile projectors) respectively while using location-aware applications during outdoor cultural heritage site explorations. **Study 3** shifted focus to group dynamics, examining how the two devices (smartphones and mobile projectors) influenced togetherness, collaboration, and interaction among group members during their

TABLE 3.1: Summary of the three user studies conducted in the thesis

	Objectives	Methods	Data Gathering	Analysis Method
Study 1	Influence of smartphone on users' embodied, social and affective engagement	Field trial, Observations, Semi-structure interview, Drawing	Audio records, Video records, Participants' Drawing	Thematic Analysis
Study 2	Influence of mobile projector on users' embodied, social and affective engagement	Field Study, Observations, Semi-structure interview, Drawing	Audio records, Video records, Participants' Drawing	Thematic Analysis
Study 3	Influence of different mobile technology on Group dynamics – cohesion, interaction and collaboration	Field trial, Observations, Semi-structure interview, Questionnaire	Audio records, Video records, Experience Maps, pre and post-questionnaire	Thematic Analysis

visits. Together, these studies aimed to understand the influence of mobile technologies on both individual and collective behaviours, thoughts, and interactions in the context of heritage site exploration.

To understand these different dimensions such as embodied, sensory and social encounters and emotional responses and grasp users' experience of heritage and technology from a subjective point of view a multi-method and qualitative methodological design was adopted.

As discussed in Chapter 2, users' experiential heritage interpretation practices and heritage experiences, are interlinked and arise from their engagement with the physical, social, cultural and atmospheric qualities of the heritage site. Further,

when mobile guides are used they get intertwined in users' corporeal, social and cognitive meaning-making processes with physical outdoor spaces of the heritage site [76]. Therefore understanding how users incorporated the mobile guides in their meaning-making process and conversely how mobile guides affected their encounters, involvement and engagement, during heritage walks in outdoor cultural settings required observation of a broader range of situated activities [76].

As shown in Table 3.1, To observe participants' entanglement with mobile devices and heritage sites, a field study was conducted. Observational data was gathered through video recordings of the walk across the three studies. However, not all aspects of the experience can be captured through observation alone. To gain insight into participants' subjective perspectives during the heritage walks, they were asked to create drawings of their favourite moments during studies 1 and 2. For the third study, participants were asked to write down the highlights and low points of their walk on a loose sheet of paper. However, it yielded poor data. Thus highs and lows sheer were not used for analysis in study 3. Additionally, to understand the influence of mobile guides on users' encounters and their heritage experience, it was necessary to consider affective aspects such as emotions, memories, imagination, attitudes, feelings of agency, and motivation. Therefore, post-walk interviews were conducted for which data was collected in the form of audio recordings.

In addition, to the above a pre-walk survey was used to collect general information about the participants which included their age, gender, level of familiarity with the site, motivation for participating, previous experience of heritage walks, as well as their anticipation of the heritage walk.

For the last study, a post-study questionnaire was implemented to collect quantitative data about the user experience of the mobile guide. However, the data was not included in the final analysis as the quantitative evaluation and comparison of the two modalities was not the focus of this research.

Across the three studies, the qualitative data in the form of observations, interviews and drawings were utilised to understand and contrast the user's ways

of leveraging the affordances of two distinct mobile devices for their encounters, imaginations, entanglement with the site and social interactions. The data allowed us to understand why users' practices were influenced in certain ways during the walk and ultimately how it affected the subsequent heritage experience. These findings were then utilised to conceptualise a set of design considerations for the conceptualisation of a new mobile guide to support experiential practices during pedestrian exploration of outdoor cultural heritage sites.

The third research question was concerned with generating new approaches for designing new mobile artefacts that could encourage multidimensional engagement and integrate with users' experiential practices at outdoor cultural heritage sites. This required a method that was generative and allowed for creative synthesis. Drawing from design practice, the speculative concept design [18] method was adopted as it allowed for innovation-oriented creative exploration within a framework and context. Speculative concept design allowed for the exploration of potential ideas and design possibilities through creative and organic integration of the empirical findings from the heritage walks, analysis of existing mobile guide designs and theoretical frameworks from heritage studies. Crucially, the process of generating speculative design concepts was instrumental in synthesising design directions and making otherwise theoretical and abstract knowledge more accessible and useful to designers [18].

3.3.1 Research design and method

Researchers in mobile-HCI and heritage-HCI have been evaluating prototypes in a real-use situation to understand user behaviour, emotions, and thoughts [98, 124, 154]. It is now well understood within HCI that social and cultural factors of the context, influence participants' behaviour, use of interactive technology, and attitude, and shape their experience while they perform a task or activity [44, 90, 96]. Studying interactions in the field provides researchers with an opportunity to get a sense of how users would naturally use the system in a

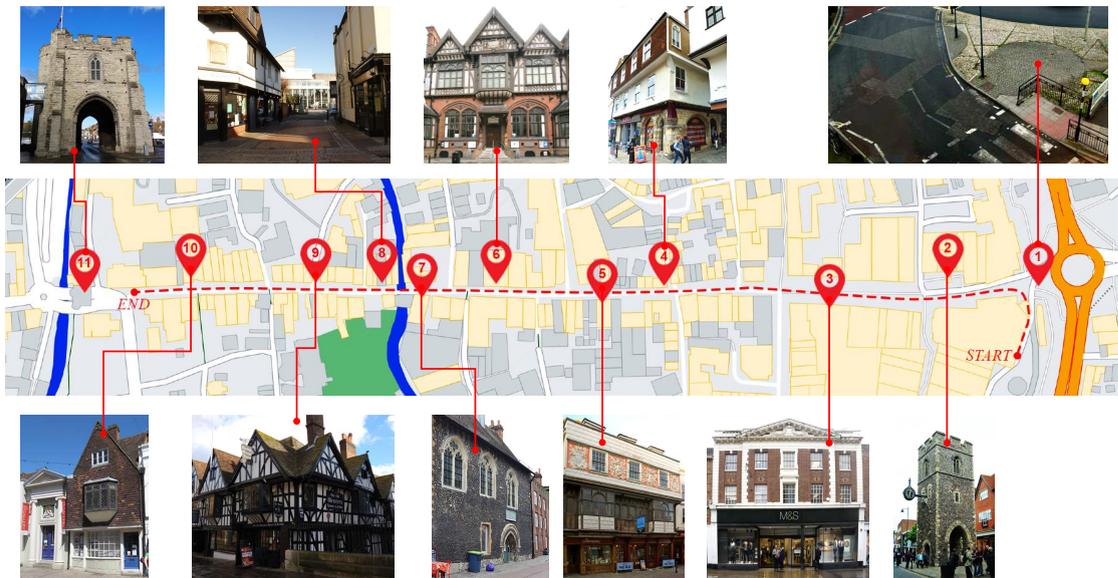


FIGURE 3.1: Map of the Heritage Walk indicating the route and locations of the selected points of interest.

given context and how the interactive systems would perform in real-world scenarios (where things are ever-changing and less predictable). Public deployment of interactive systems allows researchers to observe how users interact with physical space, with bystanders, and how bystanders behave and react towards the technological interventions, something that would not have been possible in a controlled setting [20, 83, 134, 147].

Likewise, all three studies in this thesis aimed to observe and understand participants' expectations and motivations; their interaction with the device, other people, and the environment; and the emergent feelings and thoughts within the real-world context. To study the phenomenon in a real context, all the experiments were conducted as a field study comprising heritage walks through a historic urban precinct - High Street of Canterbury City, UK.

3.3.1.1 Location, route and POIs

High Street of Canterbury City was selected due to a number of reasons. Foremost, the High Street provided an authentic heritage visit experience. It is already a popular tourist destination being adjacent to a UNESCO World Heritage site. It

contains many POIs in the form of heritage buildings associated with war history, religion, art, and culture, which also act as specimens of architectural style. Many of these buildings are included in some of the commercially offered heritage walks in the city. Secondly, As a multi-use public space, it allowed for observing the influence of the socio-cultural aspects of the space on users, interactions with bystanders, and reactions of passers-by. Thirdly, the High Street is primarily a pedestrian street. Due to very limited access for motorised vehicles, the risk of accidents was minimal and it was easier to ensure the safety of participants during the study. Lastly, as an approximately 800-meter-long straight street, it was a reasonable length to walk in terms of distance and duration.

For the three studies, the heritage walk consisted of eleven POIs (see 3.1). The selection of POIs or heritage buildings was influenced by their historical and cultural significance as well as the need to ensure an even distribution across the length of the route. Additionally, the number of sites also seemed to be an optimal number for the duration of the walk. The POIs represented different time periods and were in different physical conditions. Two heritage buildings were completely nonexistent, some were partly visible and had been adapted for a different use, and others were still in use as originally intended. Though none of the buildings were part of mainstream historical narratives they were deeply linked to the local history of the Canterbury City.

3.3.1.2 Design of application and device

During the walk, participants used a location-aware Android application (see Figure 3.4) on the smartphone or mobile projector. The application was designed and developed specifically for the study.

While the aim of the studies was not to evaluate an application design or the influence of content and media on the visitor's heritage experience, a new customised app was developed as there was no existing application for the chosen study location. A series of decisions were taken to accomplish the task.



(A) View of content on 1st slide with text and current picture.

(B) View of content on 2nd slide with visualisation of its past state.

FIGURE 3.2: The two images show the type of content presented to the user at the heritage sites

Instead of providing a navigational guide within the app or through a physical map, At the start of the walk, participants were verbally briefed about the route (which was fairly straight) and the landmark which marked the end of the walk. This approach reduced the need for users to frequently check their screens, minimising distractions from their surroundings [155]. Another reason for adopting such an approach was to promote wandering, curiosity, and discovery during street exploration [96, 119]

During the walk, the app notified users through audio and haptic feedback when they approached a POI, typically within a 9-meter radius. Haptic feedback was specifically included to ensure notifications were noticeable even in noisy urban environments, where audio cues might be inaudible, or distracting [96].

Notifications were followed by the display of media content which included a brief (40 to 50 words) along with a recent image (See Figure 3.2a) and a historic image of POI (See Figure 3.2b). The text was based on information on the 'Canterbury Historical and Archaeological Society' website. The content included in the app consisted of an interesting historical fact related to the site and a brief explanation regarding its historic significance. Wherever possible or needed, a second slide was used to draw users' attention to a unique aspect of detail of the built heritage. The tone of the text was kept neutral focusing on information and facts. It was kept short as users favour shorter segments of information [58, 155, 240].



(A) View of content on 1st slide with text and current picture and historic figure

(B) View of content on 2nd slide with a picture of revealing interiors of the building.

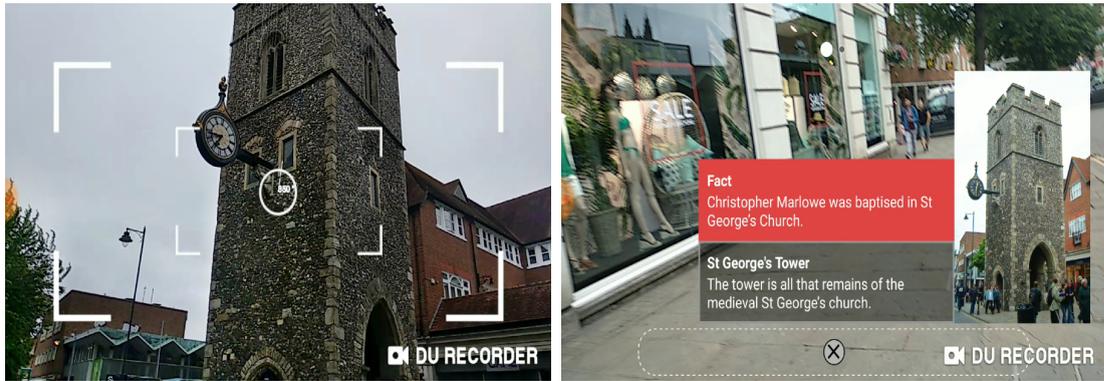
FIGURE 3.3: The two images demonstrate the inclusion of images that introduce a historic figure and hidden details

The decision to use a combination of text and images was based on the finding that combining images with text is more effective at retaining users' attention and engagement than using only text or audio-based media content [116, 192].

A significant number of studies have adopted audio as media for mobile guide apps as it gets integrated into the place [160]. However, the reason for opting for text over audio was that in studies conducted in urban settings users generally preferred reading short text rather than listening to audio [30] showing reluctance to engage with 2-3 minute audio or video that demands sustained attention while walking [58, 160, 192] or cause feelings of awkwardness and anxiety [240].

Audio narration was also excluded because headphones tend to create isolated experiences during urban heritage exploration [240]. Moreover, users feel uneasy about playing audio on loudspeakers in public spaces, fearing they might disturb passers-by [13].

Recent images of buildings or landmarks were included to help users locate the POI on the street [240]. Additionally, old photographs were included as they have been found to support learning about history [30] and enable comparison of the past and present state of built heritage [129]. As shown in Fig Figure 3.3b, for some locations, images that magnify small details, represent historic figures and reveal interiors of buildings where participants cannot enter were also added [116].



(A) View of the user interface while walking.

(B) View of the user interface with content.

FIGURE 3.4: The two images show the graphical interface of the Android application as seen while walking and at the heritage sites

As shown in Fig Figure 3.3a, wherever possible descriptions and images of historic figures were included in the content as such figures tend to act as a medium for remembering and connecting with the specific buildings [13].

The app's content was intentionally not designed as a narrative. Content with narrative characteristics can affect users' heritage encounters and experience [124]. From the perspective of this study, incorporating a narrative would have increased the complexity of the study, making it harder to assess the influence of the mobile device on emotional responses. Additionally, a narrative-based approach can highlight the fragmented nature of locative media experiences and lead to user disengagement, as the storytelling is interrupted while users move from one POI to another [240]. To eliminate the effects of the narrative qualities of the content on users' engagement and emotional response, the content was presented as a discrete informative piece at each POI, instead of an interconnected narrative that continued across all POIs.

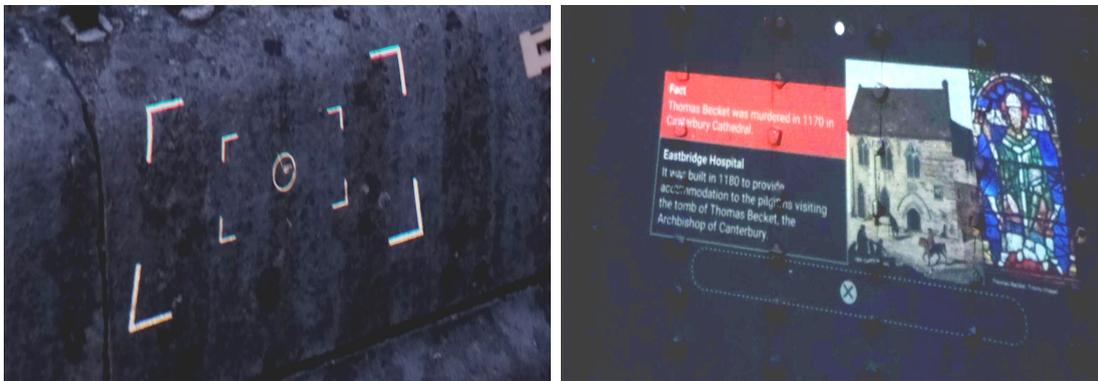
On the app interface, the Information was presented in the form of one or two slides which participants could swipe through on the smartphone screen. Fig. 3.5b) shows the layout on the smartphone's screen and Figure 3.6b, the view of media content as seen by mobile projector users. A simple swipe and tap interaction was designed for the app as users have expressed a preference for minimal engagement with the device while exploring outdoor sites [93, 181].



(A) View of the smartphone user interface while walking.

(B) View of the smartphone user interface with content.

FIGURE 3.5: The two images show the graphical interface of the Android application as seen by the user on the screen of the smartphone while walking and at the heritage sites



(A) View of the projected user interface while walking.

(B) View of the projected user interface with content.

FIGURE 3.6: The two images show the graphical interface of the Android app as seen by the user on the projected display while walking and at the heritage sites

As shown in Figure 3.5a, while walking, the interface on the smartphone displayed camera feed was overlaid with a viewfinder graphic. Whereas the interface for the projector only displayed the viewfinder graphic on a black background which acted as a transparent background when projected. As shown in Figure 3.6a), the mobile projector users saw the viewfinder overlaid on their surroundings. The layout of the interface was kept in landscape orientation across both devices to maintain consistency.

The prototype mobile guide with the projected display (hereafter referred to as **mobile projector guide**), comprised a smartphone and a wirelessly connected



(A) Grip to direct projection on the floor.



(B) Case for smartphone & projector.



(C) Grip to direct projection on the wall.

FIGURE 3.7: A custom-made case for *projector guide* housing a smartphone and mobile projector. The 3 images show the design of the case to house the smartphone and projector and the possible ways to grip the integrated casing

mobile projector (LightBeam 200C). As shown in Fig. 3.7, both devices were placed in a custom-made case, so that users could perceive and use them as a single integrated device. Both the devices were deliberately concealed to reduce the visible presence of technology [185], encourage tangible, embodied interactions, and create a more immersive experience [179]. However, a small opening was left so that users could interact with the application. The design of the casing was not made to resemble any familiar object such as a flashlight [124], as doing so could have unknowingly introduced new affordances to the mobile device. The perpendicular relationship between screen and projection is not ideal [35]. Instead, based on the context of use, users may prefer an inclination. As participants were going to use the device during a heritage walk in a street, it was assumed that they would prefer to project either on walls or the floor while walking. To identify an optimal angle between the screen and projection 5 users were asked to hold the phone and projector in two configurations:

- Ideal angle between the projector and smartphone's screen while projecting on the wall such that users could maintain a natural wrist position while holding the device and interacting on the screen.
- Ideal angle between the projector and smartphone's screen while walking such that the projection is on the floor without straining the wrist. At the same time, the projection is visible without bending down and yet not very far away from the user in the space.

The preferred configurations were photographed. The inclination angle between the smartphone and projector across different users and the two configurations was measured and averaged using those photographs. Based on the outcomes of this activity, the inclination angle of 45° was finalised for the prototype. In field studies, it is impossible to maintain the consistency of lab settings. Undeniably, each walk was unique as factors like crowd density, weather, street activities and more, varied during every walk. However, the device, app and physical location helped in maintaining consistency in study conditions during all the walks and data collection.

3.3.1.3 Participants

Participants were recruited based on their fitness to walk, age (18-35 years) and capability to give informed consent. Selection criteria were not based on participants' characteristics such as gender, ethnicity, education level or occupation. The focus on specific age groups was kept to maintain homogeneity in the sample population so that findings could hold true for the chosen segment of the population.

Participants were pre-recruited due to the difficulty of being able to reliably recruit people in public spaces. They were recruited via a call for participation which was advertised through various university mailing lists. For the first and second studies, individual participants were recruited, while for the third study, participants were recruited in groups and pairs. It was ensured that different individuals participated in each study so that none of them had prior experience with the app or the projected display system.

To ensure that as many themes as possible emerge from the data, the first and the second study was conducted with 21 different participants each. The third study focused on studying different group scenarios, 1) pre-acquainted groups of four using a mobile projector, 2) pre-acquainted pair using a mobile projector, and 3) pre-acquainted pair using a smartphone. As sufficient data about user behaviour was available from individual walks, we decided to run 3 sessions of data collection for each group scenario. Thus, 24 participants were recruited for the third study. A total of 66 people participated in the study.

All participants were university employees and students who had either lived in the city for a period ranging from 1 week to 8 years and/or had visited the High Street prior to the experiment for various purposes, such as shopping or socialising, but only one participant had visited it for a heritage walk (touristic purposes).

		<i>Data collection Methods</i>			<i>Day</i>	<i>Place</i>	<i>Dur. (mins)</i>
		Study 1	Study 2	Study 3			
		<i>Device</i>	Smartphone	Projected Display	Projected Display		
<i>Configuration</i>	Individual	Individual	Group and Pair				
Pre-walk	Researcher met the participant at the predefined venue for the field session. Participant was provided with the following: - Participant information sheet and Consent form - Introduction to application and device - Briefing on activity, etiquette and safety guidelines	1. Personal Information	1. Personal Information 2. Pre-walk Questionnaire 3. Personality Questionnaire	01	Street	15-20	
During Activity	Participants walked in High-street with the device.	3. Video observation	4. Video observation	01	Street	15-20	
Post-walk:	After the completion of the walking activity, participants were immediately invited for post-activity data collection at a nearby café.	5. Audio-recorded semi-structured interview 6. Drawing End of the session with giving of the Gift voucher.	6. Post-activity survey 7. Experience Map 8. Audio-recorded semi-structured group interview End of the session with giving of the Gift voucher.	01	Cafe on High Street	30-45	

FIGURE 3.8: Procedure of data collection.

3.3.1.4 Procedure

For the study, participants were invited to the outdoor location for the heritage walk. All the walks were conducted in the evenings, however, the walks with the mobile projector took place in the late evenings (after dark) to accommodate for the projector's display limitations during the daytime. As shown in the Figure 3.8, before the walk, participants were briefed about the data collection process, activity, route, app features, and safety precautions (see Appendix C). They read the participant information sheet and signed a consent form (see Appendix B & Appendix J) approved by the ethics committee of our institution. Demographic

information was captured for each participant to collect an accurate representation of the pool of participants. Specifically for the third study, the participants also filled out a pre-walk questionnaire (see Appendix E & Appendix F).

After receiving the consent, participants were then given the device and shown how to use the application interface. The number and names of POIs were not shared beforehand to engage participants in a curiosity-driven exploration of the street and POIs. To facilitate a more natural scenario, participants were not given any specific instructions about using the device or time limit other than to look out for their safety. For consistency, the application was installed on a single device, and all participants used the same smartphone.

During the walk, the researcher did not get involved or intervene in the activity except to answer participants' questions regarding the walk or address other concerns (e.g., rain). This position was taken so that participants did not get distracted or influenced by the researcher during the activity. The researcher followed the participants and captured **video-recordings** with a handheld video camera while maintaining a distance of 3 to 5 meters.

As seen in Figure 3.8 after the walk, participants were invited to a nearby cafe for a semi-structured **post-activity interview or group interview** (see Appendix A & Appendix D), conducted to gain further insights into their experiences. The audio recorded interviews lasted for ca. 30 minutes in studies 1 & 2 and .ca 20 minutes. During the first and second studies, as an additional activity, participants were invited to draw a significant or memorable moment from the walk and to include themselves in the drawing. For the third study, in addition to the interview, participants were asked to write down the highlights and low points of their walk and fill out a post-walk questionnaire (Appendix G & Appendix H). Each participant got a £15 gift voucher at the end of the data collection session. The amount was chosen to match the 90-minute time frame required to complete the research session - to offer a sum substantial enough to entice participation but not so large as to exert undue influence.

3.3.1.5 Pilot Study

Prior to running the first study, a pilot field study was conducted with 5 participants to evaluate the practicality of research methods, procedure and design and to improve the quality of the research by identifying weak points in the procedure.

The pilot study provided the researcher with valuable experience in conducting field studies and dealing with various data-gathering methods. During the walk, the researcher was mostly behind the participants. As a result, recording the participant's facial expressions was difficult. However, by conducting trial studies researcher was able to devise a strategy to capture participants' facial expressions when they stopped at the POIs. Because they knew where people may stop, the researcher determined the best places to position themselves in order to record participants' facial expressions (see Figure 3.9b).

Certain questions were also added or rephrased based on the experience of conducting interviews. During the trials, the drawing activity was introduced after the interview. It was found that participants were not enthusiastic about receiving another activity after the interview. To overcome this hurdle the drawing activity was integrated with the interview. Following the change, participants perceived the drawing as part of the interview rather than as a separate activity. They approached it with more enthusiasm. From the standpoint of data collection, it was found that integrating the drawing activity with the interview made the interview discussion richer as drawing refreshed participants' memories of the walk and elicited richer responses.

3.3.1.6 Speculative Design Ideation

While the previous research design catered to research questions 1 and 2, a new methodological approach was required to address research question 3. For his research concerning the design of playful technologies, Bertran [18], generated a collection of speculative design ideas as a knowledge form to inspire and propose

alternative ways of approaching future technology designs for playful HCI. He contends that such speculative ideation is “*a necessary alternative that will enrich the design and research space with new and valuable ideas*” [18]. The purposes and process behind generating new ideas for mobile guides/artefacts to support experiential heritage interpretation practices in outdoor cultural heritage sites were inspired by his work and the researcher’s first-hand experience of designing. The process followed for the development of speculative designs involved several key steps such as creative ideation, back and forth between literature, findings from heritage walks and ideas for defining design objectives, and finally, concept design development. Based on the design considerations synthesized from theory, literature review, and empirical findings, the researcher set out to explore mobile interactive technology ideas that could respond to the kinds of encounters that people seem to long for during exploration of historic urban precincts and outdoor cultural heritage sites in general. An initial pool of design ideas was generated individually by the researcher in response to the key findings from the various heritage walks. This ideation activity aimed to creatively and freely explore and respond to opportunities for intervention drawn from the design considerations and a broader understanding of visitors’ intentions during their exploration of outdoor cultural heritage sites. This process resembles the early stages of a design activity, where the focus is on generating a wide range of ideas without focusing on feasibility. At this stage, instead of crafting well-defined solutions, the ideas were created in the form of ambiguous concepts that could serve as provocative starting points for further development. Subsequently, the ideas with similar goals or intentions were clustered by affinity. This led to the emergence of the 5 design directions presented and discussed in this thesis. Throughout it was ensured that the ideas and the design directions remained related to or aligned with the design considerations that emerged from the findings of the heritage walks, and facets and practices of experiential heritage interpretation. The final design concepts presented in the thesis were selected from the initial pool of ideas and further developed while ensuring that align with the respective design directions. Refinements were made through discussions with research colleagues, who were not part

of the study, allowing for collaborative input and extension of ideas.

3.3.2 Data collection and analysis

All three studies required methods that enabled collecting data which could be used for understanding relationships between user and technology, user and space, and user and passers-by as well as users' thoughts and feelings. Therefore, a variety of methods, such as ethnographic methods like in-context observations and in-depth interviews, creative methods like drawing and experience maps, and questionnaire surveys, were used to collect data during the studies.

The reason for using these different methods of data collection was that while questionnaires, interviews and observations gave access to explicit information, drawings gave access to implicit information which was felt by the user but not explicitly observable by the researcher and articulated by the user. Further, using multiple methods allowed for the triangulation of evidence from observations, interviews, and drawings and helped arrive at more accurate and robust findings that were simultaneously supported by multiple data sources. In the following sections, each method of data collection, and approach and process of analysis of the different data types are discussed in further detail.

3.3.2.1 Video recorded observation

The facets of heritage experience comprising embodied experience, social experience, space-place experience and experiential heritage interpretation practices such as slow and environmentally attuned walking informed the overall grounding for the collection and analysis of observation data. As discussed in Chapter 2, the ability to use body movements and gestures to express and explore leads to embodied experience and embodied meaning-making. Such exploration and meaning-making of physical/material and social aspects of space is the foundation for the space-place and aesthetic experience, and ultimately the heritage experience.

To understand the effects of using mobile interactive technology on the embodied, social and place-based encounters during an activity, HCI and museum studies researchers have collected video observations of users' in situ actions and encounters [20, 134, 147]. To study users' embodied engagement with the device and space, embodied meaning-making of the site and social interaction, researchers have observed and analysed aspects such as users' use of the device, path of movement in space, orientation, movement, and gesture in relation to the heritage and their companions, interaction within the group, and orientation and position of users with respect to each other during the activity [134, 147, 208]. To study visitors' interest in the different exhibits and the whole exhibition, researchers have measured halt duration (time spent in each location) [133] and total walk duration [25, 199].

Thus, to study the users' use of the device and the influence of the two devices on visitors' encounters and experience of the site (High Street and POIs), the following aspects were identified for observation and analysis:

- Users' use of spatial resources of the physical environment, including time spent while walking and at the sites, path trajectories while walking on the street, and gestures, orientation and position in relation to POIs
- The cultural influence of the space over the user
- Users' behaviour and actions of using and manipulating the devices
- The use of interactive artefact during the activity including exploratory gestures using the device while walking
- The influence of the device and its affordances over the user's actions
- Use of the physical/digital environment during the activity
- Duration of the whole visit as well as halt at a POIs
- Use of space, orientation, proximity and gestures to support sharing, communication and coordination with passers-by/ bystanders and group members including



(A) Researcher following the participants during the heritage walk.

(B) Researcher standing at a distance from participants at a POI.

FIGURE 3.9: The two images show the researcher collecting video observation data during a study session

- Interaction between passers-by and participants

To collect the observation data, video recording was used for the three studies. Videos enabled a detailed view of each session and allowed the researcher to playback and observe situations that may have been missed when conducting the study.

The videos were recorded from the time participants started the walk to the time they finished using the application at the last POI. As shown in the Figure 3.9, during the video recording it was ensured that sufficient distance was maintained between the researcher and the participant to avoid influencing the participants' behaviour. The video recordings for smartphone users did not provide information about what was being seen on the screen by the user. To compensate, a screen recording of the smartphone was captured and combined/inserted with the video observation to derive the reading duration for smartphone users.

To begin the analysis, all video observations were reviewed, and specific episodes were selected for in-depth examination [147, 208]. The selected episodes helped in understanding how the two mobile technologies, with their different display modalities, either supported or limited the participants' ability to intertwine their actions with the surrounding space and place. These episodes were chosen to illustrate participants' movements and gestures with the device and environment. Each episode

Behaviour while walking	Location	Behaviour at location	Durations (Secs)	
<u>Path</u> Kept walking on a straight path. Changed path to negotiate with physical obstacles and pedestrian traffic from opposite direction but always returned to actual line of path. Made an awkward pass through a group near location 6 as gaze dropped into phone after receiving notification.	Loc 1	Did not trigger	Reading & Viewing	N.A.
			Halting	N.A.
	Loc 2	Did not turn Did not walk closer	Reading & Viewing	20
			Halting	18
	Loc 3	Did not trigger	Reading & Viewing	N.A.
			Halting	N.A.
<u>Gaze</u> Largely kept looking straight ahead or down on the path. Sometimes shifting gaze to either side (left side dominant) for short durations and occasionally shifting gaze down towards the screen	Loc 4	Did not turn Did not walk closer	Reading & Viewing	23
			Halting	23
	Loc 5	Did not turn Did not walk closer	Reading & Viewing	23
			Halting	22
<u>Use of Device</u> Held the device steady and still in hand below the chest height with one hand	Similar Transcription was undertaken for Loc 6 to Loc 11 as well.			
	Whole walk			757

FIGURE 3.10: Example of transcription of video observation of a smartphone user.

was broken down into image sequences, capturing aspects such as body movement, orientation, proximity, gestures, use of the device, and gaze with respect to the physical environment. These actions were then interpreted within the context of the heritage walk activity. Moreover, video observations were transcribed to note users' behaviour patterns as shown in Figure 3.10. The transcription included notes on the following aspects:

- path taken during the walk
- time taken to complete the walk
- behaviour at each POI
- halt time at each POI
- use of the device during the walk and at POI

Video recordings were used to measure the duration of the walk and halt periods. To extract the 'total walk duration', the researcher measured the time taken by the participant to walk from one specific landmark on the street to when the participant closed the information for the last location on the app. The 'halt duration' i.e. the time spent by the participant at each heritage building, was

calculated from the time participant came to a complete stop after receiving the notification to the time when the participant started to walk away, even if they might maintain visual attention towards POI or if the information display was still on. Any movement made by the participant after the complete stoppage and before they walked away from the POI e.g. to find a better surface to project on or to walk towards or away from the POI to get a better view of the site were considered as activities towards the POI and therefore included in the halt duration for a site.

During the walk, the participants received relevant digital information at each site. Participants spent a substantial part of their time reading the information about the site. That time was measured as ‘reading duration’, i.e. the total time spent by the participant looking at and reading the displayed information. It was measured from the time information was visible to the time participants last looked at the information with the intent to read. Sometimes participants forgot to close the information slide after leaving the heritage building. Such events were not included in the reading time. The time during which the participant was glancing or looking at the site was excluded while measuring the ‘reading duration’. It was measured separately as ‘site viewing duration’; i.e. the number of total time participants paid direct visual attention to the site. This was the total of all the glances made by the participant towards the site to locate it on the street or to observe it.

Observations belong to non-verbal methods. Thus, observations do not enable researchers to gain insight into aspects of personal experiences and meaning associated with bodily movement within the physical space. To overcome these limits the video observation was complemented with other methods such as individual / group interviews and participant-produced drawings.

3.3.2.2 Semi-structured interviews

Interviews are a well-established qualitative method in HCI and heritage research. They were used in this study to elicit rich details about people’s thoughts, feelings,

and experiences of the activity and the prototype. Interviews were scheduled immediately after the heritage walk so that the participants' memories, thoughts, emotions, motivations, and concerns were still fresh. 1:1 interviews were conducted for the first and second studies, and group interviews were done for the third study to explore and understand group dynamics.

The interviews were conducted in a semi-structured format. This allowed for consistent data collection across participants as well as the flexibility to pursue unanticipated themes. Accordingly, all the participants were asked the same set of questions based on predefined research themes (see Appendix A & Appendix D). Additionally, probing questions were posed based on participants' observations, views, and feelings, which were unknown to the researcher prior to the interview. Participants were also asked additional probing questions based on observations made by the researcher during the walk.

All interviews were audio recorded. The researcher transcribed all the interviews verbatim to ensure accuracy. Para-language was not transcribed unless it was deemed relevant to understanding participants' meaning. After transcripts were prepared, they were again verified against the audio recordings to ensure accuracy. In a handful of instances where audio passages could not be discerned, they were indicated as **unclear** on transcripts.

Subsequently, to apply thematic analysis [27], -i.e. to find patterns and themes - the transcripts were manually coded. According to Braun and Clarke [27], codes are the smallest meaningful items (containing words, word groups, sentences, or paragraphs) that inform research questions. Before coding, the transcripts were read a few times to gain familiarity with the data. Initially, codes were derived from notions of embodied, social, space - place and aesthetic experience. Some of the aspects related to participants' experiences that were coded include:

- Experience of walking with and using the device
- Experience of the street and the POIs
- Experience of using the device

- Awareness of social activity and social experience
- Perception of the impact of their activities on passers-by around them.
- Desires, motivations, and disappointments during the activity
- Perception of the cultural situation of the space
- Experience of heritage walk

During the initial round of open and unorganised coding, codes were added to capture all the significant aspects that were reported by participants, such as attitudes and habits of using mobile devices while walking. After a set of codes were in place, the second round of coding was undertaken to refine and reassign codes. This process enabled the researcher to be more open to unanticipated findings and reduce their bias.

After the coding, patterns were analysed by mapping codes in relation to each other and grouping them into potential themes. The themes were drawn and defined based on the data as well as considering the literature. According to Braun and Clark [27], a theme is not dependent on a quantifiable measure but is based on its ability to capture something important about the data concerning research goals. In the thesis, the findings are presented using participants' quotes in the context of the researcher's analytical frame, orienting information, and followed by analysis. The quotes were selected to represent a wide range of users as well as contrasting examples.

3.3.2.3 Drawings

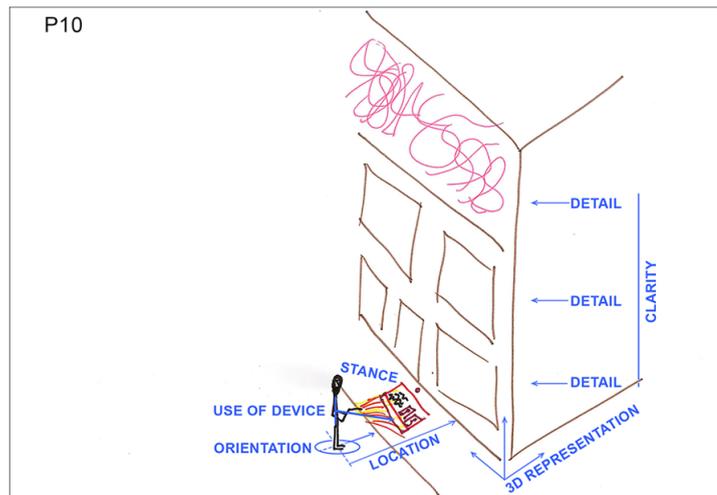
Drawing as a tool for data collection can complement interviews and in-situ observations. The use of visual methods in conjunction with verbal research methods offers a way of exploring both the multiplicity and complexity of human experience [86]. The cognitive process required to draw evokes specific memories and leads to a more succinct presentation of the key elements of participants' experiences [121] enabling the researcher to collect rich representation.

Within, HCI researchers have employed **drawings** to gain a qualitative understanding of users' somatic awareness [95, 122, 169], their experiences of the technology [70] and their perception of geographical space [201]. Janelle et al. [7] analysed participant-produced drawings to identify aspects users focused on and physical actions performed during the interaction. Researchers have also used drawing to study users' postures while interacting as well as situations of interaction [165]; social configurations and roles within a group while using interactive technology [196]. Such use of drawings as a tool for collecting data and analysing themes motivated using it during the post-activity interview.

The drawing was only used in the first and second studies. During the interview, participants were asked to sketch of a significant or memorable moment from the walk, including themselves on a blank A3 paper. Participants were given very little guidance on what to draw. During the drawing and after the drawings were done, they were discussed with the participant, to ensure that the right interpretation of the drawings was made [71, 121].

A concern among researchers about the use of drawing is the participants' reluctance to draw as they may perceive the activity to be childish or they may be self-conscious about their ability and feel embarrassed [71]. To overcome these concerns and make participants comfortable participants were reminded that the purpose of the activity was not to test their drawing abilities. Another concern about using drawings as data has been regarding extrapolating valid and reliable findings from them. However, we used drawing as a complementary research tool with in-situ observation and interviews.

While analysing the drawings, the goal was to observe the embodied, social, space – place and aesthetic experiences of the participants. Therefore drawings were analysed for their content [148, 201]. Content analysis is “*a research technique for the objective, systematic and quantitative description of the manifest content of communication*” [17]. It is used to determine the presence of certain words or elements (in the case of drawing), themes, or concepts within the qualitative data. Accordingly, the representation of elements related to bodily movement, device,



(A) A coded drawing



(B) Image from the video used to verify the stance of the participant

FIGURE 3.11: An example of how drawings were coded and how the codes were verified against video recordings

physical space and social experience was observed in the drawing. As shown in Figure 3.11 the drawings were analysed for the following aspects:

- Participants' awareness of their body stance at/in relation to the site To study participants' proprioceptive and egocentric location (body-space relation) awareness, drawings were coded for representation of aspects related to body stances such as posture, gesture, orientation, and location with respect to their POI and surroundings.
- Participants' awareness of physical/material qualities of the POI/street To evaluate participants' visual and spatial awareness of their surroundings, drawings were coded for representation of space (3D or 2D), representation

of scale (loose/fair/good), and level of clarity and detail (limited/fair/good) [138].

- Participants' awareness of social activity To evaluate participants' social awareness, we coded the drawings for representation of passers-by and users' social interaction with passers-by.
- Elements that played a key role in shaping their experiences. To identify elements that played a key role in shaping participants' experiences, drawings were coded for aspects or elements that were in key focus such as the device and its use, POI, people, information, etc.

To ensure the reliability of the drawing-based data, participants' representations of themselves in the drawing were verified against video records of the same moment before initiating coding. After an initial round of doing, the heuristics of applying the code were further refined for clarity. Based on the revised heuristics, codes on a few drawings were modified for consistency. After coding all the identifiable elements in the drawings, the researcher counted how many times each element appeared in the drawings to identify the patterns in the drawings of each group of users and infer the difference in attitude and focus towards the activity, their surroundings and the device. The key elements in the drawing such as the POI, street, social interaction, device or interrelationship between them were used to identify the significant aspect of the users' experience.

The challenge of coding the drawings was that they were implicit and therefore more complicated. To address the issues of reliability and validity, rules for coding and interpretation of the elements or the relationship between elements based on the context were clearly defined.

3.3.2.4 Questionnaires and experience maps

In addition to the methods described above, for Study 3, we used pre- and post-walk questionnaires with a Likert scale to collect data on users' perspectives and

experiences before and after the heritage walk. Though both questionnaires featured an identical set of questions concerning users' expectations, privacy-related issues, and the social impact of using the device, the post-walk questionnaire had a few extra questions about actual experience of using the device. Further, questionnaires were also adapted slightly for different devices (see Appendix E, Appendix F, Appendix G & Appendix H). On the basis of these quantitative scores, a simple analysis was performed to compare users' opinions before and after the walk, as well as while using two devices with distinct display modalities.

To obtain open-ended qualitative data about the highs and lows of the heritage walk an **experience mapping** activity was employed before the interview. We provided each participant with an A3 sheet with a map of the street in the middle and urged them to note their reflections and thoughts related to spots of their choice on the street. However, due to the quantitative nature of the data for questionnaires, they were not included in the final analysis and data from the experience maps was not found suitable for analysis.

3.4 Credibility and transferability

When doing qualitative research, ensuring credibility, i.e., giving a true account of the phenomenon of the findings is crucial. During the study, participants create different truths while walking and later while reflecting on their individual experiences of the heritage. To ensure credibility the method of data collection and analysis has been clearly described. To ensure that interpretation is holistic and representation is true, the researcher attempted to take multiple participants' points of view into account, without giving more importance to one point of view than the others [46]. A sufficiently large sample size was recruited for each study that provided access to as many experiences (points of view) as possible, and the researcher stopped only after 'saturation' (no new phenomenon was revealed by further data collection) was reached.

Additionally, a multimethod approach was taken for data collection which allowed for the triangulation of data from observations of the walks, interviews and drawings. This multimethod approach for data collection helps mitigate the limitations of individual methods which have been discussed in previous sections. Triangulation of data helped gain an additional perspective, overcome the limitations of one method, strengthen confidence in collected data and ensure the trustworthiness of the findings [34, 184].

Another challenge with qualitative research is to ensure transferability of the findings to a different context. The experiences captured in the studies in this thesis are attached to the time and context. To ensure that the results are meaningful to other researchers, a rich description of participants and research context has been provided in the chapter [46]. The emergent themes have also been richly described and findings have been related to existing literature. Thus the findings can be applied to similar contexts such as cultural heritage with some limitations, but they may still produce comparable outcomes.

3.5 Methodological limitations

In any research, limitations are inevitable and must be acknowledged to ensure transparency and validity of the findings. This study has several key limitations that may affect the generalisability and interpretation of the results, including the lack of participant background information, the specificity of the study site, and variations in environmental conditions during data collection. However, various strategies have been employed to address these limitations and enhance the robustness of the findings.

One significant limitation of this study is the absence of detailed participant background data, such as prior experience with mobile technology or cultural heritage sites. Without this information, it is difficult to fully contextualise user engagement and responses. For instance, participants with greater technological proficiency may have found the mobile guide easier to use, while those less familiar

with technology could have faced challenges in incorporating it into their meaning-making process.

Additionally, participants with prior exposure to cultural heritage experiences may have found it easier to form a deeper connection with the site, affecting their interaction differently than those with less exposure. These factors limit the ability to generalise the results across broader audiences with diverse backgrounds. Triangulation of data helped mitigate this limitation, as it allowed for comparing observational data, interviews, and creative drawings to identify consistent patterns and form a deeper understanding of users' experiences, regardless of participants' background knowledge. Furthermore, in-depth engagement with the data during the analysis allowed for capturing nuances in language and behaviour, which offered indirect insights into participants' technological comfort and familiarity with heritage experiences.

A second limitation of this study is the specificity of the study site, which was restricted to a single urban heritage precinct. The characteristics of urban environments, such as their spatial arrangement, density of points of interest, and fast-paced dynamics, may not apply to other heritage settings, such as rural or natural sites. This limits the generalisability of the findings to other types of outdoor cultural heritage settings where user behaviour and engagement while using mobile guides might differ significantly. To address this, wherever necessary the findings have been framed with contextual specificity, clearly acknowledging that the results are highly relevant to urban settings but may not hold in different environments. While discussing the findings, the researcher has also tried hypothesising how user behaviour might change in other types of heritage settings, such as rural or natural landscapes. In addition, recommendations for future research are provided, suggesting the need to explore a wider variety of heritage environments to test the robustness of the findings across diverse contexts.

The third limitation of the work is that the participants recruited in all three studies were not tourists. This was due to the challenges and ethical implications associated with finding and recruiting such participants. Study participants were

from different cities and countries, and had varying levels of familiarity with the High Street of Canterbury. However, all the participants volunteered and self-recruited for the study and were genuinely interested in the heritage walk offered during the study. Hence, they had a similar motivation as an actual heritage site visitor.

Lastly, since the findings are based on qualitative data, there is a risk of biases while interpreting and coding these data, which could have an impact on the accuracy of the findings. To overcome these issues to a certain extent, firstly, a sufficient number of participants were recruited. Secondly, while analysing the interviews, videos and drawings, the data was iteratively coded inductively instead of fitting the data into the pre-defined framework. Lastly, the data from all three modalities was triangulated to verify the interpretation and corroborate the findings. While the study faces limitations, including the lack of participant background data, type of participants, and site specificity, various strategies have been implemented to mitigate their impact. Data triangulation, rigorous coding, contextual framing, and comparative analysis have all been employed to strengthen the study's findings.

3.6 Research ethics and safety

This research adhered to the guidelines of the Central Research Ethics Advisory Group at the University of Kent. The first and second studies commenced following the approval # 0401819 of the study protocol by the ethics committee in March 2019 and were completed by September 2020. The third study began in December 2021 following the ethics approval # CREAG004-11-2021 and was completed by August 2022. To comply with the ethical standards, all the studies began by informing the participants about: 1) the voluntary nature of their participation and their right to withdraw at any time; 2) methods of data collection; 3) who would have access to the data; 4) storage of data; and 5) steps that will be taken to maintain the confidentiality or anonymity of participants while publishing the

findings. Following that, informed consent was obtained from all the participants before commencing the study and data collection.

In addition to video observations, audio-recorded interviews, and drawings, personal data such as names and contact details were collected during the study. Personal information of the participants was not shared with anyone and was deleted once the analysis was completed. All the data was stored on secured servers at the University of Kent.

One of the challenges of conducting these studies was the participants' health and safety as well as the risk of disturbing passersby. Using mobile devices in public spaces may distract participants' attention, and they may not pay attention to traffic and pedestrians. Several precautions were taken to minimise the health and safety risks. Participants were informed about the dangers of using a mobile device while walking in the city and advised to stay alert. Participants using the projected display were advised to avoid projecting towards the faces of passersby. As discussed earlier, the location was also selected such that it had restricted motorised vehicular traffic. Lastly, as the researcher was following the participants during the walk, they could intervene if a risky situation arose.

A significant ethical challenge of the study was collecting video observations in outdoor public spaces. It raised concerns because various passers-by and their recognisable facial data would be captured inadvertently. To inform the passers-by, the researcher wore a large sign announcing that a video recording for research purposes was in progress (see Figure 3.12). The researcher's email address was also displayed on the sign so that passersby could contact the researcher to discuss their issues or worries. The researcher also made their best efforts to avoid recording vulnerable individuals. All the facial data was blurred before publishing any images.



FIGURE 3.12: Researcher with a handheld camera and wearing a 'recording in progress' sign during data collection

3.7 Conclusion

This chapter has provided an in-depth outline of the research methodology used to address the research questions guiding this PhD study. The chapter presents and justifies the selection of research methods based on the specific context of the study and the nature of the research questions, which aimed to explore how mobile devices influence heritage experiences during on-foot explorations of cultural heritage sites. By detailing the research approach, the chapter demonstrates how the chosen methods align with the objectives of the study and explains the practical implementation of these methods for data collection and analysis.

The chapter first discusses the selection of empirical methods such as participant observations, semi-structured interviews, and creative activities like drawings. These methods were chosen for their ability to capture the multifaceted nature of participants' interactions with mobile devices, their physical environment, and social context during heritage walks. The research design was organised around three empirical studies, each focusing on different aspects of mobile device use—individual and group dynamics. This was further complemented with the use of creative method of speculative design to address the last research question.

The chapter also outlines the analysis procedures, including thematic analysis, and the rationale behind combining qualitative methods to provide a holistic understanding of user experiences. Furthermore, the chapter identifies and addresses methodological limitations, such as the absence of participant background data and the specificity of conducting the study within a single urban heritage precinct. It describes strategies employed to mitigate these limitations, such as data triangulation and careful contextual framing, ensuring the findings remain robust and meaningful despite the constraints.

In summary, this chapter provides a clear structure for the research methodology and establishes the rationale for the methods chosen, highlighting how these methods effectively address the research questions. Through a detailed explanation of the research approach, design, data collection, and analysis, as well as a transparent discussion of limitations, the chapter ensures the credibility of the study and lays the foundation for understanding how mobile devices influence user engagement during heritage explorations.

Chapter 4

Heritage walks with smartphone

The aim of this chapter is to investigate how smartphone mobile guides influence users' exploration, engagement and meaning-making with heritage sites such as urban historic precincts during heritage walks. Taking a phenomenological perspective on meaning-making, this study aims to explore the impact of smartphones on bodily engagement, spatial awareness, and social interaction, to understand how smartphone guides affect embodied and place-based heritage interpretation practices.

The motivation behind this study stems from the growing integration of mobile technology such as smartphone-based guides (hereafter referred to as smartphone guides) into cultural heritage experiences. As discussed in section 2.3 of Chapter 2, various studies have explored different approaches and designs for smartphone guides. The predominant approach while designing these guides has been education-based heritage interpretation, where the primary aim is to help users acquire new knowledge.

Alternatively, researchers have highlighted the importance of bodily engagement material and tangible environments during outdoor cultural heritage exploration in enabling embodied forms of heritage interpretations which emerge from a deep and personally meaningful understanding of cultural heritage [44, 72, 179]. While

smartphones provide easy access to information, they can disrupt bodily engagement with heritage sites [179].

To design mobile guides that not only facilitate but also enhance these embodied and place-based practices, it is crucial to study and analyse users' bodily movements while they interact with heritage environments. Insights into users' embodied and spatial practices—specifically, how they physically engage with and respond to the heritage space while using mobile guides—provide a foundation for designing mobile guides and interactions that can leverage users' natural movement patterns. This understanding can enable researchers and designers to deliver immersive and contextually relevant experiences for mobile guide users during outdoor cultural heritage exploration.

However, little is known about how smartphone mobile guides, with their screen-based display, might alter users' embodied and spatial interactions during urban heritage walks. The study seeks to bridge this gap in knowledge by focusing on users' physical responses, their movements, and how these are mediated by the presence of a smartphone. The main research questions addressed in this chapter are:

1. How do smartphone mobile guides influence visitors' bodily engagement with their surroundings during a heritage walk?
2. To what extent do mobile guides enhance or detract from visitors' spatial awareness and social engagement with the environment?
3. How do everyday smartphone habits affect users' embodied and spatial practices in an urban heritage walk context?

The first results section of this chapter discusses the walking patterns of participants, highlighting the predominance of hurried, non-exploratory walking behaviours among smartphone users. The next section focuses on how the use of smartphones disrupted participants' experience of space, reducing their engagement with the surroundings and leading to feelings of isolation. This is followed by

an analysis of participants' embodied engagement with points of interest (POIs), showing that while some users interacted meaningfully with the heritage sites, most exhibited superficial awareness, prioritising the device over their surroundings. The chapter also addresses how participants appropriated the smartphone in different ways, from using it as a scanner to enacting playful behaviours, though such engagement often waned as the walk progressed.

This chapter underscores the dual role of smartphones as both facilitators and barriers to embodied heritage interpretation. While they enhance access to information, smartphones can also isolate users from the sensory and social dimensions of heritage sites. The study's findings suggest that smartphone mobile guides, as currently designed, often hinder deep engagement with the environment. The chapter closes by discussing the need for mobile guide designs that aim to support users' embodied, spatial, and social interactions with heritage spaces.

4.1 Study

To study the influence of a smartphone on visitor's embodied and spatial heritage interpretation practices, individual participants were invited to undertake a heritage walk on Canterbury High Street using the prototype location-aware application (see 3.3.1.2 of Chapter 3). The field study was conducted with 21 participants - m1 to m21, aged 18-35 (11 female, 10 male) (see Table 4.1. As described in Chapter 3, the researcher met the participants at the start of the heritage walk at a pre-designated location on Canterbury High Street. Before the walk, participants were briefed about the data collection process, activity, route, app features, and safety guidelines. To facilitate a more 'natural' scenario, participants were not given any specific instructions about using the device, a time limit or any guidelines other than to look out for their safety. Participants were free to walk as they liked and for as long as they liked on the predefined route.

To collect data on participants' embodied, spatial and social behaviour, the researcher video recorded the participants [134, 147, 191] by following them during

TABLE 4.1: Participants

Participant	Age	Gender	Time spent in Canterbury (months)
m1	18-24	female	30
m2	18-24	female	30
m3	18-24	female	09
m4	18-24	male	09
m5	25-29	male	10
m6	25-29	female	48
m7	25-29	female	12
m8	18-24	female	36
m9	30-35	male	17
m10	25-29	female	24
m11	30-35	male	51
m12	25-29	female	84
m13	25-29	female	01
m14	30-35	male	0.5
m15	30-35	female	30
m16	18-24	female	48
m17	18-24	male	02
m18	25-29	male	02
m19	18-24	male	36
m20	25-29	male	02
m21	18-24	male	12

their walk. To understand their thoughts and feelings during the walk, a semi-structured interview was conducted immediately after the walk at a nearby cafe. To collect data regarding their awareness and engagement with the heritage site, participants were to create a drawing of a self-selected moment.

4.1.1 Data analysis

The focus of the analysis was participants' embodied and spatial actions with the device, the site and the POIs during the heritage walk. Modes of bodily engagement, such as navigation, orientation and gestures, in relation to the site and POIs lead to embodied and spatialized understanding and meaning-making of the cultural heritage [72, 208]. Total walk duration and time spent by the visitor in each location have been considered an indicator of their interest towards the exhibits and the whole exhibition [25, 199]. Thus, to understand how smartphones

influenced participants' embodied engagement and appreciation of the space (High Street), the following aspects were analysed:

- User's path on the street while walking
- User's exploratory gestures using the device while walking
- Time spent by the user to walk across the site
- User's orientation in relation to the building at the POI
- User's movements to reach towards or further from POI to appreciate the building
- Gestures made by the user towards the POI
- Time spent at each site

Relevant episodes were selected from the video observation and decomposed into image sequences to analyse the above-mentioned aspects in the context of the activity of heritage walk [147, 208]. Interviews were thematically analysed [27] and coded for the following aspects to compliment the observational findings, with the understanding of participants' intentions for actions and personal experiences:

- Experience of walking with the device
- Experience of the street and the POIs
- Experience of using the device
- Awareness of social activity
- Perception of the impact of their activities on passers-by around them.
- Desires, motivations, and disappointments during the activity
- Experience of heritage walk

To complement the explicit findings of interviews and in-situ observations, the analysis of drawings was aimed at understanding the tacit experience of participants such as somatic awareness of movement [72, 95, 122, 169], their experiences of the technology [70] and their perception of geographical space [201], awareness of the situation of interaction [165]. Drawings were analysed for their content [17, 148, 201] for the following aspects:

- Users' awareness of their body's stance (posture, gesture, orientation, and location) at/in relation to the site
- Users' awareness of physical/material qualities of the POI/street through the representation of space (3D or 2D), representation of scale (loose/fair/good), and level of clarity and detail (limited/fair/good) [138].
- Users' awareness of social activity through the representation of passers-by and social interaction with passers-by.
- Elements that played a key role in shaping users' experiences such as device and its use, POI, people, information, etc.

To ensure the reliability of the drawing as data, users' representations of themselves in the drawing were verified against video records of the same moment.

4.2 Results

Based on the combination of data (i.e., videos, drawings, and post-activity interviews), the findings are categorised and presented into the following themes:

1) *Pattern of walking*; 2) *Awareness and feelings of 'being there'*; 3) *Embodied engagement and meaning-making*; and 4) *Social engagement and experience*.

Participant	Number of POI triggered	Total duration of the walk (min:sec)
m21	10	10:08
m10	11	10:18
m11	11	10:19
m12	8	10:35
m13	9	10:44
m2	9	10:55
m1	9	12:38
m4	10	12:39
m3	10	12:57
m17	11	13:03
m19	10	13:19
m18	10	13:23
m16	9	13:25
m15	8	13:38
m7	10	13:40
m8	9	14:08
m9	9	14:31
m6	11	14:32
m5	10	15:11
m20	11	19:01
m14	10	20:46

FIGURE 4.1: Total duration taken by each smartphone user to complete the heritage walk

4.2.1 Non-exploratory and hurried pattern of walking

As discussed in Chapter 1 and Chapter 2, not just the POIs but the whole space of the historic urban precinct (in this case the Canterbury High Street) contribute to the visitors' heritage and visit experience. Walking slowly and in attunement with the environment plays an important role in allowing people to observe, become aware, appreciate, reflect on and understand the surroundings laying the ground for embodied interpretation (dialogue with the cultural past) and aesthetic experiences of the heritage site [64, 217, 242]. Thus, the pattern of walking and the nature of the bodily engagement that smartphone users had with their surroundings were observed through video recordings.

It was found that the users typically exhibited non-exploratory and hurried patterns of walking. Usually, the typical time to walk 800 meters (the length of the heritage walk from start to end) without stopping is ca. 10 minutes. The researcher verified this by walking across the street multiple times. m20 (2 months, m) and m14 (1 year, m) completed their heritage walks in almost double the time as compared to the standard walking duration. Of those two, m14's long walk duration was the result of them spending substantial time stopping, approaching, and observing each site with deep attention. However, m20 kept reading the information on the app while walking causing them to walk very slowly however their engagement with the POIs was low. At the POI they often paid more attention to the device than POI. m8 (3 years, f), m9 (1.5 years, m), m6 (4 years, f), and m5 (10 months, m) took ca. 14 minutes 30 seconds to finish the walk. 10 participants whose duration of stay in Canterbury ranged between 4 years and 2 months took marginally longer to finish the walk averaging ca. 13 minutes. However, as seen in Figure 4.1 5 participants completed their walk through High Street in almost the same time as standard time. It can be suggested that their prior acquaintance with the site influenced their walk time. Their stay durations in Canterbury were 8 years (m12, f), 4 years (m11, m), 2 years (m10, f), and 1 year (m21, m), the only exception being 1 month (m2, female). Among these 5 users, it was observed that while walking and after the content was triggered, their attention was largely focused on the device. Their stops at the POIs were either very brief or they did not stop. These users who walked rapidly acted more like locals who were more interested only in learning new information about specific POIs, whereas those who took longer, for example, m5, m6, m7, m8, m9, m14, and m20 acted more like tourists who were interested in exploring the place [155].

The analysis of the total duration taken by each smartphone mobile guide user to complete the heritage walk shows that most users engaged in a form of walking that is generally employed when the goal is to efficiently reach a destination, even though there was no time limit for the heritage walk. The observation of videos reveals that users maintained a non-exploratory path and a hurried pace while walking from one POI to the next. They only diverted from the path to negotiate

physical obstacles and pedestrian traffic from the opposite direction, often returning to their original trajectory after passing the obstacle. This behaviour can be attributed to the convenience smartphones offer, allowing users to engage with content while walking, a flexibility that many users took advantage of. Similar findings have been noted in previous studies, where it was observed that users often begin walking while still listening to audio guides rather than lingering at a POI to finish absorbing the information. Instead, they [58, 160]. Likewise, in line with previous findings, it was observed that many participants skipped reading through the parts of the content, preferring to move ahead [58].

Results indicate that a majority of smartphone mobile guide users generally moved quickly through the space. They missed the opportunity to make observations of the place, admire, explore, discover, and interact with POI and enjoy the atmosphere of the street by walking in a non-exploratory manner.

4.2.2 Disrupted experience of space and place

Users reported that using a smartphone-based mobile guide during the walk not only distracted them from their surroundings but also interfered with their ability to fully engage with the heritage site. It was observed that 12 out of 21 smartphone users (m1, m4, m5, m12, m13, m14, m15, m16, m8, m18, m20, m21) regularly kept glancing at the screen while walking in anticipation of notification as confirmed by the participant who reported that during the walk *“I started to look at the screen most of the time to see if it started popping the thing [notification and information] up”* (m6). Another participant described the effects of these regular shifts in attention: *“it was definitely taking away my eyes from the street down to the screen at times when there was nothing on the screen. So, in that sense, it definitely took away some engagement with the street”* (m4).

It is not surprising that the majority among these 10 users (m1, m4, m5, m8, m12, m15, m16, m18, m20, m21) chose to maintain a *blasé attitude* [74] towards their surroundings, i.e., instead of paying attention to the surrounding they only



FIGURE 4.2: m15's walks awkwardly through a group as their focus is on the screen.

paid selective attention to the surroundings or kept looking straight to support their navigation. Previous work has reported the cocooning and blinding effect of smartphone use where individuals mentally isolate themselves from their surroundings [105, 141, 225]. As observed in Figure 4.2, after the notification, m15's focus shifted to reading the information on the screen. They lost the awareness of a group of people approaching them. By the time they noticed the group, it was too close. As a result, they had to awkwardly walk through the group, instead of avoiding it (see frames 4 to 8). After crossing the group, m15 immediately stepped on the side of the street as a corrective measure (see framed 9 & 10). Only a few participants who as previously discussed maintained a touristic approach during the walk (m3, m7, m9, m11, m13, m14, m19) regularly kept looking around the street while walking and appropriated the street as a place for observing, exploring, engaging and appreciating.

During a smartphone mobile guided aided heritage walk users expect to be able to receive information while they are still walking [160]. Hence it was not a surprise that many participants chose to not stop at all at a site. When the notification and information regarding a POI popped up, instead of stopping at the site, they chose to continue walking while reading the information on the smartphone's screen. However, this expectation from a smartphone mobile guide aided the urban heritage walk experience hindered their ability to observe and connect with the site. As seen in Figure 4.3, after the notification, m21 did not stop to look for the site or come in the visual presence of the site. Instead, they continued to walk ahead while reading the information on the screen with their head down (frames 1 to 4). By the time they decided to look for (make a visual contact/connection with) the POI, they had walked past the POI (frame 5). Thus, they did not find it even after repeated attempts to locate it (frames 7 & 8). While they leveraged the smartphone's affordance of facilitating reading on the go, importantly, they missed the opportunity to observe and appreciate the POI and the environment of the street.

Another user expressed concern about how the use of the smartphone mobile guide disrupts their walking experience: *"I cannot focus on my walk as well as on looking*

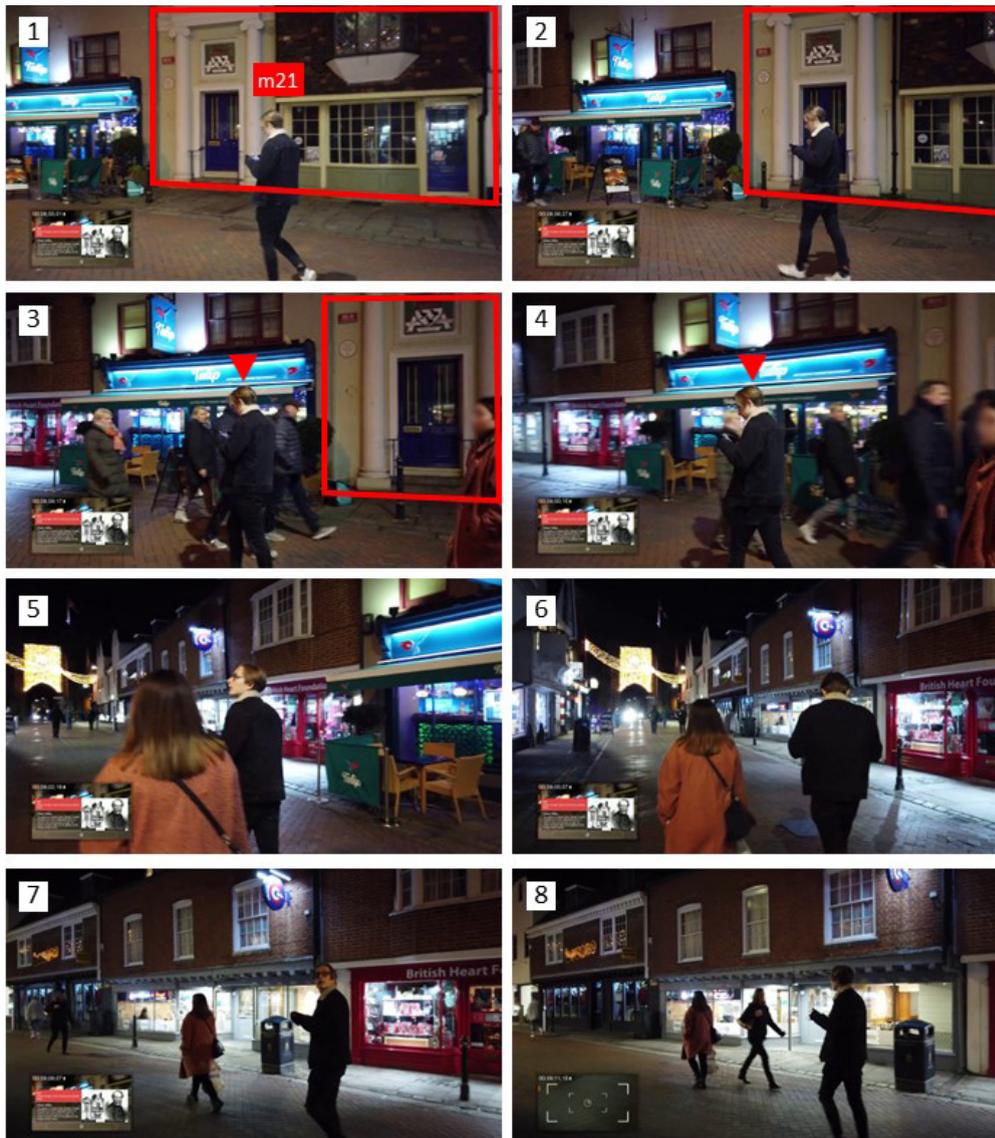


FIGURE 4.3: m21 could not locate the POI even after repeated attempts as they had walked past it (frame 5) while reading the information on the screen with their head down (frames 1 to 4).

at the information on the application ... one drawback that I have felt is that we have to stop at one point to completely read out everything, which is there on that application” (m5). The user found it challenging to simultaneously engage with both the physical environment and the digital information provided by the application. Specifically, they pointed out that to absorb the content fully, they would have to stop walking, which according to them would break the flow of their movement and the natural progression of the walk. This indicates that while the app provides valuable information, its use can detract from the overall experience

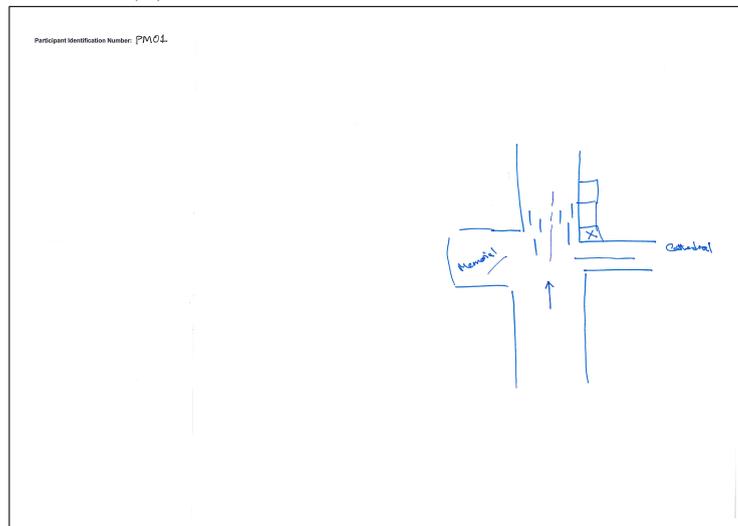
by requiring users to pause and focus solely on the screen, rather than seamlessly integrating with the walk itself. Various researchers have also acknowledged this concern about using text-based content in smartphone mobile guides and have adopted audio content [58, 73].

Participants also highlighted the issue of experiencing a 'digital divide' [117] between themselves and their surroundings while using smartphones during the walk. This digital divide refers to a sense of disconnection from the physical environment caused by an overreliance on the smartphone screen. Several participants noted that using the phone as a viewfinder or tool for scanning the street reduced their engagement with the environment. For example, a user who participated in the walking tour as if they were a tourist during the walk explained, *"I was sort of disengaging with the surrounding area, I was focusing on my phone and trying to find houses"* (m6), indicating that the need to focus on the smartphone distracted them from fully experiencing the historic precinct. This repeated focus on the device, as m6 reiterated, resulted in *"engaging in looking, but that looking was more about trying to find something or looking through the phone"* (m6), further emphasizing how the act of using the phone shifted their attention away from the broader surroundings. Participant (m9) who was involved in the experience like a tourist during the walk, described how using the phone for this purpose was contrary to their expectations, noting it created a sense of isolation. They reflected, *"Your intention is to be with the other side of the surroundings that you're in, and you end up ignoring people"* (m9), expressing how the phone distracted them from connecting not only with the environment but also with other people around them. This illustrates how the smartphone mobile guides, while intended to enhance the experience, can inadvertently lead to a more detached and isolated interaction with the environment and others in the group.

Analysis of the depiction of space and quality of depiction in drawings offered further, insight into the influence of smartphone use on participants' experience of physical space as seen in Figure 4.4. Out of 21, 14 participants represented the built environment using a 2D mode of representation such as a map of the place or elevation of the building, whereas only 7 participants represented space as 3D



(A) 3-dimensional representation of space



(B) 2-dimensional representation of space

FIGURE 4.4: Representation of space

immersive space. Further, 16 participants represented the scale of POI incorrectly or loosely, and 17 participants expressed structures and details of POI sparsely. Only 5 participants depicted sensorial information like materials and textures. Thus, analysis of drawings also indicates that smartphone mobile guide users had a superficial utilitarian awareness of space instead of a thorough and appreciative awareness.

Observing and interacting with people can lead to space - place and aesthetic experience (see Chapter 2). Analysis of video for social encounters revealed that

none of the 21 smartphone users had any direct interactions with the passers-by. This often led to users feeling **alone and isolated**. m16 described feeling more isolated while using the smartphone guide, stating, *"It made me feel more aware that I was walking on my own, [...] because I was focusing on the phone and my surroundings, so I wasn't really aware of the people around me"* (m16). This highlights how the simultaneous focus on the phone and the environment reduced the participant's awareness of social interactions, contributing to a sense of isolation. They further explained that *"it felt pretty isolating in a way"* (m6), underscoring how technology, meant to enhance the experience, created a barrier between the user and their social surroundings. Similarly, m19 observed that while the mobile guide effectively engaged them with the place itself, it diminished their awareness of the social environment: *"If you talk about place, I was engaged, but if you talk about people, I wasn't"* (m19). This comment points to the limited social connection participants experienced while focusing on the information provided by the mobile guide. Another participant, m9 who was deeply involved with the architectural aspects during the walk discussed how the phone disrupted their engagement with the social dynamics of the street, stating, *"It makes me think of the people walking down the high street, which was kind of what I disappeared from because I was with the phone and the architecture"* (m9). This illustrates how using the smartphone mobile guide as a tool for exploring the physical environment led to disengagement from the social life of the street, creating a separation between the user and the broader urban experience.

m7 noted a trade-off between increased interaction with the surroundings and reduced social awareness, mentioning that while the smartphone guide encouraged them to observe buildings more closely, it decreased their awareness of other people. This pattern is supported by an analysis of participants' drawings, which revealed that only 6 participants depicted passers-by, suggesting a generally low awareness of the social aspects of the environment during the smartphone-guided walks. This visual evidence further confirms the participants' reports of social disconnection while using the mobile guide.

TABLE 4.2: Average duration of halt at POI

Average halt duration at POI	No. of Participants
3 seconds	6
18 seconds	9
28 seconds	4
36 seconds	2

Observation and bodily engagement with surroundings - POI and people lay the ground for embodied, social, space-place and aesthetic experience. However, the use of smartphone mobile guides hindered users' embodied, social, space-place and aesthetic experience. The observations from the videos that participants had low awareness of their surroundings, people and POIs during the walk are further confirmed by the data for interviews and analysis of the drawings. Several researchers have anticipated such an influence of smartphone-based guides and explored ways to design guides that eliminate the distraction caused by the screen-based display [99, 119, 192].

4.2.3 Embodied engaging with the POIs

The central aspect of the heritage walk is understanding the cultural heritage through observation and engagement with POIs. Within embodied interpretive practices, visitors are not only required to be in the physical presence of the POI to view them but also use bodily movements of reaching closer or further to pay attention to the different physical features, construction style and its relation to the surroundings (e.g., the significance of the city's gate by the river). Doing so is important as it allows them to have a dialogue with the past through the POI, imagine events that might have taken place in the past, and form personal connections and memories at the POI. Thus, how participants engaged with the individual POI while using the smartphone mobile guide was observed.

A person's choice to stop at a place, turn towards it and move closer to it in the context of a heritage visit becomes an embodied expression of them paying attention, engaging and forming a connection with the POI [51, 73, 217]. Therefore, to

TABLE 4.3: Orientation at POI

Orientation at POI	Average halt duration at POI
Turned towards the heritage	9
Did not turn towards the heritage	12

TABLE 4.4: Stoppage at POI

Nature of Stoppage at POI	No. of Participants
Strolled forward while reading	8
Stopped to read at the heritage site	13

analyse users' engagement with the POI, the duration of the halt, the nature of the stoppage and participants' orientation and proximity at the POI were analysed.

As discussed in Chapter 2, time plays an important role in a person's ability to observe their surroundings and form an attachment with the place [69, 223]. A user spending more time at the POI would have more time to observe, understand and remember the place. Researchers evaluating exhibitions have also considered time spent at an exhibit as an indicator of visitors' interest in the exhibit [25, 199]. As seen in table 4.2, only 6 smartphone mobile guide users who were in tourist mode spent an average of .ca 30 seconds at each POI. 6 users typically did not stop at the POIs averaging just 3 seconds stoppage time per POI. 9 participants did spend more time, averaging 18 seconds per POI, but it would be still considered a significantly short stoppage duration in the context of a heritage walk.

Many smartphone mobile guide users did not feel compelled to stop and turn at the POI during the walk. As seen in table 4.4, nearly half of the smartphone users did not stop at the site or turn towards the site. As seen in Figure 4.5, when the information regarding a POI popped up, many participants chose not to stop at the POI. They continued to walk/stroll ahead while reading the information on the smartphone's screen. A participant explained that as they could read while walking they were not motivated to stop *"I don't feel like I was anywhere compelled to stop ... whenever the thing (Information) popped up, I would just read as I went because I had the information with me, I didn't have to stop"* (m2). They leveraged their capability and smartphone's affordance to facilitate reading

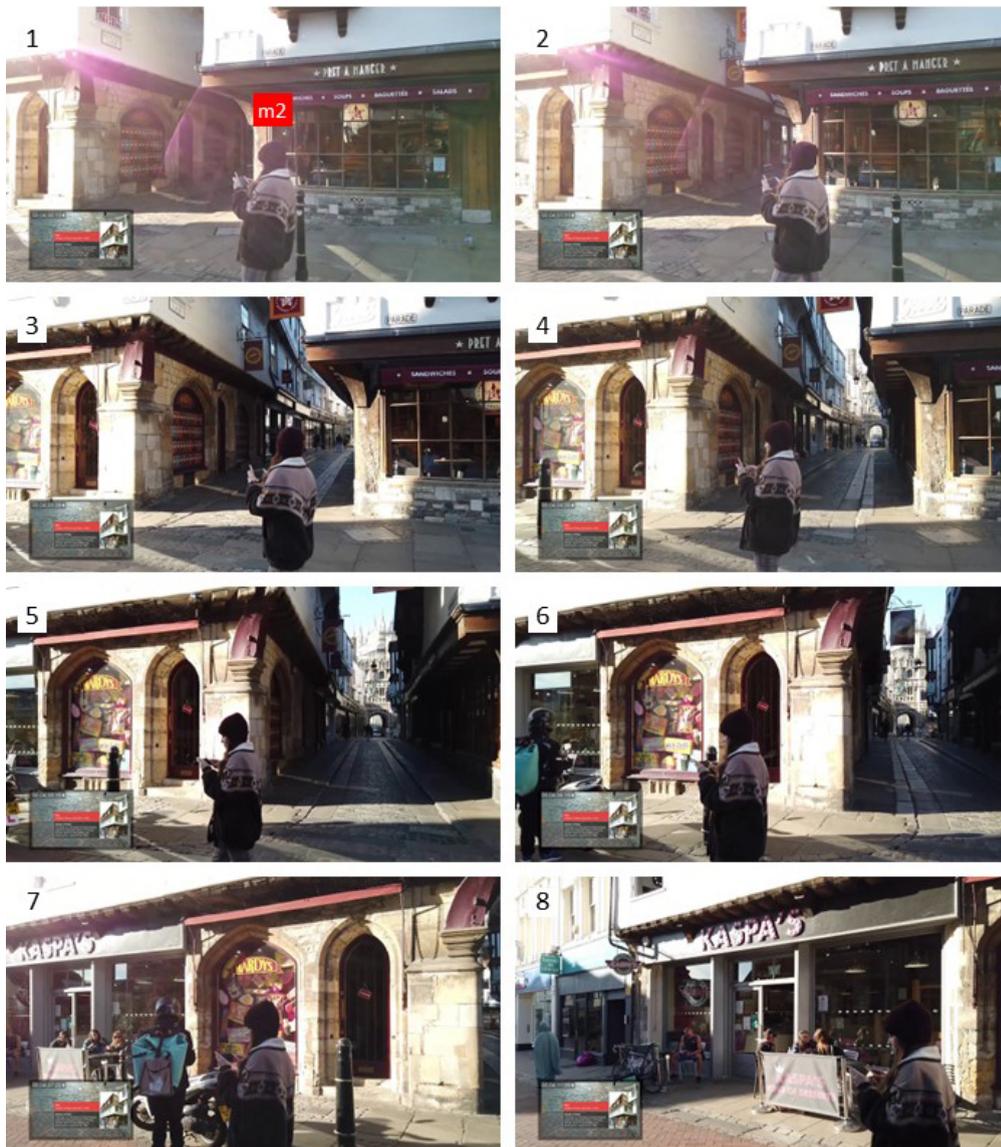


FIGURE 4.5: m2 did not stop at the POI after the notification. Instead, they only glanced at the POI (frames 2 & 3) and continued to walk ahead until they passed the site (frame 8) while reading the information on the screen (frames 4 to 8).

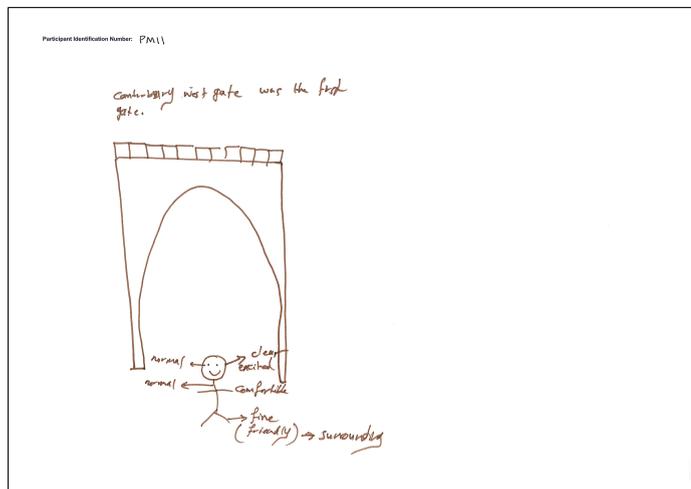
on the go, however, unfortunately, they missed the opportunity to observe and appreciate the environment of the street.

Among those who stopped at the POI, most smartphone users stayed at POI for a very short time and largely remained physically distant paying limited attention to the POI: *“I felt a bit distanced as I am distanced from the actual thing”* m1. As seen in table 4.3, 9 out of 21 users turned towards the POI to form a visual connection with it while reading the information. Out of those 9, only 6 users

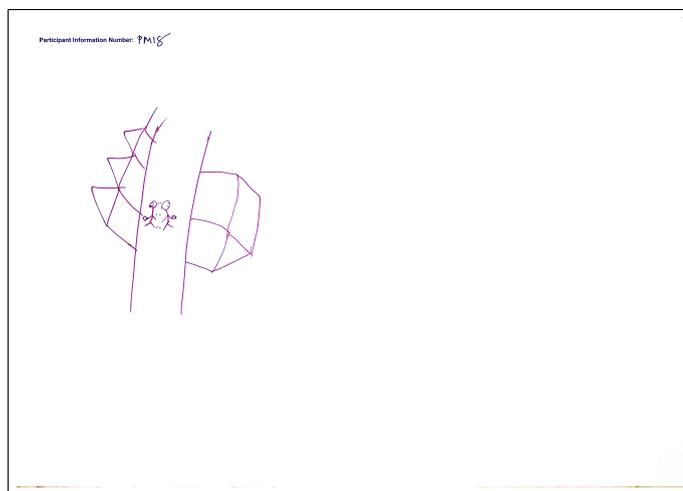
turned consistently across all the POIs while others turned occasionally. Most smartphone users generally did not spend time observing the building and if they did it was for a very short time. 18 participants looked at the site only in the form of one or two short glances (see frames 2 & 3 of Figure 4.5). A very small number of mobile guide users engaged in sensorimotor exploration at the POI. Only 4 users re-positioned themselves in the space after stopping to move closer or away from the building to get a better view.

Overall, instead of leveraging the physical environment and material tangible nature of the POI to imagine and experience the past, form emotional connections and make memories users remained distant and gave priority to reading information on the screen.

To further understand the participants' experience of engagement with the POI during the walk, the depiction of their actions such as posture, orientation and location in space was also analysed (see Figure 4.6). 9 participants depicted correct orientation with regard to the POI and only 5 participants represented body posture. 10 participants did not clearly depict their position in relation to the POI. However, 11 participants represented themselves and POI but did not depict themselves performing any action such as looking or pointing towards the POI (see Figure 4.6a). The analysis of the drawings indicates that participants had low awareness of their own bodily presence and movement in relation to space during the walk which would have affected their feeling of 'being-there' in the space. However, embodied and somatic awareness of the body and its movement and feeling of 'being-there' is foundational to embodied and spatial interpretive practices [72]. A user acknowledged the value of being physically present and exploring the space but physically moving through it *“opposed to something like sitting down and watching a video ... it [heritage walk] was definitely more positive ... far more enjoyable, [you] actually get up and move around. That's something to be said about actually physically moving your body making you happier as well”* (m4).



(A) Participant did not depict any action in relation to POI or with the device



(B) Participant depicted the activity of looking for a site.



(C) Participant depicted the action of looking at the smartphone.

FIGURE 4.6: Representation of Activity in drawings

4.2.4 Appropriation of the device

As mentioned in Chapter 3, while walking, the interface offered the view of the camera feed with an overlay of a viewfinder graphic. It was observed that this influenced the way participants held and used the smartphone. As seen in Figure 4.7a & Figure 4.7b, most participants held the smartphone in landscape orientation. Further, it was observed that the participants often held the smartphone in front of their faces or chests so that they could become immediately aware of the notification or could see the surroundings through the smartphone's screen, indicating their desire to tightly blend their digital and physical experience of the heritage walk.

The camera feed and the viewfinder graphics overlay gave the smartphone a frame-like or scanner-like affordance. This influenced 6 participants (m2, m8, m9, m10, m11, m19) to appropriate the smartphone as an environment scanner while walking. m16 described how they used the smartphone to engage with the physical environment by scanning the surroundings with the device, as seen in Figure 4.7a. This act of "scanning" enabled them to satisfy their curiosity about the street: *"As I walk along the path, I was looking around, like scanning through every place"* (m7). This use of the device highlights how participants incorporated the smartphone into their spatial exploration, using it as a tool to visually investigate their environment, which added a layer of interaction with the space beyond traditional walking. Similarly, another participant emphasized the enjoyment derived from actively searching for points of interest through the smartphone's camera: *"I think it would be less enjoyable if I wasn't actually searching around with the camera for these spots"* (m9). This comment suggests that the process of using the phone to find specific locations added an element of discovery and engagement, enhancing their experience of the guided walk.

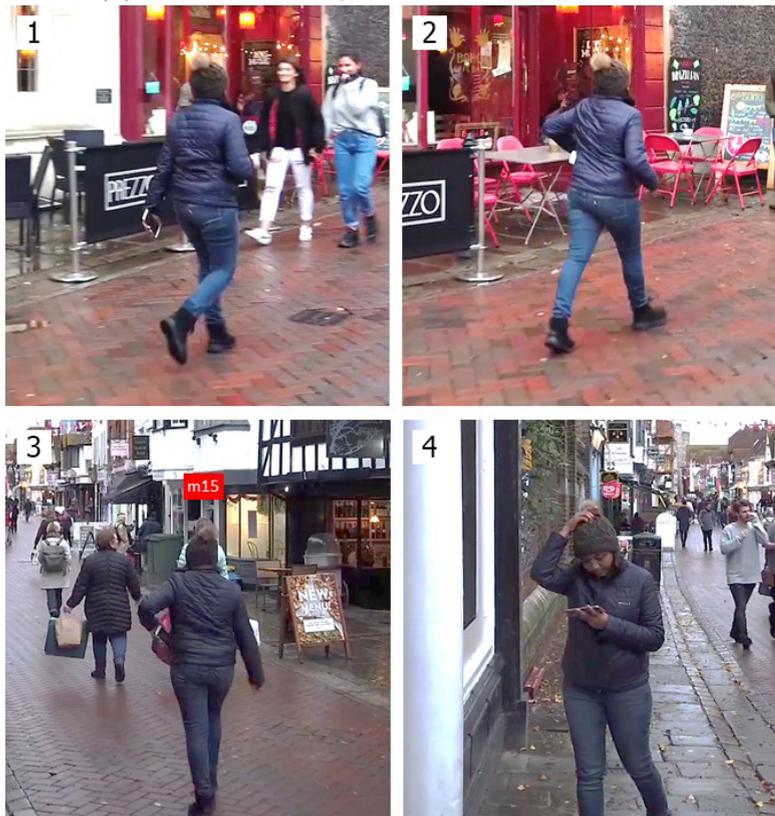
Other participants (m3, m7, m17) used the smartphone in a slightly different way, focusing on capturing and appreciating elements of interest by pointing and framing them with the device. For example, m7 explained, *"Rather than me having to walk out, I just found it much more interesting looking through the camera ..."*



(A) m17 appropriating the smartphone as an environment scanner.



(B) m5 appropriating the smartphone as a camera.



(c) m15 holding the smartphone as per their everyday habit.

FIGURE 4.7: Users' appropriated and used the device in different ways to perform their heritage exploration.

it's just because of that, the icon, I mean the border itself [referring to the target icon on the screen], so it was kind of interesting ... [also] I'm so used to using my phone ... [to] scanning things" (m7). This statement reflects how the action of using a phone camera to frame objects enhanced their engagement, making the exploration more interactive and reflective of modern digital habits. At specific points of interest (POIs), participants also used their phones to mimic the act of taking photos, reinforcing their memory-making process. For instance, m5 who had lived in Canterbury for 10 months, shared, *"I was trying to capture all the beautiful places ... to memorise this information"* (m5), indicating that using the phone as a camera allowed them to create a personal record of their experience. This performative use of the device, As seen in Figure 4.7b, transformed the walk into a playful and performative activity, blending exploration with personal documentation. In addition to framing heritage-related elements, participants extended this behaviour to other objects of personal interest, such as pets of passers-by (m3) or items in window displays (m7), showing how the smartphone facilitated broader engagement with the environment beyond its intended use.

However, not all participants found the camera feature intuitive. One participant expressed confusion over the camera feed, stating, *"I didn't understand why it was a camera? I didn't know if you could take pictures or something, I didn't understand why it had to be a video ... I didn't understand, why/what the point of that was?"* (m2). This confusion reflects a lack of clarity regarding the purpose of the camera function within the app. Another participant raised concerns about the appropriateness of using the camera in public, noting that *"the way of putting the camera in front of people ... maybe a little bit tricky"* (m11) suggesting that the act of pointing a phone at others in public could feel intrusive or uncomfortable. These mixed responses highlight the varied ways in which participants interacted with the smartphone guide, with some finding it enhanced their experience through performative and playful exploration, while others questioned the design and social implications of certain features. Wakkary et al. [232] also found that not all users may would be open to notion of play while using mobile guides.

Similar to Moss's findings [160], this study reveals that users' perceptions of the smartphone guide's technological capabilities elicited a range of behavioural and emotional responses. The presence of a target or focus graphic on the display led users to believe that they could scan the site or take a picture of the site using the smartphone guide and motivated different actions.

However, not all participants fully engaged with the smartphone guide in an active or performative manner. A total of 11 participants (m1, m4, m6, m12, m13, m14, m15, m16, m18, m20, m21) did not display any specific enactive behaviour with the device, meaning they did not interact with it beyond basic use. For some, the smartphone remained an object of passive interaction, functioning more as a tool to receive information rather than something that altered or enhanced their experience of the walk. Among these participants, three individuals (m1, m6, m16) held the smartphone in its usual portrait orientation throughout the walk, reflecting their everyday phone usage habits (as shown in frame 1 of Figure 4.7c). This indicates that, for these participants, the smartphone was not integrated into the experience in a novel or meaningful way, but rather used in a routine manner, limiting its potential to engage them with their surroundings.

In contrast, m15 attempted to disengage from the smartphone physically by putting it away during the walk. As seen in frames 2 & 3 of Figure 4.7c, m15 explained, *"In the middle of the walk, I tried to put it [smartphone] in my jacket ... [as] it was not natural for me to hold the phone in my hands and walk"* (m15). This comment reflects discomfort with the idea of continuously holding the device, suggesting that for some participants, the act of carrying the smartphone disrupted the natural flow of the walk. However, by placing the phone in their pocket, m15 missed one of the location-triggered notifications. They noted, *"Since I put the phone in my pocket, it still triggered, and I didn't feel it [vibration]"* (m15). This incident led to a moment of frustration, as depicted by their gesture of placing a hand on their head (see frame 4 of Figure 4.7c). By missing the notification, the participant's experience of the walk was interrupted, demonstrating how the reliance on technological prompts can occasionally hinder rather than enhance engagement with the environment.

This scenario underscores the tension between the intended interactive nature of the smartphone guide and the ways in which some participants struggled to integrate it into their physical experience of the walk. For participants like m15, the smartphone was not seamlessly incorporated into their behaviour, leading to a less immersive experience. These varied levels of engagement highlight that while the smartphone guide has the potential to enhance interaction with the environment, it also introduces challenges for users who may not find it intuitive or natural to interact with the device during a walk.

These observations are consistent with Moss's findings [160], which highlight the challenge of using everyday devices such as smartphones in heritage settings. Although different behaviours and interactions with the device may be needed in the context of a heritage walk compared to everyday use, some users struggle to adjust their habitual device use to fit the expectations of the heritage experience.

Although not all participants utilised their smartphones in a performative and playful manner, the overlay of target or focus graphics on the camera feed changed the perceived affordance of the device and encouraged some users to engage with their surroundings—both across the street and at POIs in new ways. This aligns with Moss's observations [160], which indicate that smartphone guides inspire users to adopt new modes of movement, behaviour and thought during urban heritage walks. Consequently, the use of these guides promoted a level of bodily engagement and a sense of connection with the site within the urban heritage precinct.

However, such enactive playful behaviours with the smartphone guide were occasional or if the frequency was good in the beginning, it started to wane as the walk progressed. Such waning of behaviour across the length of the walk has been observed by other researchers as well albeit in the context of users' behaviour towards listening to the full audio of the guide [160]. This may be due to the absence of any feedback in response to their actions. Some participants who exhibited enactive use of the device were tentative in their actions. This may be because they were not comfortable enacting these behaviours with devices in a public space.

While users playfully engaged with the smartphone guide, In this configuration, the phone acted as a distraction and barrier between the users and the environment. A drawback of holding the smartphone in front of the face or chest and seeing the surroundings through the smartphone's screen or playfully using the phone to scan the place was that participants' visual attention was largely directed towards or focused on the smartphone guide and scaled-down view of space on the screen as seen in Figure 5.5, instead of the actual environment around them. A participant said "*My engagement was just with the phone*" (m15). Similar observations regarding balancing the play with the device vs engagement with the physical environment have been made by researchers when deploying playful mobile guides [232].

4.2.5 Influence of everyday habits and norms on smartphone usage

Habits of the users influenced their behaviour and smartphone guide usage during the heritage walk. A participant explained that they did not stop at the POIs during the heritage walk as "*I personally walk quite fast, and I think that influenced the fact that I didn't stop. I just kept going*" (m2). They also explained that they did not need to pay direct or conscious attention to their surroundings while walking with the phone as "*I'm always on my phone when I'm in town. So, I have sort of like an awareness of like [surroundings], [while] looking at the screen as I walk. I don't have to, like, look up*" (m2). m9 also made a similar observation "*I have plenty of experience not crashing into people whilst doing something else. So, maybe that's also something that's there previously in me. This compulsion to sweep in and out of people without ... seeing them necessarily*" (m9). Thus, participants suggested that they were okay walking the street while using the phone as they were habituated to navigating while paying only partial or selective attention to the environment and people.

m4 and m6 reflected on their habitual tendency to keep looking at the smartphone's screen out of curiosity even when the screen was not displaying any information: *"I definitely found myself looking down at the screen. Even at times when it wasn't prompting me. Just out of habit, an interest, maybe just if something had happened on the screen, without me noticing, I would be looking down maybe, I'd guess maybe every 20 seconds, 10 to 20 seconds or so. I just looked down at thing [smartphone], maybe even less than that"* (m4). However, m4 argued that *"it's 2019. Everybody is holding a phone constantly ... if I was walking down that street, just of my own accord, I probably might have my phone now. So, it [using the smartphone] didn't really take away anything that would have been there"* m4. Thus, the participant implied that as we all use smartphones while walking, it is acceptable to be walking while being distracted by the smartphone.

The usual practice while using a smartphone is to see the smartphone when required and put it back in the pocket. However, the participants held their phones continuously during the walk. Some participants commented on their experience of holding the phone all through the walk: *"I would not prefer holding the phone in my hand and walk. I would usually prefer it being in my pocket, back pocket or in my jacket pocket ... So, it was odd for me to hold it in my hands and do it [walk]"* (m15). A participant explained that they experienced discomfort when they had to do something different from their habitual practice. m20 and m21 also expressed that they would have preferred putting the phone in the pocket and taking it out when it buzzed. A participant reacted to the landscape orientation of the app and needed to hold the phone in landscape *"Obviously, that's not a natural way to hold it ... it felt a bit unnatural"* (m2). m21 also suggested that they would prefer to hold the device and have the layout of the application in portrait orientation as they were habituated to it.

Some participants also reflected on their experience of holding the phone or using the phone in a way that is different from usual and publicly accepted practice: *"Towards the start, I felt a bit self-conscious, especially when I was literally holding it [phone] up [in front of the face] and people were looking directly at me"* (m2) and *"It can be a little bit embarrassing ... you definitely feel like people are watching"*

you ... when ... you're holding the phone in one hand, then you're looking up and then you're looking down and then you're looking up, people around can see that. And if you do that for a while people catch on" (m4). These statements indicate that though it is common to use mobile phones in public spaces if users were to use the smartphone in an unusual way, it can be awkward for the users. Thus, cultural norms of the place can also influence users' experience of using a device.

Overall these findings are consistent with the findings of Moss [160] regarding the challenge of adapting an everyday object like a smartphone as an interpretive medium in a context such as heritage walks that require a different way of acting and behaving with the device.

4.2.6 Enhanced affective engagement

Many participants (m2, m3, m7, m8, m9, m15, m16, m17, m18, m19, m20, and m21) expressed that the location-aware application enhanced the walk by adding a sense of purpose and engagement. In line with findings of previous studies [160], a participant noted, *"It was really interesting. I enjoyed learning more about the street,"* (m19) highlighting the added educational value the app provided. Another participant who was involved during the walk, (took 14 minutes 31 seconds to complete the walk) emphasized how the app transformed the walk into a more intentional experience, stating, *"It gave more purpose to the walk ... it's not just a stop here. It's something for you to look at"* (m9). This sentiment reflects that the mobile guide played a role in structuring the walk with specific points of interest, which encouraged deeper interaction with the environment. Participant m13 who was fairly new to Canterbury (4 months) described the experience as fulfilling, saying it brought a *"sense of satisfaction,"* making the experience *"very meaningful."* This underscores how the app contributed to their personal connection with the heritage site. Participants m6, m7, and m10 similarly conveyed feelings of satisfaction, suggesting a consistent positive reception of the app-guided walks.

Users noted that not having a map fostered a sense of curiosity, anticipation, and excitement during their exploration as anticipated by [96]. One user articulated this experience by likening the use of the location-aware application to a treasure hunt, stating, *“made it [walking on the street] quite interesting because it was ... like ... [a] treasure hunt. So, you are given clues, right? And then you look at the clues, and then next up, you find more clues ... So, it was kind of exciting”* (m7). This sentiment underscores how the clues transformed the act of walking into an engaging quest, encouraging active participation in the environment.

Another participant highlighted the engaging aspect of unpredictability, remarking on how they were kept intrigued by not knowing when the next POI would trigger: *“curiously waiting for the time when the next location will trigger”* (m5). This element of surprise motivated them to *“anticipate how many stops there were”* (m12) and heightened their motivation to observe as they actively searched for potential POIs before the app indicated them: *“look around to see if I could find them [POIs] before it [app] could”* (m4). Such interactions illustrate how the design of the mobile guide can enhance user engagement by turning the exploration into a curiosity-driven situated play experience.

4.2.7 Zooming in on a bit more content

While the content of mobile guides is not a central concern of this study, in this section the concerns expressed by smartphone users regarding content, especially the amount of information are discussed. As expected, participants felt positive about using a location-aware mobile guide: *“[it is] such a convenient way, it’s not like you’re googling stuff ... it’s just coming as you’re passing along the streets”* (m3).

Regarding the amount of the content on the app in the context of outdoor heritage walk, a participant expressed that *“the amount that was there was probably the best amount to have ... - not too much, not too little* (m4) and *“that was a good quantity ... especially in this circumstance like you were looking at a mobile phone*

and standing in the street. You don't want to be there for a very long time. You just want to have this decent nugget of information. Like, it is giving you something ... it's enough for you to go - Aha! Yeah, well, that's really nice really" (m9). The user expressed satisfaction with the amount of information provided by the mobile guide. They appreciate that the amount of information was concise and appropriate for the context of being outdoors, standing on a street while looking at a mobile phone, suggesting that in the context of heritage walk, they don't want to spend a long time reading. Instead, they preferred concise information—enough to be informative, engaging, and meaningful, but not overwhelming, allowing them to have a quick yet fulfilling experience.

Participants who actively engaged with the walk and adopted a tourist perspective expressed a desire for more detailed content. For instance, one participant suggested, *"it would be really interesting to have maybe a 'learn more' section ... just more information if you're interested"* (m4), while another felt that *"the amount of information that I got was very limited ... I think it's better if we can elaborate"* (m5). Similarly, m11 proposed adding not only more content but also additional visuals, stating, *"you can add more ... pictures, different angles"* (m11). This aligns with Moss's findings [160], which highlight that when using smartphone guides users during heritage walks often desire additional information to enhance their heritage experience. When the amount of content provided in the smartphone guide did not align with users' knowledge expectations, it affected their overall experience.

The users highlighted both the benefits and challenges of using a smartphone as a mobile guide. One user appreciated the portability of a smartphone, *"I think it's very portable. Rather than carrying ... an iPad ... a phone is small. It doesn't really come in the way"* (m3). However, other users expressed difficulties with reading on the small screen, particularly in situations where the phone is unstable due to hand movements or vibrations, *"it must be a kind of large phone ... because in reading your hands under some kind of vibrations ... you have to stabilize it and then you have to focus on it. So, whenever you see and the fonts are a little bit smaller"* (m20). They suggested that a larger phone or features allowing text

and images to be magnified would improve the experience, *“it’s better if we can magnify this information ... if we can provide a feature to ... zoom in or zoom out the information”* (m5) and *“interactive element would be nice ... maybe like ... I could zoom in a bit more ... because some of ... images were a bit small. So I couldn’t figure out whether it’s the right building or not”* (m7). Overall, the feedback reflects that users seek a balance between the portability of the smartphone and the large screen for better readability.

The users indicated that the information provided by the mobile guide may not always align with their personal interests or preferences. While the guide delivers general information, it might not be engaging or relevant to every user, *“you are feeding them information but then ... it may not be of interest to you”* (m7). They suggest that a more personalised approach, where the content is tailored to their specific interests—*“maybe if it [information] was something else like ... something I definitely wanted to do ... say if I came here for food and it showed me restaurants ... it would make me want to stop more”* (m2)—would make the experience more engaging. This feedback reflects a desire for customisation and a desire for the information that accounts for the fact that they are in an urban space during the heritage walk.

4.3 Conclusion

Theoretical perspectives on embodied heritage interpretation content that the experience of space and its past is grounded in the individuals’ body and emphasise the importance of bodily movement, spatial engagement, and sensory experience in creating knowledge of a site [72]. Therefore, this chapter aimed to explore the influence of smartphone mobile guides on visitors’ embodied and spatial engagement during heritage walks in historic urban precincts. The study was driven by the growing integration of smartphone mobile guides into cultural heritage experiences (see Chapter 2) and the concerns that these technologies may disrupt sensory and spatial connections with heritage sites. Through the use of video observations,

post-walk interviews, and participant drawings during a heritage walk on Canterbury High Street, the study examined how smartphones affect users' embodied heritage interpretation practices, where the body's movement and interaction with the heritage environment shape the user's experience.

The findings of this study contribute to understanding how smartphone-based guides affect users' embodied interpretation of historic urban precincts during heritage walks through the hybridised landscape consisting of both the physical space of the site and the information landscape presented by the mobile guide. While some users were able to engage meaningfully by stopping, turning, approaching, patiently observing, and having a somatic dialogue with POI, most users exhibited hurried, non-exploratory walking patterns in which they did not engage in meaningful embodied and spatial engagement. The screen-based nature of smartphones often acted as a barrier, diverting attention away from the physical environment and leading to a superficial awareness of the physical surroundings. Many participants focused on their devices instead of fully experiencing the sensory and material aspects of the heritage site, limiting their ability to engage deeply with the space. These observations support concerns that smartphone mobile guides hinder rather than enhance embodied heritage interpretation.

As proposed by phenomenological theories of perception, embodied engagement is essential for forming an understanding of the culture past of the site [72]. The user's focus on smartphone mobile guides' digital content disrupted this potential for somatic attention [51]. Users struggled to maintain an active and reciprocal relationship with their heritage surroundings, which is crucial for producing cultural knowledge [72]. Participants rarely exhibited the bodily modes of interaction—such as walking, turning, or reaching—that enabled a deeper connection with the site, as smartphones demanded much of their attention.

Despite this, the study revealed that some users appropriated the smartphone guide to engage playfully with the space. They performed bodily actions of scanning their environment or capturing moments using the device as a scanner or a camera, reflecting an active and reciprocal body - device -space relationship and

the user's conscious somatic engagement with the site. However, these interactions were brief, and users found it difficult to sustain playful or performative actions. Their habitual use of smartphones in everyday contexts impeded their ability to adopt behaviours more appropriate for heritage exploration [160]. Additionally, as seen in previous studies [194], some participants felt self-conscious about performing performative actions using their phones in a public space, further limiting their engagement. The study also demonstrated that the use of smartphone guides had a negative impact on users' experience of space and place, as its use reduced their ability to engage with the physical, material, cultural, and social dimensions of the site. Many participants felt isolated, focusing more on their screens than on the people and activities around them. This sense of detachment created a "bubble" effect, hindering the experience or presence and immersion that heritage walks are intended to provide [97, 225]. Users often prioritised digital content over engaging with their physical and social surroundings, which supports previous findings about the isolating effects of smartphones during cultural experiences.

To address these challenges, mobile guides should be designed to promote performative and playful modes of engagement while encouraging slower, more attentive exploration. By prompting users to pause, observe, and physically interact with the environment, mobile guides can help users maintain a deeper sensory connection with heritage sites [73]. Designs that minimise screen attention and encourage more embodied interactions would help bridge the gap between digital content and physical engagement. Additionally, providing expandable, tailored content can allow users to adjust the depth of their experience based on their interests, creating a more personalised and meaningful cultural encounter.

Ultimately, translating bodily interactions into digital interfaces remains a challenge, but it is crucial for enhancing the immersive potential of mobile guides. With thoughtful design, mobile guides can support both the informational and experiential needs of users, fostering a richer and more connected exploration of outdoor heritage sites.

Chapter 5

Heritage walks with a mobile projector

This chapter examines how mobile projector guides influence users' embodied meaning-making processes and heritage experiences during walks in urban historic precincts. Existing smartphone-based mobile guides often lead to passive, "head-down" interactions that limit sensory and spatial engagement with heritage sites [85, 115]. To address this limitation, this study explores the potential of handheld projector-based guides to enhance bodily movement, spatial awareness, and sensory interaction during heritage interpretation.

The research is motivated by phenomenological theories of embodiment, which posit that our understanding of the world is fundamentally shaped by our bodily interactions with it [51, 238]. In the context of cultural heritage, scholars have argued for the importance of embodied and spatial practices in forming meaningful connections with heritage sites [44, 72, 179]. This study aims to investigate how mobile projector technology can support these embodied approaches to heritage interpretation.

The main research questions addressed are:

- How do mobile projector guides influence users' walking patterns, spatial awareness, and bodily engagement with heritage sites?
- In what ways do mobile projector guides facilitate embodied meaning-making and spatial practices in heritage interpretation?
- How does the use of mobile projector guides affect social interactions and experiences in public heritage spaces?

To answer these questions, a field study was conducted with 21 participants using mobile projector guides during heritage walks on Canterbury's historic High Street. Data was collected through video recordings of the walks, post-walk interviews, and participant drawings. The analysis employed a combination of behavioural coding, thematic analysis of interviews, and interpretation of participants' drawings.

The results are structured into four thematic areas. The first section discusses how mobile projector guides influenced participants' walking speed, patterns, and movement. For instance, participants frequently adopted users who exhibited slower, more exploratory walking patterns while navigating the heritage site, as they frequently stopped at various POIs to project onto various surfaces. The second section explores how the use of a mobile projector guides heightened participants' spatial and bodily awareness, due to the outward-facing nature of the projection, contributing to a stronger sense of presence and connection with the heritage environment. The next section highlights how mobile projector guides facilitated embodied interaction with the physical environment by enabling users to project digital content with the physical environment. This fostered a sense of agency and control. Further, projecting historical images directly onto heritage buildings allowed for embodied meaning-making. The final section examines the social implications of mobile projector guides. The public nature of the projection often drew the attention of passers-by, fostering spontaneous social interactions. While some participants enjoyed the spontaneous social interactions that arose from public projections, others expressed discomfort with the attention they attracted.

The chapter concludes by synthesizing these findings to demonstrate how mobile projector guides can transform heritage interpretation from passive information consumption into a more dynamic, embodied, and social process by encouraging physical movement, spatial exploration, and communal engagement. It highlights the potential of this technology to foster deeper connections between users and cultural environments, aligning with Tilden's principles of heritage interpretation [216].

The conclusion also discusses implications for the design of future mobile guides, emphasizing features that encourage bodily interaction, spatial exploration, real-time feedback and opportunities for social engagement to create more immersive and participatory heritage experiences.

By examining the interplay between body, technology, and cultural heritage, this chapter contributes to the growing body of work on designing mobile guides for embodied heritage experiences [44, 72, 179] and offers insights into creating more engaging and meaningful interactions with heritage sites through mobile technologies.

5.1 Study

To examine how the use of a mobile projector (see Figure 3.7b) and projected display (see Figure 3.6b) influence individual users' interaction with POIs as well as the whole site (High Street) a field study was conducted with 21 participants (p1 to p21), 10 female and 11 male, aged 18-35 (see Table 5.1). The number and names of POIs were not shared with participants to create a sense of curiosity. Walks took place in the evening to account for the projector's display limitations during the daytime. The heritage walks on the Canterbury high street (see Fig. 3.1) were video recorded for collecting observations. To understand their thoughts and reflections after the walk, participants were interviewed (audio-recorded) at a nearby cafe, during which they were also asked to produce a drawing of a significant moment from the walk.

TABLE 5.1: Participants

Participant	Age	Gender	Time spent in Canterbury
p1	18-24	male	36 months
p2	18-24	female	10 months
p3	18-24	male	10 months
p4	25-29	male	08 months
p5	18-24	male	72 months
p6	30-25	male	12 months
p7	30-25	male	09 months
p8	25-29	male	10 months
p9	18-24	male	17 months
p10	18-24	male	48 months
p11	30-35	male	0.3 month
p12	18-24	female	0.3 month
p13	25-29	male	84 months
p14	18-24	female	0.5 month
p15	18-24	female	01 month
p16	25-29	female	02 months
p17	18-24	female	03 months
p18	18-24	female	02 months
p19	18-24	female	02 months
p20	18-24	female	02 months
p21	18-24	female	03 months

5.1.1 Data analysis

The video recordings were coded to analyse:

- Participants' behaviour while walking between heritage buildings (path, gaze, use of device)
- Participants' behaviour at each heritage building (orientation, movement, gesture [208], use of the device)
- Halt duration (time spent in each location) [133] and total walk duration [25, 199]

After reviewing all the videos, and preparing initial notes regarding the relationships between the user, their physical and social environment, and the device-specific moments from different walks were chosen as examples that highlight and

represent some key scenarios. These clips of those moments were then decomposed into image sequences and transcribed for aspects related to body movement, orientation, proximity, gestures, and the use of devices in relation to the physical environment.

Drawings were analysed for two key aspects: a) participants' awareness of their body and physical surroundings; and b) participants' representation of their surroundings. To study participants' proprioceptive and egocentric location (body-space relation) awareness, representations of body stance within the drawing (posture-gesture), orientation, and location with respect to their surroundings were observed. To evaluate participants' visual and spatial awareness of their surroundings (see Fig. 3.11), the drawings were annotated in terms of representation of space (3D or 2D), representation of scale (loose/fair/good), and level of clarity and detail (limited/fair/good) [138]. Representations of the device and the quality and detail of the other elements represented in the drawing were also analysed. Finally, participants' representations of themselves were verified against video records of the same moment for further reliability.

Lastly, audio recordings of post-walk interviews were transcribed, coded, and labelled by the researcher using thematic analysis [27]. The data from interviews were used to augment the understanding of users' intentions, motivations, and actions. Initial codes were assigned (i.e., 'awareness', 'embodied engagement', 'experience of using the device', and 'experience of heritage walk') based on the research questions. Subsequently, more codes were added to capture significant thoughts reported by participants.

The triangulation of different data types reveals how the mobile projector and its features influence participants and their activities with the physical, social and cultural aspects of the street. Based on the combination of data (i.e., videos, drawings, and post-activity interviews), the results are categorised and presented into the following themes: 1) *Walking patterns and behaviour*; 2) *Awareness and feelings of 'being there'*; 3) *Embodied engagement and meaning-making*; and 4) *Social engagement and experience*.

5.2 Results

Participants acknowledged that walking with a location-aware mobile projector guide added value to their heritage walk experience as it was informative. Additionally, the results indicate that the use of mobile projector guides influenced the embodied and social experiences of the user differently than smartphone users.

5.2.1 Walking patterns and behaviour

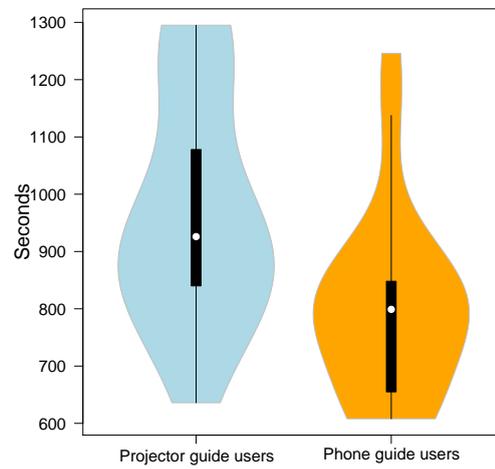
On average, mobile projector guide users took more time to complete the walk with an exception of p14 who had recently arrived in Canterbury from an Asian country and felt uncomfortable using a device that attracted passers-by's attention towards her (see Table 5.2). However, most users tended to adopt a slower pace during their heritage walk compared to those using smartphones. They stopped and stayed longer at each building as well as spent more time engaging with the provided information compared to smartphone users (see Fig. 5.1). The observations of behaviour align with participants' own reflections, as noted in the interviews: *"I was walking fairly naturally, perhaps a little slower"* (p9), and *"it might have slowed me down a little [...] in a good way"* (p18). These quotes highlight how the use of a mobile projector guide influenced walking patterns by promoting a more deliberate and immersive engagement with POIs and overall heritage sites. A participant's intention during the walk provides valuable insights into potential reasons for their slower pace: *"I was not just walking, I was looking. Looking, in a sense, looking at things and looking for things around me. Rather than just walking without thinking, I was looking and looking for things"* (p19) and *"Normally, we walk very much close. You walk like, not like occupying space. You just walk and try to be as quiet and as normal as you can and just as fast and just leave the place. But by getting that [mobile projector guide] you're actually opening up opening up to, "okay, what this?" and people pass by you because you're walking rather slow, slowly in ... kind of that would be I think, instead of being closed, you're like open to see what's around"* (p19). These reflections suggest that

TABLE 5.2: Walk duration of Participants

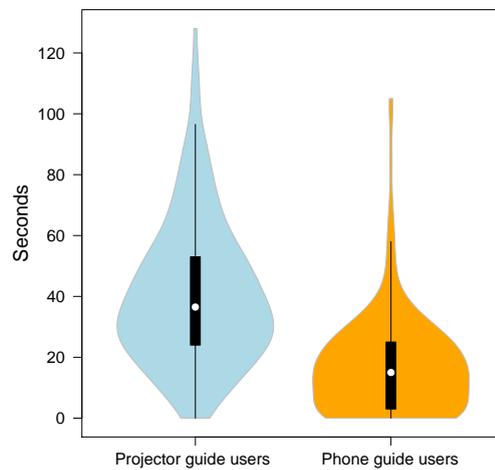
Participant	Gender	Lived in Canterbury	Walk Duration
p1	male	36 months	14:49 mins:secs
p2	female	10 months	15:26 mins:secs
p3	male	10 months	15:36 mins:secs
p4	male	08 months	14:39 mins:secs
p5	male	72 months	15:35 mins:secs
p6	male	12 months	21:23 mins:secs
p7	male	09 months	12:41 mins:secs
p8	male	10 months	21:00 mins:secs
p9	male	17 months	14:00 mins:secs
p10	male	48 months	17:57 mins:secs
p11	male	0.3 month	13:06 mins:secs
p12	female	0.3 month	15:32 mins:secs
p13	male	84 months	15:22 mins:secs
p14	female	0.5 month	10:36 mins:secs
p15	female	01 month	13:07 mins:secs
p16	female	02 months	17:58 mins:secs
p17	female	03 months	12:53 mins:secs
p18	female	02 months	21:35 mins:secs
p19	female	02 months	20:37 mins:secs
p20	female	02 months	21:05 mins:secs
p21	female	03 months	14:12 mins:secs

using the mobile projector guide encouraged a way of walking that is slower; more present in the space; and attuned, attentive and curious about the surroundings. Overall, the statement suggests that using the mobile projector guide transformed the rhythm of their walking and therefore, their relationship with the heritage site from a passive, hurried experience to a more engaged, exploratory one. This is significant as such a form of walking leads to sensemaking of the heritage site and potentially uncovering these hidden narratives [53, 173].

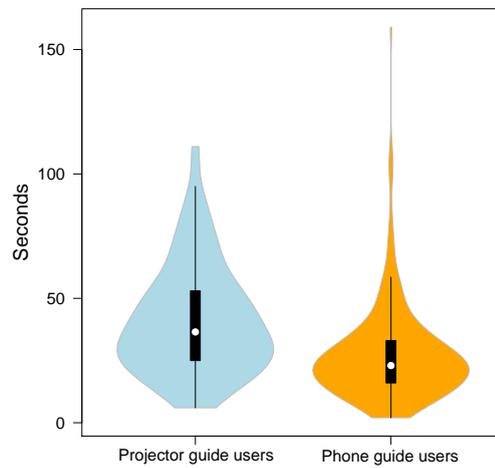
The slower pace during the walk can also be partially attributed to the need to find suitable projection surfaces, as one participant remarked, *“I have to search for a relatively dark area so that I can see the projection [...] Sometimes, it’s like you have to change the position several times”* (p6). This behaviour aligns with psychogeographical practices of “disrupted walking” sites [173], where users are compelled to engage more attentively with their surroundings. The process of seeking appropriate surfaces for projection created additional opportunities for



(A) Comparison of overall walk duration



(B) Comparison of halt duration at heritage buildings



(C) Comparison of read & view duration at heritage buildings

FIGURE 5.1: Walk duration violin plots for phone guide and projector guide users.

participants to interact with the POIs and reflect on the heritage sites, potentially enriching their experience of the place. This unintended consequence resonates with de Certeau's concept of place as a palimpsest, where layers of history and use are revealed through attentive exploration [53, 173]. This behaviour aligns with the notion of embodied and spatial practice in heritage interpretation, where users' interaction with physical space and movement plays a critical role in their experience and understanding of cultural heritage [44, 72, 242].



FIGURE 5.2: An example of a projected display user exploring and walking a zigzag path on the street (P1).

Further, the extrovert and blended nature of the projected display led to a **exploratory walking** pattern, during which users spent more time observing and absorbing their surroundings [69]. Having the display projected in the surroundings motivated participants to use it to interact with the street from different vantage points. Fig. 5.2 illustrates p11 **walking in a zigzag path** along the street

to approach elements that evoked their interest. Their overall body movement reveals attempts to explore the environment - e.g., changing orientation (frames 6, 10, 15), positioning themselves in close proximity, and performing probing gestures (frames 7, 12). Another mobile projector user noted they were “*going this zigzag motion or at least sticking towards the middle*” (p5) because that provided a better experience. One of the reasons, that such behaviour was motivated and sustained among mobile projector users throughout the walk could have been the fact that they received continuous and instant feedback for their every action in the form of displacement of the projected display in the space.

The mobile projector guide’s influence on users’ walking patterns and behaviour is noteworthy as such forms of walking enable psychogeographical approaches to experiencing a place, as described by Overall [173] and Matoswunderlich [72]. The extrovert and blended nature of the projected display fostered an **exploratory walking** pattern, encouraging users to spend more time observing and absorbing their surroundings [69].

The ability to continuously project a target onto the environment motivated participants to playfully perform their exploration of the street. They utilised the extended display to interact with their surroundings from various vantage points. Fig. 5.2 illustrates p11 **walked in a zigzag path** along the street to approach elements that evoked their interest. Their overall body movement reveals attempts to explore the environment - e.g., changing orientation (frames 6, 10, 15), positioning themselves in close proximity, and performing probing gestures (frames 7, 12). This behaviour aligns with the conception of walking as a spatial practice that allows for the discovery of hidden histories, layers of place and personal interpretations [53, 72, 73, 173, 217]. The zigzag motion was noted by another mobile projector user: “*going this zigzag motion or at least sticking towards the middle*” (p5), who found that it provided a better experience.

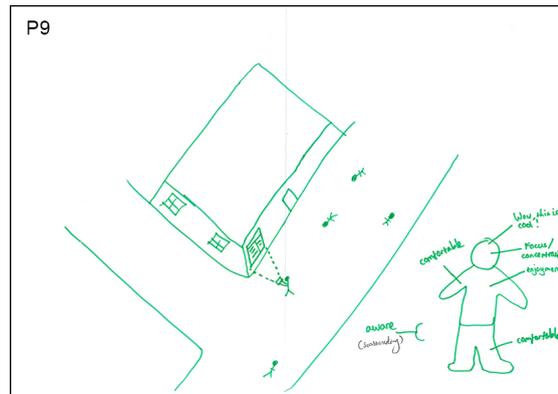
The sustained exploratory behaviour among mobile projector users throughout the walk may be attributed to the continuous and instant feedback they received for every action, manifested as the displacement of the projected display in space.

This immediate visual response to movement created a more intense and immersive experience of space [173].

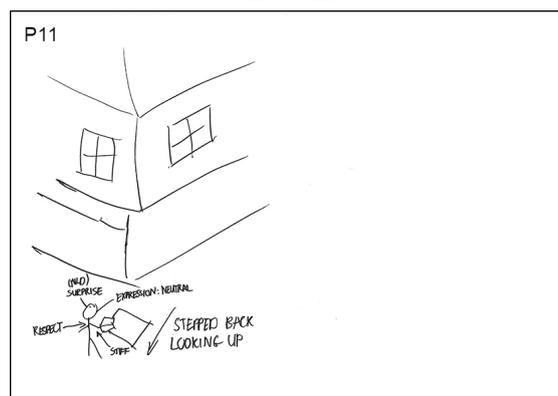
Previous studies often relied on explicit instructions to encourage users to adopt playful and performative behaviours, aiming to intensify affective engagement with POIs [73, 194]. In contrast, the results from this study demonstrate that the integration of mobile projectors, with their extended display capabilities, inherently motivated users to engage in these behaviours. The technology itself fostered spontaneous interaction with the environment, reducing the need for external prompts while enhancing the overall immersive experience. By seamlessly supporting with spatial interaction, the mobile projector guide actively influences how users physically navigate and somatically interpret heritage environments, supporting embodied and spatial heritage interpretation.

5.2.2 Awareness and feelings of “being there”

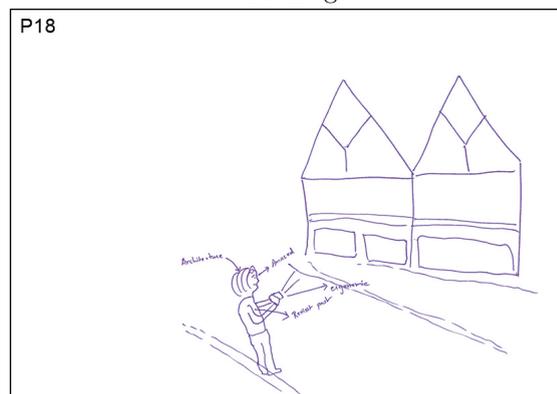
The findings from this study provide significant insights into how mobile projector guides influence users’ awareness and feelings of “being there” within heritage environments. Throughout the study, participants using location-aware mobile projector guides demonstrated enhanced attention to architectural features and a heightened awareness of their surroundings. A participant noted, *“I was looking at the projection a lot of the time [but] I still felt like I knew more about what was happening around me because it was like peripheral vision”* (p21). A mobile projector user reported increased awareness of other people: *“I was more conscious of everyone else around me because [...] I was pointing it [projected display] out to people’s way”* (p5). The experiences of the participants suggest that the mobile projector guides facilitated a more holistic engagement with the environment, allowing for both focused attention on the projected information and a broader awareness of the surroundings. The analysis of participants’ drawings provides additional evidence of the mobile projector’s impact on spatial awareness and embodied understanding. The significant differences observed between the mobile projector and smartphone guide users (see Fig. 5.3) in depicting 3D space (p: 66% vs. m:



(A) p9 drew passers-by whose attention they wanted to grab by projecting on the wall.



(B) p11 drew how they re-positioned themselves to get a better view of the building.



(C) p18 represented themselves projecting onto the heritage building façade.

FIGURE 5.3: Drawings created by mobile projector users after the outdoor heritage walk.

38%), scale accuracy (p: 48% vs. m: 10%), and clarity of representation (p: 71% vs. m: 42%) suggest that the mobile projector guides facilitated a more nuanced (qualities, scale and details) and embodied perception of the heritage environment.

Particularly noteworthy is the finding that users of mobile projector guides more accurately depicted corporeal aspects such as stance, orientation, and position in space. This suggests that the use of handheld projected displays encouraged somatic awareness of users' own bodily presence and led to conscious engagement with the heritage site [51]. The enhanced awareness towards these corporeal aspects in relation to the physical world among mobile projector users indicates that users of mobile projectors contributed to the development of the experience of presence and 'being-there' [243]. The observed differences between smartphone and mobile projector users in terms of environmental awareness and social engagement highlight the importance of considering how different technological devices shape users' phenomenological experiences of heritage sites. While smartphone users reported feeling disconnected from their social surroundings, projector users maintained a sense of connection with both the architectural features and other people present. These findings suggest that mobile projector guides have the potential to facilitate a more phenomenologically rich and embodied experience of cultural heritage sites. It can be suggested that by encouraging users to attend to their bodily presence and spatial relationships within the environment, mobile projector guides enable a deeper and more meaningful engagement with cultural heritage, leading to richer interpretations and understandings of the past [72].

5.2.3 Embodied Engagement and Spatial Practices in Heritage Interpretation

The data from both studies demonstrate that smartphone and mobile projector guide users engaged in embodied meaning-making with the heritage site (the High Street) and the POIs. However, the nature of this embodied meaning-making differed significantly between the two groups, shaping their experiences in distinct ways.

The ability to project and control the placement of digital content in physical space by using of mobile projector guides enhanced users' sense of agency to engage in the embodied meaning-making process. A participant described the device as

“a magic box” (p5), elaborating that *“the fact that you’re in control of where the plaque [projected display] is, and sort of where the [projected] information is... gives you control over how the information is presented to you”* (p5). In addition to talking about a sense of control, a participant highlighted the process of augmentation: *“you could position it [projection] where you wanted... you can see it and then from that... join it [digital content] with the site”* (p10) and *“it is basically augmenting real life. it’s taking real life and enriching it with more information”* (p9).

These observations demonstrate the way the mobile projector guide becomes an extension of the user’s body, allowing them to interact with and enhance their environment through physical gestures. The use of mobile projector guides enhanced the users’ sense of agency as it gave them the ability to get actively involved in placing digital information or act of merging digital and physical elements through bodily actions like positioning the projection and controlling where digital content appears in the environment [147]. These comments collectively suggest that the use of mobile projectors enabled users to engage in personalised embodied meaning-making, where users could use their physical movements to engage with both digital and real-world content, connecting their bodily actions to their cognitive processing [238].



FIGURE 5.4: p19 relocates to project onto the correct building and compares the old image with the current building.

The process of embodied and spatial meaning-making using a mobile projector was observed during the walk. As seen in frame 1 of Fig. 5.4, the participant (p19) was projecting information on the wall of the building. On realising that the information was related to the adjacent building, they re-positioned in the space to project on the building which was included in the application. This demonstrates

the user's desire and tactic to connect their body, digital information and the physical heritage site. Once in alignment with the actual building, they adjusted their distance to the structure, and moved farther away, to enlarge the size of the projected image (as seen in the last frame of Fig. 5.4). The participant explained their actions: "Being able to compare on real, on a scale, [...] you can put it [projected display] on top of a real-life building [...] which is much more fun" (p19). Similarly, another participant noted: "[you] do a comparison. Does it look similar? What is the difference between the times this picture has been taken and the picture now?" (p6).

Through these statements, participants highlighted that due to the use of mobile projector guide users, they were not only able to physically control and manipulate the spatial placement and scale of projection of information on the heritage building but were also able to control cognitive aspects of how they perceive, process, and potentially internalize the information. By physically choosing the placement and size of the digital project information on the physical building through bodily movement, participants were able to connect body actions and cognitive processes and engage in a process of embodied heritage interpretation [44, 72]. Such comments also highlight how the projection technology fostered imaginative thinking. The participant's ability to project an image of the past on the current state of the building sparked their imagination about the heritage site in different time periods, allowing users to mentally reconstruct the site's history and reflect on the passage of time.



FIGURE 5.5: A participant (p18) utilised the extended reach in the space provided by the projected display, along with the manoeuvrability of the handheld device, to explore and discover elements of the heritage site by scanning the surroundings. This interaction turned the heritage walk into a playful activity, engaging the user's imagination.

As shown in Fig. 5.5, the extended nature of the projection and the handheld nature of the mobile projector guide motivated the user (p18) to frequently project on the walls of the street moving it in a to-and-from motion while walking. The ability to extend one's actions into space afforded by the handheld projectors allowed users to transform geometric space into a space of sensorimotor experience and form an embodied understanding of space [217].

A participant explained this behaviour and motivations behind it: "*I was just scanning everywhere ..., especially when ... that building or ... place had ... some kind of history*" (p3), suggesting that they were engaged in pointing and scanning gestures driven by their curiosity regarding the buildings which would feature in the heritage walk. Similar to smartphone guide users, the target graphics on the interface triggered users' curiosity and imagination about the heritage buildings of the site.

The participant's description of "scanning everywhere" with the mobile projector, especially when a building or location "had some kind of history," shows how the handheld device encouraged imaginative engagement with the environment. The projection's mobility allowed the user to playfully explore their surroundings, turning an otherwise static observation of a heritage site into a dynamic and creative exploration. This process transformed the environment into a space where the user could engage their imagination and curiosity, shaping their own experience of history and place.

The act of scanning with the projector while walking and moving the beam across walls can be seen as a form of playful embodied interaction with the space. As these bodily behaviours were motivated by users' curiosity and imagination, embedded in the context of ongoing heritage walks and supported creative exploration of space the users' engagement with heritage sites, these behaviours can be interpreted as situated and emergent play [3]. The use of the mobile projector guide allowed users to get into an active, embodied, reflective and playful engagement with the physical environment of the heritage site. This situated play is important for embodied heritage interpretation [194], as it allows users to experiment with

their environment, see things from different perspectives, and connect with the space.

Using mobile projector guides allowed users to re-imagine the hybrid landscape as an environment for playful engagement. A participant described the perceptual shift and play experiences emerging from the use of a mobile projector: *“[It is] another way to look at the world ... playing with the surfaces, like how they change when you put the projector on them, the lighting. I enjoyed it ... Because when you have that kind of reality or a different reality, it’s literally another way to look at the world. Because you are projecting something that you have, that you can control into something that’s there, that you can’t change. But you can change it for a second when you put that thing [projected display] on top of the real thing”* (p19). This statement offers an insight into the experience of their activities and behaviours during the walk. It highlights that the process of merging the digital and physical environment comprised embodied play in the form of moving projections across the surface of various buildings on the heritage site. Such embodied play is known to evoke a feeling of connecting with the place and intensify the affective and aesthetic experience of the heritage walk in the form of pleasure, excitement and empathy [194, 200]. Schaper [196] and Kidd [124] also concluded that the use of mobile projector guides allowed for a more empathetic connection between users and heritage sites.

Furthermore, by manipulating their surroundings temporarily through digital augmentation, they were able to alter their perception of an otherwise static physical reality. This shift in perception aligns with the broader aims of cultural heritage interpretation, which seeks to offer new perspectives on the heritage site [216].

The comments also indicate that the use of a mobile projector supported embodied spatial practices (playful bodily engagement with the environment), enabling users to become active agents in the process of heritage interpretation. This resonates with the core principles of embodied heritage experiences, where users play a central role in meaning-making through physical interaction [72].

Along with play, the use of a mobile projector guide also reinforced the sense of immersion. p19 remarked, *“You are kind of like in the space where you are playing ... so you are kind of in a chessboard. And you are looking to make the move ... like the surroundings transforming into your chessboard. And you are the, I don’t know, one of the pieces”* (p19). The participant’s comparison of themselves to a chess piece in the space implies that they felt fully immersed in the experience, not just an observer from the outside. As discussed earlier in this section, the chess piece analogy also indicates their sense of agency as they actively engaged in strategizing and interacting with their surroundings. The metaphor of a “chessboard” for the space indicates that the digital overlays created by the mobile projector guide shifted the user’s perception of the space from being seen as a static geometric grid to an interactive space filled with potential for bodily and sensory exploration and playful meaning-making [72]. This indicates that using mobile projectors opened the space for embodied spatial practices – a reciprocal relationship between the user’s body and the environment that forms the foundation of embodied meaning-making and knowledge creation [72, 217].

Other participants also highlighted the mobile projector guide’s ability to foster a playful reciprocal relationship between the body, device, digital content and the environment. One participant noted, *“I like the interactive aspect of it ... it feels like it’s got more purpose to it”* (p12), while another remarked, *“it’s funny to just project something on the wall and see how the shape changes”* (p2), indicating that their experience of using mobile projector guide for heritage walk as interactive, playful, and enjoyable.

Nevertheless, some participants were dissatisfied with the distortions and lack of visual clarity in the projected display. While expressing their dissatisfaction with the distortion, a participant mentioned: *“It doesn’t project like a square. Like you don’t see it as a square. You see it like as a trapezoid”* (p1). Some participants found it difficult to read (P3, P13 & P16) from the projected display due to unfocused projection at a very small or large size. Other participants suggested that they were distracted while reading in a crowded street (P8, P14 & P20) and it was slightly inconvenient to find an even surface to project onto (P6, P8 & P18).

There were no similarities per say in the users chose to project and place/overlay the digital information on the buildings. In instances where similarities were observed, these were attributed to specific factors such as the physical condition of the point of interest (e.g., a façade covered in scaffolding, leaving only the door available for projection), the lighting conditions surrounding the POI, the participant's proximity to the structure, and the quality of the available projection surfaces.

A disparity was observed in embodied engagement between mobile projectors and smartphone users. This gives insight into the efficacy of a device with extroverted and extended display for embodied, performative, and playful heritage interpretation. This distinction is particularly evident in the users' spatial practices and somatic modes of attention, which are crucial elements in the formation of cultural knowledge and interpretation of heritage sites [44, 72, 180].

The difference in embodied engagement between the two groups is further evidenced by the fact that a higher percentage of mobile projector users (42%) visually aligned themselves with the POI while reading information, compared to smartphone users (29%). Similarly, 42% of mobile projector users actively repositioned themselves to get a better view of the buildings, compared to only 19% of smartphone users. These findings suggest that mobile projectors were more physically engaged with the heritage site and more inclined to pay somatic attention to the heritage site, i.e., attended to the heritage environment by turning, or repositioning their bodies [51] and engage in developing a spatialized understandings of cultural heritage by exploring the space [44, 217]. The sustained use of scanning and pointing gestures by mobile projector users, in contrast to the declining engagement of smartphone users as the walk progressed, further reinforces this distinction. These actions can be interpreted as bodily movements and gestures that are integral to the embodied interpretative process. The mobile projector appears to facilitate a more sustained form of embodied exploration, facilitating a form of walking that is attuned to or reciprocal to the environment and leads to knowledge generation [53, 64, 242].

In conclusion, the use of mobile projector guides in heritage interpretation seems to encourage a more embodied, interactive, and playful engagement as well as engage users in imagination and reflection with heritage sites compared to smartphones. The sense of agency experienced by the users due to mobile projectors enhanced bodily engagement, a sense of immersive, aesthetic experience, and a sense of felt connection/empathy for the heritage site. This likely contributed to a deeper understanding and embodied interpretation of the cultural heritage site, as individuals' understanding of the world is fundamentally shaped by our bodily interactions with it [51, 238]. These results underscore the potential of mobile projection technology to foster physical engagement with heritage sites.



FIGURE 5.6: A passer-by noticed p6 reading information on the projected display (1). They proceeded to stand next to p6, joined the experience (2), and then more people noticed and joined (3 & 4). The engagement became more interactive with P6 guiding passers-by's attention and communicating the information.

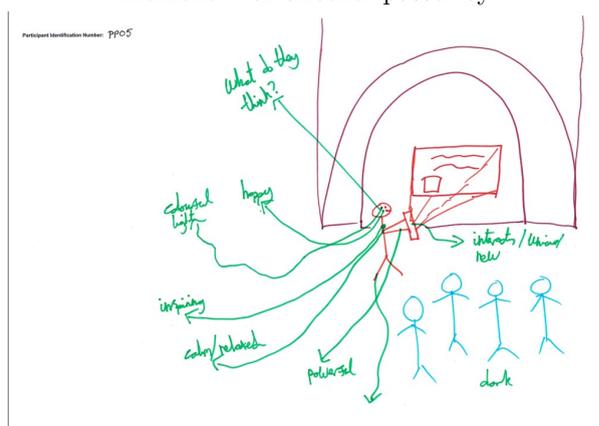
5.2.4 Social engagement and experience

The results also reveal several implications of using mobile projectors for heritage interpretation in public spaces such as urban precincts with respect to social experiences.

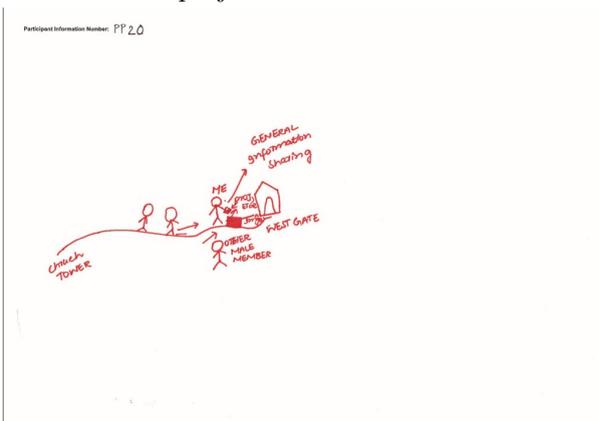
Several participants appreciated the projector's ability to initiate social interactions, as exemplified by p20's comment: *"It was good when all these (people) are trying to ask me, what you are doing?"* (p20). The incident where a passerby joined p6 in reading the projected information (Fig. 5.6) exemplifies how the projector can function as a shared display, supporting co-located shared activities. These observations regarding the participation of passers-by in the interpretation



(A) p12 drew themselves directly sharing a moment with another passer-by.



(B) p5 drew a moment where a group of passers-by stopped behind them to read the projected information.



(C) p20 drew the whole walk showing multiple passers-by they had encounters with.

FIGURE 5.7: Drawings created by mobile projector users showing different kinds of social encounters.

process due to the public nature of the projected display align with the findings of Betsworth et al. [20]. Simon's [203] concept of using 'social objects' as resources

to trigger and support communication among strangers within museums can be used to explain this phenomenon. In this case, the extrovert and public projected display served as a technological social object, facilitating shared use and collective meaning-making which are important for heritage interpretation [16, 136, 177].

This addresses the concern raised by researchers about mobile phones diminishing face-to-face interactions [115, 225]. Participant p9's act of deliberately creating a large wall projection to share their heritage experience with passersby demonstrates the user's desire for social engagement by leveraging the social potential of the technology. Their reflection, "*I thought that was cool because other people [...] see it too, that could maybe foster some interest*" (p9), indicates a desire to leverage the projector's capacity to enhance the social dimension of heritage interpretation. Similarly, P6's comment, "*I have the power [...] I'm inspiring these new people to question and engage with what's going on,*" reflects users' desire to seek participation of strangers (residents and tourists) in the heritage interpretation process, which is a key aspect of heritage interpretation process: the discovery of poly-vocal and personally relevant narratives through interactions with locals and other visitors [197, 198]. This behaviour and response also resonate with the idea that social interaction can stimulate affective and cognitive responses, increasing visitors' involvement and understanding of heritage sites [177]. The fact that 5 out of 21 participants depicted these social interactions in their drawings (Figure 5.7) indicates these social encounters contributed significantly to users' experiences of the heritage walk. This supports the belief that social interactions can play a significant role in shaping visitors' overall heritage experience [177].

Thus, the use of mobile projectors in public heritage spaces opened the possibility for or triggered spontaneous social interactions with strangers. This is significant as visitors often view heritage sites as places for social experiences [65, 202] and interacting with residents and other tourists contributes to the interpretation of the heritage site and overall experience of the visit [36, 177, 197, 198]. This ability of mobile projectors to foster social interactions addresses a key aspect of heritage interpretation and experiences.

However, observing participants' reactions to these social interactions also revealed the negative aspects of using projected displays in public spaces. Not all participants were comfortable with the attention drawn to them due to the use of a mobile projector. Some users reported feeling awkward or uneasy about standing out in public, as exemplified by p1's comment who otherwise engaged in performative and playful exploration of the street (see Fig. 5.2): *"I don't think I would like to attract too much attention. I don't like people talking to me in the street randomly"* (p1). Privacy concerns were also raised, as illustrated by p6's comment: *"It's very annoying because some people keep looking at you while you're walking ... you might say it's like they are interfering in a personal issue"* (p6). Some participants (p8, p11 and p12) attributed their discomfort to personal characteristics rather than the technology itself, as expressed by p8: *"I would prefer to not explain things to them [passers-by] ... but I can see that it might be because of my characteristics and not because of the nature of this device"* (p8). This finding echoes the importance of balancing social interaction with individual control and privacy, a concern also noted in previous research on mobile guides [85]. This highlights the need for designers to consider individual preferences and comfort levels when developing mobile guides for public use.

Interestingly, p12 suggested that wider adoption of the technology might reduce self-consciousness: *"if more people had them (projector) or were using it and it was quite a common thing, I would not be conscious about [using] it"* (p12). This points to the potential for social normalization of new technologies in heritage interpretation.

These results demonstrate the potential of mobile projectors to enhance social interactions and shared experiences in heritage interpretation. However, the users' concerns about privacy and social comfort highlight the complexity of designing mobile guides for public heritage spaces. There is a need for flexible mobile guide designs that support social experiences while respecting individual preferences and boundaries [191].

5.3 Conclusion

This study was motivated by the need to explore ways to support sensory and spatial engagement with cultural heritage sites such as urban heritage precincts through mobile technologies, addressing limitations found in existing smartphone-based guides, which often lead to passive, head-down interaction. Drawing on phenomenological theories of embodiment, the study examined how handheld projector-based mobile guides facilitated bodily engagement, spatial awareness, and sensory interaction and contributed to users' heritage experiences. The research aimed to explore how mobile projector guides afforded and enabled users to engage more actively and meaningfully with both the physical environment and the historical narratives embedded in heritage sites.

Key findings from this study reveal that handheld projector guides profoundly affect user behaviour and engagement with POIs and the physical environment. Participants adopted slower, more deliberate walking patterns, frequently scanned their surroundings and halted more frequently at POIs to project content onto surfaces. They engaged in "exploratory walking" [69]. This behaviour aligns with psychogeographical practices of "disrupted walking" [173] or "conceptual/reflexive ways of walking" [242], where users interact more attentively with their surroundings. Compared to smartphone users who tended to rush through the experience with minimal spatial engagement, the outward-facing projections fostered deeper connections to the physical site, allowing users to engage in spatial and sensory interpretation by overlaying historical content onto the built environment.

In line with the findings of Schaper et al. [196] and Kidd [124] the findings of this study also suggest that projector-based mobile guide facilitated embodied meaning-making. This study gave a deeper understanding of how embodied meaning-making unfolds and how it can be supported. By allowing users to directly overlay historical images and digital content onto the current structure of heritage buildings the technology supported an embodied and spatial practice of heritage interpretation [72]. This study demonstrates that the use of mobile projector guides transformed the static heritage sites of urban heritage precincts

into dynamic hybrid spaces for interaction, where users actively participate in the interpretive process (reflection, imagination, appreciation) through embodied movements [217].

The findings also suggest that mobile projector guides enhance users' sense of presence, sense of agency and spatial understanding. This was evident in their more frequent use of gestures, such as scanning and pointing, and playful and imaginative ways of connecting digital and physical elements of the site. These actions can be interpreted as somatic modes of attention, and exploration [51], integral to the embodied interpretative process [72]. This suggests that technological tools like handheld projectors can play a crucial role in shaping how users interpret and connect with cultural heritage, supporting Ciolfi [44] argument for the importance of embodied engagement in heritage experiences.

The public-facing nature of the projected displays often drew attention from passers-by, leading to spontaneous social interactions and shared experiences. While some users welcomed these interactions, others expressed discomfort due to the attention they attracted. This suggests that future designs of mobile guides should consider the diverse preferences of users when it comes to social engagement. The study shows that handheld projectors can serve as social objects, fostering communal interpretation and interaction, which is particularly relevant for public heritage settings.

The study also highlighted the social dimension of mobile projector guides. The public-facing nature of the projected displays often drew attention from passers-by, leading to spontaneous social interactions, and making the heritage experience more communal. This projected display served as a technological "social object" [203] that facilitates shared use and collective meaning-making. While this extroverted nature of the device was welcomed by some participants, others expressed discomfort, pointing to the importance of considering user preferences for public engagement in future design.

The contribution of this research lies in its ability to inform the design of future mobile guides that support embodied engagement with heritage sites. To enhance

the immersive quality of heritage experiences designers should consider integrating features that evoke curiosity, provide an extension to the body, and offer real-time feedback to users' bodily movements. For instance, enabling gestures like scanning or pointing as interaction mechanisms could reinforce the connection between the body, digital content and physical space. Additionally, mobile guides should offer personalization options to cater to diverse user preferences, promoting both individual exploration and social interaction in public heritage settings.

Future designs could also explore ways to design publicly visible artefacts which when needed could respect users' privacy concerns. This might involve developing adjustable tangible devices. Furthermore, the findings suggest the potential for integrating playful elements into mobile guides to intensify affective engagement with heritage sites. While Ryding et al. [194] and Fosh et al. [73] achieved playful engagement and exploration in heritage contexts through explicit interactions the findings suggest that extrovert and extended nature of device/display that connects body, digital content and physical space can provide intrinsic motivation for situated play.

In terms of broader implications, this study advances the understanding of how mobile technologies can transform heritage interpretation from passive information consumption into a dynamic, participatory, embodied process. It demonstrates the potential for handheld projectors to encourage a more profound connection between users and their cultural environment, aligning with Tilden's [216] principles of heritage interpretation that emphasize personal connection and active participation.

This research contributes to the growing body of work on embodied heritage experiences [44, 72, 179] by demonstrating how specific technological affordances can shape users' physical and cognitive engagement with heritage sites. It provides empirical evidence for the value of embodied, spatial practices in heritage interpretation, supporting theoretical arguments made by scholars like Flynn [44, 72, 178].

In conclusion, this study offers valuable insights into the design and use of mobile technologies for embodied heritage interpretation. By addressing the interplay

between body, technology, and cultural heritage, this chapter contributes to the understanding of how to create more engaging, meaningful, and embodied experiences of heritage sites. As researchers continue to develop new tools for heritage interpretation, this work highlights the importance of considering the embodied, spatial, and social dimensions of the heritage experience.

Chapter 6

Group heritage walks with mobile technologies

This chapter examines how different mobile guide technologies influence group dynamics and collective heritage interpretation practices during walks in historic urban precincts. While previous research has explored the use of smartphone guides and mobile projector guides to support social experiences during interpretation activities in museum settings [20, 85, 134, 177, 191], less is known about their effects on group experiences in outdoor heritage environments which presents distinct physical, social, and cultural challenges.

The growing integration of mobile technologies in heritage interpretation raises important questions about how these tools shape social interactions and collective meaning-making [134, 177, 191]. This study aims to investigate the impact of two distinct mobile guide technologies—smartphones and mobile projectors—on group cohesion, collaborative exploration and shared meaning-making in outdoor heritage settings.

To address this aim, the study poses the following research questions:

1. How do different display modalities (smartphone vs. mobile projector) affect group dynamics during heritage walks?

2. In what ways do mobile guides influence collaborative exploration and collective meaning-making practices?
3. How does the awareness of public perception impact the use of mobile guides in urban heritage settings?

To answer these questions, user studies were conducted with pairs and groups of four participants, using either smartphone or mobile projector guides during a heritage walk along Canterbury High Street. Data was collected through video recordings, pre- and post-walk questionnaires, experience mapping exercises, and semi-structured group interviews. The analysis focused on observing participants' behaviours, interactions, and reflections on their experiences.

The results section of this chapter is organized into several key themes:

- The experience of device holders versus companions
- The influence of mobile guides on group dynamics and cohesion
- Collaborative meaning-making practices facilitated by different guide technologies
- The effect of public awareness on guide usage
- The role of location-aware media in balancing exploratory discovery and navigation

This study contributes to the field by extending our understanding of how mobile technologies shape social experiences in outdoor heritage contexts. It provides insights into the ways different display modalities can support or hinder group cohesion and collaborative interpretation. The findings highlight the potential of mobile projector guides to foster shared experiences and embodied meaning-making, while also revealing challenges related to public perception and navigation in urban spaces. These insights offer valuable guidance for designers of mobile guides aimed at enhancing collective heritage experiences in public spaces, addressing the

tension between individual control and shared experiences [191], and supporting the discovery of polyvocal and personally meaningful narratives [197, 198].

6.1 Study

To examine the impact of mobile guides with different display modalities on group social behaviour and experiences, user studies were carried out during a heritage walk along Canterbury High Street using a custom-designed location-based media application. By inviting groups to participate using both smartphones and mobile projectors, the study was able to explore how different display types affect social dynamics. To assess the influence of mobile projectors across varying group sizes, walks were conducted with two configurations: a) pairs and b) groups of four.

Three sessions of data collection were conducted for each study condition:

1. Pairs using one smartphone, represented in the results section 6.2 as ‘w’;
2. Pairs using one mobile projector, represented as ‘t’;
3. Groups of four using one mobile projector, represented as ‘f’.

In total, 6 unique pairs were recruited, with 3 pairs completing the walk using (a) a smartphone and the other 3 pairs using (b) mobile projectors. Additionally, 3 groups of four were recruited to participate in walks using a mobile projector. All participants were between 18 and 35 years old, and the pairs and groups consisted of familiar individuals (self-selected) to replicate the real conditions of group visits to heritage sites.

Data were collected before the walk using two methods: a) the Ten Item Personality Measure (TIPI) [214], and b) a pre-walk questionnaire to capture user expectations and motivations. The TIPI was selected as it is designed specifically for contexts where short assessments need to be undertaken, and personality is not the primary focus of the study.

To observe participants' natural behaviour during the walk, video recordings were made [134, 147, 191]. After the walk, participants were invited to a nearby café for a post-walk survey, an experience mapping exercise, and a semi-structured group interview to gather more detailed qualitative data. The interviews were audio-recorded for later transcription and analysis.

The pre-walk questionnaire, post-walk questionnaire, and interview questions were adapted from the studies of Lanir et al. [134] and Jarusriboonchai et al. [114]. These questionnaires included both closed questions, using a Likert scale ranging from -3 to 3, and open-ended questions. The Likert scale questions asked participants to indicate whether they “Disagree Entirely” (= -3) or “Agree Completely” (= 3) with statements that positively reflected their feelings about the device.

Due to the small sample size, the quantitative data analysis from the pre- and post-questionnaires did not yield significant results, and thus these findings are not discussed further in this chapter.

6.1.1 Data analysis

The analysis specifically concentrated on the sequential nature of participants' behaviour and how they carried out their actions and activities through their interactions with both those they were “with” and others who were present in the “same space.”

The qualitative analysis focused on the behaviours and practices exhibited by participants, as well as the reasoning behind their actions, both while walking in groups between points of interest (POIs) and while at the POIs. All video data collected were reviewed to identify relevant events and activities. From these, the most interesting and clear examples were shortlisted. These selected fragments were then analysed in detail to map participants' behaviour in the form of image sequences and transcriptions. Following the framework used by Lanir et al. [134], Vom Lehn et al. [136], and Steier et al. [208], the video observations were analysed based on the following parameters:

- Configurations of standing: together, sub-groups, separated
- Distance from each other: within conversation supporting distance or more
- Leader and their role: clarity on the leader or not; collaborative activities or not
- Device management (facilitation): holding, sharing, and passing the device
- Gestures and actions: collaboration; communication (with group members)

By comparing and contrasting the actions and activities that were consistent across different fragments, specific patterns emerged, revealing how users interacted, collaborated, and performed their heritage exploration.

The qualitative data from the experience maps, open-ended questionnaire responses, and post-activity interviews were thematically coded for aspects such as ‘collaboration’, ‘roles’, ‘group experience’, ‘experience of using the device’, and ‘experience of the heritage walk’.

6.2 Results

This study reveals significant insights into how different mobile guide technologies influence the social experience during heritage interpretation in historic urban precincts. During the analysis of the video data and interviews, themes previously discussed in Chapter 4 and Chapter 5 also resurfaced. However, the findings in this chapter concentrate exclusively on the themes of individual agency, cohesiveness, and collaboration as demonstrated by various group members while interacting with two different mobile guides within groups of varying sizes. In the following sections, these results are presented thematically, integrating excerpts from videos and interviews to explore and discuss these aspects in depth.

The presence of a companion significantly influenced participants’ engagement with the heritage walk, regardless of the type of mobile guide used. Companionship

led to greater attention and time spent at each point of interest (POI). A clear distinction emerged between solo and paired smartphone users: while individuals often read the information while walking, pairs exhibited more engaged behaviours. They would stop to read, observe the POIs closely, use gestures to point out features to each other and engage in discussions about their observations.

This behaviour pattern indicates that having a companion changed how participants interacted with both their devices and the surrounding environment. The social nature of the experience seemed to promote more cognitive and corporeal engagement with the site, such as stopping to examine POIs and using body gestures to exchange knowledge. These observations suggest that the companionship enhanced the overall heritage interpretation process.

The mobile guide proved to be an effective tool in directing groups' attention towards the heritage site. This is evidenced by participants' own reflections. One participant, using a smartphone guide in a pair, remarked: *I am pretty confident that without the device, we wouldn't focus as much on the site itself, ... we would have just casually talked about other things [and] not get really involved"* (w2). Another participant, from a pair using a mobile projector, shared a similar sentiment: *Before that, we were discussing about shopping, boots, these kinds of shops. But this time we were discussing about Westgate [POI], library [POI], old heritage more during the walk"* (t2). These reflections suggest the introduction of the mobile guide, regardless of its type, served to redirect users' attention and conversations towards historically and culturally relevant topics. By doing so, the mobile guide facilitated more focused, site-specific discussions between companions, enhancing their engagement with the heritage experience. These findings suggest that the mobile guides helped in effectively redirecting groups' attention towards the heritage site, enhancing their overall engagement with the heritage experience.

Similar to findings in Chapter 4, smartphone users in pairs reported a sense of familiarity and comfort with using phones while walking (w3). Due to their everyday use of smartphones, it was easy to incorporate smartphone use into their

heritage walk experience.

Both smartphone and mobile projector users expressed that they enjoyed the walk while using the mobile guide. Smartphone users said: *“It was all pretty enjoyable; I quite like the entire walk”* (w6) and *“I enjoyed it very much ... I would consider it [smartphone-based location-aware media] a very useful tool when I’m visiting a city”* (w1). In addition to enhancing enjoyment, smartphone guide users perceived the mobile guide as a very useful and valuable tool. Mobile projector users highlighted that in addition to being enjoyable, the experience was unique and worth doing again *“it’s a bit more engaging and a bit more novel”* (t6), implying the uniqueness of the tool. Mobile projector users felt that the experience was unique and memorable, expressing a willingness to repeat the experience and boast about it among peers: *“I can, yeah, tell people like - oh! one time I did a tour with a like a projector”* (t4) and *“we would love to do that again”* (f3). This desire to repeat the heritage walk with the device is a strong indicator of satisfaction that mobile projectors guide users’ experience.

Overall, both technologies were positively received. The users’ satisfaction with each mobile guide indicates that integrating mobile technology into heritage interpretation enhances the experience rather than diminishing it [160]. However, while smartphone guides were viewed as useful, mobile projector guides stood out for creating unique and memorable experiences.

6.2.1 Experience of device holders and companions

Notable differences emerged in participants’ experiences depending on whether they were holding the device or accompanying someone holding the device. These differences were particularly evident in areas such as engagement with the environment and social participation, as discussed in this section.

Participants holding devices, whether smartphones or mobile projectors, reported a heightened focus towards the interpretation activity. Mobile projector guide

users reported holding the device brought their focus to the walk, as one participant expressed: *“When I was not holding the device, I was not focused ... But when I hold the device, I feel like I’m more in control. I have control on the device. So, I was more focused”* (t1). This quote reveals the sense of control over the device increased the device holder’s engagement with the heritage experience. However, for smartphone guide users this focus often came at the cost of reduced environmental engagement and social interaction. A smartphone holder noted: *“I would say [I was] affected a bit. Because I ... [expected] on the phone to get some notification. So, I was talking less. If the phone was not with me, then I would have talked with him [companion] more”* (w3). A user holding the mobile projector in the groups of 4 also felt constrained by the device and noted that the companions had more freedom: *“They [companions] were busy talking and chatting, but I was feeling a bit more ... restricted and conscious because I was holding a device ... I had to take care of where I’m going and how the path is ... I have to be very careful, I might not fall”* (f3). This statement highlights a critical implication of holding mobile guides: the device’s presence and the app design can create a psychological barrier to participation in social interaction. The anticipation of notifications or new information and the responsibility of holding the device keeps the holder’s attention divided between the digital and physical realms, potentially diminishing the quality of social engagement during the heritage experience.

The positive effects on users’ engagement during the interpretation activity due to the ownership and sense of control over the device when the users are in a group, resonate with findings of Lanir et al. [134] and Rennick-Egglestone et al. [191] as it allows them to explore the place at their own pace. However, the findings from this study also highlight the negative effect of holding mobile guides on users’ freedom to explore and participate in the group’s interaction.

While device holders suggested that holding the device was beneficial as it provided focus and control, companions reported a greater sense of freedom which they utilised to engage with the environment and other aspects of the experience. A companion in smartphone guide walks observed: *“I was enjoying the environment, not just the site itself, but also the rest, like the weather, the people”* (w2) and

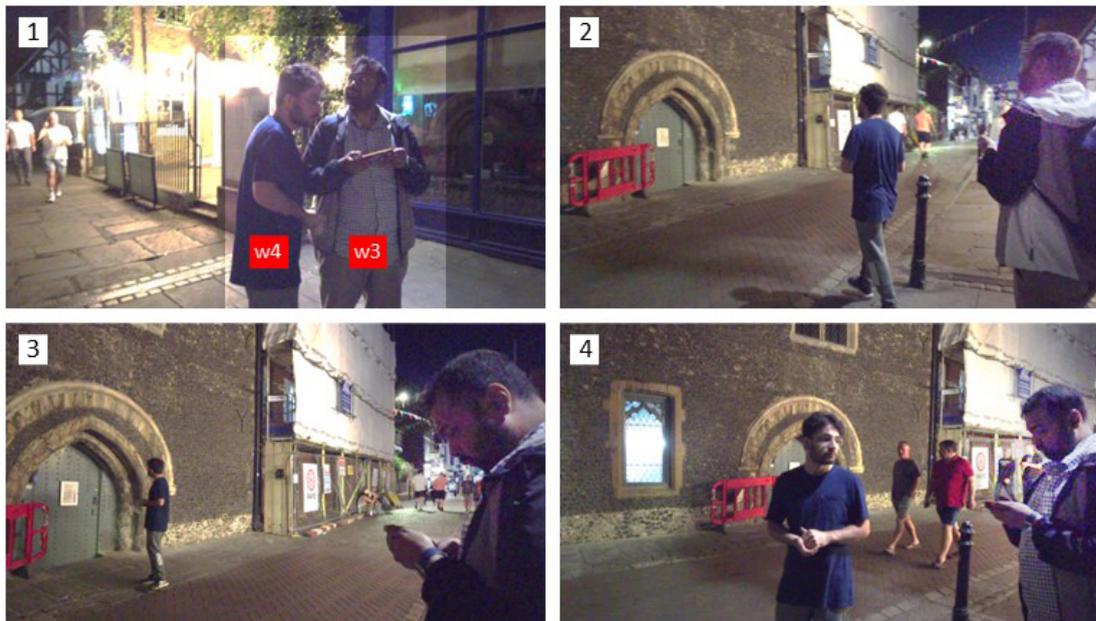


FIGURE 6.1: The device holder (w3) stays engaged with the information on the device, while the companion (w4) moves closer to examine the POI. This illustrates the differing behaviours between the device holder and those not holding the device.

“while he [person holding the device] was reading, I could also locate the heritage site” (w2). Another companion noted: *“Through the walk, I was feeling - oh! I’m going to the historical, historical buildings, and many buildings, not just only two, three, but a lot of historical buildings”* (w4). A companion from the group using a mobile projector also noted the same aspects: *“we could also talk and look around more ... can enjoy more perhaps”* (f2). However, they noted that *“holding the device might have its own charm”* (f2).

These behaviours were also confirmed by the analysis of video recordings. A participant who was not holding the smartphone took the initiative to explore the POI in the environment. As seen in Figure 6.1, after the notification was triggered, initially both participants (holder and companion) huddled together to view the information. Subsequently, companion (w4) went closer to the site to inspect it (see frames 2 and 3), but w3 kept reading the information on the screen (see frames 3 and 4).

These findings indicate that holding the mobile guide, whether a smartphone or a mobile projector, heightened participants’ focus on the interpretation activity

by giving them a sense of control. However, this focus often came at the expense of reduced environmental engagement and social interaction. Device holders reported feeling more restricted and less free to engage with their surroundings and companions. In contrast, companions, free from the responsibility of managing the device, experienced a broader awareness of the environment and greater freedom to interact with others and enjoy the overall heritage experience. To be able to have a broader awareness in the heritage landscape is crucial as immersive, multisensory and affective engagement with the heritage site and its surroundings is key to holistic and personal interpretation [44, 77, 106, 179]. The companions were able to appreciate and reflect on the collective historical significance of the area rather than focusing solely on individual points of interest. As discussed in Chapter 1, historic urban precincts are cohesive entities rather than collections of individual points of interest. The comments of the companions also highlight that at outdoor cultural heritage sites, they valued a holistic heritage experience that goes beyond just the historical information provided by the mobile guide and includes sensorial and social aspects.

These findings indicate that although holding the mobile guide—whether a smartphone or mobile projector—increased participants’ focus on the interpretive activity by providing a sense of control, it frequently resulted in reduced environmental engagement and social interaction. Device holders felt more restricted and less able to interact freely with their surroundings and companions, as their attention was directed towards the device. Previous research has also highlighted the difficulty of balancing engagement with the device and engagement with the heritage site [194, 232]. This underscores the need to pay additional attention to designing mobile guides that push users’ attention towards their surroundings.

In contrast, companions—unburdened by the task of managing the device—reported greater environmental awareness and freedom to interact with group members. This broader awareness is essential for immersive, multisensory, and emotional engagement with the heritage site, which contributes to a more holistic and personal interpretation [44, 77, 106, 179]. Companions were able to reflect on the collective historical significance of the area and appreciate it as a whole rather than focusing

solely on individual points of interest. This aligns with the understanding that historic urban precincts should be experienced as integrated entities, rather than as isolated sites (see Chapter 1). Their comments further suggest that companions value a heritage experience enriched by sensory and social dimensions. These insights emphasize the importance of designing mobile guides that not only support engagement with the heritage landscape but also encourage group interaction and a holistic experience.

6.2.2 Shared information access

The study revealed intriguing dynamics in how information was shared between device holders and companions, particularly with smartphone users.

While discussing the use of smartphones in group settings a participant who was a companion in a pair suggested that it is normal to use the smartphone as a shared device in a group: *“from my perspective, I didn’t feel anything different just because usually when we go travelling with friends ... then somebody will just be like - ‘hold on, I’m checking Google Maps,’ and everybody just crowds around that person, ... so it’s just natural ... And then they will probably just read out whatever it is on the screen ... [during the walk] I just tried to lean in and try to look at the screen as well ... No awkwardness. Nothing”* (w5), implying that gathering around a smartphone has become a standard social practice, especially in travel contexts. Another smartphone guide holder remarked: *“There were a few moments where a discussion started in between us, thanks to the information that popped up ... so, I think this was good for the group experience”* (w1), implying that information presented by mobile guides triggered discussion.

The everyday smartphone usage patterns interfered with their shared use during heritage walks. As seen in the Figure 6.2, after the information was triggered, the holder of the device (w4) continued to hold the device in their personal space. This made it slightly uncomfortable for the companion to read the information. To overcome this, the companion (w3) decided to take shared control of the device by



FIGURE 6.2: The device holder (w4) kept the device within their personal space, prompting the companion (w3) to hold and pull the device slightly towards them to read the information. This highlights the challenges of using smartphone guides in pairs and the strategies companions adopt to overcome these difficulties.

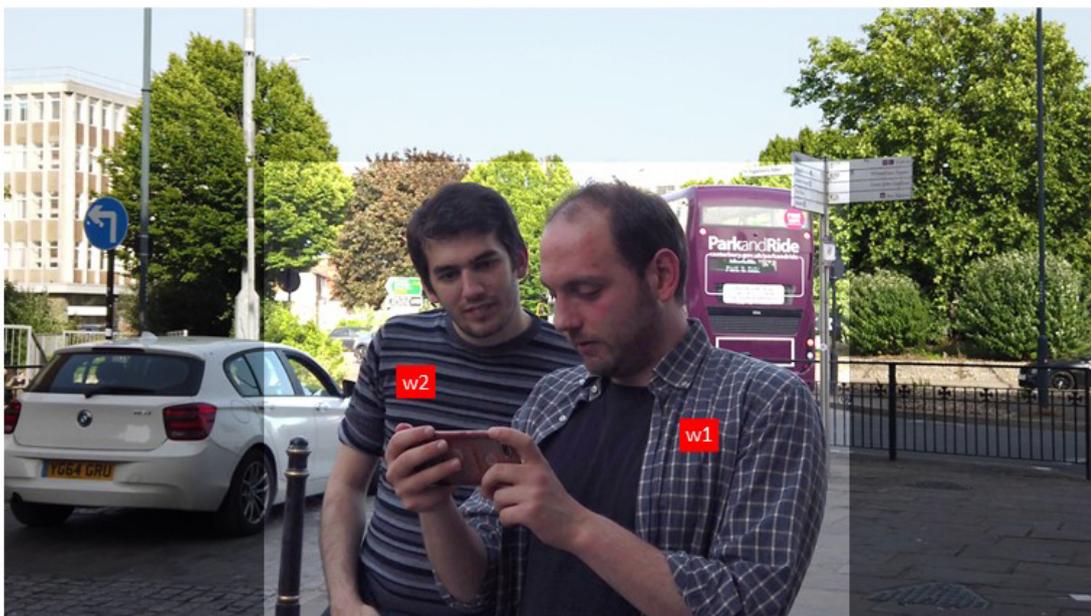


FIGURE 6.3: The device holder (w1) kept the device within their personal space but read the information aloud to ensure the companion (w2) could also understand the POI. This illustrates the challenges of sharing information when using smartphone guides in pairs and the strategies device holders employed to overcome them.

holding the smartphone (frame 2) and pulling it closer to themselves for reading. Similarly, w1 also held the smartphone within their personal space, close to their body (see Figure 6.3). This positioning of the smartphone guide required the companion (w2) to awkwardly lean in or stand behind the holder's (w1) shoulder to view the screen. To avoid the discomfort of huddling around the device for a companion, the holder intuitively adopted the tactic of reading the information aloud, ensuring that their companion could access the content. During the interview, the smartphone guide holder (w1) explained that they felt a sense of responsibility to ensure that the companion also had access to the information. Hence, to share the information with their companions they read it aloud: *"I held it [a smartphone] for the whole time, and I thought that I had some kind of responsibility to share the information that I was receiving"* (w1) and *"I was just worried that you [companion] couldn't see the screen. So, we tried to read out the descriptions or little info fun facts"* (w6).

These quotes and observations highlight a key limitation of smartphone-based guides in group settings: the difficulty in sharing visual information from the smartphone screen. The need to read aloud or pass the device demonstrates how the physical characteristics of smartphones can hinder simultaneous information access and potentially disrupt the flow of the heritage experience. This finding highlights the persistence of the problem of sharing information withing a group using small screens of smartphone guides as identified by Lanir et al. [134]. However, the issue is not only limited to the small size of the screen but is related to everyday individual practices of using smartphones and individual's comfort to share physical and personal space with others.

In contrast, mobile projector users found it easier to view information simultaneously. As a participant noted: *"it's much easier to share the information rather than all trying to crowd around one small phone screen; makes it easy enough"* (f11) and *"I think with the projected display, it's easier for the groups to read it together ... if it's just a handheld [like smartphone] device ... then only the person holding it will be reading it, but if it's projected on the floor, three or five or whoever [in] the group can read it very easily ... that is the main benefit of the*

projection on the floor” (f3). Another user in a pair highlighted that by making it easier for group members to share and access information simultaneously, the mobile projector guide promoted the exchange of ideas within the group: *“it was easier for both of us to share the information at the same time and discuss about it”* (t1). Indeed, facilitating simultaneous access to information fostered collaborative heritage interpretation and enriched the overall heritage experience of the group. This aligns with the findings of Betsworth et al. [20] and Lanir et al. [134] on the potential of mobile projectors to trigger reflections and promote collaborative meaning-making, enriching group heritage experiences.

This study extends these findings from controlled indoor museum settings to dynamic outdoor environments of historic urban precincts, suggesting that the benefits of shared displays persist across different heritage contexts.

6.2.3 Influence of mobile guides on group dynamics

This section presents an analysis of the influence of mobile guides on the group dynamics during heritage walks as interaction and cohesion between the group members can lead to reflection and collective meaning [16, 136] and improve visitors affective responses, involvement and understanding of the heritage site [177]. It was observed that the mobile guide device influenced individual participation, group dynamics and cohesions during the group walks.

The use of mobile projectors guides significantly enhanced cohesion among the group. One participant observed: *“It was a nice group activity. Sometimes I feel like in tour guides, ... when someone is leading and talking ... the group is divided into pairs or individuals ... but this one [mobile using projector], ... I think it involves everyone, even if this was ... like six or eight people, everyone would be watching the projector”* (f10). This comment highlights that, unlike traditional tours where individuals within the group may be distracted, the projector kept the entire group cohesive, by enabling them to focus on the same content simultaneously.



FIGURE 6.4: The device holder (t4) and the companion (t3) of the mobile projector guide shared control of the device at the POI. This demonstrates how extrovert technology with shared display can facilitate collaborative interactions between users during a heritage walk.

Another way mobile projector guides fostered group cohesion was by giving each member a sense of individual agency. This was achieved by facilitating easy access and shared control over the mobile projector guide during heritage walks. One companion in a group using a mobile projector noted: *“I feel like people are more willing to read because you don’t need to pass on objects. Everyone can just look at the same thing, and if we need to switch pages, we just have to ask”* (f12). This implies that, despite not holding the devices, they could still influence how they engage with the content. Moreover, as seen in Figure 6.4, even though the primary device holder maintained possession of the guide, their companion (t3) felt at ease interacting with the app. These observations highlight that the shared nature of the projected display not only allowed for easier, simultaneous access to information but also promoted collective control among group members. These findings indicate that the use of a shared display led to a sense of shared ownership and operation of the device, which temporarily diminished the traditional leader role [191], thereby fostering a more collaborative approach to meaning-making.

The use of the mobile projector guides facilitated increased flexibility and personalized pacing for group members. A mobile projector guide user observed: *“[as it] was projected ... so each one of us could read at our own speed ... and we could also go back to the slides”* (f3), suggesting that they experienced flexibility in terms of pacing their reading and their ability to revisit information. These results show that the use of mobile projector guides addresses a common challenge in guided tours, where participants often struggle to keep up with a guide’s pace or miss

information. These findings show that projected display offered a more accommodating and personalized way of consuming information within a group setting and addressed the concern raised by Perry et al. [177] and Rennick-Egglestone et al. [191] about the need for flexibility in group experiences to accommodate individual visitors' varying paces and interests, allowing for both shared experiences and individual exploration within a group context.

The impact of projected display on the collective focus was discussed by a participant in a group of four: *"It did provide a focus ... when you're in a group of people, you kind of get lost in the conversation ... [yet] it was kind of like a guide, really big sort of guide [projected display] ... just felt that you are doing it together"* (f8). This comment highlights that by acting as a shared visual reference and being simultaneously accessible to all group members, the projected display evoked a sense of doing interpretation activity collectively, which is crucial for visitors during heritage and museum experiences [67, 177]. Another participant from the same group of mobile projector guide users provided a resonating perspective on the aspect of collective experience and group dynamics: *"I quite like it because he [f10, holder of device] looked like a person on a quest. He had the thing [device], and then he was looking around, and we were all looking around ... we shared the experience; we all went on a quest together"* (f9). The statement suggests that the shared projected display along with the app interface (which had target graphics) helped frame the heritage walk as a shared adventure or mission and provided synchronicity to the group's exploration activity, increasing collective engagement and enjoyment. It also implies use of the mobile projector guide injected a sense of collective play and shared imagination into the heritage walk. Echoing the simultaneousness of experience, another companion added: *"you can also have the same experience at exactly the same time rather than one [person] and one [person] than one [person]"* (f11), implying that using a projected display allowed everyone to have an experience that was synced.

These comments indicate that the users valued the ability to have synchronise and shared experiences with group members as it enhanced their experience of exploring the heritage site. Systems like Sotto Voce used audio and an 'eavesdropping'

mechanism to support synchronicity [6, 85]. However, the mobile projector guide supported synchronicity while allowing the use of visual content which is useful in outdoor heritage explorations [30, 240].

Overall, the findings from observation and statement align with the previous findings related to mobile projectors' ability to support 'togetherness' [134], a key measure for social interaction and cohesion during museum visits [56]. However, this study offers insight into how mobile projectors support group dynamics and cohesiveness during the heritage walks.

Firstly, the shared display fostered a sense of collective control and participation. Even when participants did not physically hold the device, by having a shared view of display they were able to exercise influence over the group's interaction with the guide. This evoked a sense of shared ownership and encouraged egalitarian group dynamics where all group members were able to play a role in the exploration process.

Second, the mobile projector guide offered flexibility in terms of pacing and revisiting information. Participants could consume content at their own speed, and multiple individuals could access the same material simultaneously. This flexibility addressed a common issue in guided tours, where participants may struggle to keep up or miss key information. By allowing personalized and flexible engagement within a group context, the projector guide enhanced the individual and collective exploration of the heritage site, supporting both shared and independent learning experiences.

Lastly, the projected display served as a visual focal point where everyone could experience the same content at the same time, encouraging group members to remain synchronized in their exploration. By supporting a sense of synchronicity, the projector guide enabled playful collaboration and reinforced the feeling of collective participation. The mobile projector guide enriched the shared experience by fostering a shared sense of imagination and discovery.

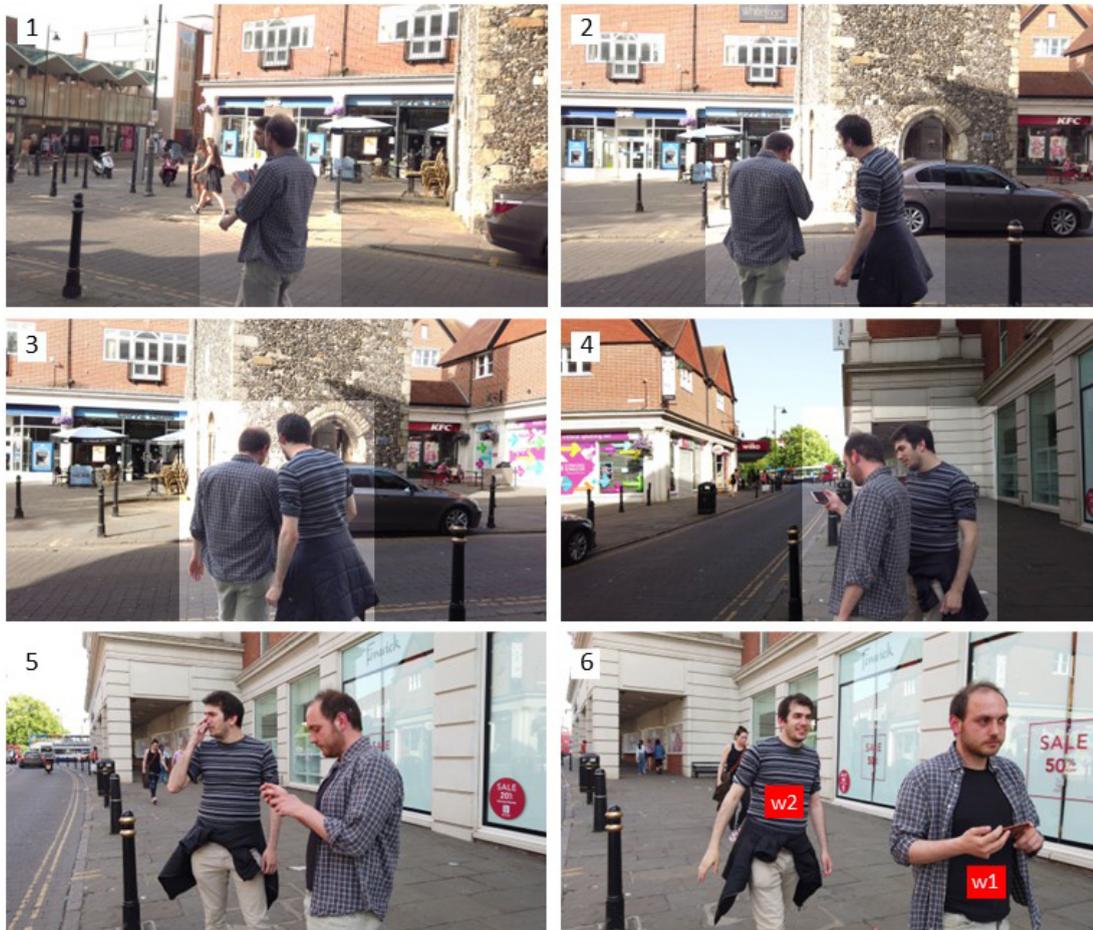


FIGURE 6.5: The device holder (w1) became absorbed in the smartphone guide and forgot to communicate/coordinate with their companion. As a result, the companion (w2) was left to follow the device holder (w1). This lack of coordination made the companion (w2) feel excluded, leading to a loss of interest in the heritage walk.

In essence, mobile projectors enhanced group cohesion by balancing individual agency with collective engagement, making the heritage walk a more immersive, shared, and dynamic experience.

The use of smartphone guides also significantly influences the group dynamics, cohesion and the social aspects of heritage experience experiences. As seen in Figure 6.5, after the smartphone guide holder (w2) received a vibration-based notification, they turned towards the point of interest (POI). However, the companion (w1), lacking direct access to the notification, was left with no choice but to follow the movements and orientation of the device holder (w2) in order to align their position. Further, as shown in frames 2 and 3 of Figure 6.5, the companion

(w1) had to step back and position themselves behind the device holder (w2) in order to view the screen. Eventually, the companion (w1) stopped trying to read the information and distanced themselves from the device holder (w2) (as seen in frame 5), due to the difficulty in seeing the content on the screen. Once the device holder (w2) finished reading, they began walking away from the POI without communicating with the companion (w1). In frame 6, the companion (w1) noticed the device holder (w2) leaving and began to follow them. This sequence highlights how the device holder (w2) unintentionally controlled the interaction, while the companion (w1) was reduced to merely observing and following the device holder's movements. This observation highlights how the use of smartphones as guides unintentionally left the companion with a limited sense of agency and created a divide between group members, disrupting the group's cohesion.

As a result of the inability to access information, reduced sense of agency and poor social cohesion of the pair, the companion (w1) exhibited a gradual disengagement from the heritage walk activity. The demand from w1 to constantly observe, follow, and adjust to the device holder's actions diminished their ability to participate meaningfully in the shared experience. While it is known that smartphones are not suitable for shared use [134], these observations give an insight into the nature of the influence of smartphone guides on group dynamics. Unintentional isolation for companions caused by the use of smartphone guides leads to poor cohesion among group members, hindering the collaborative meaning-making process.

While both smartphones and mobile projectors offer advantages, mobile projectors uniquely facilitate shared experiences, promote group discussions, and provide more flexible engagement with information as confirmed by prior studies in museum settings [20, 134]. This study, however, extends these findings to outdoor heritage environments in historic urban precincts, which introduce distinct challenges and opportunities.

Further, this study provides a deeper understanding of how mobile projectors enable and support collective heritage experiences. The use of mobile projector

guides fostered a sense of collective control over the mobile guide device and individual agency. Consistent with the findings of the previous study, the results from this study suggest that the shared display of mobile projector guides encouraged an egalitarian group dynamic [147] by empowering non-device holders to interact with content. This enhanced group dynamics, and cohesiveness, encouraging collective participation and shared experiences during heritage walks. Further, the shared nature of mobile projectors facilitated both synchronized group experiences and personalized engagement, making them more effective for group-based heritage explorations than smartphones. In contrast, the use of smartphones as guides unintentionally isolated companions, diminishing their sense of agency and disrupting the social cohesion necessary for collaborative meaning-making.

Therefore, to foster collective heritage experiences, designers of mobile guides should focus on providing shared access and control over the display, which allows all group members to interact with content simultaneously. Additionally, mobile guides should facilitate both synchronized experiences and allow for flexibility in engagement to ensure group cohesiveness and individual participation during heritage walks.

6.2.4 Collaborative meaning-making

The projector-based system not only enhanced group cohesion but also facilitated greater collaborative exploration and collective meaning-making within the groups. Similar to observations made during individual walks with a mobile projector (see Chapter 5), pairs and groups using of mobile projector guide were also observed engaging in exploratory walking, utilising the projector to engage with their surroundings. As depicted in Figure 6.6, the projector facilitated a collaborative exploration process among device holders and companions. The device holder (t5) used the projector beam as a pointer, sweeping it across various building surfaces to highlight points of interest. This approach also kept the companion (t6) actively engaged, as they could interpret where the device holder (t5) was focusing and showing interest within the space, allowing them to participate in t5's exploration



FIGURE 6.6: While using the mobile projector guide, both the device holder (t5) and companion (t6) easily synchronized their exploration without needing additional coordination, due to the shared view of the projected display.

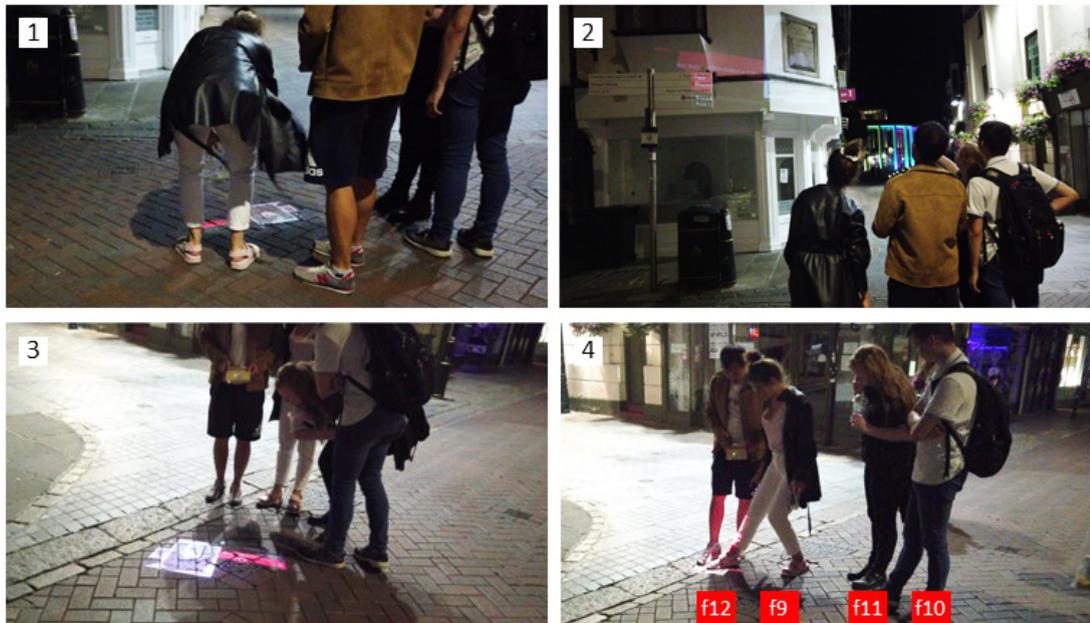


FIGURE 6.7: The projected display created a shared visual information space that all members utilized for collaborative interpretation and discussion. They engaged their entire bodies to connect visual information with the physical site while interacting with one another to share their insights.

of the heritage site. Companion (t6) described how the use of a mobile projector guide facilitated the collaboration and collective exploration during their walk: “So you look around, saying - Oh, my God, that looks really interesting; let’s shine on that and see what it says” (t6). Similarly, as shown in frame 2 of Figure 6.7, the device holder (f12) fulfilled the wish of the group members by projecting on the plaque. The statement and the observations indicate that the use of mobile projector guides facilitated collaboration and transformed the physical environment of the heritage site into an interactive space for collective play and exploration and reinforcing the sense of a shared experience. Both the device holder and companions were able to collaborate to express their affective responses such as wonder and appreciation by performing heritage site exploration. This addresses the concerns raised by Rennick-Egglestone et al. [191] about the need to support different roles within groups.

Interaction with group members during heritage activity enables users to explore diverse, multi-faceted narratives and personally meaningful connections, supporting pluralistic interpretations of heritage [197, 198]. The results show that mobile



FIGURE 6.8: Group members engaged in collaborative interpretation and discussion using the projected display and the shared visual information space it created. They employed bodily gestures to connect the virtual information with the physical site. This shared display-supported interaction allowed them to share insights, appreciation, and understanding of the POI.

projector guides enabled a rich collective meaning-making process. As seen in Figure 6.8, a projected display created a shared visual information space in which group members engaged in verbal communication, embodied meaning-making (physically performing connections between the projected information and the physical site) and collaborated to enhance their heritage interpretations by exchanging their understandings. As seen in frame 2, to explain and share their interpretation with the group and to make connections between information and the site, f5 physically pointed at aspects of the image and the site. Subsequently, other group members also participated in the discussion using the images shown in the projected display and sites as seen in frames 3, 5, and 6. The discussion



FIGURE 6.9: The mobile projector guide allowed group members to take on different roles and responsibilities, fostering collaboration and enriching each other's heritage experience. One user managed the device, while another interacted with it. Additionally, another member identified a specific feature of the POI highlighted in the app and directed the group's attention to it.

continued as f5 kept revisiting the image and highlighting different features.

In this context, the projected display served as a digital 'social object' supporting the participatory experiences in heritage setting [202]. Having a projected display led to a performative (embodied and social) interpretation activity [20]. This is crucial because physical gestures can play an important role in supporting shared understanding among group members during an interpretation activity [91].

Another tactic to perform collective exploration was also observed among users of mobile projector guides. Different group members adopted different roles and shared responsibilities within the group. As seen in frame 2 of Figure 6.9, f3 held

the mobile projector guide, one of the companions (f1) interacted with the device to change the content screens and as seen in frame 4, another companion (f4) took the lead in locating the POI and directing the group's attention to specific features (as seen in frames 4 and 5). The group members maintained these roles throughout the walk. This observation demonstrates that the projector allowed for a more fluid distribution of leadership within the group, where any member could guide the collective attention or interaction with the mobile guide. An automatically shared information displays empowered group members to actively participate in the collaborative exploration process, enhancing the overall heritage experience.

In alignment with the findings of Malinverni et al.[147] from their research involving schoolchildren during storytelling activities, this study demonstrates that mobile projectors contribute to collaborative exploration and collective embodied meaning-making in the context of outdoor heritage walks in historic precincts. This study enhances the understanding of how mobile projectors facilitate collective meaning-making, offering valuable insights for designing mobile guides that promote shared interpretation experiences. The use of extrovert devices such as mobile projector guides can address the tension between individual control and shared experiences [134, 191] by providing a shared focal point while preserving opportunities for individual agency within the group. Furthermore, the research underscores the ability of mobile projectors to create shared visual information spaces, facilitating embodied interactions, and performative practices during heritage experiences. Lastly, the results suggest that within groups users took roles and distributed responsibilities to facilitate collaboration during the heritage interpretation and exploration process. Designers can leverage the understanding of roles and responsibilities to imagine new mobile guide designs for supporting collective and collaborative heritage experiences.

6.2.5 Effect of awareness of public perception of mobile guides usage

The integration of mobile technologies into heritage walks revealed nuanced effects on participants' social experiences due to their awareness of public perception of their actions during the heritage walks activity. These effects varied based on the type of device used (smartphone vs. mobile projector) and group composition. Interestingly, while individual smartphone guide users generally felt inconspicuous, pairs using smartphones reported an increased awareness of their behaviour in public spaces. This finding adds a new dimension to the understanding of smartphone guide use in heritage contexts such as historic urban precincts. One participant articulated: *"the thing I was worried, sometimes when the ping [audio notification after arriving near a POI] comes, we just stop abruptly ... stop and then people behind us or people walking towards us, they just like - whoa! what's happening? So, that was ... a little worrying for me. I was just like - Okay, should I stop here first? Or should I read the ping out?"* (w6). Another participant elaborated: *"if you see a pop-up notification, you stop at that location and you see like this [heads-down]. Observe the other people in the town - Oh! What happened? [why are] these guys stopping at the same time, and [why are] they see[ing] one mobile"* (w4).

These comments reveal that using mobile guides induced behaviours that were different from everyday use. These new behaviours heightened users' consciousness of how technology-mediated behaviour might disrupt the natural flow of public spaces. The participant's concern about abrupt stops and potential interference with other pedestrians suggests that pairs using smartphone guides were apprehensive about inadvertently creating social friction in busy urban heritage settings. This statement also suggests that the collective behaviour of pairs using smartphones created a more noticeable presence in public spaces than individual use. This finding extends the current understanding of the implications of using mobile guides in public spaces like urban precincts on visitors' experience. These insights underscore the need for exploring mobile guide designs and notification

methods that inform the users about their arrival at the POI in a more fluid and less disruptive way in public spaces.

Users of mobile projector guides noted feeling more self-conscious when using the device in urban settings, though being part of a group helped alleviate this sense of awkwardness. A participant in a group of 4 explained: *“I felt a bit awkward because ... you’re shining a projector on the floor, on the walls; I’d say it’s quite eye-catching. So, you know people obviously [say] - Oh! look a projector, and then look at the person who’s holding the projector”* (f10). However, the same participant noted that being in a group mitigated their discomfort: *“I think it was fine to just play around and point to the ground ... I still wouldn’t do it alone ... I guess the group does help”* (f10). These comments reveal a tension between the using extrovert, attention-seeking technology and social norms in public spaces. The participant’s initial discomfort aligns with findings from Jarusriboonchai et al. [114] regarding potential embarrassment caused by social displays. However, being in a group while using mobile projector guides appeared to positively influence participants’ comfort levels. The mitigating effect of the group suggests that collective use can facilitate the adoption of such attention-seeking technologies in public settings, a finding that extends the understanding regarding the adoption of mobile projector guides for heritage walks in urban space beyond previous research on mobile guides.

In addition, many participants using mobile projectors reported a more positive sentiment with public attention. A participant in a pair made a similar observation: *“It wasn’t bad or anything; it’s just that you could hear people like going - Oooh! What’s that? ... there’s a light on the floor ... and they’re looking at you funny, but apart from that, it’s not a problem”* (t6), implying that while the projector did attract attention, users didn’t find this attention problematic. In fact, the participant viewed the public interest as a positive aspect of their experience. A participant in a group of 4 expressed: *“I felt that passers-by were a bit ... concerned about what I was holding, but I felt good ... [because] it was a new kind of technology that I was walking with, so it was a pleasant experience. Overall, I didn’t feel like ... awkward or anything like that”* (f3). This response

indicates that for some users, the novelty of the technology can be a source of enjoyment and pride, outweighing any potential discomfort from public attention. This finding adds to the understanding of how visitors feel about engaging with novel technology in the context of heritage interpretation activity. It suggests that the use of extrovert attention-seeking devices can enhance the overall experience by making visitors feel special or avant-garde.

As observed during individual walks, (see Chapter 5, participants using mobile projector guides in groups also appreciated the potential for sharing information with the public: *“other people can also take advantage of this by viewing it while we are having the information displayed on the floor”* (t1). A participant using a mobile projector guide in a pair identified a significant moment for them: *“There was a guy who was looking at the projector [when] we were looking at some building and information ... he was surprised to see [the projection] ... it was kind of exciting for him ... he sounded like surprised. Yeah, it was a key moment for me”* (t2). Consistent with the findings discussed in Chapter 5, these observations suggest that mobile projector users enjoyed and valued the shared experiences that extended beyond the group members and involved bystanders in incidental sharing and learning. By fostering such spontaneous encounters with bystanders mobile projectors could facilitate the discovery of poly-vocal and personally meaningful narratives which emerge from interactions with locals and other visitors [197, 198].

The awareness of public perception can be a key concern for the integration of mobile guides in heritage walks in urban precincts. This impact of awareness of public perception varies depending on the type of device (smartphone vs. mobile projector) and group dynamics. Smartphone guide users were more self-conscious about how their actions disrupted public spaces, while mobile projector users experienced mixed feelings—some felt self-conscious about attracting attention, while others found the public interest in the technology to enhance their experience. Designers aiming to implement mobile projector guides or other extrovert mobile guides may have to consider ways to address users’ concerns about public perception.

6.2.6 Location-aware media: exploratory discovery vs navigation

This section explores how the location-aware application design used in this study influenced participants' engagement with the device and their surroundings during the heritage walks. As described in Chapter 3, the application did not display a map with a route and locations of POIs. The users were only notified about a location once they arrived in its vicinity.

Discussing the influence of application on their attention, one of the participants using a mobile projector guide articulated: *“when you start the walk ... you don't know where they [POIs] are or how close together they are ... so you're going to be more attentive to the device ... because you're waiting for your next one [POI]”* (f6), indicating that the uncertainty about POI locations compelled users to be alert towards the device.

For some users the application' design fostered curiosity towards the environment. Participants using a smartphone guide in a pair noted: *“it increased my curiosity ... it makes you even more curious about the environment you are in”* (w1) and *“I was wondering when the next information was going to pop up, [and] tried to predict it - Oh, is it going to happen here?”* (w2). These comments demonstrate how the application turned the heritage walk into an interactive guessing game by generating anticipation around potential POIs. It sparked users' curiosity about their surroundings, keeping them mentally engaged throughout the experience. This heightened sense of attention encouraged users to observe their environment more carefully, potentially fostering a deeper appreciation of the heritage site.

This finding aligns with the assumptions of Jylha et al.[119] and Hornecker et al.[96] about the effectiveness of not revealing POI locations on a map in promoting free exploration and serendipitous discovery. The application design successfully elicited strong emotional responses and enhanced visitors' cognitive engagement with heritage sites by frame walk a playful exploration [194, 200], contributing to a more memorable and immersive experience.

To describe their experience, mobile projector guide users drew parallels between the experience of heritage walk and treasure hunting: *“it was like a treasure hunting kind of thing. It was like a compass direction or ... metal detector”* (f10). This analogy suggests that the interface design of the target and compass-like needle enabled mobile guide users to reappropriate the device and use it imaginatively. This observation highlights that the ‘handheld’ nature of the device and the visual design of the interface engaged users in an embodied play with the heritage site. It echoes the findings of Wakkary et al. [232], who found that tangible user interfaces (TUIs) allowed open interpretation of the device, easing the playful integration of technology into the heritage interpretation activity.

These findings suggest that the use of location-aware media in heritage walks transformed participants’ engagement with both the application and the surrounding environment. The unpredictability of information triggers heightened users’ attention and curiosity, transforming the passive act of walking into a proactive, involved, exploratory, playful experience. This approach fostered a deeper cognitive and affective engagement with heritage sites. These findings indicate that a combination of an extrovert device and an application without a map may address the concerns of Fosh et al. [73] and Ryding et al. [194] regarding supporting playful and performative heritage interpretation without the use of explicit instructions.

While the element of surprise in the location-aware media sparked curiosity, many participants expressed a desire for some level of navigation support to locate POI locations. A smartphone mobile guide user suggested: *“if there is a clear navigation with this [application] ... if it will tell me that you go like 50 meters, you will find this one, then it will help me more”* (w3). This comment indicates that users seek distance cues to the next POI to efficiently reach the location.

Participants also expressed interest in understanding their progress within the overall route: A smartphone guide user suggested: *“One thing that I hope to see in the app is ... sort of have an overview of ... where are the spots [POIs] ... instead of like, blindly walking, and then just waiting for a ping”* (w5) and *“I was thinking that maybe a screen of like where we are on the map will probably be useful*

as well. So that we kind of know, how far of a journey ... this map has ... before [the] guide ends" (w5). This feedback suggests that some users value having a sense of orientation and progress. Providing an overview of POI locations could help users reduce potential frustration arising from waiting to arrive near a POI. A sense of context and completion provided by the map could enable users to pace themselves and manage their expectations throughout the walk.

Mobile projector users had additional suggestions related to support to locate the POI once they were at the location: *"once it buzzed, and the thing [information] came up ... it would also be nice if it [application] was like, please look to this direction"* (f10) and *"feature like telling us if the building is either on your left or right"* (f1). These comments indicate that mobile projector guide users seem to desire more guidance in orienting themselves and the projection towards relevant points of interest.

These findings reveal a tension between ambiguity and guided navigation in shaping users' experiences with location-aware heritage applications in outdoor settings. While the element of surprise was generally well-received, users also expressed a clear desire for features that would provide orientation, progress tracking, and enhanced interaction with their environment. Thus, designers may want to explore ways of balancing the two aspects in future designs.

6.3 Conclusion

This study investigated the impact of mobile guides, specifically smartphone and mobile projector guides, on group dynamics and collective heritage interpretation practices during walks in historic urban precincts. As heritage sites increasingly incorporate digital technologies to enhance visitor experiences, understanding how these tools shape social interactions and collective meaning-making becomes crucial [67, 134, 177]. This research aimed to not only evaluate but also examine how different display modalities affect group cohesion, collaborative exploration, and shared meaning-making in outdoor heritage settings.

The study revealed significant differences in how smartphone guides and mobile projector guides influenced group dynamics and collective heritage interpretation practices. Smartphone guides, while familiar and easy to use, presented challenges for group cohesion and collaborative exploration. As reported in previous studies, device holders often became absorbed in the screen, leading to reduced environmental awareness and social interaction [115, 225]. The study gave a further understanding of companions' experience, revealing that companions experienced diminished agency and engagement, often relegated to following the device holder. While information sharing was hindered by the small screen size [134], the study demonstrated that strategies like reading aloud were adopted to overcome the challenge. Surprisingly, pairs using smartphones reported increased self-consciousness in public spaces, concerned about disrupting pedestrian flow.

Mobile projector guides demonstrated significant potential for enhancing group experiences. In line with previous findings, the shared display fostered group cohesion by creating a collective visual reference [20, 134]. As group members were able to influence the exploration process regardless of who held the device [147], all members maintained a sense of agency which laid the ground for enhanced collective experience. By enabling performative and playful interpretation practices, the projected display facilitated collaborative embodied meaning-making. Due to the shared display, individuals within the groups using mobile projector guides reported that they experienced more flexible pacing and personalized engagement with content which was appreciated. While some mobile projector guide users felt self-conscious about attracting public attention, others viewed it positively, appreciating the novelty and potential for incidental sharing with bystanders.

This study extends our understanding of how mobile technologies shape social experiences in heritage contexts. It demonstrates that the affordances of mobile guide devices can significantly influence group dynamics and collective meaning-making practices in outdoor heritage settings, building on previous research focused primarily on indoor museum environments [134]. The research highlights how mobile projectors can address the tension between individual control and shared experiences in group heritage interpretation [191], offering insights into designing for both

collective and personal engagement. It provides empirical evidence of how mobile projectors support 'togetherness' [56] and collaborative exploration in dynamic outdoor heritage environments, expanding on findings from controlled indoor settings. The study offers new insights into how awareness of public perception influences the use of mobile guides in urban spaces, a factor not extensively explored in previous heritage technology research. Based on these findings, designers of mobile guides aimed at supporting collective and social heritage interpretation in public spaces should be considered. Designers should prioritize shared displays that allow simultaneous access to information for all group members, fostering individual agency as well as collective engagement and discussion. Features that support flexible role-sharing within groups can be incorporated into the design to allow for distributed leadership and varied forms of participation [191]. Further, designing interfaces that encourage embodied and performative interactions with the heritage environment can also support collective engagement. Designers should Consider how to design notification systems that inform users about points of interest without disrupting the natural flow of movement in urban spaces. Additionally, they should aim to balance the benefits of ambiguity and location-based surprises with users' desire for orientation and progress tracking, perhaps exploring different ways of providing navigational cues.

While designing new mobile guides, designers should explore ways to leverage the potential for incidental sharing with bystanders to support the discovery of polyvocal and personally meaningful narratives [197, 198]. However, to address users' concerns about public perception, particularly for attention-grabbing technologies like mobile projectors, designers should make choices that would help users feel more comfortable in public spaces. In conclusion, this study underscores the significant impact that mobile guide technologies have on shaping collective heritage experiences. By carefully considering display modalities and interaction design, future mobile guides can better support the social, embodied, and collaborative nature of group heritage interpretation in public spaces. As we continue to integrate digital technologies into heritage sites, prioritizing designs that enhance

rather than hinder social connections will be crucial in creating meaningful and engaging collective experiences.

Chapter 7

Implications for the design of mobile devices in heritage walks

This studies in Chapters 4, 5, and 6, explored the complexities of how different mobile guides influence users' embodied exploration, interpretation and experience in outdoor cultural heritage contexts of historic urban precincts. The findings demonstrate that the extent to which users can employ bodily movement and gestures to engage with a hybrid heritage landscape (consisting of the digital content and the physical environment) is largely determined by the affordances of the mobile guides.

Based on the observations from the three studies, this chapter bridges the gap between the understanding of the influence of mobile guides on users' intention and bodily behaviours during heritage walks and designs that can enhance embodied interpretation practices in outdoor cultural heritage exploration. It translates empirical insights into actionable design principles for mobile guides that enhance embodied interpretation practices during heritage walks in outdoor cultural heritage contexts.

To arrive at these design principles, the chapter draws upon theoretical foundations in embodied cognition, phenomenology, and play theory, as well as empirical

insights gathered from three studies investigating the use of smartphones and mobile projectors in heritage exploration. By integrating these diverse perspectives, this chapter seeks to bridge the gap between theoretical knowledge and practical design considerations.

The chapter is structured into four sections. First, it introduces the concept of *playful walking* as an approach to designing mobile technology for embodied heritage interpretation practices. This concept synthesises play and walking to emphasise the embodied, affective, spatial, and social aspects of the embodied interpretation process [51, 72, 217].

Next, the chapter presents a set of design considerations for mobile guides in experiential heritage contexts. These considerations address various aspects of the user-device-content-space relationship, including the user's attitude towards technology, the device's role as an extension of the user's body, the importance of open-ended and ambiguous interactions, the need to bring surroundings into play, and the device's potential as a social facilitator.

Building on these considerations, the chapter then proposes four specific design directions: 'Touchy connectors', 'Curious explorers', 'Wonder eyes', and 'Hello Heritage'. Each direction is illustrated with concrete design ideas that exemplify how mobile guides can support playful, embodied, and social engagement with heritage sites.

The chapter also offers critical reflections on selecting appropriate mobile guide devices, comparing the strengths and limitations of smartphones, AR glasses, and mobile projectors in various heritage contexts. This discussion provides practical insights for researchers and heritage professionals considering technology deployment in outdoor cultural heritage settings.

The main contribution of this chapter is a shift in the conceptualization of mobile guides. By offering both theoretical grounding and practical suggestions, this chapter contributes to the development of a more engaging and meaningful mobile guide design for embodied exploration of outdoor cultural heritage contexts.

7.1 Conceptualising *playful walking* as an approach to design mobile technology

There has been a growing discussion on the complexity of the heritage interpretative process. The discussion in Chapter 2 draws attention to the phenomenological perspective on the heritage interpretation process and experience that constitutes embodied, spatial and social aspects that constitute the interpretation process.

In such embodied interpretation process [72], the interpretation is grounded in the body. The bodily activity with the material-social space functions is seen as an interpretative device for understanding the past and expression. The bodily movements and gestures are seen as a way of paying somatic attention [51] and engaging in spatial practices [217] with the material aspects of built heritage to reveal and experience the past.

The visitors' subjective embodied self frames their interpretation and experience of heritage sites. In addition to spatial movement, visitors' attitude towards the material heritage is crucial for embodied meaning-making [217]. Through intentional action motion, perception and comprehension intertwine.

The world is seen as composed of relationships which are grounded in relationships between individuals and space. The space of the world is seen as space for sensory experience and movement instead of geometric construct [217]. Thus, walking through the heritage landscape is seen as an integral aspect of embodied interpretation practices [217].

As discussed in section 2.1.6 of Chapter 2, a slow and environmentally attuned form of walking is a multidimensional activity that can motivate and facilitate embodied heritage interpretation practices by allowing visitors to intertwine their memory, reflection, creativity and imagination with the space of heritage site. However, it is challenging to motivate people to consciously engage in such a form of walking as it is significantly different from an individual's everyday approach and walking practice.

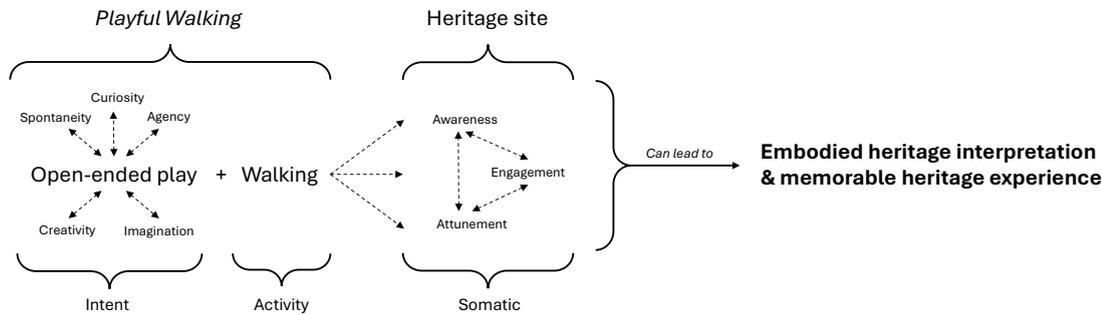


FIGURE 7.1: *playful walking* harnesses play to shape visitors' intentionality towards the world by harnessing their creativity and imagination and prompting them to pay attention and engage with space through slow and environmentally attuned walking.

Also as discussed in section 2.1.7 of Chapter 2, being in a playful mindset changes individuals' intentions towards their surroundings. It provides individuals with a feeling of agency and prepares them to respond (more positively) to unfamiliar situations by triggering their creativity and imagination towards their surroundings. Play and playfulness generate awareness, attunement and engagement with their surroundings and lay the ground for a more reciprocal and intense relationship between individuals and the space around them. Thus, the thesis contends that by bringing open-ended play to walking can motivate visitors to consciously and intentionally engage in environmentally attuned and possibly slow walking, leading to a more embodied heritage interpretation and experience. Therefore, the thesis proposes designing mobile technology and interactions for *playful walking* – which is propelled by visitors' creativity, imagination, curiosity, spontaneity, and agency (see Figure 7.1).

This suggestion of bringing playfulness into walking is further complimented by observations made during Studies 1, 2 and 3, where it was observed that location-aware app, target-like graphical user interface (UI) and the device shaped users' relation with space enabled play. As participants were unaware of the location of POIs while walking and the UI graphics, they appropriated the mobile guide devices as a scanner or a mine detector and the walk as a treasure hunt. The playfulness triggered by the use of mobile devices motivated participants to perform their exploration of the physical space creatively and imaginatively. However, the intensity of play differed across the two devices. The analysis of walk duration,

halt duration and embodied engagement suggest that mobile projector users experienced a more intense playful state resulting in users walking slowly and being environmentally attuned (aware and responsive to their surroundings). At POIs, the playfulness afforded by the projector motivated users to creatively engage and reflect on the heritage by projecting images of the past onto the current POIs.

Based on the theoretical discussion and empirical evidence, this thesis suggests that situating walking as an open-ended playful activity can motivate slow and environmentally attuned forms of walking within the outdoor cultural heritage context of historic urban precincts.

Within this approach, play should be set in the context - centred on the possibilities embedded in the space, such as its arrangement of space, visual qualities, visible or missing pieces of history, social activities and interactions between the environment and people.

The notion of *playful walking* can act as an integrated approach for designing and researching mobile technology for experiential outdoor heritage exploration and lay down the ground for a new direction in the field.

7.2 Mobile guides for experiential heritage: Design Considerations

To lay the foundation for designing mobile technologies/devices that would support embodied interpretation practises this research documented the user's bodily engagement in relation to the space and its translation to the affective responses such as appreciation and reflection during their mobile guide aided exploration of the heritage site.

Studies investigated the potential of different display technologies to facilitate embodied heritage practices during outdoor heritage walks which included:

1. Enabling bodily ways of exploring and engaging the heritage site;

2. Aiding awareness of the multisensorial aspects of a space;
3. Enabling embodied and collocated social practices;
4. Prompting reflections and emotions;
5. Triggering imagination and creativity-driven participation.

The analysis of these bodily encounters with the architectural morphology of the historic urban heritage site across the study 1, 2 and 3 with reference to the theoretical discussion (see Chapter 2) provides the knowledge required to design mobile guides that can translate users' movement through heritage site and ways of converting space into the place of exploration/meaning-making into digital interaction scenarios.

Based on the analysis of the affordances, strengths, and weaknesses of smartphone and mobile projector guides across three studies, this section focuses on identifying desirable affordances and discussing them in the form of design directions of technology that may lead to playful walking practices.

7.2.1 Design to change user's attitude towards technology

The results indicate that the behaviour of smartphone users was influenced by their pre-established attitudes towards the device and ways of using smartphones while walking. Consistent with prior findings, this research also observed that while walking with smartphones for the heritage walk many participants did not reappropriate the device for this new context [160]. As users viewed the activity similar to every day walking with the smartphone, they frequently adopted the navigational mode of walking, and remained physically distant from heritage buildings at POIs, resulting in a lack of involvement and exploration. In contrast, mobile projector users were more inventive, explorative, and aware of their use of the device. Considering that none of the participants had seen or used a mobile projector before this study, it was a novel device for them. As they were unfamiliar

with the device their attitude and approach to the activity was more aligned with performing a ‘special’, non-routine activity.

Based on these observations, the thesis suggests that designers of mobile technology for heritage exploration should consider leveraging the users’ familiarity or unfamiliarity with the chosen technology to prompt new and desirable behaviour. In the thesis, this was achieved by using a mobile projector which was concealed in a wooden case and a device that users were not particularly familiar with.

Alternative ways to exploit the users’ familiarity with an artefact could be explored. Designing prop-like devices to give the user a meaningful presence or role on-site could be done by designing cases for existing devices (e.g. smartphones). For example, in ‘The Lost Palace’ experience, a mocked-up burned torch [123] or in the ‘Ghost in the Garden’ a radio-like prop [185] was used as a handheld device to conceal the technology. As a result, the technology recedes into the background, enabling participants to concentrate on the artefact’s performative and narrative potential, and thereby engage in a deeper exploration of the site and its history. When designed sensitively, mobile devices can be integrated into visitors’ activities at outdoor heritage sites [43, 179, 180, 233]. The device could act as an affective connector between visitors and the site by transforming participants into performers and heritage sites into settings for exploration [123]. Further, interactive objects with a meaningful presence can also prompt slowness and provide moments for reflection [226]. In general, whether through familiarity or unfamiliarity, mobile technology that changes users’ intentionality and attitude towards the activity of exploring heritage sites has the potential to support meaningful explorations of historical contexts.

7.2.2 Design technology as an extension of the user’s body

A blind person’s stick seamlessly becomes a person’s sensory (tactile) extension, influencing how the person interacts with and perceives the environment and experiences place [64]. Similarly, when used while walking, mobile technology and the

body come into an embodied relation [108], meaning technology becomes part of the body's schema and shapes the users' actions and cognition, and influences their social practices [112]. During the study, it was observed that participants using both display modalities exhibited a desire to perform body movements to enact exploration and engagement. However, the frequency of such enactments was higher among mobile projector users. During the walks, it was observed that participants intuitively controlled the projector and its beam as an extension of themselves to reach, touch, and interact with the surroundings. This was facilitated by the fact the device and user came into an embodied relation [107]. The handheld mobile projector acted as an involuntary tangible controller for pointing and placing the projection in space. Thus, users were able to focus their actions towards the physical surroundings instead of the device. The embodied relationship between the device and users was one of the factors that motivated and facilitated expressive, creative, and playful actions of exploration among *projector guide* users.

Conversely, the smartphone did not support such actions of exploration since the smartphone remained a device to 'interact with' instead of becoming an interactive artefact through which people could mediate and express themselves in their surroundings. This may explain why smartphone users gradually abandoned the use of the smartphone as a means to frame interesting elements in the surroundings as their walk progressed. Since smartphone users were able to see everything on a screen in their hand, it negatively influenced their desire to walk closer to the heritage building, turn towards it to view it properly, or sometimes even stop. In fact, the smartphone acted as a barrier that interfered with the formation of connections between users and the heritage site.

Therefore, while designing mobile technologies for embodied heritage practices, HCI researchers and interaction designers may want to consider the technology as an extension of the visitor's mind and body and base their design choices on an understanding of the opportunities for the interrelationship between the human body, movement, activity, and the physical and social setting that emerge during a heritage walk. Mobile interactions and technology for outdoor heritage exploration may be designed not only for interference-free interactions [99, 119] but as

artefacts that can act as a ‘medium for interaction’ with the heritage site (much like a blind person’s stick) instead of as a device to ‘interact with’. The ‘Digital Binoculars’ mentioned in Ciolfi’s work [45] is an example where the device becomes a medium to explore and interact with the site, rather than only an object to interact with. In this context, designing mobile technology as tangible artefacts would be beneficial as tangible objects are inherently playful, imaginative and poetic [232]. Further, through their physical form and tactile quality, tangible digital artefacts can engage users’ senses and body movements and stimulate spontaneous actions toward their surroundings [111, 233]. Interactions can be developed to reward embodied actions where users could be provided with information based on their orientation, movement towards, proximity to, or time spent near a POI.

7.2.3 Design open-ended and ambiguous interactions

During the study, it was found that users using both devices were often interested in expressing themselves (thoughts and imaginations) during the walk. Being able to creatively express themselves positively influenced their involvement in the heritage walk. It was observed that mobile projector users easily adapted and used the device to support their imaginations about the past, express their curiosity, and engage playfully with the surroundings. This was facilitated by: 1) the physical extension provided by the beam of the projector which magnified the users’ actions in space; and 2) the ability to transform the physical space by overlaying it with digital images. Further, creativity and playfulness were evoked by the ambiguity of how the device may be used. The observations from the walks with smartphone users indicate that having a camera layered with a target graphic triggered some playful behaviour but the majority of participants used the device in a way similar to their usual everyday practice. It resulted in a lack of involvement and exploration during the walk as participants did not engage with the heritage buildings. This was due to the influence of their pre-established habits of using a smartphone as well as the limitation of features and the form of the smartphone, and their affordances to induce creative expression and play.

In line with this observation, Mazel et al [153] also suggest that it is beneficial to enable users to engage their creativity during the heritage visit as they have a “*desire for ambiguity and speculation about heritage*”. To invite and support creative expression and voluntary play, mobile technology could be conceived as a medium for creative appropriation and self-expression over the surroundings and interactions should be designed to be open-ended, flexible and ambiguous [2, 3, 79, 80, 194] instead of utilitarian or efficient [62, 226]. As observed in Study 2, to trigger imagination and support creative expressions, mobile guides for heritage explorations could be designed for open-ended and ambiguous interactions that users could appropriate in their own ways.

7.2.4 Design interactions that bring users’ surroundings into play

It was observed that mobile projector guide users were in a reciprocal relationship with their surroundings. Their actions and reactions were in response to their physical and social environments and affected by their responsiveness to different elements and events on the street. This happened as the use of a mobile projector brought the surroundings into play and enabled users to momentarily alter them by projecting wherever they wanted. The display was continuously embedded and visible in the physical surroundings. Every movement of the users displaced the projection in the space and, in turn, was connected with the space. In contrast, even though smartphone users were also interested in discovering heritage buildings, they were often unaware of other aspects of their physical and social surroundings and frequently remained in their own ‘bubble’. The screen of the smartphone served as a barrier between body and space, interfering with the natural coupling that exists between people and their surroundings. This led to smartphone users missing the opportunities to make their own observations, discoveries, and connections with the site.

Based on the research findings, it could be argued that the use of mobile projectors enhances participants’ aesthetic experience of the heritage site by facilitating

a more immersive walk which entangles their actions and perceptions with the surroundings. It also helped anchor their experience to the physical and social aspects of the space, enhancing users' sense of 'being-there'. For example, 'Wandertroper' [159], brought the surroundings into play by playing a constant location-responsive sound which encouraged exploration and enhanced the experience of walking. The location-responsive sound explicitly and continuously interlinked the users' body movement with the surroundings. The generative sound altered the sonic perception and transformed the (senory-perceptual) experience of the physical environment. Similarly, Fosh et al. [73] added a musical piece at each POI in their location-based mobile guide to add a new sensory dimension to the perception and interpretation of Sculpture. As seen in studies 2 and 3 of this thesis, the immersion was enabled by the user's ability to change their perception of the physical environment. Thus, mobile guides could be designed to endow users with the power to creatively alter or transform their perception of space, tapping into users' creativity, imagination, and curiosity, and triggering situated play.

To encourage bodily engagement and spatial practices, designers should consider exploring and conceptualising surrounding-focused technology and interactions which enable new relationships between user and space through situated interactions with the surroundings instead of device-focused interactions. Mobile technology should be integrated into the physical exploration of the heritage site rather than technology acting to draw users' attention away from the surroundings [178]. Based on the findings from the three studies and other examples, developers are encouraged to conceive mobile interactions that bring the surroundings into play by explicitly intertwining users' actions with the physical, material and social aspects of the site. Interactions should be such that they establish a continuous connection between user and environment, and that they are possible all the time or at any time or place (at any POI), even while users are on the move so that visitors can engage with the things they find interesting.

7.2.5 Design technology as a social device

Carr et al [33] suggest that when people visit public spaces, they seek to observe, interact with people and participate in ongoing social activities. During tourist visits, social encounters with locals, tourists play a significant factor in the overall experience of heritage tours [36]. Hence, it is understandable that many participants using mobile projectors were pleased by the unplanned social encounters and interactions with strangers. These moments initiated by the social nature of the display became one of the memorable aspects of their walk (as reported in interviews and drawings) (see Chapter 5).

During the group walk use of a mobile projector enabled the device holders to retain the companions' interest and provided agency to the companions in the performing heritage exploration. On the other hand and not surprisingly, most smartphone users felt alone during the activity as they missed the opportunity to observe other people. The private nature of the display did not invite strangers' attention, let alone facilitate interaction with them while walking (see Chapter 4). Thus, there is a need to create opportunities for and support such chance social engagements during individual outdoor heritage walks.

Within the heritage visit context, interactions with locals and group members can help visitors discover poly-vocal and personally relevant associations and narratives (pluralistic views of heritage) instead of institutionally *authored heritage discourses* [197, 198]. Thus, designers and researchers in museum and heritage contexts have been studying and exploring ways to support social interaction among groups of visitors to enhance individuals' social experiences during the visit [134, 177, 191]. As suggested by Jarusriboonchai et al [114] and observed in the studies done in the thesis, it is important to share some information about the users' activities with co-located individuals – group members or strangers, to initiate and facilitate co-located interactions. In this thesis, the projected display acted as a social display which anchored the attention of all group members and passers-by. As the projected display blended with the environment, it created a shared information space which made it easy to share with strangers as well

as group members, facilitating embodied communication and collective meaning-making. The social display provided by the mobile projector acted like *social objects* [203] which triggers and supports verbal and embodied communication as well as shared use among group members as well as strangers.

As reported by Lanir et al [134], it is not advisable that group members have their own devices as it can negatively influence group cohesiveness. Instead, designers could explore designing mobile technology as a social device whose physical form and display modality: 1) facilitates the holder to guide their companions' attention in space; 2) makes the holder engage in performative or playful actions such that this can be observed and influenced by their companions; 3) facilitates shared ownership of the device; and 4) facilitates simultaneous access to the information. Doing so will also help trigger and support interactions with passers-by.

During the study, some users did not perceive the use of the projected display in a public space like high street positively. They felt uncomfortable due to the attention they received from passers-by or were concerned about bothering passers-by with the projector's beam. Such reactions towards the use of public displays were also observed by Jarusriboonchai et al. [114]. This is explained by Goffman's proposition that in any social context, people are constantly conscious of their appearance to others and the impression they are giving [82]. As observed in Study 3, holders found it easy to overcome the feeling of discomfort when the device was used in a group. Thus, it is an important factor to consider while designing technology to support social interactions in public spaces as it may affect users' experiences and their motivation to adopt the technology. Additionally, public spaces including different outdoor heritage sites would have their own cultural norms. Therefore, when designing mobile technologies for outdoor heritage exploration, designers should carefully consider the cultural appropriateness of the artefact.

7.3 Mobile guides for playful outdoor heritage walks: Design directions for

In the previous section, this thesis provides a range of design considerations based on the understanding of bodily engagement and the affective aspects or intentions of the users behind these bodily engagements with the built heritage site. In this section, design directions or interaction scenarios are explored based on opportunities that emerge during users' embodied and spatial practises of intertwining/interlinking their bodily engagement with digital information and the physical environment through their bodily movement in the hybrid heritage landscape.

To illustrate the implication of the aforementioned design considerations, this section presents four design directions based on different experiential and playful opportunities that arise related to a) bodily engagement with the site, b) exploring the overall landscape, and c) social interactions. The design directions are exemplified by presenting related design ideas (novel or inspired by existing work) that could inspire other designers to develop mobile technology for heritage experiences at outdoor sites. The role of mobile technologies in the proposed concepts is not to deliver information or complete an activity efficiently. Instead, mobile guides and interactions are conceived to give visitors an agency - the role of the mobile guide is that of initiator and enabler of imagination, curiosity, creative expression, and situated play [2, 194]. Considering that the proposed design would be used in outdoor public spaces, socially, culturally and contextually appropriate objects are selected as interactive devices.

Design Direction 1: Touchy connectors

As observed in Chapter 5 and Chapter 6, the extended reach enabled by the beam of the mobile projector enabled users to express their curiosity and perform bodily and spatial engagement with the built architectures of the High Street laying the ground for embodied heritage interpretation. A corresponding playful opportunity that emerges during walking through natural heritage sites or archaeological ruins



FIGURE 7.2: Mockup of *Touchy connectors* - a wearable device that extends user's reach in space and motivates users to physically engage with the site.
Credit: Grace Lau

embedded within a natural landscape is the visitors' ability to touch the site and pick objects/rocks which may be linked to nature or man-made architecture for further inspections and imagination of past [173, 174].

During the study, it was observed that by enabling extended reach in space and connection with the surface of the architect, the mobile projector supported exploratory forms of walking and continuous playful and performative engagement between the user and heritage landscape (see Chapter 5).

Therefore, Design Direction 1 refers to mobile guide designs that could enable a physical extension of the user's reach and support physical connection with the heritage landscape. It is expected that such designs may generate open-ended embodied play in the form of people touching the surfaces of the buildings or picking objects in their surroundings.

To illustrate this design direction the interactive *Reach grabber*¹ prototype inspired by Rebecca Horn's 'finger gloves' (1972) [236] is proposed. Figure 7.2 illustrates the concept of a 'reach grabber' design, which aims to amplify users' spatial reach and interaction capabilities. This design could encourage users' tactile engagement with the environment, promoting users to physically explore, touch, and manipulate objects as they playfully navigate through the heritage site. This approach responds to previous research in the design of mobile guides, such as those explored by [73] and [194], which have investigated more instruction-based approaches to motivate visitors to engage in interactive and embodied experiences. The proposed design would work by altering users' physical relationship with the surrounding environment as distant objects would come within reach opening up new opportunities for spatial engagement (see results of Chapter 5).

Moreover, facilitating direct physical interaction with the environment would strengthen users' sense of connection with the heritage site and sense of attachment with the place, an element that prior studies have identified as crucial for enriching heritage experiences [44, 179]. As observed in this study, bodily engagement fosters a deeper connection between visitors and the historical site, enhancing the overall immersive quality of the heritage encounter.

As discussed earlier, mobile guides like *Reach grabber* may be suitable and desirable in the context of a natural heritage site or an open-air site consisting of archaeological ruins embedded in a larger natural landscape. In large, outdoor archaeological ruins where visitors are allowed to explore freely, *Reach grabber* could enhance engagement by allowing users to "touch" distant remains or fallen rocks. In parks or nature reserves, such a mobile guide could help visitors interact with flora or geological features that are typically out of reach, promoting a more immersive experience of the natural environment.

However, design may not be feasible in busy, compact heritage sites, as the extended reach of multiple visitors could lead to disruption for other visitors. Similarly, the design may not be suitable for heritage sites which have very strict rules

¹A hand-held mechanical device that extends a user's reach.

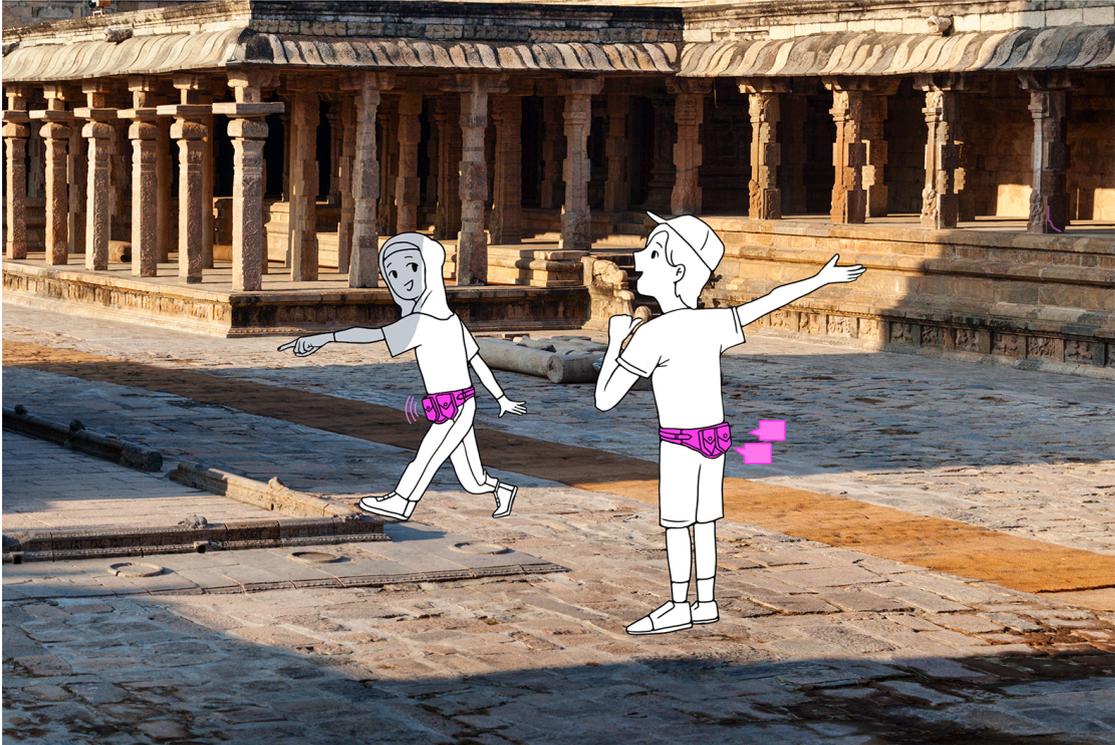


FIGURE 7.3: Mockup of ‘Curious explorers’- a wearable belt that motivates people to explore the place. Credit: Grace Lau

about physical interactions to preserve the integrity of the site or they might be considered disrespectful or culturally inappropriate such as religious sites.

Design Direction 2: Curious explorers

The findings from studies 1, 2, and 3 strongly indicate that users’ curiosity about their environment serves as a catalyst for engaging in playful and performative exploration of the hybrid heritage landscape. Moreover, as evidenced in the results of studies 1 and 2, the unawareness of the location of POIs prompted users to assess each building along the street for its potential heritage significance. This approach led to users uncovering and observing details that were not included in the mobile guide.

The experience of walking without a specific destination, driven by curiosity, offered users a distinctly different perspective. It provided an opportunity to immerse themselves in the atmosphere of the area, notice subtle elements that contribute to the High Street’s unique character and engage in a more spontaneous and

serendipitous exploration of the heritage site. This curiosity-driven, open-ended approach to heritage exploration facilitated a richer, more nuanced understanding of the site's cultural and historical significance.

Design Direction 2 thus proposes the development of mobile guides that function as catalysts for unstructured urban exploration, inspired by the *situationist* approach of the *dérive*, or drift, where individuals allow themselves to be drawn by the attractions of the terrain and the encounters they find there. These guides would aim to stimulate users' curiosity about their urban environment and encourage spontaneous wandering and serendipitous discoveries. It will adopt a less prescriptive approach to experiencing urban spaces.

As seen in the results of our study and previous work [96, 119, 179], replacing a visual map/navigator with location-based vibrio-tactile can be a fun way of encouraging serendipitous exploration of urban space. Inspired by these design explorations, a waist-belt-based design is proposed that would offer vibrotactile notifications to playfully nudge users to pause, be consciously aware of their environment, reflect, and choose the direction of their further exploration to be driven by curiosity. As shown in Figure 7.3, a wearable waist-belt with vibrators in eight directions, linked to a GPS would be used to provide directions, encouraging people to take offbeat routes, go into uncharted spaces, get lost and ultimately make discoveries. Different vibration patterns based on: a) levels of intensity, and b) sudden-ness or gradual-ness of the feedback, could be explored to trigger different behavioural (choice of direction) responses. Like *Explore* [155], the waist-belt-based mobile guide could offer further navigation guidance when the user arrives in the vicinity of a POI or attraction and notify them with interpretive content at the POI.

The proposed design would be suitable for cultural tourism in historic urban precincts as they usually have a high density of points of interest, making serendipitous discoveries more likely and rewarding. Users such as tourists or locals who often have flexible schedules and are open to discovering hidden gems related to art and architecture would find such a guide valuable as the unstructured approach

may allow for a more authentic and immersive experience of the local culture and history. However, visitors with limited time or interest in covering only specific sites may prefer a more structured approach with clear navigation to ensure they see key attractions as reflected in the findings of study 1.

Design Direction 3: Wonder eyes

The findings from Study 2 highlight that augmenting heritage sites with projections of old images influenced participants' perceptions of the buildings, prompting reflection and imagination about the past. As discussed in section 2.1.4 of Chapter 2, engaging visitors in reflection, which emerges from viewing a heritage site in novel ways, can lead to affective responses and new interpretations, fostering a deeper aesthetic appreciation of the place. In response to these insights, Design Direction 3 proposes developing mobile guides that encourage visitors to perceive heritage sites in ways they may not have considered before. These guides could help users notice previously overlooked details or see the site from a different perspective. By doing so, the technology could surprise visitors, spark reflection, and enhance their admiration for the location. A historical example of such a shift in perception is the use of *Claude glasses* [152] in the 18th and 19th centuries. This portable device, a convex mirror with a dark tint, simplified the colour and tone of landscapes, distorted perspective, and framed the view of landscape like a painting. Tourists would turn their backs on the scene and view the altered reflection in the mirror, changing their perception of the landscape and enabling a heightened aesthetic experience. Inspired by Design Direction 3, the concept of a new type of smart glasses, *Wonder Eyes*, is proposed. Rather than overlaying additional information onto the user's view, *Wonder Eyes* would enable users to experience heritage sites in novel ways. These glasses would allow users to zoom in on specific areas of the built heritage that capture their attention, providing an increasingly detailed view the longer they focus on a particular feature. Inspired by *Claude glasses* [152], the mobile guide could also add colour filters enabling the wearer to look at the site in new ways.

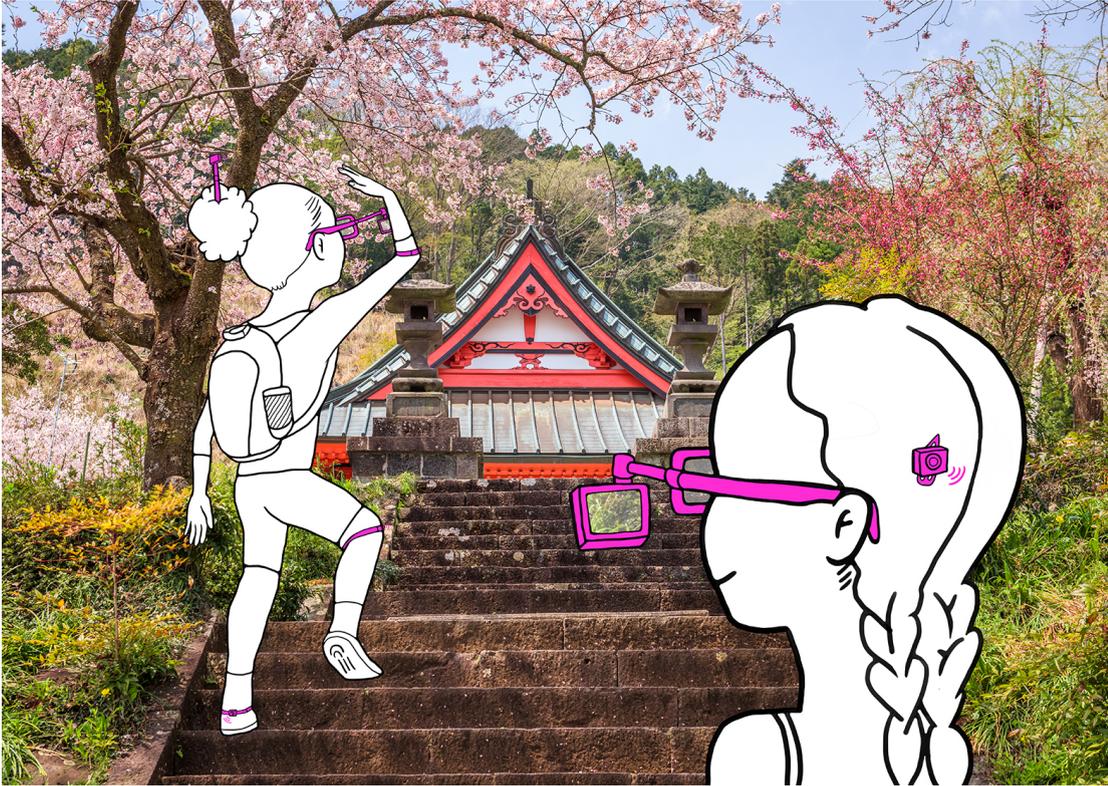


FIGURE 7.4: Mockup of *Wonder eyes*, a device that enabled people to see the space from different perspectives. Credit: Grace Lau

As illustrated in Figure 7.4, the mobile guide would also enable users to view the world from various eye levels and perspectives, offering a more dynamic visual experience. While people typically perceive their surroundings from their own eye level, *Wonder Eyes* would allow users to explore heritage sites from different heights by integrating cameras placed at various body levels, such as on the shoe, knee, or above the head. By viewing the site from these alternative angles, users could discover previously unnoticed details, fostering a deeper appreciation and understanding of the heritage site.

The concept of *Wonder Eyes* would be particularly beneficial for exploring historical sites with detailed architecture. At sites such as ancient ruins, religious structures, or palaces—where intricate carvings or hidden details play a vital role in the heritage narrative—users could greatly benefit from this design. *Wonder Eyes* would enable visitors to closely examine subtle architectural elements and environmental features that may otherwise go unnoticed. Zooming in on specific areas or viewing the built environment from different perspectives would add a

playful and imaginative dimension to the exploration, allowing users to discover the site in ways not possible with the naked eye. This could engage users in deeper reflection and imagination, fostering a heightened aesthetic appreciation of the site.

However, some concerns may hinder its widespread adoption. Positioning cameras at different body heights, such as on shoes or above the head, poses challenges from the perspective of social and personal comfort. Further, switching between different perspectives without disrupting the user experience could be difficult. Instead of enhancing the experience, some users may feel overwhelmed by the features and distracted from the immersive and reflective nature of heritage tourism.

Another concern is social isolation. While *Wonder Eyes* would offer a personalized experience, it may reduce opportunities for group interaction, as users become more focused on their exploration.

Design Direction 4: Hello Heriatge

Various researchers have explored ways to foster social interactions among group members during cultural interpretation activities [85, 134], acknowledging the critical role these interactions play in shaping visitors' interpretation and overall experience [177, 197]. The results of studies 2 and 3 confirm that shared displays trigger chance encounters with passers-by and significantly enhance these interactions by providing a shared visual anchor. These displays not only engage passers-by but also stimulate discussion among group members, enriching their interpretation of the heritage site and creating memorable experiences. Shared projected displays, as seen in these studies, facilitate fluid, flexible interactions. They act as catalysts for spontaneous social exchanges, encouraging participation without imposing it.

Building on these findings, Design Direction 4 highlights the need to trigger and support impromptu social interactions during heritage visits. Mobile technology can play a key role here, empowering visitors to initiate connections and conversations with others nearby.

From this design direction, the concept of *Hello Heritage* emerges. It involves a mobile app combined with a wearable, flexible, low-power e-ink display integrated into a T-shirt. The goal is to enhance social interactions by transforming the visitor's attire into a dynamic, personalized gallery of their heritage site exploration. By combining the common practice of photography with wearable displays, *Hello Heritage* allows users to select and showcase their favourite photos taken during their visit, directly on the T-shirt's display.

Hello Heritage would function as a 'social object,' or a visual conversation starter inviting playful and organic interactions between the wearer and those nearby - group members as well as strangers. It would foster shared experiences and encourage deeper engagement with the site and its artefacts.

The *Hello Heritage* concept would be most desirable at heritage sites where multiple tourists from different cultures converge, which encourages visitors to move freely and explore at their own pace, which fosters casual encounters between different groups of visitors and where visual aspects of the site enhance the visitor experience. These would include Open-air museums and archaeological sites, Historic urban precincts and cultural districts, World heritage sites with diverse international visitors, or Artistic or architectural heritage sites.

The feasibility of this idea rests on advancements in wearable technology, particularly flexible e-ink displays and low-power consumption devices. However, potential hindrances include the cost of integrating such technology into everyday clothing and ensuring the durability and readability of the display under various lighting conditions. Additionally, acceptance among users may vary, with some individuals possibly perceiving the wearable display as intrusive or unnecessary. To overcome these obstacles, careful consideration of user comfort, aesthetic appeal, and the seamless functioning of the technology will be crucial.

7.4 Reflections on selecting the mobile guide device

The development of new devices is not always feasible. In such cases, researchers may need to deploy existing technology. This section outlines key considerations when choosing between the two mobile technologies investigated in this thesis for cultural heritage contexts.

When selecting a mobile guide, practical implementation is a primary concern. Smartphone-based guides are often a suitable choice, as they leverage users' own devices, reducing the need for organisations to provide equipment. Smartphones offer high-quality displays, portability, and can be used in various settings. From a curatorial perspective, they are well-suited for information-focused interpretation. Techniques like storytelling, pervasive gaming, and presence-based information delivery can enhance affective engagement [63, 143]. However, smartphones can distract users from their surroundings, a significant drawback in outdoor heritage contexts [119, 133]. The studies in this thesis suggest that smartphones negatively affect visitors' lived experiences and social interactions at outdoor sites, such as historic urban precincts. To mitigate these issues, researchers could repurpose smartphones with custom-made cases or props to encourage more playful and experiential use [123, 185].

Another consideration is the appeal of new and novel technologies. Smart AR glasses, which deliver information without obstructing the view of the surroundings, have been studied in museums and outdoor sites due to their perceived novelty and attractiveness to visitors [142, 151]. Despite their engaging nature, current AR glasses face significant implementation challenges (see 2.3.9 in Chapter 2), limiting their widespread use. Moreover, the private display of visual information on AR glasses mirrors the isolating effect seen with smartphones. In their current state, AR glasses do not effectively facilitate social interaction with group members or strangers.

The observations from studies 1 and 2 indicate that AR glasses are unlikely to encourage physical proximity to heritage sites. Like smartphones, they do not offer a means to extend users' presence and reach in the heritage site. Without such direct interaction with the physical environment, the visitors' experience of heritage sites may remain limited experiences derived from visual perception and content-based learning. For this reason, handheld projectors or other mobile technologies that blend digital content with the physical surroundings may be a more appropriate choice.

Mobile projectors, however, are not without limitations. Their primary drawback is ineffectiveness in daylight. Despite this, as observed in study 2 and 3, mobile projectors enable shared views and blend digital information with the physical environment, fostering group interactions, playful embodied engagement and meaning making, and reflection and imagination about past. The results suggest that projectors play a crucial role in supporting embodied, aesthetic, and collective experiences, which are central to embodied heritage interpretation. Therefore, mobile projectors may be particularly suitable for heritage walks in low-light settings, such as night tours or sites with tunnels or underground structures.

In summary, selecting a mobile guide technology requires balancing practicalities, user engagement, and environmental context. While smartphones are familiar and widely available, alternatives like AR glasses and handheld projectors offer unique advantages in certain heritage experiences.

7.5 Conclusion

This chapter aimed to bridge the gap between theoretical knowledge, empirical insights and actionable design principles for mobile guides in outdoor cultural heritage contexts. Drawing upon the findings from three studies presented in earlier chapters and grounded in theoretical understanding, it offered a comprehensive exploration of how mobile guide devices can be designed to enhance embodied interpretation practices during heritage walks. Previously, researchers in heritage and

museum HCI have proposed design principles for mobile guides that can support embodied and social engagement [139, 179, 213]. They suggest that technology and interaction should:

- Be intuitive to use and memorable;
- Be contextually apt and meaningful;
- Connect visitors physically and sensorially to the heritage;
- Support social interactions;
- Offer open-endedness and variety to cater to different needs.

These principles while useful still seem to be more aligned to HCI goals of easy to use and catering to variety of users. This resonates with the concern of Moss [160] regarding biases in conception of mobile guides. While these design principles are useful, as shown in the studies in this thesis mobile guides can play a more influential role in heritage interpretation and shaping of heritage experience.

This chapter advocate for a shift in the conceptualization of mobile guides with the aim to foster an embodied heritage interpretation. Instead of viewing mobile guides as information conduits, this thesis proposes reimagining them as catalysts for embodied, playful, and social experiences. This fundamental reorientation manifests in several design considerations and design directions.

This thesis expands upon the previously identified principles by proposing novel design considerations such as ‘extending the reach of the visitor’ and ‘bringing surroundings into play’. These considerations emphasise the importance of **fostering an active and reciprocal relationship between visitors and heritage sites**, suggesting that the connection should transcend beyond user and site being in passive visual presence of each other. By enabling a dynamic interplay between visitors’ bodies and the site’s architecture mobile guides can promote continuous physical engagement with the hybrid heritage landscape, bridging the gap between the user, digital content, and the physical surroundings to create a more embodied understanding and cohesive experience of heritage.

Furthermore, the thesis advocates for integrating open-ended and ambiguous interactions in the design of mobile guides not to cater needs of different user but to **stimulating memory recall, curiosity, reflections, emotional responses, and imagination-driven engagement**. By incorporating these elements, the design can encourage a more creative, immersive and participatory experience, such as **serendipitous discoveries in urban heritage landscapes** and **altered perception of heritage sites** thereby enhancing visitors' overall engagement with heritage sites. The design directions proposed in this chapter embody these core principles while addressing specific experiential opportunities that emerge during heritage walks.

This chapter makes several key contributions to knowledge in the field of mobile guide design for cultural heritage. Firstly, it provides a novel conceptual framework for designing mobile guides, centred around the notion of 'playful walking'. This approach integrates insights from embodied cognition, phenomenology, and play theory to propose a model for heritage exploration that responds to the embodied heritage interpretation practices [72].

The chapter offers a set of concrete design considerations that translate complex theoretical concepts and empirical findings into actionable guidelines for designers and researchers. By bridge between theory and practice, these considerations provide a framework for designers to create mobile guides that align with embodied heritage practices, fostering a more immersive and meaningful exploration of cultural heritage sites. By emphasizing the importance of bodily engagement, spatial practices, visitor's intentionality, and social interactions, these design considerations contribute to the growing body of knowledge on embodied interaction in cultural heritage contexts [44, 179].

The proposed design directions offer innovative concepts that challenge conventional approaches to mobile guide design. These directions not only demonstrate how the proposed design considerations can be translated into tangible technological solutions but also serve to inspire future research and development in mobile guide design and technology for outdoor heritage exploration, pushing beyond

traditional information delivery approaches to create more engaging, playful, and embodied experiences [2, 194].

The chapter contributes to the ongoing discussion about the role of technology in heritage experiences. By advocating for designs that enhance rather than distract from the physical and social aspects of heritage sites, it aligns with and extends the trends in heritage studies that emphasize embodied, affective, and social dimensions of interpretation [44, 179].

The chapter also provided critical reflections on selecting appropriate mobile guide devices, comparing smartphones, AR glasses, and mobile projectors. This discussion contributes practical insights for researchers and heritage professionals when considering technology deployment in various heritage contexts.

In conclusion, this chapter provides a comprehensive framework for designing mobile guides that support embodied heritage interpretation practices. It offers both theoretical grounding and practical guidance, paving the way for future innovations in mobile technology for cultural heritage exploration. By doing so, it contributes to the development of more engaging and meaningful technological interventions in outdoor cultural heritage contexts, opening up new avenues for research and practice in the field.

Chapter 8

Conclusion

This thesis has explored the potential of mobile technologies to enhance embodied engagement and meaning-making during heritage walks in historic urban precincts. By comparing mobile projector guides and smartphone guides, this research aimed to provide a comprehensive understanding of how these technologies influence heritage experiences, thereby informing both theoretical discourse and practical design approaches.

The study was guided by five key research questions, each addressing a crucial aspect of mobile guide use in outdoor cultural heritage contexts:

1. How do users engage with the physical environment using their mobile guides in historic urban precincts during heritage walks?
2. What kind of inter-relationships emerge between the user, mobile guide and heritage site during a heritage walk in an outdoor cultural heritage site?
3. How does the use of mobile guides in historic urban precincts during heritage walks affect the social experience of the users?
4. What feelings, attitudes and concerns do mobile devices with different display modalities evoke during heritage walks in historic urban precincts?

5. How can we design mobile guides that motivate and support embodied interpretation heritage practices in outdoor cultural heritage sites during heritage walks?

To address these questions, this thesis adopted a multi-faceted approach, combining theoretical exploration with empirical research. Chapter 1 laid the foundation by introducing the research, providing the motivation and background, and highlighting the study's contributions. Chapter 2 presented a comprehensive literature review, grounding the study in pertinent scholarly debates and key concepts, particularly addressing the first research question and highlighting the state of the art in mobile technology for outdoor heritage contexts.

Chapter 3 detailed the research design, outlining the methodological approach and data collection and analysis methods. This chapter was crucial in ensuring the reliability and ethical integrity of the research, aligning with best practices in multi-methods research in the field of heritage HCI.

Chapters 4, 5, and 6 presented the empirical core of the thesis, reporting on three distinct studies. Chapter 4 focused on heritage walks with smartphones, while Chapter 5 examined heritage walks with mobile projectors. Chapter 6 explored group heritage walks with mobile technologies. Collectively, these chapters provided rich insights into the second, third, and fourth research questions, illuminating the complex inter-relationships between users, technology, and heritage sites.

Chapter 7 synthesises the key findings from the empirical studies, re-framing the role of technology in heritage interpretation. This chapter conceptualized a novel design approach and presented design recommendations for mobile technology in outdoor cultural heritage contexts, directly addressing the fifth research question.

This chapter offers a holistic view of the research outcomes. It reflects on the implications of these findings for both theory and practice in the fields of digital heritage and HCI. Furthermore, it considers the limitations of the study and

suggests promising avenues for future research, contributing to the ongoing dialogue about the role of digital technologies in shaping embodied experiences and understanding of cultural heritage.

8.1 Summary of Key Findings

This research aimed to investigate and compare the potential of mobile projector-based guides and smartphone-based guides in enhancing embodied engagement and meaning-making during heritage walks in historic urban precincts. The primary goal was to provide an understanding of how mobile guides influence heritage experiences, thereby informing theoretical and design research. The study addressed five key research questions through three distinct studies, each contributing to a comprehensive understanding of mobile guide use in outdoor cultural heritage contexts.

8.1.1 RQ1: User engagement with the physical environment

Study 1 and Study 2 provided complementary insights into how users engage with the physical environment using mobile guides during heritage walks in historic urban precincts.

Study 1, focusing on smartphone-based guides, revealed that users often exhibited hurried, non-exploratory walking patterns, failing to engage in meaningful embodied and spatial interaction with their surroundings. The screen-based nature of smartphones frequently acted as a barrier, diverting users' attention away from the physical environment and leading to a superficial awareness of the surroundings. This raises concerns that smartphone mobile guides may hinder rather than enhance embodied heritage interpretation [160].

The findings from Study 1 highlight a crucial challenge in digital heritage interpretation: the tension between information delivery and experiential engagement. While smartphones provide easy access to rich historical information, they risk creating a disconnect between the user and the physical heritage site. This disconnect challenges the core principles of heritage interpretation as outlined by Tilden [216] and Flynn [72], which emphasize the importance of personal connection and active participation in the interpretive process.

In contrast, Study 2, which examined mobile projector guides, demonstrated more promising results for embodied engagement. Users of mobile projector guides exhibited more deliberate and exploratory walking patterns, frequently scanning their surroundings and halting more often at points of interest (POIs) to project content onto surfaces. This behaviour aligns with psychogeographical practices of "disrupted walking" [173] or "conceptual/reflexive ways of walking" [242], where users interact more attentively with their surroundings.

The outward-facing projections fostered deeper connections to the physical site, allowing users to engage in spatial and embodied interpretation by overlaying historical content onto the built environment. This aligns with the conception of embodied interpretation practices where embodied engagement is essential for forming an understanding of the cultural past of a site [72].

The contrasting findings from these two studies underscore the significant impact that the choice of technology can have on users' physical engagement with heritage sites. While smartphones risk creating a barrier between the user and the environment, mobile projectors have the potential to bridge the digital and physical realms, encouraging a more embodied and spatially aware exploration of heritage sites.

8.1.2 RQ2: Inter-relationships between user, mobile guide, and heritage site

Studies 1 and 2 provided rich insights into the complex inter-relationships that emerge between users, mobile guides, and heritage sites during a heritage walk.

Study 1, focused on smartphone guides, revealed that the device often created a "bubble" effect, hindering the experience of presence and immersion that heritage walks are intended to provide [97, 217, 225]. Users frequently prioritized digital content over engaging with their physical and social surroundings, supporting previous findings about the isolating effects of smartphones during cultural experiences [160].

However, Study 1 also revealed an interesting phenomenon: some users appropriated the smartphone guide to engage playfully with the space, performing bodily actions like scanning their environment or capturing moments using the device as a scanner or camera. These actions reflected an active and reciprocal body-device-space relationship, albeit brief and difficult to sustain due to habitual smartphone use patterns [160].

This finding highlights the potential for creative use of smartphone guides, suggesting that with careful design, it might be possible to encourage more embodied and playful interactions even with screen-based devices. It raises questions about how we might design smartphone interfaces that explicitly encourage such playful, embodied engagement with the heritage environment.

Study 2, examining mobile projector guides, demonstrated a more dynamic and integrated relationship between user, device, and site. By allowing users to directly overlay historical images and digital content onto current structures, the technology supported an embodied and spatial practice of heritage interpretation [72]. This transformed static heritage sites into dynamic hybrid spaces for interaction, where users actively participated in the interpretive process through embodied movements [217].

The projector guides enhanced users' sense of presence, agency, and spatial understanding, evidenced by more frequent use of gestures such as scanning and pointing, and playful, imaginative ways of connecting digital and physical elements of the site. These actions can be interpreted as somatic modes of attention and exploration [51], integral to the embodied interpretative process [72].

The findings from Study 2 suggest that mobile projector guides have the potential to create a more seamless integration of digital content and physical space, fostering a deeper connection between the user and the heritage site. This raises intriguing possibilities for the future of heritage interpretation.

Both studies highlight the critical role that mobile guide devices play in mediating the relationship between the user and the heritage site. They suggest that the design of these guides can significantly influence the nature and quality of the heritage experience, underscoring the need for thoughtful, theoretically grounded approaches to mobile guide design.

8.1.3 RQ3: Impact on social experience

Study 3 provided valuable insights into how the use of mobile guides affects the social experience of users during heritage walks, revealing striking differences between smartphone and projector-based guides in this aspect.

The study found that smartphone guides often led to reduced environmental awareness and social interaction [115]. In group settings, device holders frequently became absorbed in the screen, leading to diminished agency and engagement for companions, who were often relegated to following the device holder. Information sharing was hindered by the small screen size [134], although strategies like reading aloud were adopted to overcome this challenge.

This finding highlights a significant challenge in the use of smartphone guides for group heritage experiences. The personal nature of smartphones, designed primarily for individual use, seems at odds with the social nature of many heritage

visits. This raises important questions about how we might design smartphone interfaces that better support group interactions and shared experiences.

Conversely, mobile projector guides demonstrated significant potential for enhancing group experiences. The shared display fostered group cohesion by creating a collective visual reference [20, 134]. All group members maintained a sense of agency, as they were able to influence the exploration process regardless of who held the device [147]. This laid the groundwork for enhanced collective experiences and collaborative embodied meaning-making.

The public-facing nature of projected displays often drew attention from passers-by, leading to spontaneous social interactions and shared experiences. While some users welcomed these interactions, others expressed discomfort due to the attention they attracted. This suggests that future designs of mobile guides should consider the diverse preferences of users when it comes to social engagement in public spaces.

These findings from Study 3 highlight the potential for mobile technologies to not only support but actively enhance the social dimensions of heritage experiences. They suggest that the choice of technology can significantly influence group dynamics and social interactions during heritage walks.

The study raises important questions about the design of mobile guides for group use. How can we create interfaces that encourage rather than hinder social interaction? How might we balance the benefits of shared displays with concerns about privacy and unwanted attention in public spaces? Can we develop adaptive interfaces that cater to different social preferences?

Furthermore, the findings point to the potential for mobile guides to facilitate not just within-group interactions, but also interactions with other visitors and even local communities. This opens up exciting possibilities for using mobile technologies to create more inclusive, community-oriented heritage experiences.

8.1.4 RQ4: User feelings, attitudes, and concerns

Studies 1, 2, and 3 collectively provided insights into the feelings, attitudes, and concerns evoked by mobile devices with different display modalities during heritage walks. This aspect of the research revealed nuanced user experiences and highlighted important considerations for future design.

Study 1 found that smartphone users often reported feeling isolated and detached from their surroundings, focusing more on their screens than on the people and activities around them [97]. Surprisingly, findings from Study 3 suggest that pairs using smartphones reported increased self-consciousness in public spaces, concerned about disrupting pedestrian flow.

These findings highlight the potential negative psychological impacts of smartphone use during heritage walks. They suggest that the convenience and familiarity of smartphones may come at the cost of a fully immersive and connected heritage experience.

Studies 2 and 3, which examined mobile projector guides, revealed more diverse and complex user feelings. While users experienced enhanced engagement with the site and their companions, some felt self-conscious about attracting public attention. Others viewed this attention positively, appreciating the novelty and potential for incidental sharing with bystanders. This highlights the need for designers to consider the social implications of using attention-grabbing technologies in public spaces.

These findings underscore the importance of considering not just the functional aspects of mobile guides, but also their emotional and social impacts. They suggest that the ideal mobile guide should not only provide information but also create positive feelings of engagement, connection, and even excitement or wonder.

Across all studies, users expressed concerns about balancing digital information consumption with direct experience of the heritage site. This reflects a broader tension in digital heritage between information delivery and experiential engagement [44].

The diverse user reactions also highlight the need for personalization in mobile guide design. What works well for one user may be uncomfortable or distracting for another.

8.1.5 RQ5: Designing mobile guides for embodied interpretation

Drawing on the findings from all three studies, several key design principles and considerations emerged for creating mobile guides that motivate and support embodied interpretation heritage practices in outdoor cultural heritage sites.

The concept of 'playful walking' emerged as a promising approach to designing mobile technology for embodied heritage interpretation practice in outdoor cultural heritage sites. This approach, particularly evident in the use of mobile projector guides in Study 2, harnesses play to shape visitors' intentionality towards the world, engaging their creativity and imagination, and prompting them to pay attention and engage with space through slow and environmentally attuned walking [2, 194].

To promote more deliberate and exploratory walking patterns, mobile guides should provide open-ended interaction that prompts physical exploration of the site and implement interactions that motivate users to discover hidden details or take alternative routes as observed in Study 2.

Mobile guides should be designed as extensions of the user's body, encouraging physical engagement with the site. Features that support gestures like scanning or pointing as interaction mechanisms could reinforce the connection between the body, digital content, and physical space. This principle was particularly successful in the mobile projector guides examined in Study 2.

Designs should encourage users to maintain awareness of their surroundings. In this thesis instead of achieving this through a prompt that reminds users to look up from the screen, it is suggested to make surroundings a more active part of

the interaction of the mobile guide. This may address the challenges of spatial disconnection observed with smartphone users in Study 1.

Mobile guides should be designed with features that support both individual exploration and social interaction. Shared displays, as seen in the projector guides in Study 3, can foster group cohesion and collaborative interpretation. However, Designers should be mindful of the potential social implications of using mobile guides in public spaces, particularly for attention-grabbing technologies like mobile projectors. Features that allow users to control their level of public visibility might be beneficial, addressing concerns raised by some users in Studies 2 and 3.

These design principles offer a framework for creating mobile guides that support embodied, spatial, and social engagement with heritage sites. They challenge designers to move beyond simple information delivery to create tools that enhance the overall heritage experience.

8.2 Reflections on methodological considerations

This study, while comprehensive in its approach, faced several limitations that are important to consider when interpreting its findings. These limitations stem from various aspects of the research design, methodology, and execution.

One significant limitation was the scope of the field study. The research was conducted in a single location - the High Street of Canterbury City, UK. While this site provided an authentic heritage experience and met several criteria for the study, it limits the generalizability of the findings to other types of heritage sites, particularly non-urban settings. The characteristics of an urban environment, such as its spatial arrangement and the density of points of interest, may not apply to rural or natural heritage sites. This specificity of the study site constrains the broader applicability of the results to diverse heritage contexts.

The number and nature of participants also present limitations. The study involved a total of 66 participants across three studies, which, while sufficient for

qualitative research, may not be representative of the broader population of heritage site visitors. Moreover, the participants (though seeking a heritage experience) were primarily university employees and students, not tourists.

The study also faced a gap in collecting some crucial data regarding participants' previous experiences. Information about participants' prior exposure to mobile technology or cultural heritage sites was not systematically gathered. This oversight limits the ability to contextualize user engagement and responses fully. Participants with varying levels of technological proficiency or prior heritage experience might have interacted with the mobile guide and the site differently, affecting the interpretation of the results.

The varying nature of the site across different walks introduces another layer of complexity. Factors such as crowd density, weather conditions, and street activities changed during each walk, making it impossible to maintain consistent environmental conditions across all participants' experiences. This variability could have influenced participants' behaviours and perceptions, potentially affecting the comparability of data across different sessions. However, this also added to the richness of the data. The patterns identified from different walks were influenced by varying conditions giving more validity to the patterns.

The decision to allow participants complete freedom during the walk while enhancing the naturalistic aspect of the study also introduced potential risks and limitations. There was a possibility that this approach led to inconsistencies in how participants engaged with the mobile guide and the heritage site, making it challenging to draw definitive conclusions about specific aspects of the user experience. However, this approach led to a rich data collection on the lived experience of the users.

Despite these limitations, the study employed several strategies to enhance the robustness of its findings. The use of multiple data collection methods - including video observations, interviews, and participant-produced drawings - allowed for data triangulation. This approach helped mitigate the limitations of individual methods and strengthened the credibility of the findings.

The researcher's careful consideration of the study design, including the selection of the site and the development of a custom mobile application, helped maintain some consistency across participant experiences. The detailed documentation of the research process and context also enhances the transferability of the findings to similar urban heritage settings.

Furthermore, the iterative coding process and the researcher's efforts to capture nuances in language and behaviour during data analysis helped to partially overcome the lack of background information on participants. This approach allowed for indirect insights into participants' technological comfort and familiarity with heritage experiences.

While the study faced several limitations, the researcher's awareness of these constraints and the strategies employed to address them contribute to the overall validity and value of the findings.

8.3 Avenues for future investigation

While this research has provided valuable insights into the use of mobile guides for heritage interpretation, it also opens up several promising avenues for future investigation.

Given that this study was conducted in a single urban location, future research should explore the applicability of these findings in diverse heritage contexts. This could include rural settings, natural heritage sites, and archaeological sites. Such studies would help determine whether the observed patterns of embodied engagement and social interaction are consistent across different types of heritage experiences.

While this study focused on immediate user experiences, future research could investigate the long-term impact of different mobile guide technologies on heritage understanding and appreciation. Longitudinal studies could explore how the

use of projector-based guides versus smartphone guides affects users' retention of information and their overall heritage experience.

This study highlights the importance of examining various prototypes to gain insight into how mobile guides affect user engagement and meaning-making. Future research could focus on further developing some of the prototypes discussed in this thesis and conducting field studies to assess their impact on the design of mobile guides that support embodied interpretation practices.

To enhance the generalizability of the findings, future research should conduct cross-cultural studies. This would help understand how cultural backgrounds influence the reception and use of different types of mobile guides, potentially revealing culturally specific patterns of embodied engagement and social interaction.

Building on the findings related to social interaction, future research could explore how mobile guides might be designed to foster deeper connections between visitors and local communities. This could involve developing features that facilitate interactions with local residents or incorporate local perspectives into the heritage narrative. By pursuing these avenues of investigation, researchers can build upon the findings of this study to further enhance the understanding of how mobile technologies can support embodied, engaging, and meaningful heritage experiences.

8.4 Closing Remarks

This research has illuminated the complex interplay between mobile guide technologies, user engagement, and heritage interpretation in urban settings. By comparing smartphone-based and projector-based mobile guides, the research has uncovered valuable insights into how different display modalities can significantly impact the embodied and social dimensions of heritage experiences.

The findings underscore the potential of mobile projector guides to foster more exploratory, playful, and socially engaged heritage walks. These guides seem to

bridge the digital and physical realms more effectively than their smartphone counterparts, encouraging users to interact with their surroundings in ways that align with the principles of embodied interpretation practices [51, 72]. This aligns with recent research on the importance of embodied experiences in cultural heritage contexts [44].

However, it is crucial to note that technology alone cannot guarantee an enriched heritage experience. The design of these guides must be carefully considered to balance information delivery with experiential engagement, a challenge that has been noted in previous digital heritage research [160]. The findings suggest that the concept of 'playful walking' [2, 194] could be a fruitful approach to achieving this balance, encouraging users to engage more deeply with their surroundings while accessing digital content.

The social dimensions of heritage experiences, often overlooked in mobile guide design, emerged as a critical factor in this research. The ability of projector-based guides to foster group cohesion and spontaneous social interactions points to exciting possibilities for creating more inclusive, community-oriented heritage experiences. This aligns with recent calls in the field for more socially engaged approaches to digital heritage.

Yet, the limitations of the study must also be acknowledged. Conducted in a single urban location with a specific demographic, the findings may not be universally applicable across all heritage contexts. Future research should explore these concepts in diverse settings and with varied user groups to build a more comprehensive understanding of mobile guide use in heritage interpretation.

The future of mobile guides in heritage contexts lies not just in their ability to deliver information, but in their capacity to shape how users physically and socially engage with heritage sites. The challenge for designers and heritage professionals will be to create tools that enhance rather than distract from the direct experience of place, fostering a sense of presence and connection that is at the heart of meaningful heritage interpretation [216].

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Appendix A

Study 1 and Study 2: Semi-structured Interview Schedule

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

Opening remarks: Thank you for agreeing to give this interview. During the interview, we will mostly discuss your experience of the heritage walk. Most of my questions will be about your experience, your feelings, and your thoughts during the walk. Kindly answer the questions with reference to the heritage walk that you undertook. The interview would last between 30 - 35 minutes. Feel free to ask me to clarify if required. I will be audio recording the interview. If you have any questions or suggestions, we can take them at the end.

Interview Schedule

Q.1 So could you describe what were you doing during the walk or the activity?

Q.2 How were you feeling during the walk?

Q.3 What were you thinking during the walk? What was going through your mind?

Q.4 Would you say that you were engaged or distracted during the walk?

Q.5 What was your immediate thought or reaction when information popped up?

Q.6 How do you feel about walking with this device in your hand? Did you feel that it affected the pace at which you were walking?

Q.7 How did you feel about looking at the information in this way on the screen?

or

Q.7 How did you feel about looking at the information in this way-projected in your surroundings?

Q8. How did you feel about the way you were using the device?

Q9. **Drawing Activity:** Try to recall a moment that you found interesting or significant during the walk. Make a sketch of that moment or situation with yourself at that moment. You are not required to make an exact or perfect drawing but just a representation of that movement. You can take 4 to 5 minutes to do this.

Materials provided: 12 colour pens and A3 paper.

After the drawing is complete: I would ask you, some questions related to the drawing. Please feel free to annotate your drawing with the response to the question.

Q.9a A thought that was going through your mind at this point.

Q.9b if you can recall, the expression on your face at that point of time, what was the expression on your face or eyes at that moment?

Q.9b What were you feeling emotionally in your heart at that point?

Q.9c Were you tired or feeling comfortable at that point?

Q.9d What did you think about the device at that point?

Q.9e How did you feel about your surroundings at this point?

Q.10 Where did you find yourself looking most of the time during the walk?

Q.11 [For smartphone users] Could you describe, how using the smartphone affected your experience or awareness of your surroundings?

Or

Q.11 [For mobile projector users] Could you describe, how using the projector affected your experience or awareness of your surroundings?

Q.12 [Only for mobile projector users] So while you were walking you were constantly projecting on the environment. Did you feel that because you were projecting in the street, it affected your perception of the ambience of the street in any way?

Q.13 You received location-aware information during the walk. Could you describe the relationship you perceived or experienced between the digital information and the physical environment or POI during the walk?

Was it separate? Integrated/intertwined? Or it felt like an add-on over the physical environment?

Q.14 Did you find the notification in sync or out of sync with the physical location of the POI?

Q.15 How did you feel about the content? What did you feel about the quantity and quality of the information?

Q.16 How was your experience of looking at and reading the information?

Q.17 How would you describe the effect using this device and application for the walk had on your relationship with the street?

Did it connect you with the street in some way? Or it made you explore the street? Or did you feel that it helped you to interact with the street in a certain way?

Q.18 How did you feel about the high street after this walk?

Q.19 How did you feel about walking with and using this device in a public space like this street?

Q.20 How was your social experience during the work? Were there any social encounters that happened during the walk?

Q.21 [Only for projector users] Did you feel that using the projectors affected the situation or dynamics on the street in any way?

Q.22 Can you describe your overall experience of the walk?

Q. 21 What do you think might discourage people from using something like this?

So those are all the questions from me. But if you have any other thoughts to share or questions or suggestions, that you would want to share with me or ask me, feel free to do so.

Appendix B

Study 1 and Study 2: Informed Consent Form

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

Name of the researcher: Mayank Loonker

Participant Identification Number:

1. Taking part in the study

I have read and understood the information sheet. I have had the opportunity to ask questions and have had these answered satisfactorily.

Yes : No

I consent voluntarily to be a participant in this study and understand that I can withdraw at any time up to 1 month after the end of data collection without giving any reason. Contact Mayank Loonker at : ml604@kent.ac.uk

Yes : No

I understand that taking part in the study involves a questionnaire survey, video-recorded walking activity, device-tracked app usage, audio-recorded interviews, and drawing. I consent to take part in this study

Yes : No

I confirm that I am currently healthy and will not have any problems with the walking activity in this project.

Yes : No

2. Use of the information in the study

I understand that information I provide will be used for research outputs like the doctoral thesis, journals, conferences, publications, reports, website, video channels etc.

Yes : No

I understand that personal information collected about me that can identify me, such as my name or contact details, will not be shared beyond the study team.

Yes : No

I consent to the use of my anonymised direct quotes for dissemination in various research outputs.

Yes : No

I consent to the use of non-anonymised stills or video clips derived from my video data (including facial images) in various research outputs. I understand that this may mean that a picture of my face may appear on screen or in print, and may appear online.

Yes : No

I understand that if my facial image derived from this video is used in this way, NO other information which may link my facial image directly to my personal information will be attached

Yes : No

I agree to the joint copyright of my recorded materials related to this project to Mayank Loonker.

Yes : No

3. Future use and reuse of the information by others

I give permission for the anonymised transcript of audio recorded data, drawings, questionnaire survey, non-anonymised video recordings and the app usage data that I provide to be deposited and archived on a web-based repository at the University of Kent so it can be used for future research and learning.

Yes : No

Name of the participant [IN CAPITALS]:

Signature:

Date:

Name of the researcher [IN CAPITALS]:

Signature:

Date:

To be signed and dated in presence of the participant

Appendix C

General instructions for walking activity

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

The purpose of the study is to study the influence of using this device on your exploration of the street during the heritage walk. As a participant in this study, please follow the instructions below before you begin.

During the activity, You are required to walk from here to the West-gate tower while using the device.

There is no time limit for the activity. You may walk as you wish to.

During the walk, the researcher will follow you to record the activity. However, the researcher will maintain a distance of 3 to 5 meters at all times.

It is strongly recommended to only use the given device while walking on the predefined site.

Stay aware of your surroundings and be careful of uneven pavement, street bollards, incoming pedestrians, mobility scooters, wheelchair users, bicycles, occasional vehicles, etc.

Refrain from projecting onto the faces of other people in your surroundings.

While walking and using the devices, it may happen that the passers-by or bystanders may observe you, or/and approach or/and engage with you. In such an event continue with the activity as you were. If the passers-by show a willingness to engage in the activity, kindly accommodate them if you are comfortable.

If you come across an acquaintance, friend or family member, it will be OK to engage in a short conversation as long as you are able to continue the walk and activity.

After you finish the walk we will go to a nearby cafe for a post-walk interview.

The whole activity will take up to 90 minutes

Appendix D

Study 3: Semi-structured Interview Schedule

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

Opening remarks: Thank you for agreeing to give this interview. During the interview, we will mostly discuss your experience of the heritage walk. Most of my questions will be about your experience, your feelings, and your thoughts during the walk. Kindly answer the questions with reference to the heritage walk that you undertook. The interview would last between 15 - 20 minutes. Feel free to ask me to clarify if required. I will be audio recording the interview. If you have any questions or suggestions, we can take them at the end.

Interview Schedule

Q.1 Could you all describe some of the key moments of the walk?

Q.2 What were you all thinking during the walk? What was going through your mind?

Q.3 [To the person holding the device during the walk] Could you describe if you noticed any effects on your behaviour while you were holding the device?

Were you thinking about the group while you were holding the device?

Q.4 Could you all describe if you felt any effects of using this device on the group's dynamics or interaction within the group??

Q.5 Could you all describe some of the conversations that you had during the walk among the group?

Q.6 How did you all feel about using this device in a public space?

Q.7 Could you all describe if using this device had any effects on how you experienced the heritage sites?

Q.8 Could you describe any benefits of using this device for the group heritage walk?

Q.9 How would you describe your overall experience of the heritage walk?

Q.10 What would you change about this device to improve the experience?

Before we conclude, would you like to share any other thoughts or ask any questions?

Appendix E

Study 3: Pre-walk Questionnaire for Mobile projector Users

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

Participant Identification Number:

Date: / /

1. Age Group: 18- 24 25-29 30-35
2. Gender:
2. I have lived in Canterbury for ___months/years (cross out what is not relevant)
3. Have you used a portable projector in past? Yes: No
4. We are friends/family (cross out what is not relevant)
5. Describe briefly, what you are looking forward to during today's walk
6. I am comfortable among strangers

Completely disagree -3 -2 -1 0 1 2 3 completely agree

7. Excessive use of the smartphone is inappropriate in public spaces

Completely disagree -3 -2 -1 0 1 2 3 completely agree

8. It is difficult to show and share information with nearby people using a smart-phone

Completely disagree -3 -2 -1 0 1 2 3 completely agree

9. Use of projected displays during the heritage walk will violate my privacy

Completely disagree -3 -2 -1 0 1 2 3 completely agree

10. Using handheld projected displays during the heritage walk may violate the privacy of passers-by

Completely disagree -3 -2 -1 0 1 2 3 completely agree

11. Using handheld projected displays during the heritage walk may disturb passers-by

Completely disagree -3 -2 -1 0 1 2 3 completely agree

12. Use of projected displays may be advantageous for the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

13. Handheld projected displays will be interesting to use

Completely disagree -3 -2 -1 0 1 2 3 completely agree

14. Use of projected displays during the heritage walk will be beneficial for others around me

Completely disagree -3 -2 -1 0 1 2 3 completely agree

15. Use of projected displays during the heritage walk will improve our group experience

Completely disagree -3 -2 -1 0 1 2 3 completely agree

16. List any other effects that you expect using this device might create or have during the walk. Describe briefly, how do you feel about that?

Appendix F

Study 3: Pre-walk Questionnaire for Smartphone Users

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

Participant Identification Number:

Date: / /

1. Age Group: 18- 24 25-29 30-35
2. Gender:
2. I have lived in Canterbury for ___months/years (cross out what is not relevant)
3. Have you used a portable projector in past? Yes : No
4. We are friends/family (cross out what is not relevant)
5. Describe briefly, what you are looking forward to during today's walk
6. I am comfortable among strangers

Completely disagree -3 -2 -1 0 1 2 3 completely agree

7. Excessive use of the smartphone is inappropriate in public spaces

Completely disagree -3 -2 -1 0 1 2 3 completely agree

8. It is difficult to show and share information with nearby people using a smartphone

Completely disagree -3 -2 -1 0 1 2 3 completely agree

9. I will be comfortable using a smartphone during the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

10. Using a smartphone might be distracting during the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

11. Use of a smartphone-based mobile guide may be advantageous for the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

12. A smartphone-based mobile guide will be interesting to use during the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

13. Use of a mobile guide during the heritage walk will hinder our group experience

Completely disagree -3 -2 -1 0 1 2 3 completely agree

14. List any other effects that you expect using this device might create or have during the walk. Describe briefly, how do you feel about that?

Appendix G

Study 3: Post-walk Questionnaire for Mobile projector Users

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

1. Have you taken any heritage walks or pedestrian city tours in the past?
Yes No

2. What did you use to navigate and learn new information back then?

Tourist map Mobile app Tour guide if others, please describe:.....

3. If you were in a group back then, how did that affect your group experience?

Today during the heritage walk today I was most interested in:

- Looking for interesting things
- Interacting with and facilitating the experience of group-mates
- Focusing only on the key heritage sites
- Appreciating and enjoying the environment
- If others, please describe:.....

5. The use of the projected display during the heritage walk violated my privacy

Completely disagree -3 -2 -1 0 1 2 3 completely agree

6. Using a handheld projected display during the heritage walk violated the privacy of passers-by

Completely disagree -3 -2 -1 0 1 2 3 completely agree

7. Using a projected display during the heritage walk disturbed passers-by

Completely disagree -3 -2 -1 0 1 2 3 completely agree

8. The use of the projected display was beneficial for the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

9. The handheld projected display was enjoyable to use

Completely disagree -3 -2 -1 0 1 2 3 completely agree

10. Using the projected display during the heritage walk was beneficial for others around me

Completely disagree -3 -2 -1 0 1 2 3 completely agree

11. The handheld projected display was easy to use during the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

12. The handheld projected display was comfortable to use during the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

13. The use of a projected display made the heritage walk enjoyable

Completely disagree -3 -2 -1 0 1 2 3 completely agree

14. The handheld projected display was practical to use

Completely disagree -3 -2 -1 0 1 2 3 completely agree

15. I felt awkward while holding the projected display

Completely disagree -3 -2 -1 0 1 2 3 completely agree

16. The use of the projected display motivated me to share the information

Completely disagree -3 -2 -1 0 1 2 3 completely agree

17. The use of the projected display motivated me to explore

Completely disagree -3 -2 -1 0 1 2 3 completely agree

18. The use of the projected display motivated me to be playful

Completely disagree -3 -2 -1 0 1 2 3 completely agree

19. Using the projected display added value to my experience of the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

20. I was more self-aware of my activities while using the projected display

Completely disagree -3 -2 -1 0 1 2 3 completely agree

21. I felt I was in control during the activity

Completely disagree -3 -2 -1 0 1 2 3 completely agree

22. I felt frustrated during the activity

Completely disagree -3 -2 -1 0 1 2 3 completely agree

23. The information presented was interesting

Completely disagree -3 -2 -1 0 1 2 3 completely agree

24. The clarity of the display was good

Completely disagree -3 -2 -1 0 1 2 3 completely agree

25. The brightness of the display was good

Completely disagree -3 -2 -1 0 1 2 3 completely agree

26. Would you like to use this device in the future? Yes : No

27. Please describe your reasons for the answer to Q.20

Appendix H

Study 3: Post-walk Questionnaire for Smartphone Users

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

1. Have you taken any heritage walks or pedestrian city tours in the past?
Yes No

2. What did you use to navigate and learn new information back then?

Tourist map Mobile app Tour guide if others, please describe:.....

3. If you were in a group back then, how did that affect your group experience?

Today during the heritage walk today I was most interested in:

- o Looking for interesting things
- o Interacting with and facilitating the experience of group-mates
- o Focusing only on the key heritage sites
- o Appreciating and enjoying the environment
- o If others, please describe:.....

5. Using a smartphone during the heritage walk disturbed passers-by

Completely disagree -3 -2 -1 0 1 2 3 completely agree

6. The use of the mobile guide was beneficial for the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

7. The use of the mobile guide improved our group experience

Completely disagree -3 -2 -1 0 1 2 3 completely agree

8. The handheld mobile guide was enjoyable to use

Completely disagree -3 -2 -1 0 1 2 3 completely agree

9. Using the mobile guide during the heritage walk was beneficial for others around me

Completely disagree -3 -2 -1 0 1 2 3 completely agree

10. The handheld mobile guide was easy to use during the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

11. The handheld mobile guide was comfortable to use during the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

12. The use of a mobile guide made the heritage walk enjoyable

Completely disagree -3 -2 -1 0 1 2 3 completely agree

13. The use of the mobile guide made our group cohesive

Completely disagree -3 -2 -1 0 1 2 3 completely agree

14. The handheld mobile guide was practical to use

Completely disagree -3 -2 -1 0 1 2 3 completely agree

15. I felt awkward while holding the mobile guide

Completely disagree -3 -2 -1 0 1 2 3 completely agree

16. The use of the mobile guide motivated me to share the information

Completely disagree -3 -2 -1 0 1 2 3 completely agree

17. The use of the mobile guide motivated me to explore

Completely disagree -3 -2 -1 0 1 2 3 completely agree

18. The use of the mobile guide led to interesting discussions within the group

Completely disagree -3 -2 -1 0 1 2 3 completely agree

19. The use of the mobile guide motivated me to be playful

Completely disagree -3 -2 -1 0 1 2 3 completely agree

20. Using the mobile guide added value to my experience of the heritage walk

Completely disagree -3 -2 -1 0 1 2 3 completely agree

21. I was more self-aware of my activities while using the mobile guide

Completely disagree -3 -2 -1 0 1 2 3 completely agree

22. I felt I was in control during the activity

Completely disagree -3 -2 -1 0 1 2 3 completely agree

23. I felt frustrated during the activity

Completely disagree -3 -2 -1 0 1 2 3 completely agree

24. The information presented was interesting

Completely disagree -3 -2 -1 0 1 2 3 completely agree

25. The clarity of the display was good

Completely disagree -3 -2 -1 0 1 2 3 completely agree

26. The brightness of the display was good

Completely disagree -3 -2 -1 0 1 2 3 completely agree

27. Would you like to use this device in the future? Yes : No

28. Please describe your reasons for the answer to Q.7 and Q.18

Appendix I

Ten Item Personality Measure

Participant Identification Number:

Date: / /

Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other. 4

Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly
1	2	3	4	5	6	7

I see myself as:

1. Extraverted, enthusiastic.
2. Critical, quarrelsome.
3. Dependable, self-disciplined.
4. Anxious, easily upset.

5. Open to new experiences, complex.
6. Reserved, quiet.
7. Sympathetic, warm.
8. Disorganized, careless.
9. Calm, emotionally stable.
10. Conventional, uncreative.

Appendix J

Study 3: Informed Consent Form

Study of Smartphone and Mobile Projector for Heritage Walks in Public Spaces

Name of the researcher: Mayank Loonker

Participant Identification Number:

Please tick the appropriate boxes

1. Taking part in the study I have read and understood the information sheet. I have had the opportunity to ask questions and have had these answered satisfactorily.

Yes : No

I understand that I can withdraw at any time after the end of data collection without giving any reason. I understand that it will not be possible to fully remove my data from papers under review or accepted papers. Contact Mayank Loonker at: ml604@kent.ac.uk

Yes : No

I understand that taking part in the study involves questionnaire surveys, video-recorded walking activity (including facial images), location tracking, audio-recorded

interviews, and an experience map. I consent to take part in this study and provide the data including video recorded with facial images.

Yes : No

I understand the risk involved in walking outdoors. I confirm that I am currently healthy and will not have any problems with the walking activity in this study.

Yes : No

2. Use of the information in the study I understand that personal information collected about me that can identify me, such as my name or contact details, will not be shared beyond the study team.

Yes : No

I consent to the use of my anonymised direct quotes for dissemination in various research outputs like the doctoral thesis, journals, conferences, publications, reports, websites, video channels, etc.

Yes : No

I consent to the analysis of non-anonymised video data with facial images.

Yes : No

I consent to the use of non-anonymised stills and video clips extracted from my video data (including facial images) for dissemination in various research outputs like the doctoral thesis, journals, conferences, publications, reports, websites, video channels, etc. I understand that this may mean that a picture of my face may appear in print and may appear online.

Yes : No

I understand that my facial images may be released in the public domain. I understand that if my facial image is used for research dissemination, NO other information which may link my facial image directly to my other personal information will be attached.

Yes : No

I agree to transfer the copyright of my recorded materials related to this project to the University of Kent, represented by the research team. I understand that the research team will retain non-anonymised video recordings for up to 3 years after the data collection.

Yes : No

3. Release of research dataset publically I give permission for depositing and archiving anonymised transcripts of audio-recorded data, experience maps, and questionnaire surveys, on the University of Kent's web-based repository to be accessed by the larger research community and for future research.

Yes : No

Name of the participant [IN CAPITALS]:

Signature:

Date:

Name of the researcher [IN CAPITALS]:

Signature:

Date:

To be signed and dated in presence of the participant